

# Water Quality Standards

What's coming up for lakes?

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WI Lakes Convention

April 7, 2017



# Water Quality Standards

1. Designated Uses
2. Water Quality Criteria
3. Antidegradation



# Designated Uses

**Fish & Aquatic Life**



**Wildlife**



**Public Health & Welfare**



**Recreation**



# New criteria based on biology for protecting lakes' Designated Uses

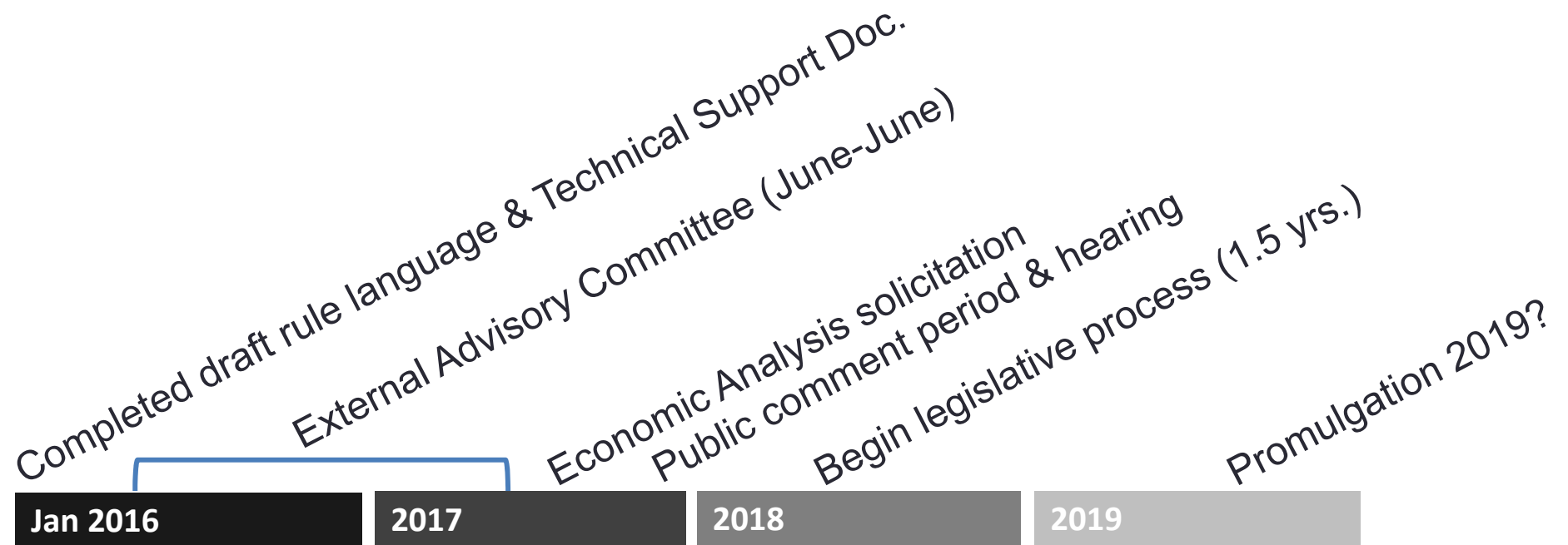


## Today's Topics:

1. Aquatic Plant “biocriteria”
2. Algae metrics:
  - Chlorophyll concentrations
  - Nuisance algal blooms
3. Two-Story Fisheries:  
Oxythermal Habitat criteria



# Rule Revision Timeline



1. Designated Uses
2. Biocriteria & Phosphorus Response Criteria
3. Site-specific criteria for phosphorus

} Moving concurrently



# Aquatic Plant Biocriteria for Lakes & Reservoirs

*“A macrophyte bioassessment  
approach for north temperate lakes”*  
In review: Journal of Envmtl. Mgmt.

**Ali Mikulyuk**

Martha Barton

Jennifer Hauxwell

Katie Hein

Ellen Kujawa

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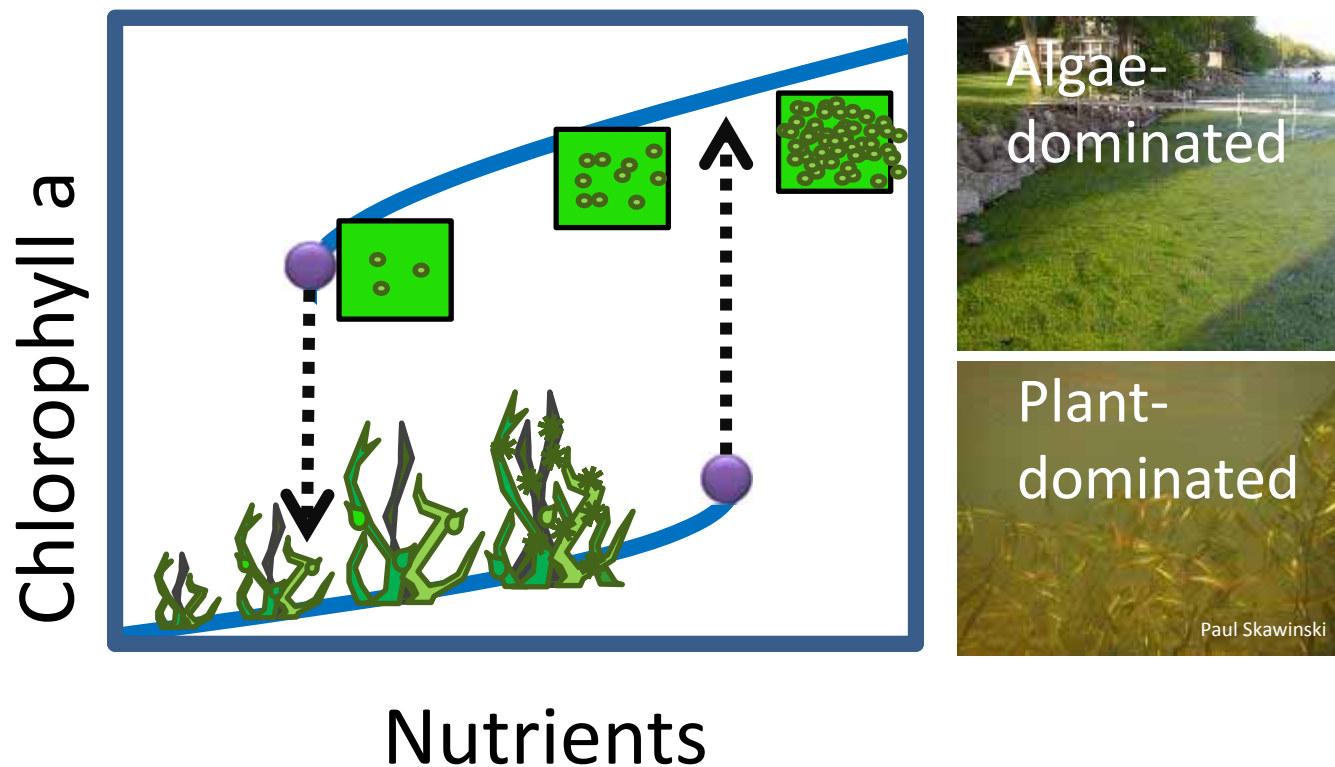
Michelle Nault

Daniel Oele

Kelly Wagner

# Why aquatic plants?

- More than 10 years of research
- Widespread & common
- Respond to human disturbances
- Sensitive to nutrients



# Proposed Aquatic Plant Biocriteria

Lake Type	Not Attaining	Biocriteria	Excellent
Northern Seepage	Moderate $\geq 69\%$	Moderate $< 69\%$ & Tolerant $> 1\%$	Moderate $< 69\%$ & Tolerant $\leq 1\%$
Northern Drainage	Sensitive $< 42\%$ & Moderate $< 83\%$	Sensitive $< 42\%$ & Moderate $\geq 83\%$	Sensitive $\geq 42\%$
Southern Seepage	Tolerant $\geq 49\%$ & Moderate $\leq 42\%$	Tolerant $\geq 49\%$ & Moderate $> 42\%$	Tolerant $< 49\%$
Southern Drainage	Tolerant $\geq 28\%$	Tolerant $< 28\%$	--

Not attaining: More tolerant species

Excellent: More sensitive species





# Steps to Developing Lake Plant Biocriteria

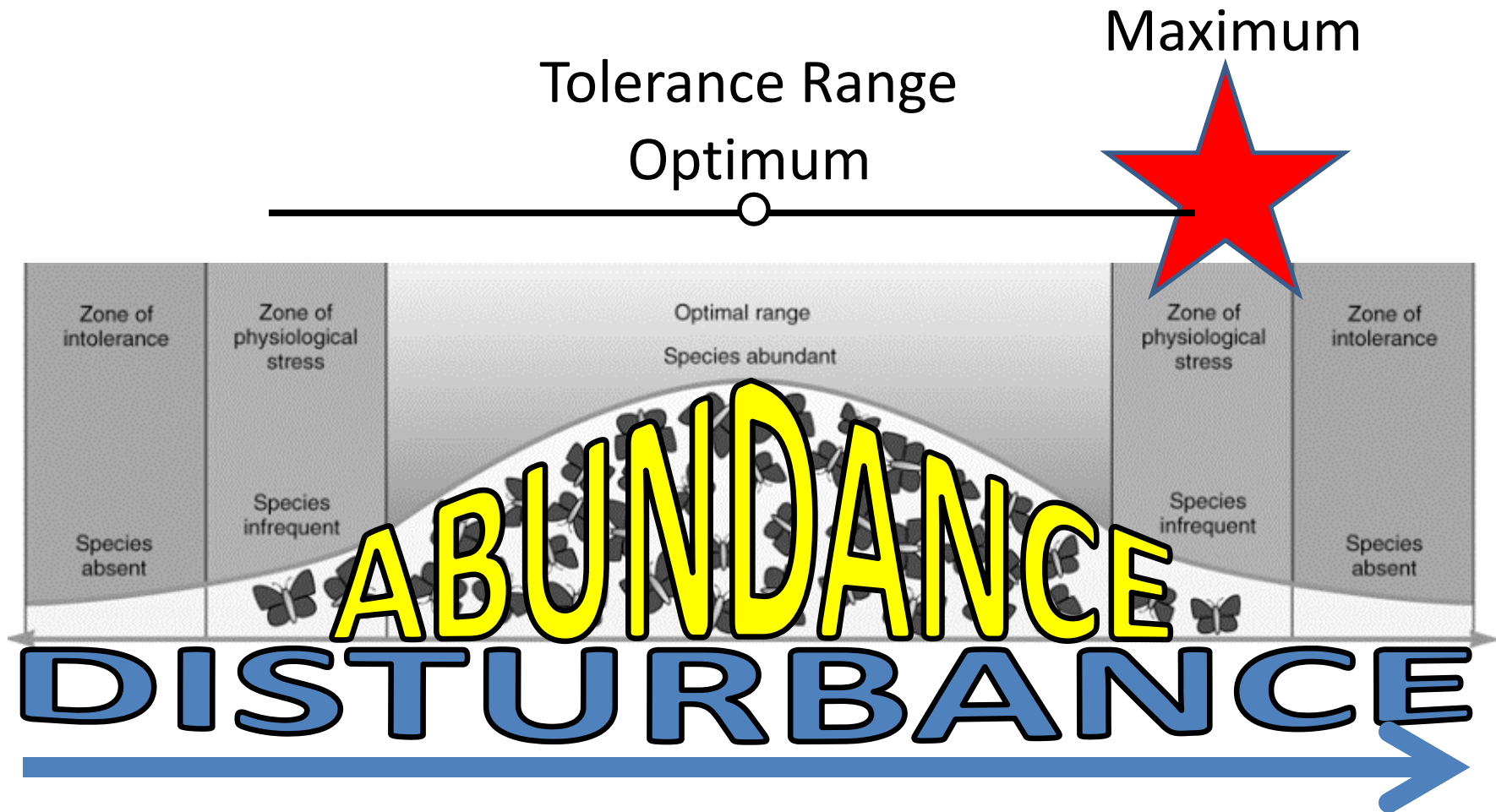
1. Disturbance Index for lakes
2. Plant tolerance groups
3. Biocriteria for each lake type

# Lake Disturbance Index

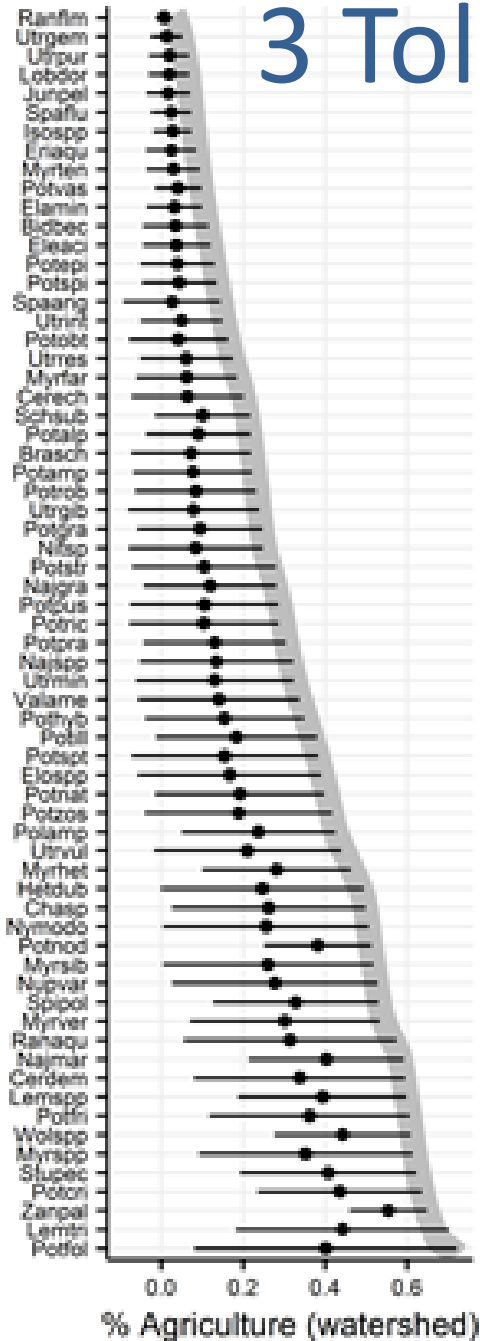
- Population
  - Population density
  - House density
  - Road density
- Runoff and Nutrients
  - Conductivity
  - Total Phosphorus
  - Chlorophyll *a*
  - Water clarity
- Land Use
  - Urban, Grassland, Pasture, Cropland
    - 500 meter buffer around the lake
    - Upstream watershed

1 = least disturbed  
10 = most disturbed

# Determine each plant species' tolerance



# 3 Tolerance Groups for 59 Species



## Sensitive

- Many rosettes
- Small, short
- Require water clarity
- Low biomass



## Moderate

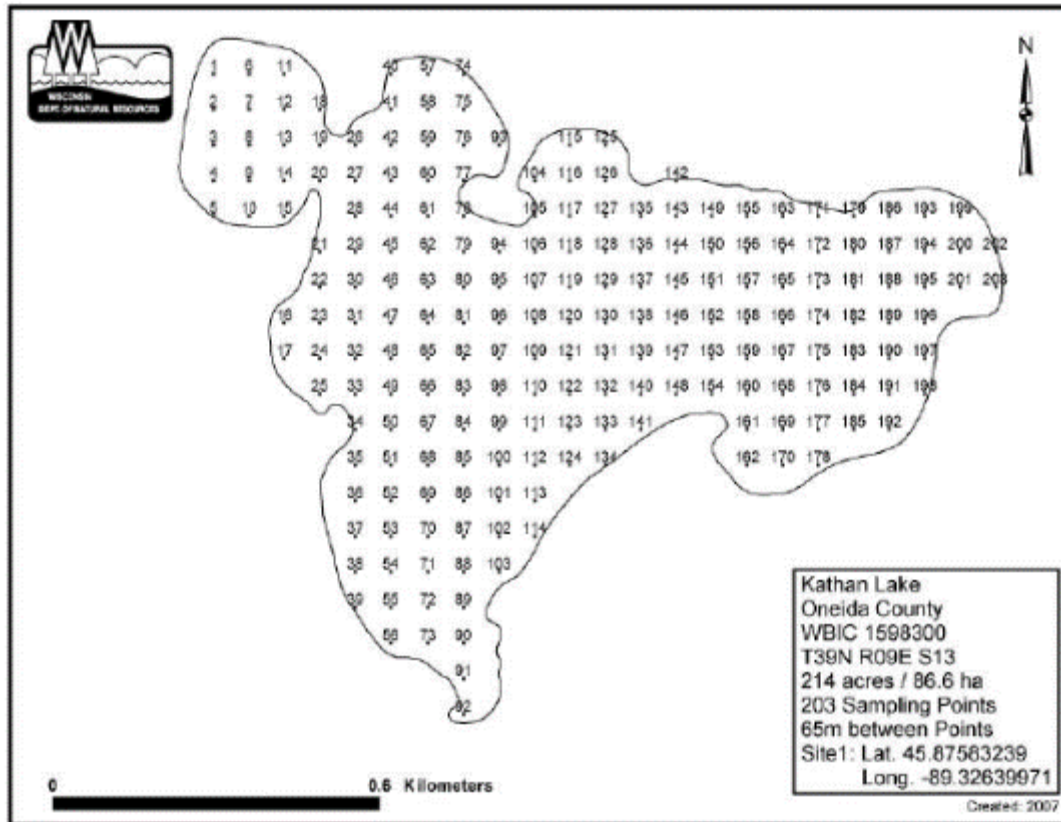
- Many pondweeds
- Floating-leaf or submersed species
- Prefer intermediate clarity/enrichment



## Tolerant

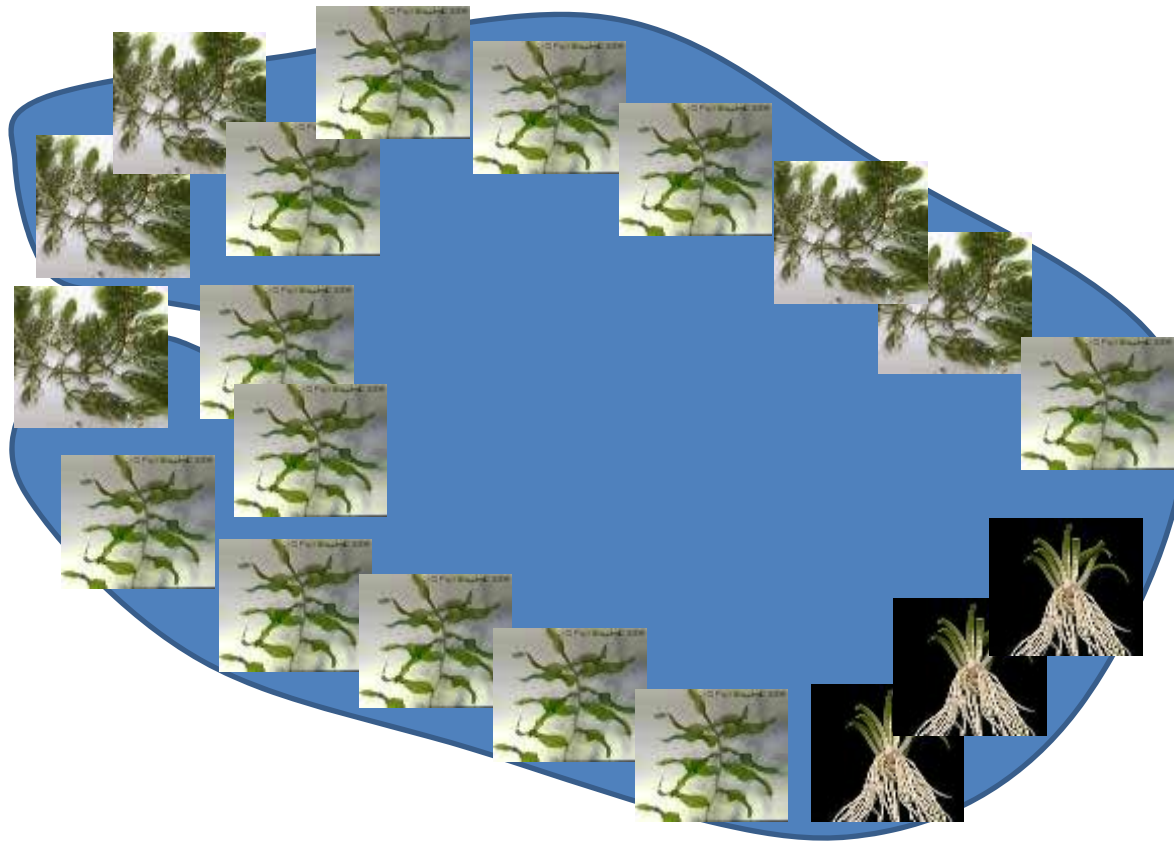
- Free-floating or tall & dense with fine leaves
- Not light-limited
- High biomass
- Ubiquitous

# Plant Survey





# Calculate percent cover of each tolerance group



Sensitive:  
15 %



Moderate:  
60 %

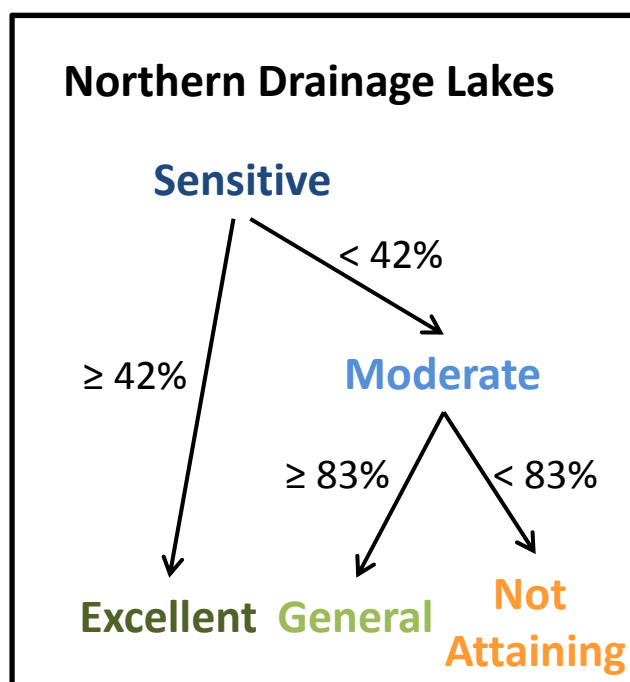


Tolerant:  
25 %



# Proposed Plant Biocriteria Metric

Grouped lakes with similar disturbance levels together



1. Northern **Seepage** Lake
2. Northern **Drainage** Lake
3. Southern **Seepage** Lake
4. Southern **Drainage** Lake

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Southern Drainage	Tolerant $\geq 28\%$	Tolerant $< 28\%$	--

Not attaining: More tolerant species

Excellent: More sensitive species

# Aquatic Plant Phosphorus Response Criteria

Lake Type	Phosphorus Response Criteria
Northern Seepage	Sensitive > 90%
Southern Seepage	Sensitive > 75%
All Drainage	Sensitive > 69%

- Developed using the same methods as plant biocriteria
  - Used species most sensitive to phosphorus instead of those most sensitive to broader disturbance (multiple factors)
- 



## Algal metrics

- Chlorophyll a conc.
- Nuisance algal bloom frequency



# Why Algae (Chlorophyll *a*)?

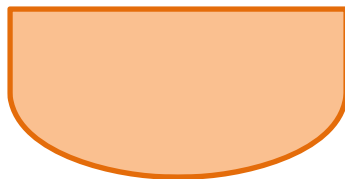
- Sensitive to phosphorus
- Impacts aquatic life and recreation
- Used to develop phosphorus criteria
- Used for assessment since 2012



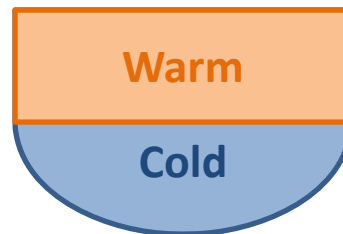
# Proposed Algae Criteria

Lake Type	Recreation Use	Aquatic Life Use
Unstratified	< 30% of days with nuisance algal bloom	$\geq 27$ ug/L
Stratified	< 5% of days with nuisance algal bloom	$\geq 10$ ug/L
Two-Story Fishery		

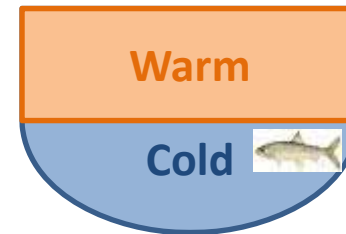
Unstratified  
(Shallow)



Stratified  
(Deep)



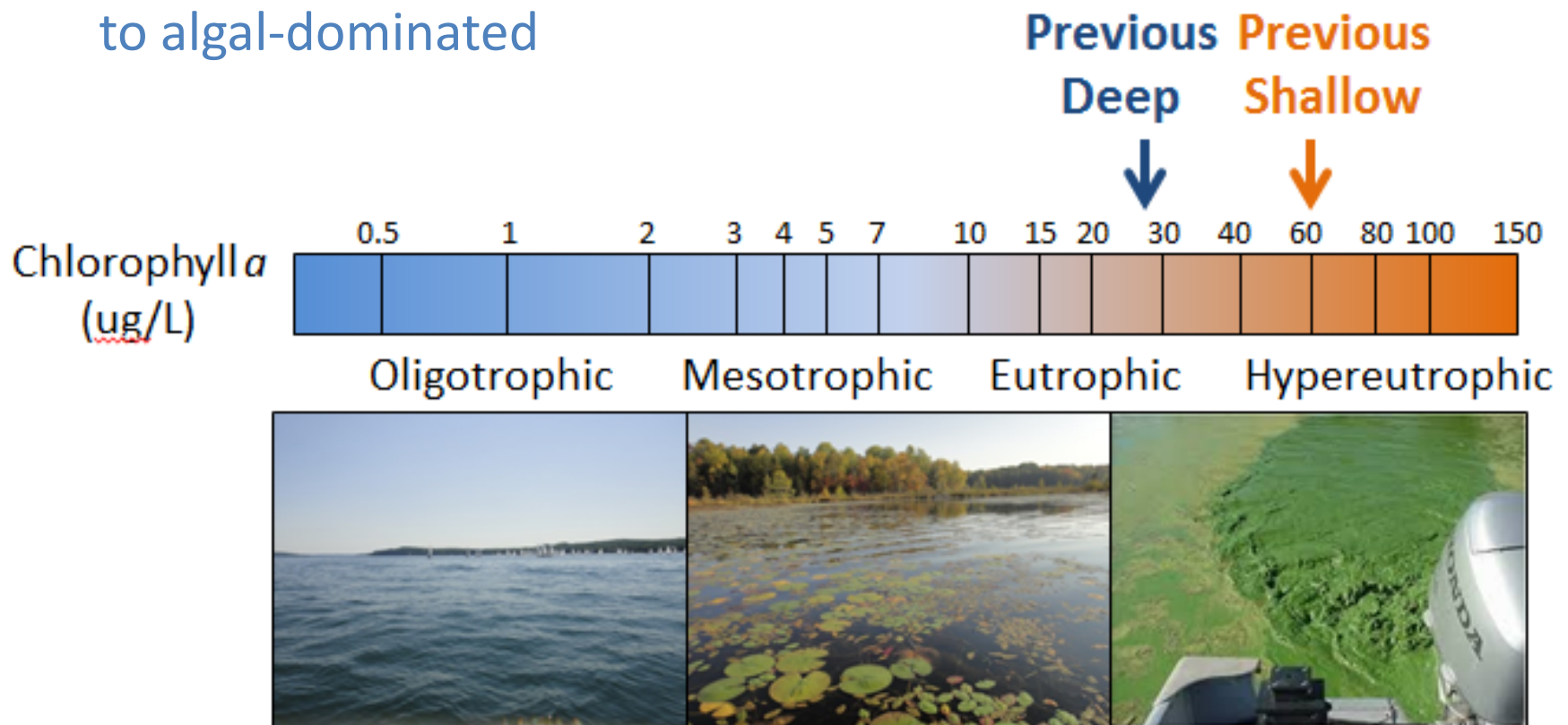
Two-Story  
Fishery



# Adjusting previous Aquatic Life thresholds

Algal abundance (chlorophyll a concentration)

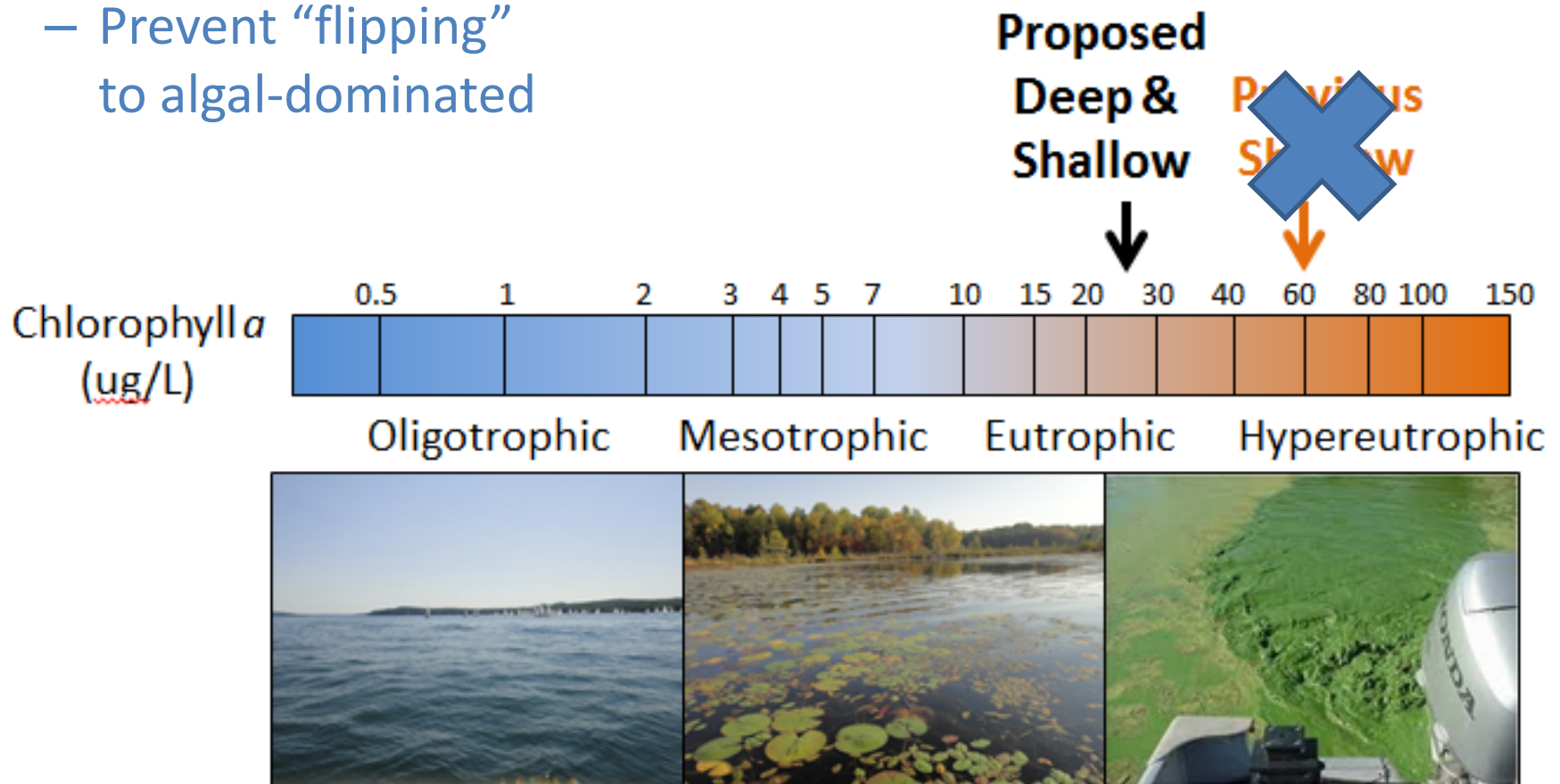
- Set at high end of eutrophic, BEFORE turns hypereutrophic
  - Prevent “flipping”  
to algal-dominated



# Adjusting previous Aquatic Life thresholds

Algal abundance (chlorophyll a concentration)

- Set at high end of eutrophic, BEFORE turns hypereutrophic
  - Prevent “flipping” to algal-dominated



# Recreation: Frequency of Nuisance Algal Blooms

Lake Type	Recreation Use	Aquatic Life Use
Unstratified	< 30% of days with nuisance algal bloom	$\geq 27$ ug/L
Stratified	< 5% of days with nuisance algal bloom	
Two-Story Fishery	< 5% of days with nuisance algal bloom	$\geq 10$ ug/L



Photo: Melvin McCartney, Lake Monona, June 2006



# Defining “Nuisance” blooms



- Goal: Protect primary contact recreation (swimming)
- Previous literature (1980s): “Nuisance” = 20 ug/L chl a
  - “Nuisance” blooms → “Severe” blooms → “Very severe” blooms
- Citizen lake monitoring network → thousands of chlorophyll samples and corresponding user perception ratings of water quality (2002-2016)
- At different chlorophyll concentrations, how do Wisconsin users rate their experience? Is 20 ug/L appropriate? Statistical analysis...

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## Observations:

### Perception

1=Beautiful, could not be any nicer

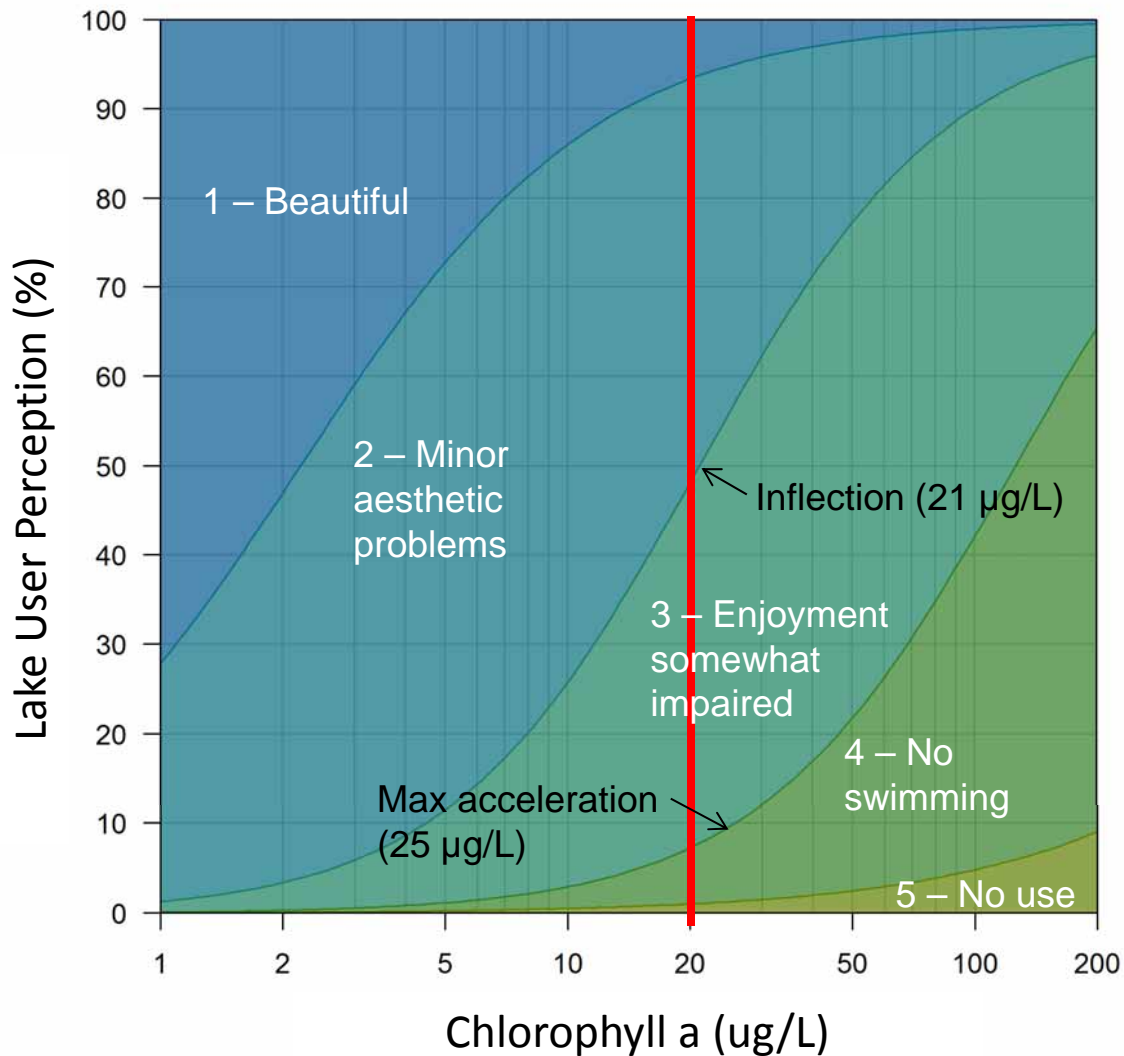
2=Very minor aesthetic problems; excellent for swimming and boating enjoyment

3=Swimming and aesthetic enjoyment of lake slightly impaired because of high algae levels

4=Desire to swim & level of enjoyment of lake substantially reduced because of algae; would not swim, but boating OK

5=Swimming and aesthetic enjoyment of lake substantially reduced because of algae levels

# Defining “Nuisance” algal blooms



20  $\mu\text{g/L}$  is appropriate for “Nuisance” blooms in WI:

Half of lake users perceive some impairment to their enjoyment & recreation due to high algae levels, and some would not swim.

# Selecting frequency of nuisance blooms

- Deep Lakes: 5% summer days is the goal stated in P Tech. Supp. Doc.
- Shallow Lakes:
  - No goal specified in P Rule
  - WisCALM used 30% of summer days
  - Ran independent analysis of shallow reference lakes
    - 75% of reference shallow lakes have nuisance blooms less than 30% of the time
    - Kept frequency at 30%; setting it lower might create unrealistic expectations
  - At this level, “severe” or “very severe” blooms are low (1-7% of days)



# Additions/removals of impaired waters

## Lakes (~600 sites assessed)

- Plant biocriteria (new):
  - ~60 lakes would be listed as impaired for plants
    - Only 23 of these not already listed for algae or P
- Plant phosphorus response indicator (new):
  - ~8 lakes exceed P criteria but have good scores on aquatic plant P indicator
- Algal metrics (codifying previous guidance):
  - Number of impaired waters stays the same
  - There are ~160 already listed for algal metrics



Big Green Lake



# Two-Story Fishery Lakes: Oxythermal Habitat Criteria

*“Evaluation of oxythermal metrics and benchmarks for the protection of cisco (Coregonus artedi) habitat quality and quantity in Wisconsin lakes”*

In review: Canadian Journal of Fisheries & Aquatic Sciences

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# Two-Story Fishery Lakes\*:

Top Story – Warm and Coolwater Fishery

e.g., Bass, Bluegills, Walleye, Musky

Bottom Story – Coldwater Fishery

e.g., Cisco, Lake Whitefish, Lake Trout



\* ~200 Two-Story Fishery Lakes: ~ 1.3% of WI total lakes

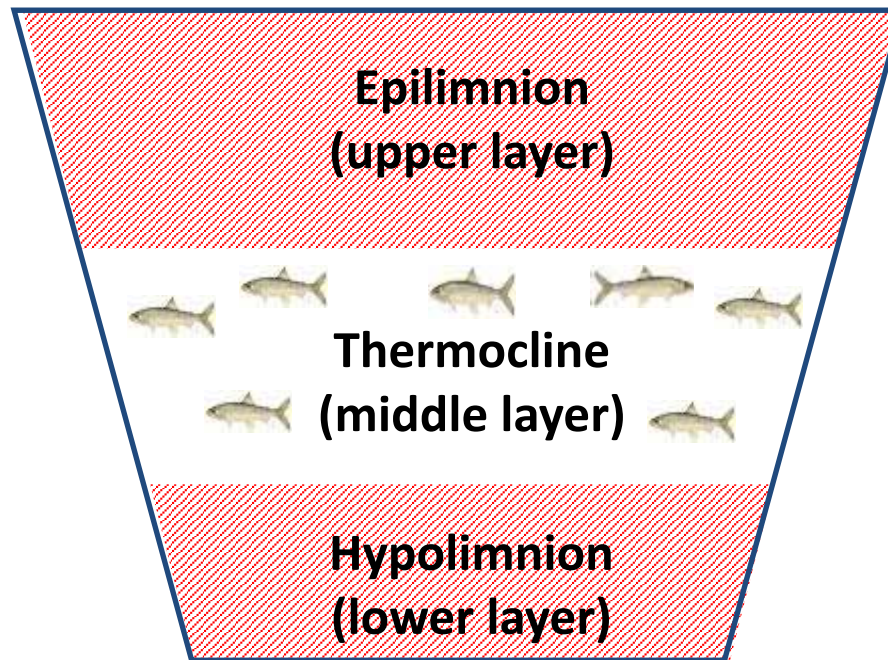
# Lake Coldwater Fish Need:

- Max. Water Temperatures < 57-73°F\*
- Dissolved Oxygen > 6 mg/l



\* < 73°F for Cisco and  
Brook, Brown, &  
Rainbow Trout  
< 66°F for Lake Whitefish  
< 57°F for Lake Trout

# Summer: Only middle part of water column has good temp & DO



Plenty of oxygen  
**But TOO WARM**

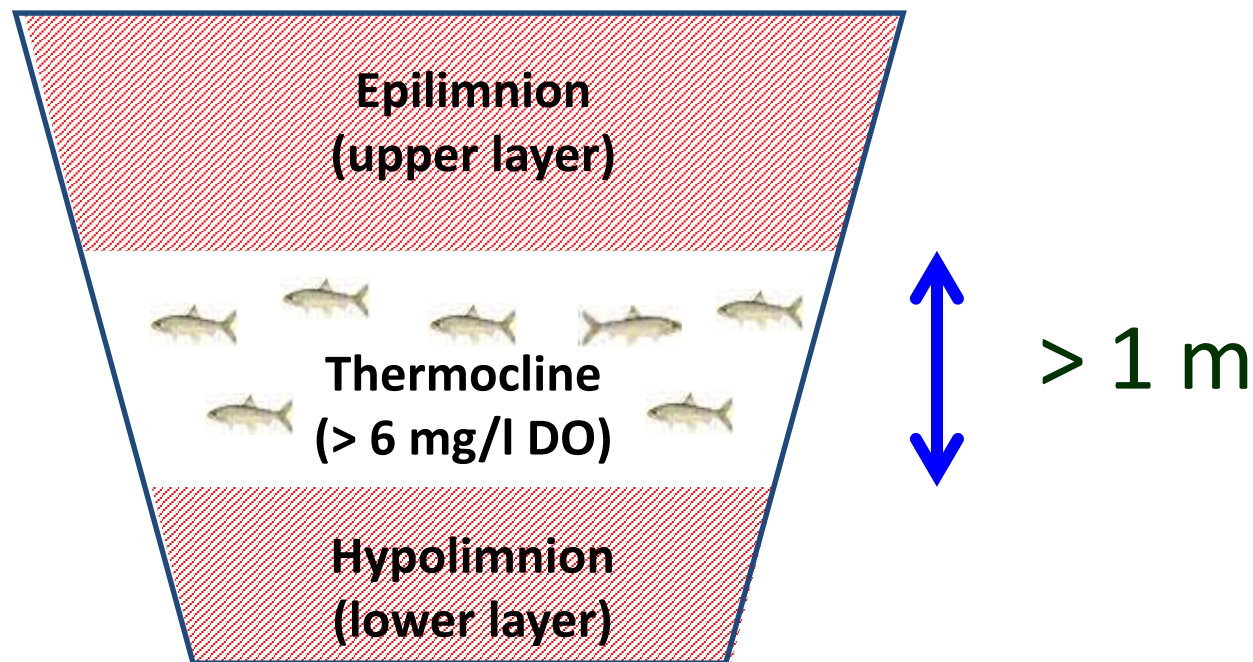
Cool enough  
Sufficient oxygen\*

Nice and cold  
**But NO OXYGEN**

*\* If summer gets longer or if eutrophication occurs, Thermocline (middle layer) may run out of oxygen, resulting in fish kill*

# Proposed Criteria: > 1 m of Column: > 6 mg/l DO + Cold Water\*

(Impaired if more than 1/3 of yrs do not attain)



*\* Thermal limit depends on species*

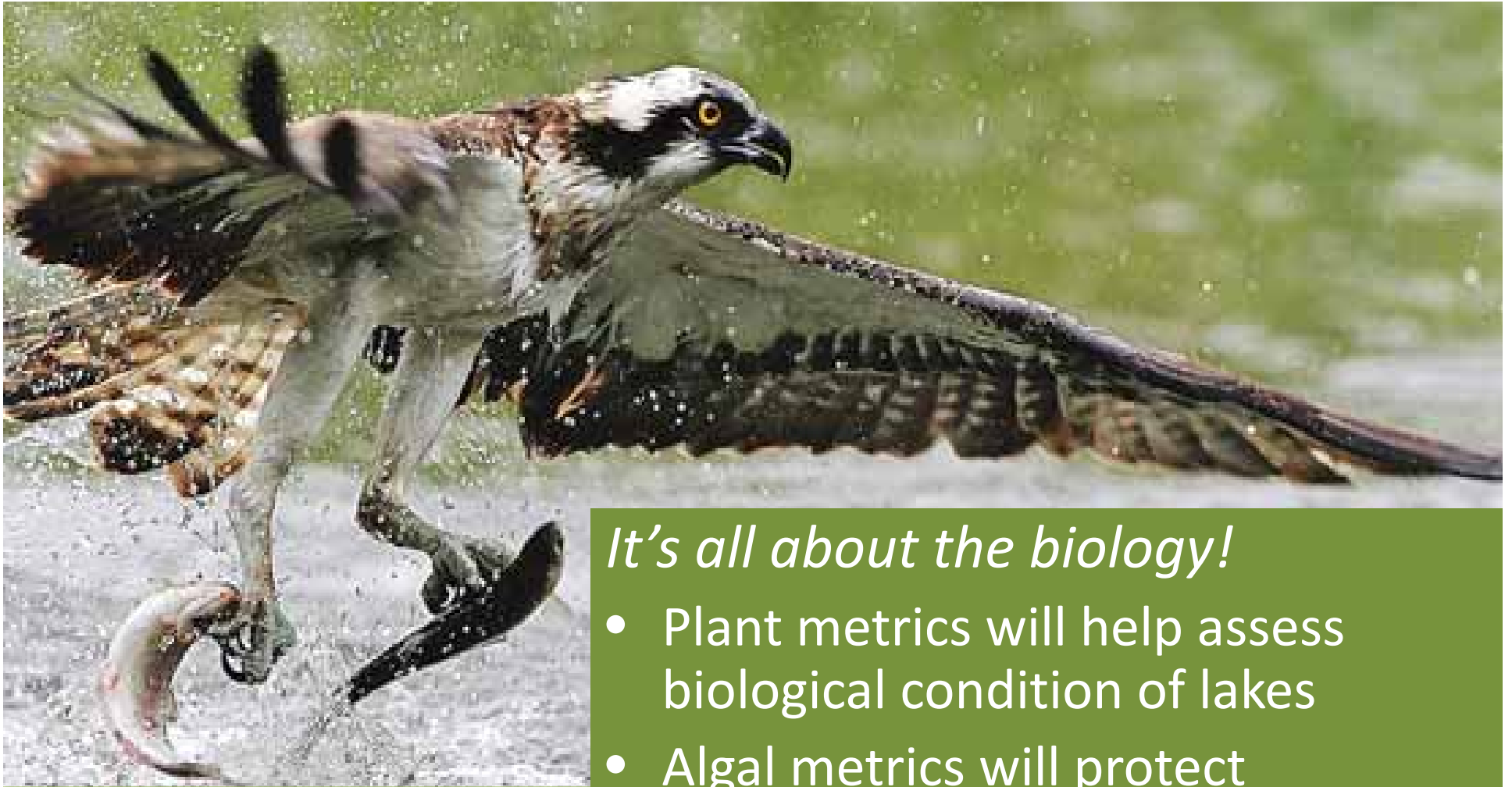
# Oxythermal Habitat Quantity Considerations:

- Layer's narrowest point in summer is key
- Varies within and among years; need multiple samples to characterize
- Sensitive to weather, climate trends, and lake eutrophication
- No change anticipated for discharge permits



Lake Whitefish





## Takeaways

*It's all about the biology!*

- Plant metrics will help assess biological condition of lakes
- Algal metrics will protect recreation & aquatic life
- Two-story fishery metric will help assess condition of these lakes for coldwater fish

# Questions?

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