

Reduced Oxythermal Habitat in a Two-Story Fishery: Implications for Phosphorus Management in a Northern Wisconsin Lake

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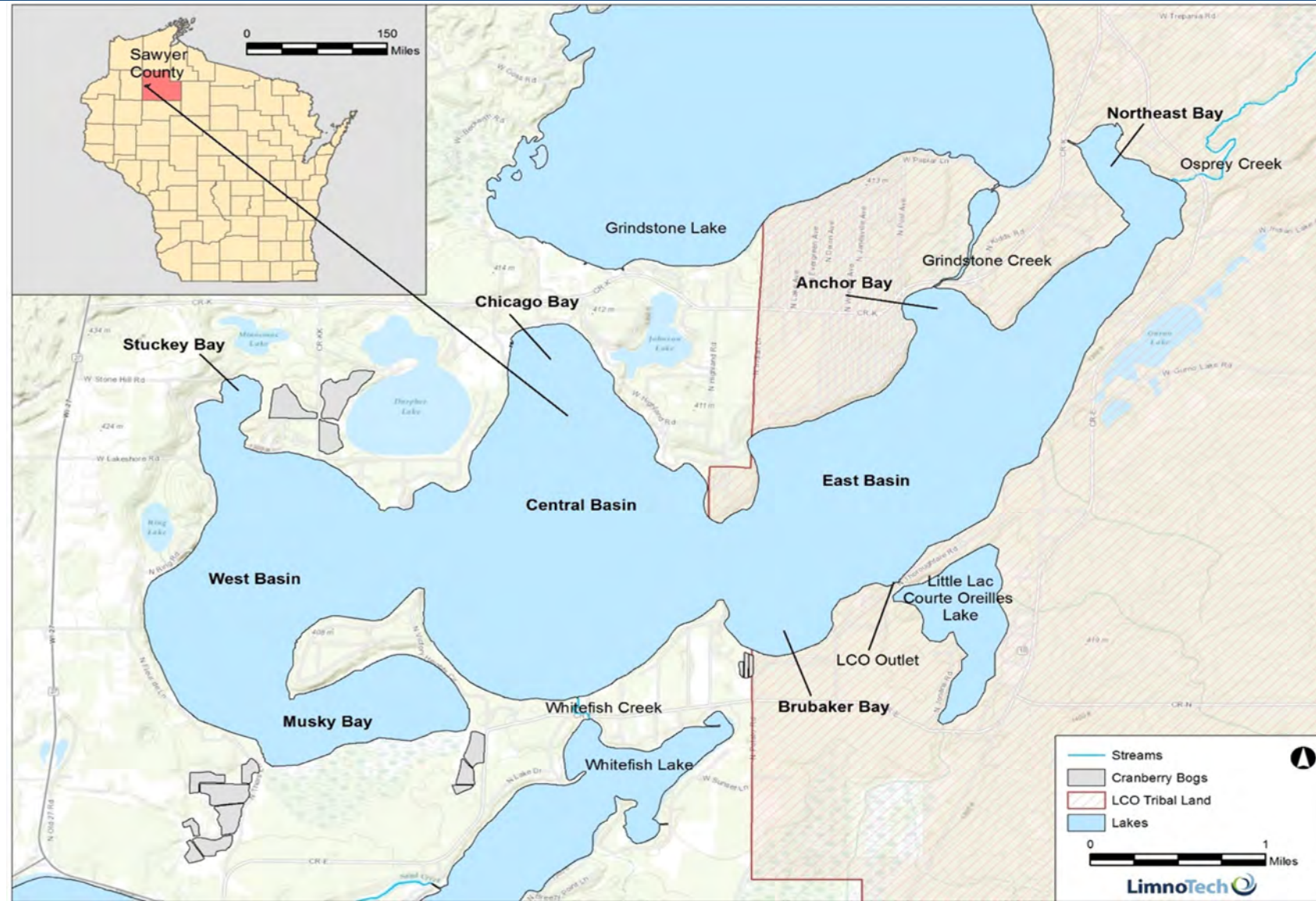
NALMS

November 1, 2018

Lac Courtes Oreilles (LCO)

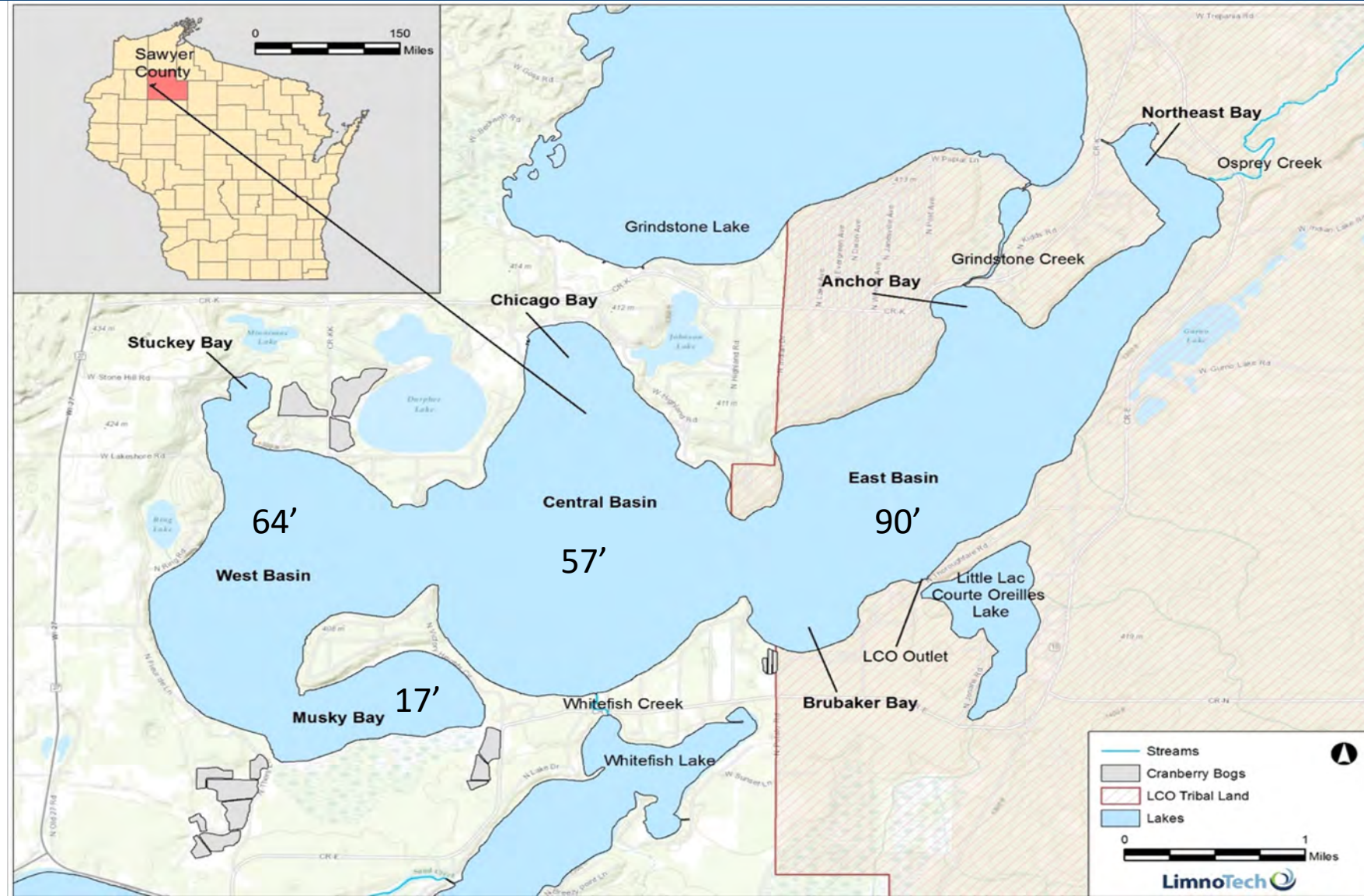


- 8th largest natural drainage lake in WI
- Lake surface area = 5,139 acres
- Watershed area = 68,990 acres
- Land use:
 - Forested
 - Agriculture
 - Cranberry bogs



LCO Characterization

- Musky Bay
 - Shallow, non-stratified, warmwater fishery
 - Eutrophic
- LCO main basins
 - Stratified, coldwater fishery
 - Oligo - Mesotrophic

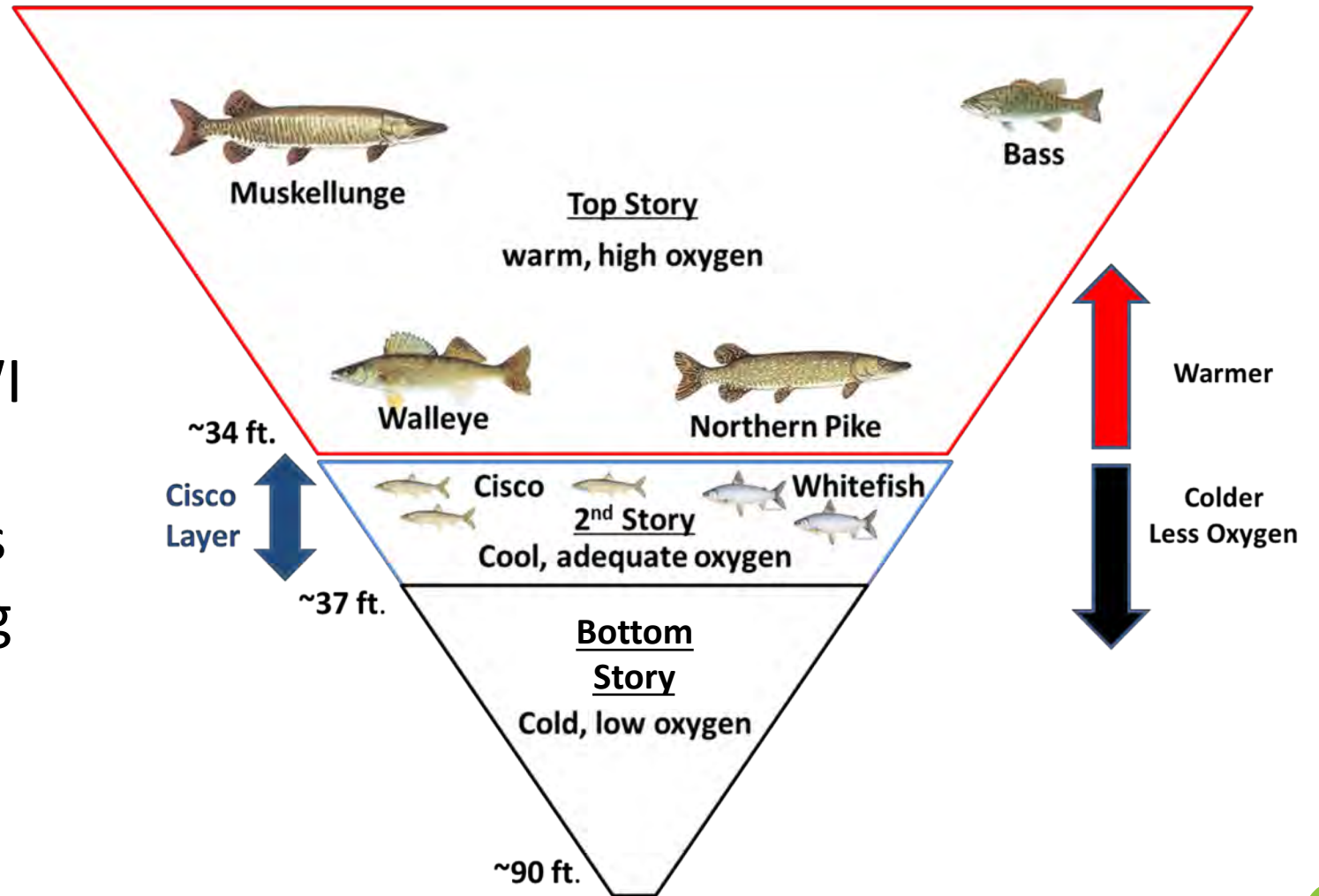


WICKED PROBLEM



Two-story fishery in LCO

- Warm upper story, cold bottom waters
- Cisco & whitefish
 - Native species in WI
 - 1 of 5 inland lakes in WI w/ both
- Distribution in WI lakes appears to be shrinking
- **Reduced oxythermal habitat**



Cisco & Whitefish

- Oxythermal requirements:
 - Cisco $\leq 73^{\circ}\text{F}$ (22.8°C)
 - Whitefish $\leq 66^{\circ}\text{F}$ (18.9°C)
 - ≥ 6 mg/L DO
- Play key roles in aquatic ecosystem
 - Feed on zooplankton (cisco)
 - Some zoops, mainly bottom-dwelling invertebrates (whitefish)
 - Forage fish for musky & walleye
- Sentinels of lake health & change



<https://nelson.wisc.edu/greenlake/docs/lyons.pdf>

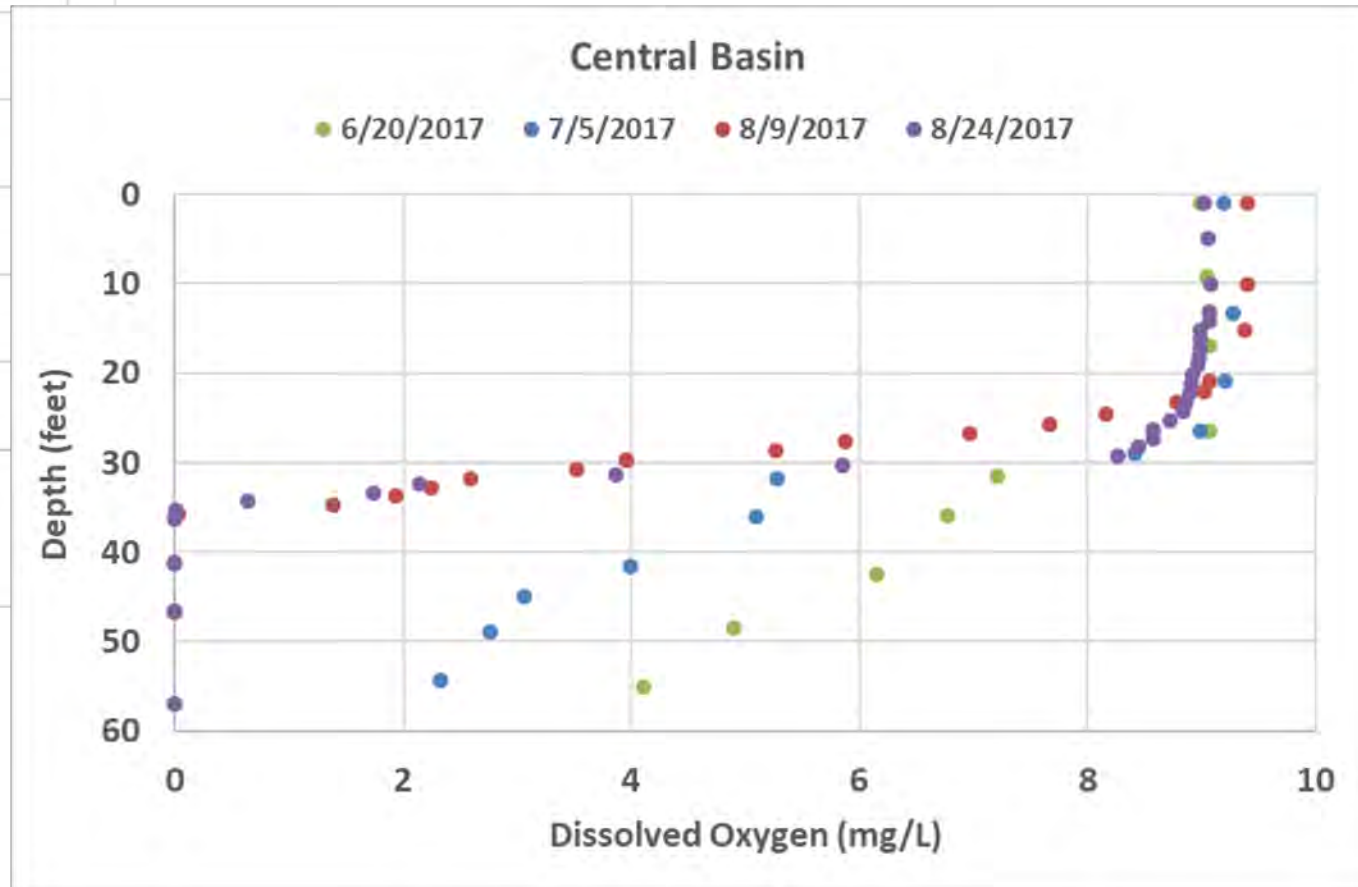
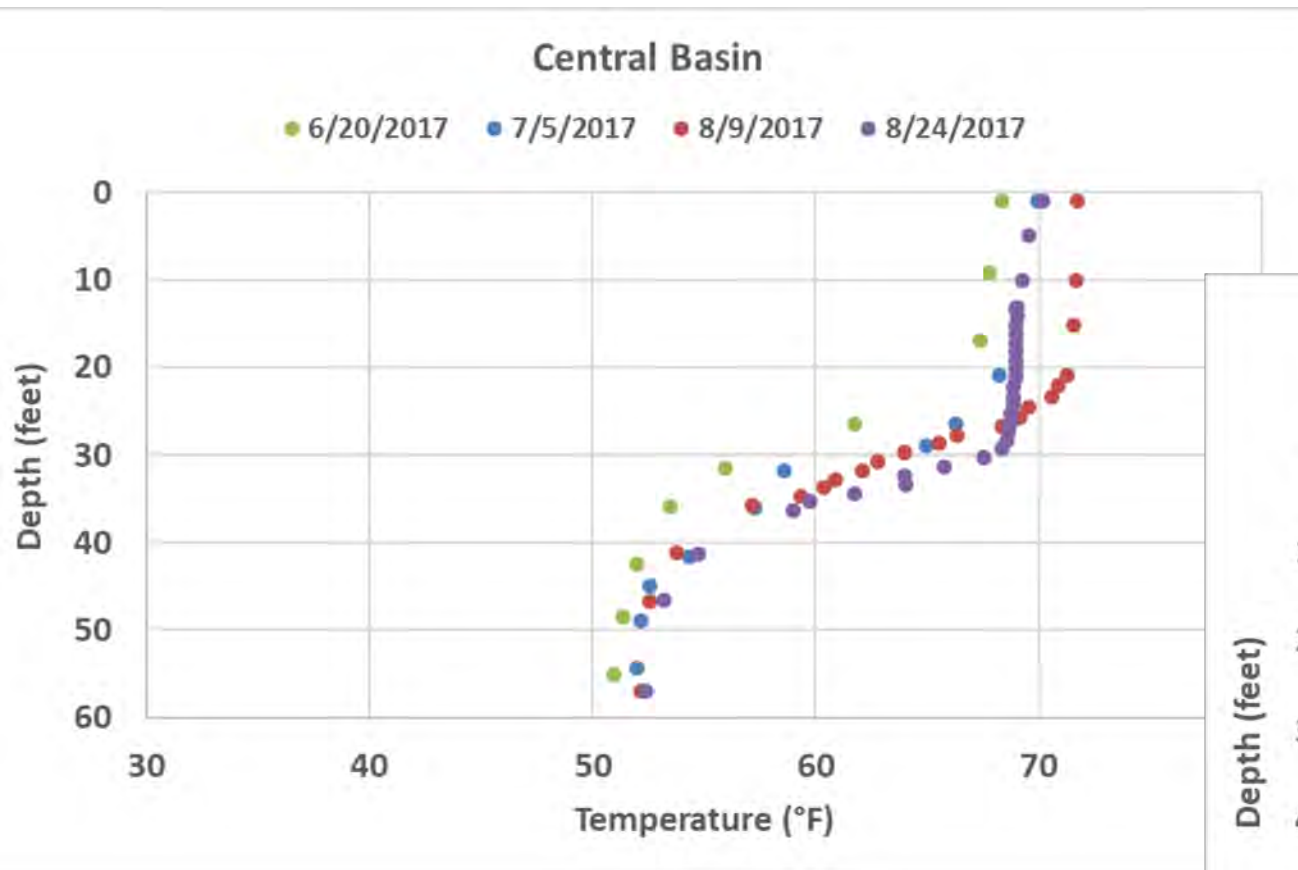


Oxythermal habitat standards – Coldwater fishes

- To avoid sub-lethal effects:
 - $\leq 22.8^{\circ}\text{C}$ (73°F)
 - ≥ 6 mg/L DO
- WI 82 Administrative Codes, WDNR, Chapters NR102.04 [4] [b] and NR102.25 [2])
- Rules will help assess condition, inform fisheries management



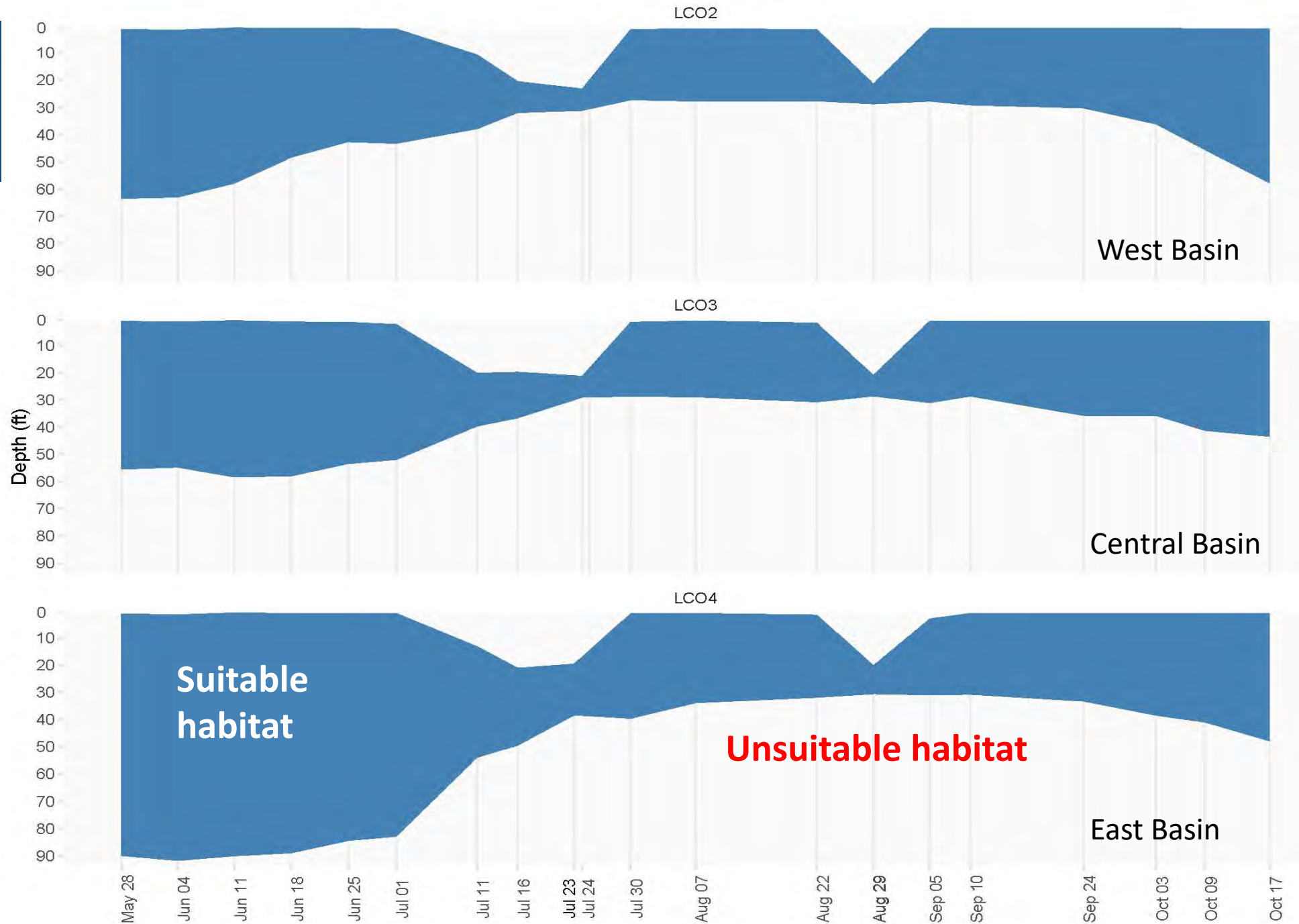
Temperature & DO



Cisco

Oxythermal habitat needs

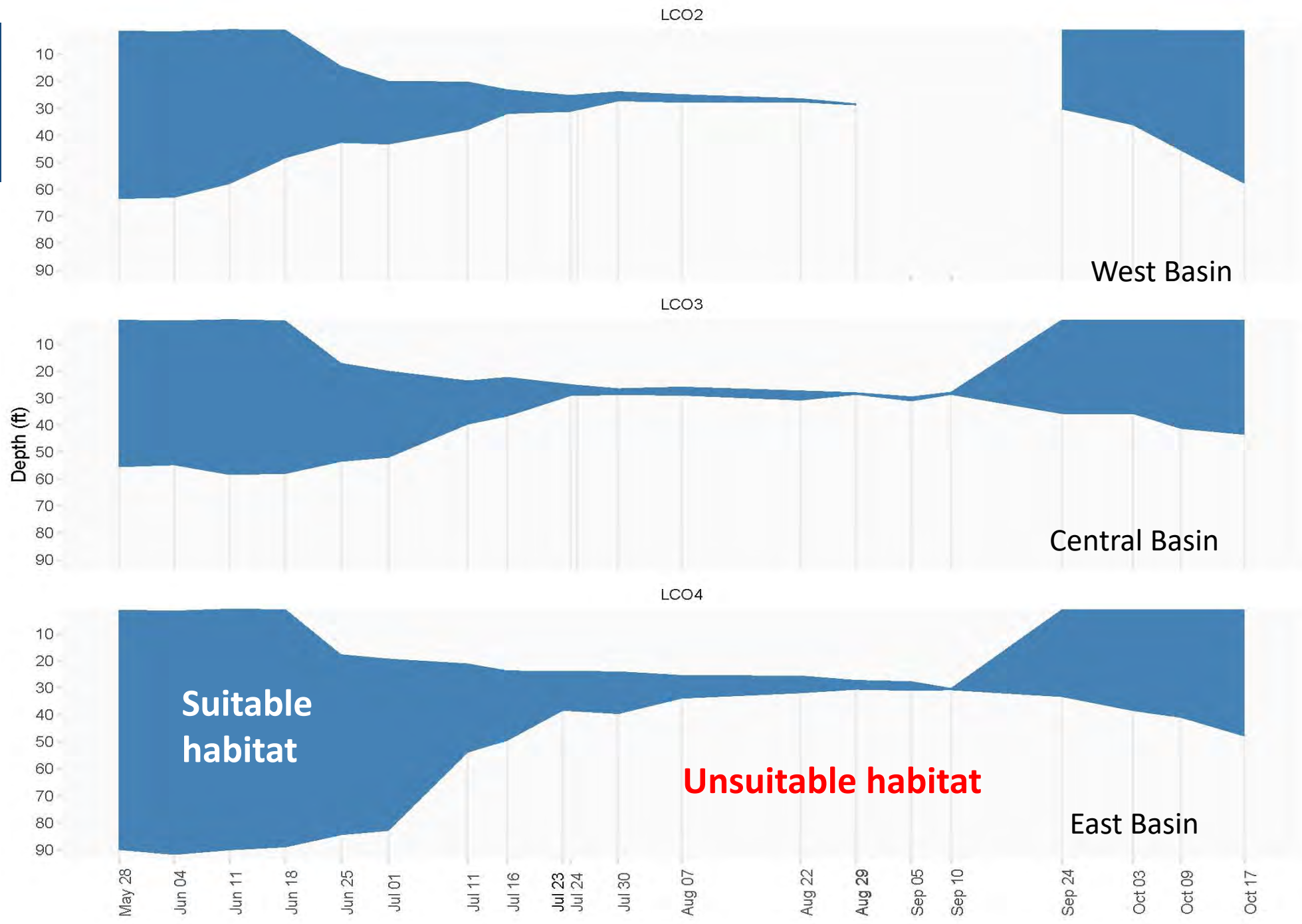
- 73°F (22.8°C)
- 6 mg/L DO



Whitefish

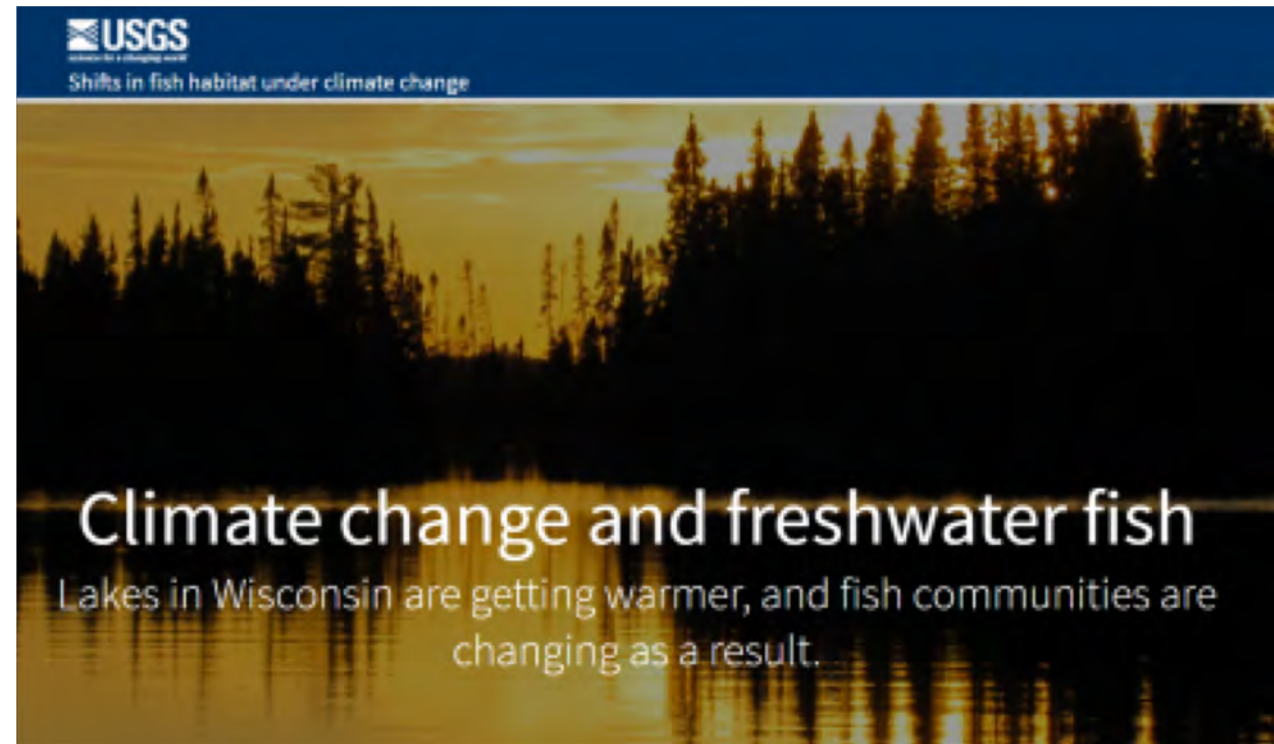
Oxythermal habitat needs

- 66°F (18.9°C)
- 6 mg/L DO



Factors influencing oxythermal habitat

- Climate change
 - ↑ surface temp
 - Longer growing seasons
- Elevated nutrient inputs (internal and external)
- Organic matter loading & production
- Decomposition → ↓ DO
- Oxidation of reduced compounds



<https://www.climatehubs.oce.usda.gov/hubs/northern-forests/tools/climate-change-impacts-wisconsin-freshwater-fish>

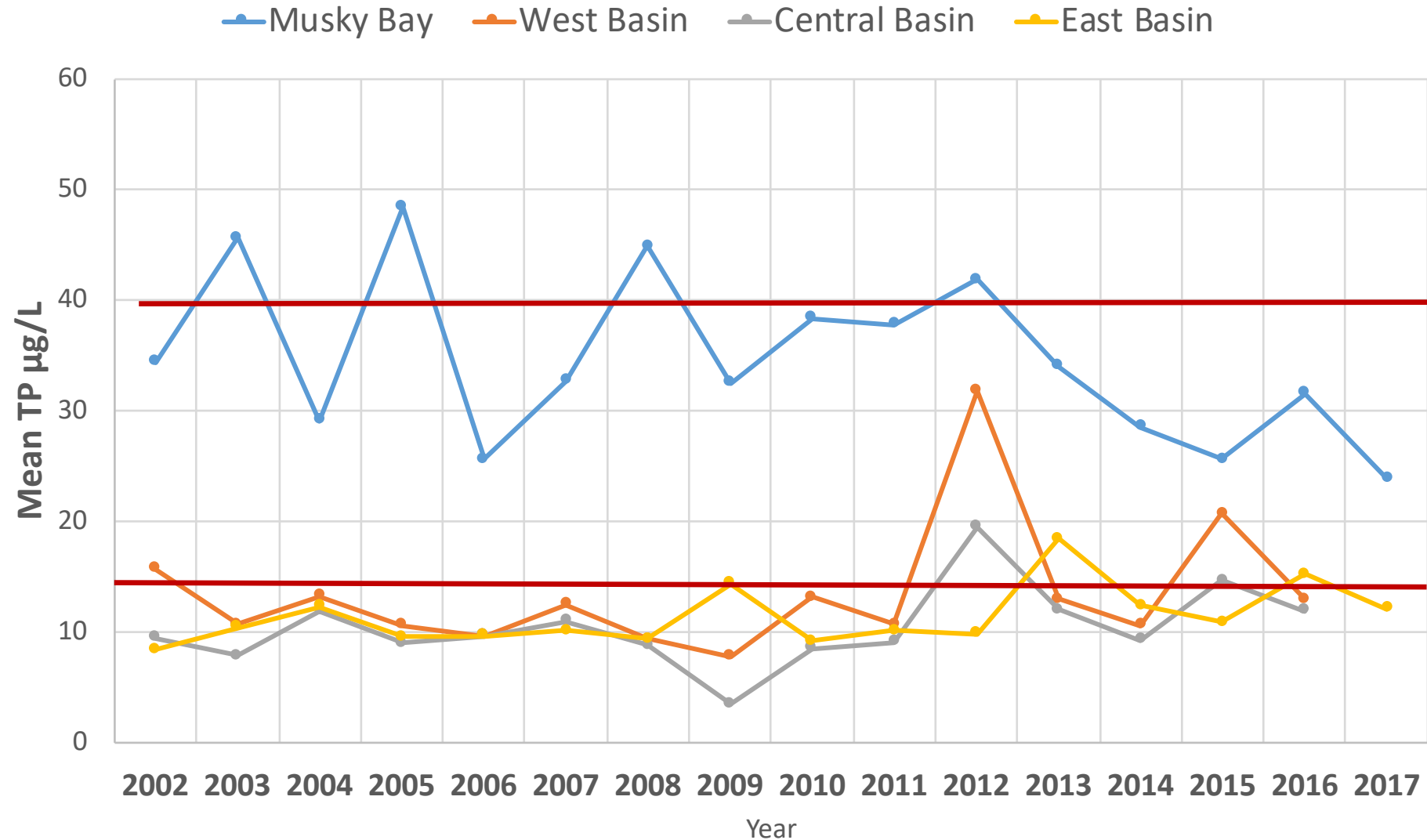


Muskellunge (Musky)

- Musky Bay primary spawning area
- World-class muskellunge fishery historically
 - Largest musky in WI in 1949 by Cal Johnson
 - ~60 inches, 67 lbs
- Degraded habitat
 - Anoxia sediment-water interface
 - Nuisance plant and algal growth
 - Curly-leaf pondweed present in Musky Bay
 - Source of phosphorus

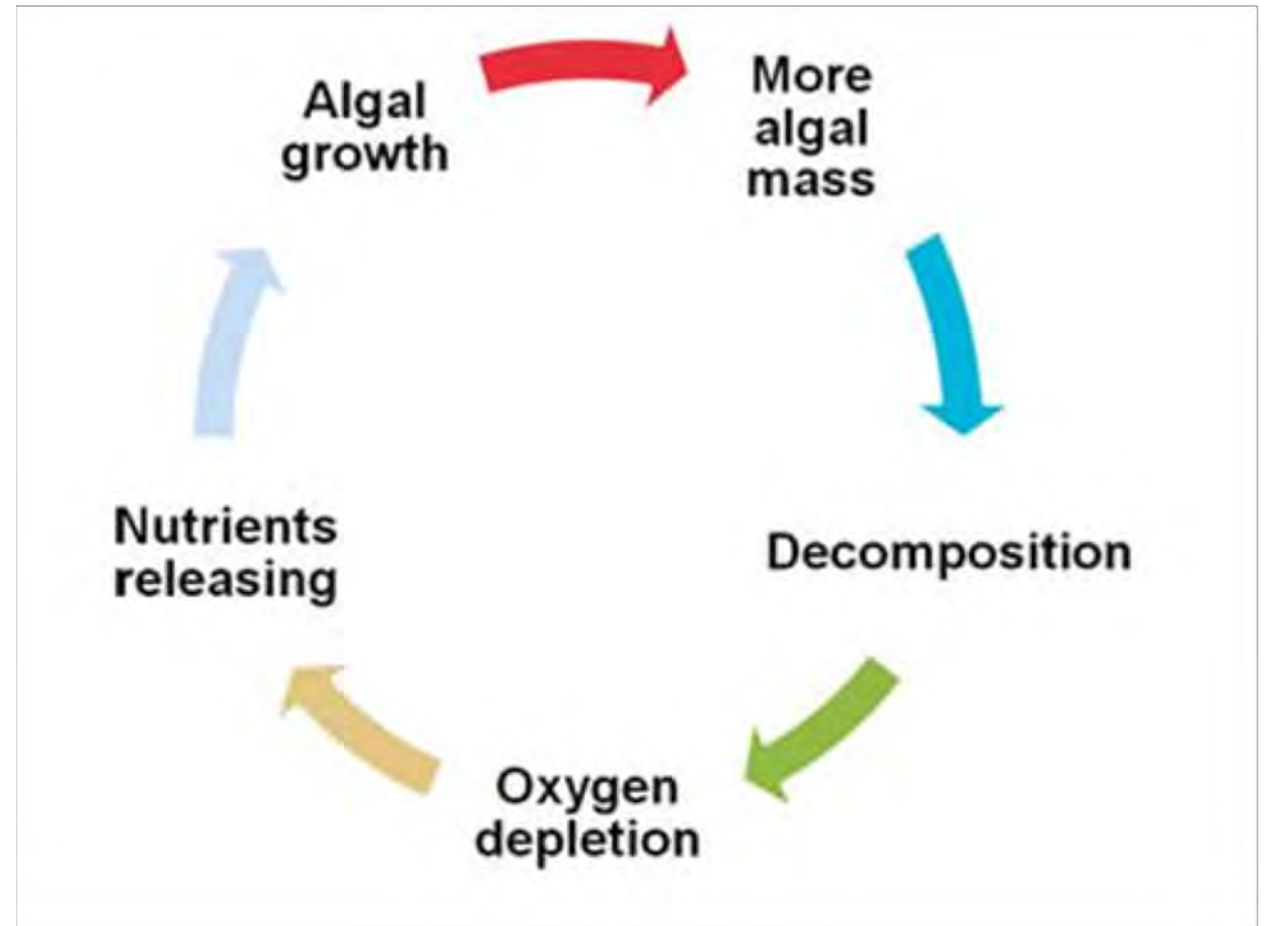


Total phosphorus (June 1 – September 15)



Summary

- TP impairment in Musky Bay
 - Future impairments?
- Biological impairment (oxythermal habitat)
- Nutrients not only factor contributing to oxygen demand, but a factor we can manage



Acknowledgements

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Questions?

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