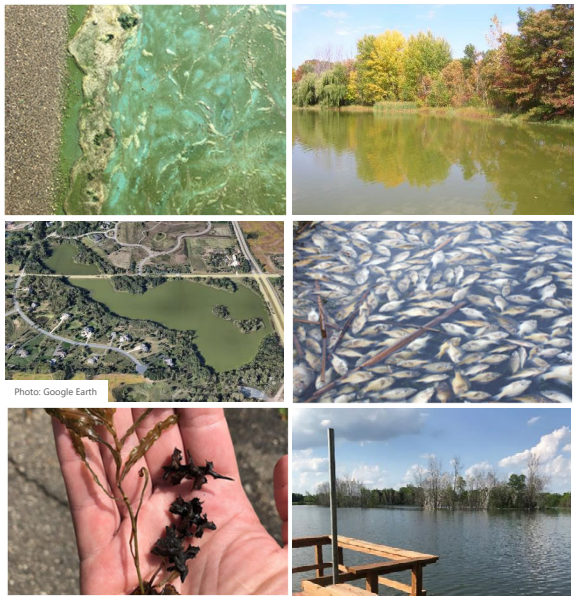


Goose Lake Ecology and Management

Joe Bischoff
Senior Aquatic Ecologist
Barr Engineering Company
November 9, 2022

1

Presentation Objectives

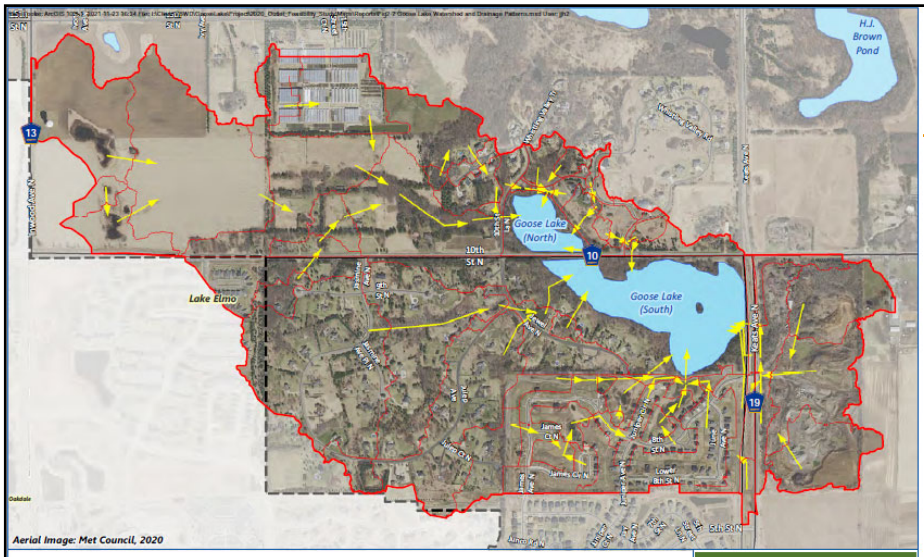
- **Background on Goose Lake**
  - Physical features
  - Water quality
- **How lakes work: a primer on lake ecology (limnology)**
  - Setting the stage for potential outcomes
  - Shallow versus deep lakes
- **Setting Targets for Lake Enhancement**
  - Setting reasonable expectations for your lake
  - What do you want from Goose Lake? What concerns about the lake do you have?
- Lake Management (Stakeholder Meeting #2)
  - Enhancing lakes for practical outcomes
  - Maximizing beneficial uses

2

Goose Lake

Understanding our Lake

3



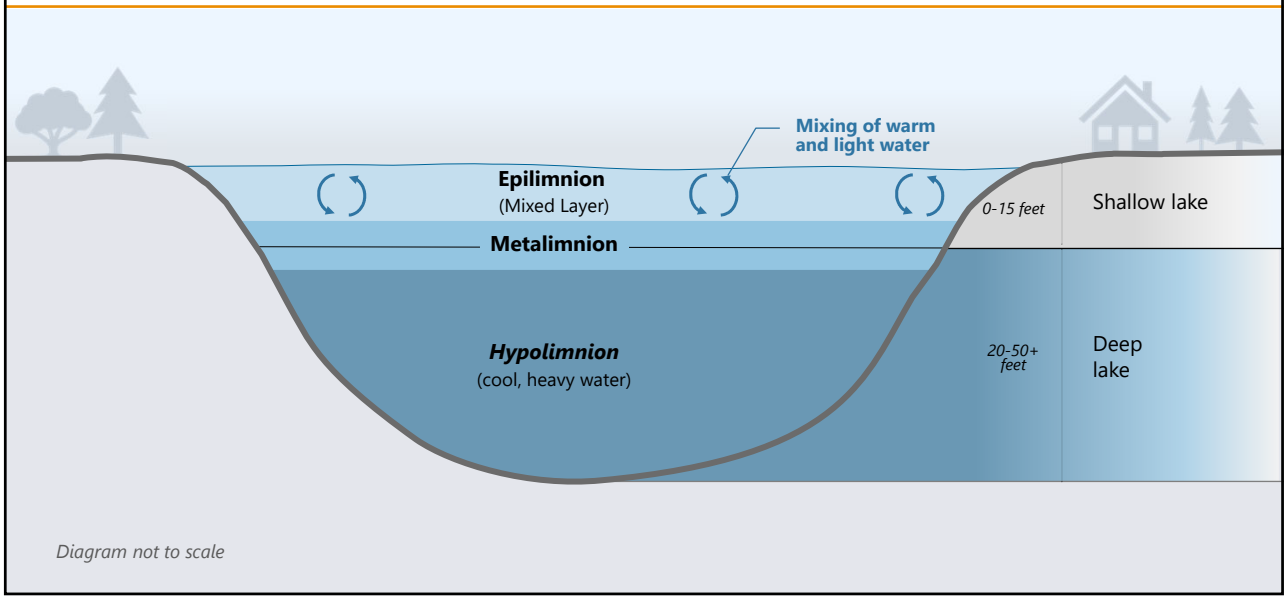
Goose Lake Watershed

- 38 acres in size
  - 6 acres north of Highway 10
- 665-acre watershed
- Landlocked
- Shallow lake

4

5

Physical Characteristics of Lakes



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Physical Characteristics of Lakes

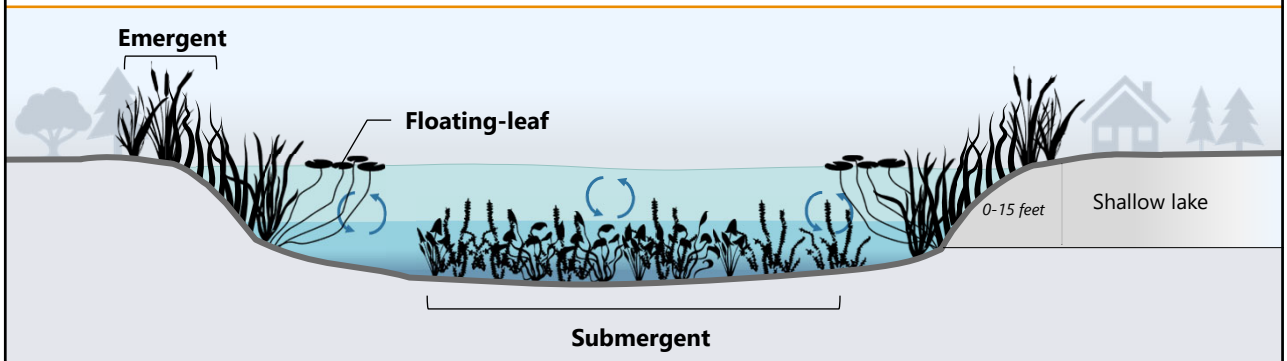
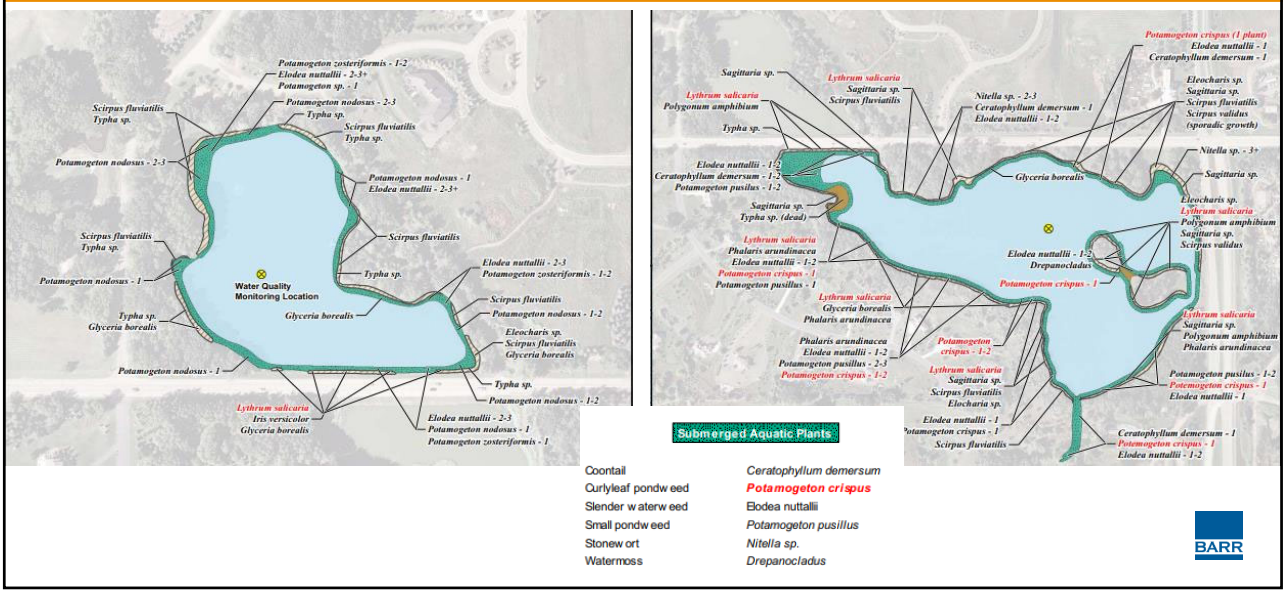


Diagram not to scale

7

2012 Aquatic Vegetation



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Deep versus Shallow Lakes

Deep Lakes

- Large open water area supporting recreational uses
- Aquatic vegetation limited to shallow (littoral) areas
- Often direct response to management actions

Shallow Lakes

- Limited open water area supporting recreational uses
- Often aquatic plants throughout the lake
  - Often at or near the surface
- Often indirect response to management actions

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Turbid and Clearwater States
Competing Equilibria in Shallow Lakes

- Turbid State
  - High algal growth
  - Low aquatic plant growth
  - Low grazer (zooplankton) growth
- Clearwater State
  - Robust aquatic plant community
  - Low algal growth
  - Large grazer population

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Photo credit: Vadnais Lakes Watershed Management Organization

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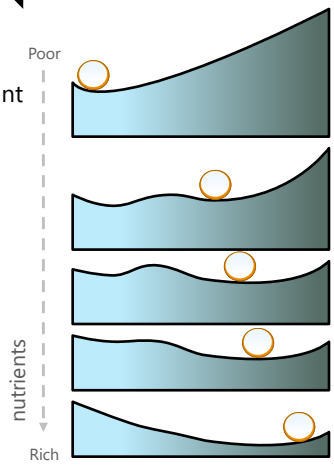
Turbid and Clearwater States

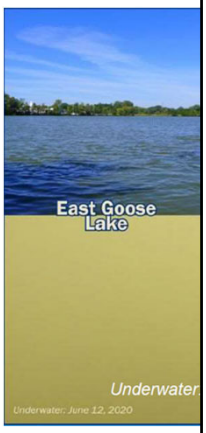
Competing Equilibria in Shallow Lakes

Clearwater State ⟷ **Turbid State**

- Large aquatic plant community
- Low algal productivity
- Large grazer population



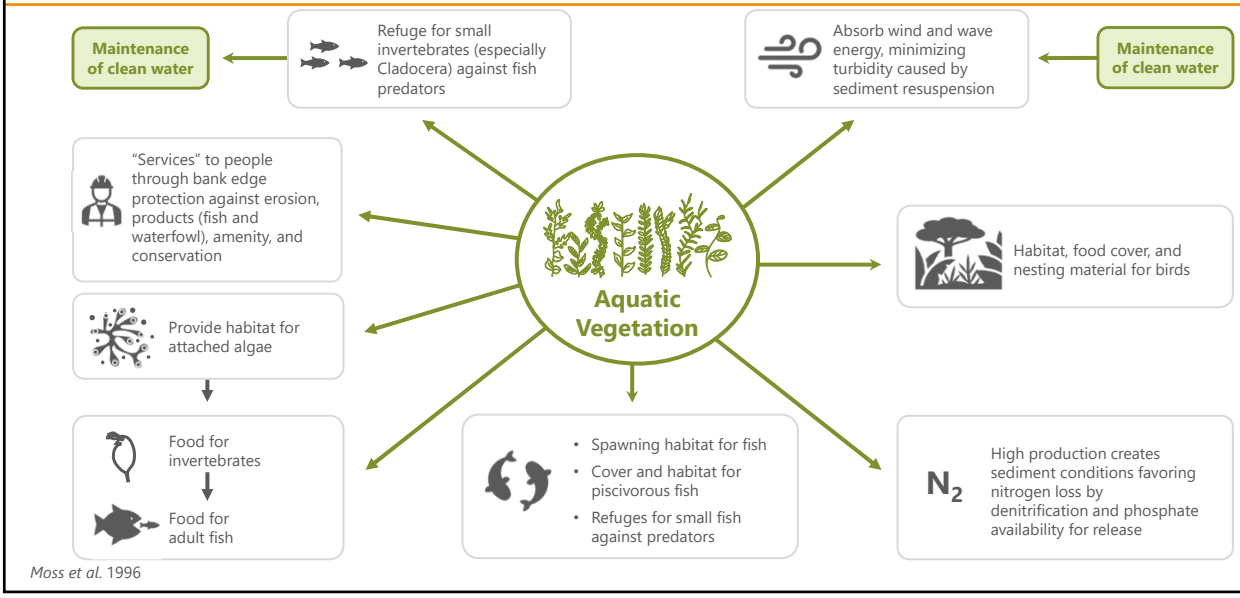
- High algal productivity
- Low aquatic plant productivity
- Low grazer (zooplankton) productivity



Scheffer et al. 2004

11

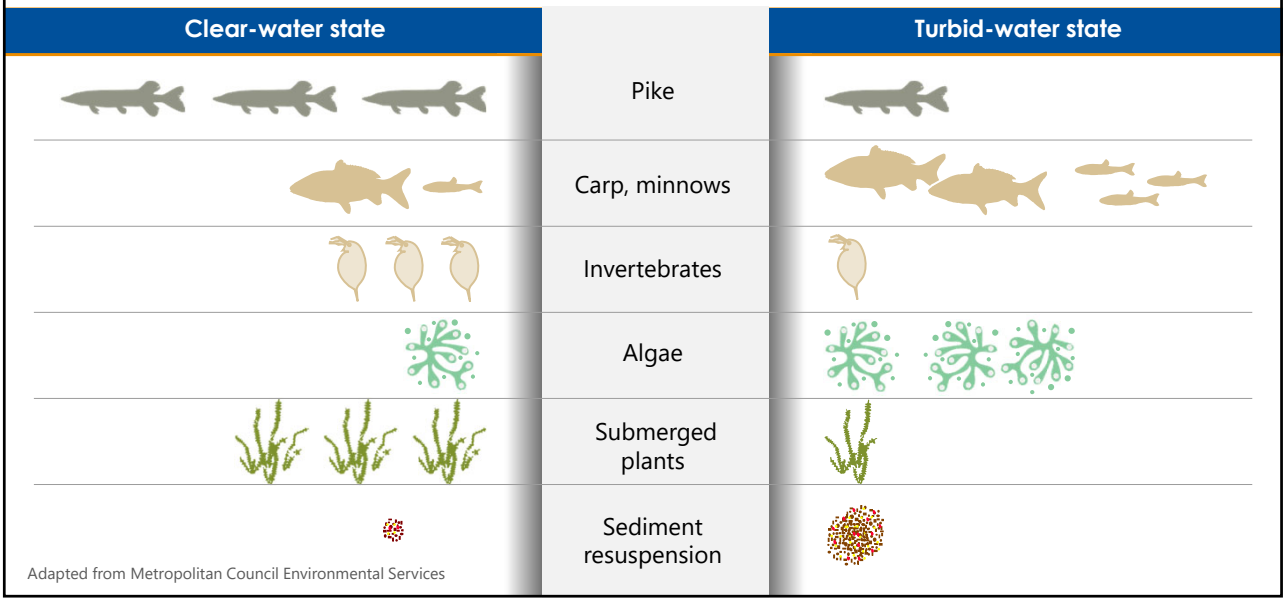
Role of Aquatic Vegetation in Lakes



Moss et al. 1996

12

Trophic Cascades – Biological Impacts on Water Quality



Adapted from Metropolitan Council Environmental Services

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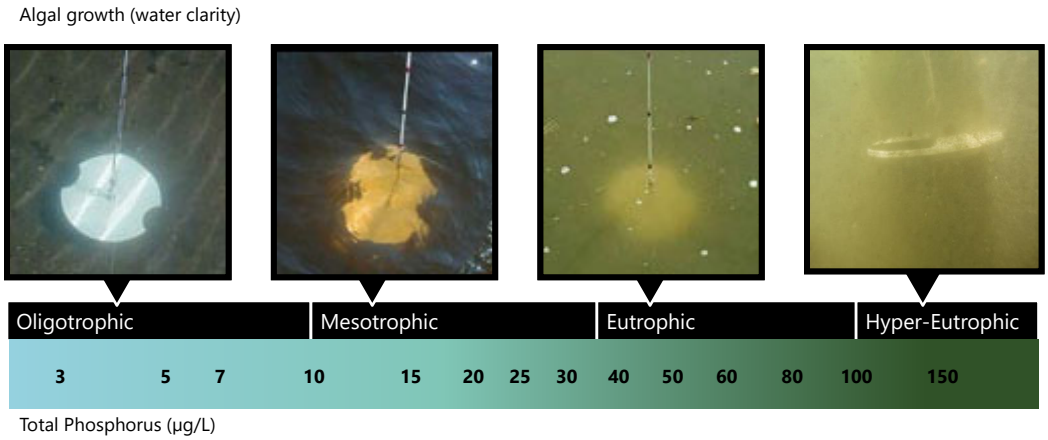
Relationship between Total Phosphorus and Transparency



Photos: Minnesota Pollution Control Agency

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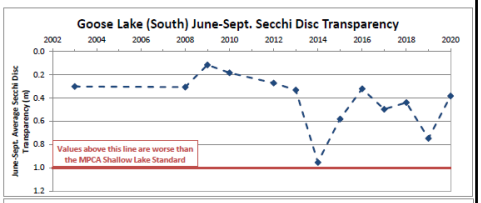
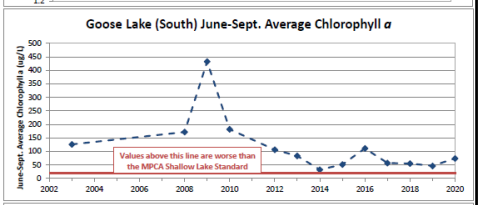
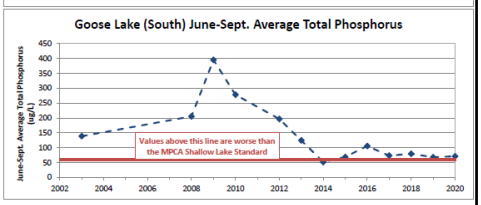
Water Quality Targets

Parameter	North Central Hardwood Forest
Total Phosphorus (µg/L)	Deep: 40 Shallow: 60
Chlorophyll-a (µg/L)	Deep: 14 Shallow: 20
Secchi Depth (meters)	Deep: 1.4 Shallow: 1

-A shallow lake is defined as having a maximum depth less than 15 feet or with 80% or more of the lake area shallow enough to support emergent and submerged rooted aquatic plants.







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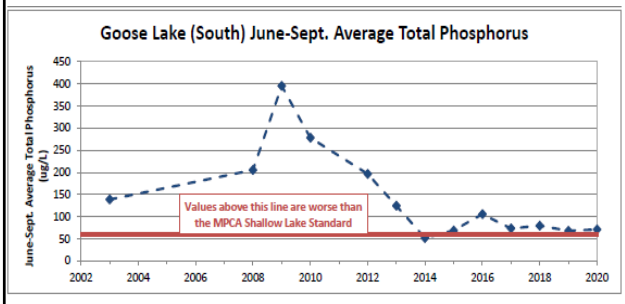
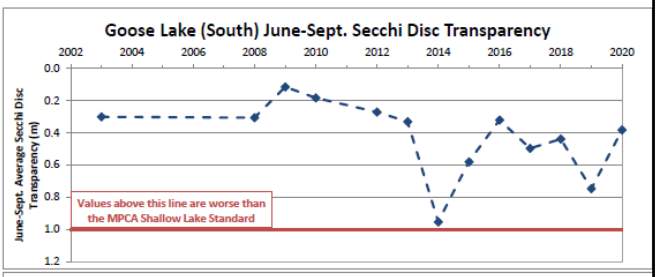
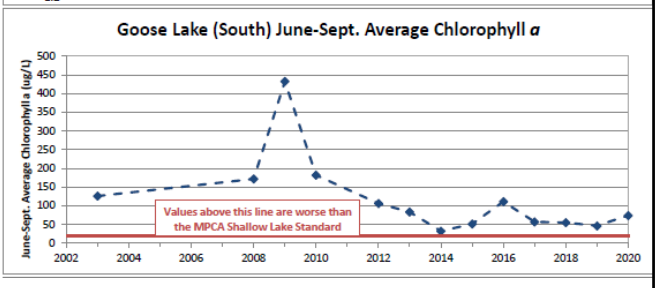
Goose Lake Water Quality







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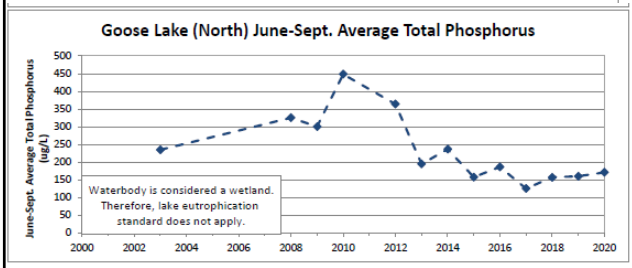
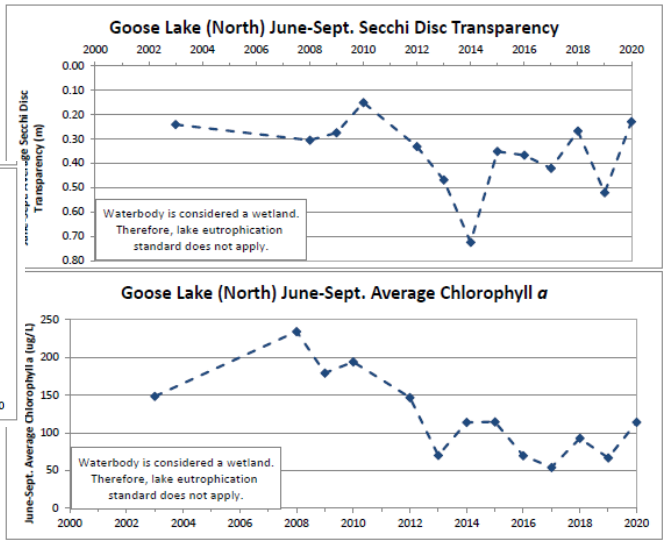
North Goose Lake Water Quality





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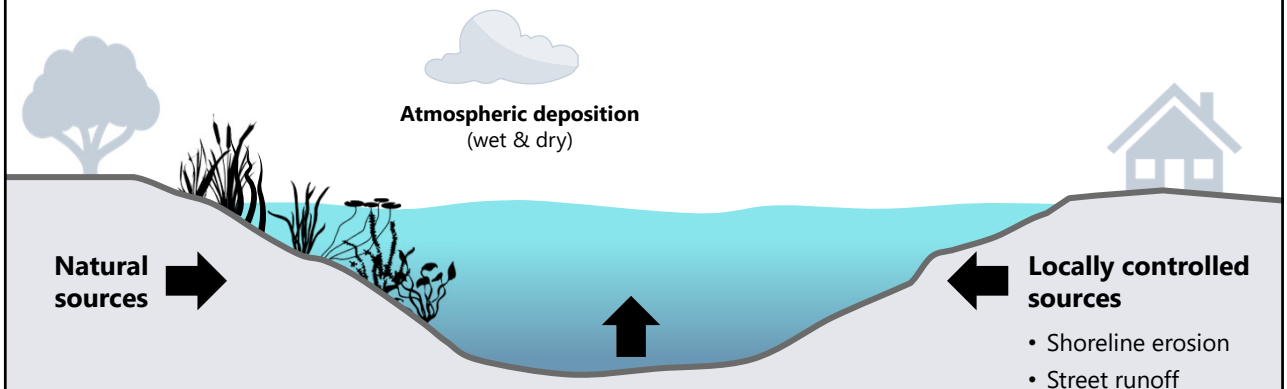
Issue: Nutrient and Pollutant Sources



Lake P Concentration = Watershed + Internal - Sedimentation

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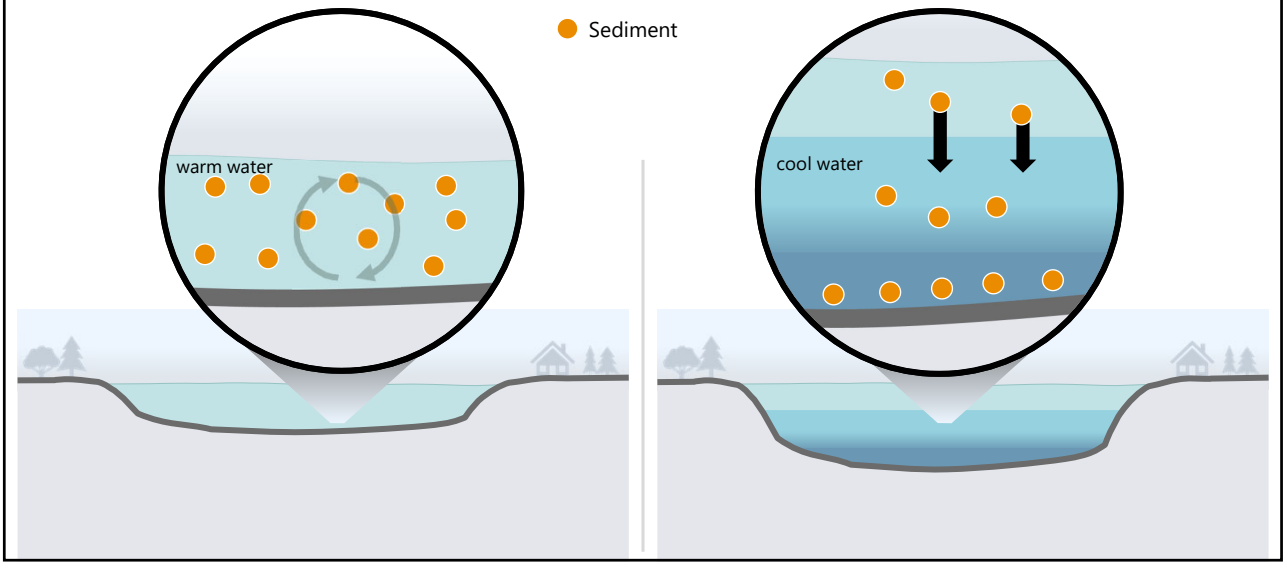
Lake Response to Nutrient – Vertical Concentration



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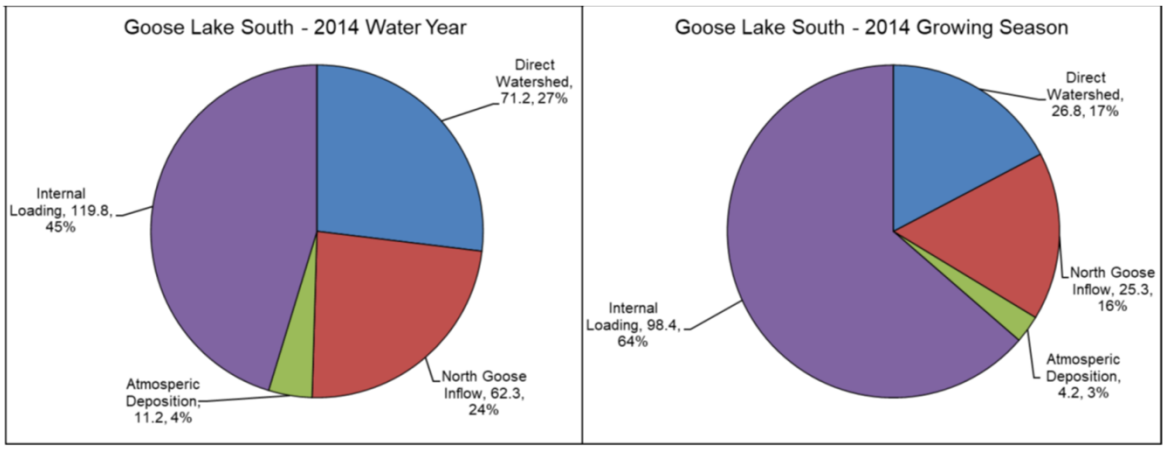
Goose Lake South Phosphorus Sources



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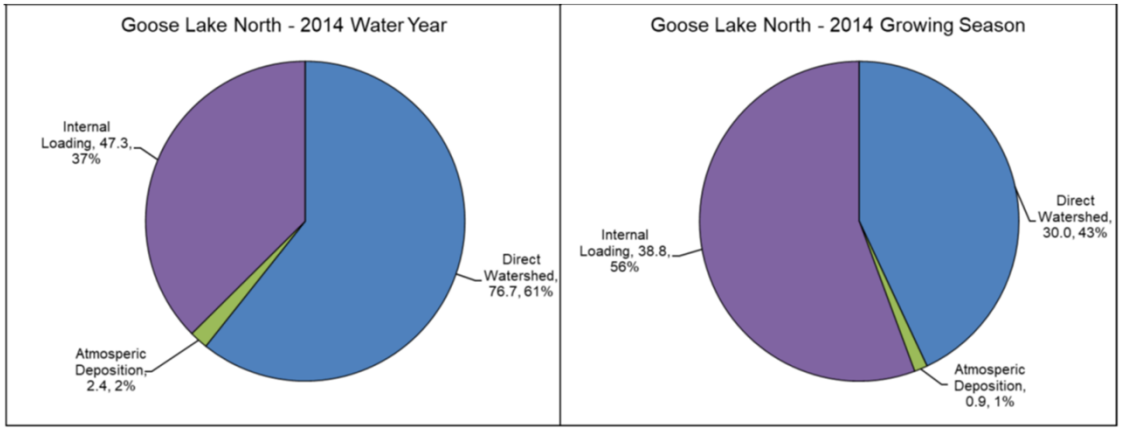
Goose Lake North Phosphorus Sources



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Setting Targets and Enhancement Strategies

Establishing reasonable expectations for shallow lakes

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Desired Lake Types in Minnesota

Alton Lake, Boundary Waters Recreation Area

Indian Lake, Cass County, MI

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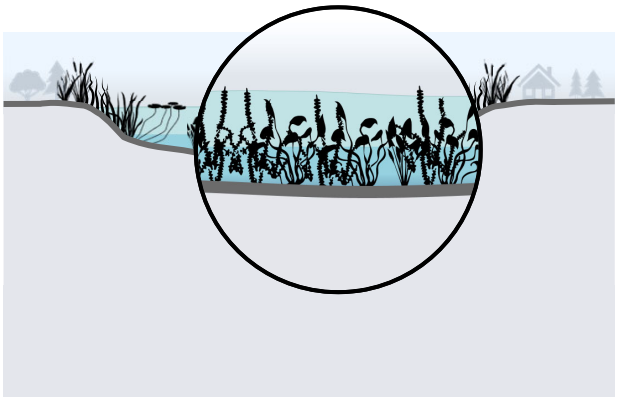
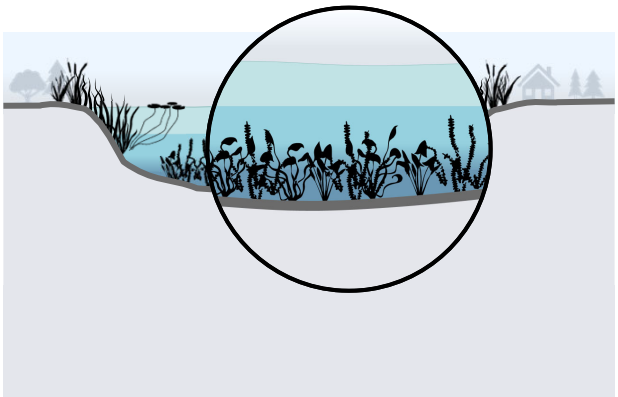
Importance of Depth
not all shallow lakes are created equal

- Depth is a key factor establishing the "level of effort" required to maintain boating as a recreational use





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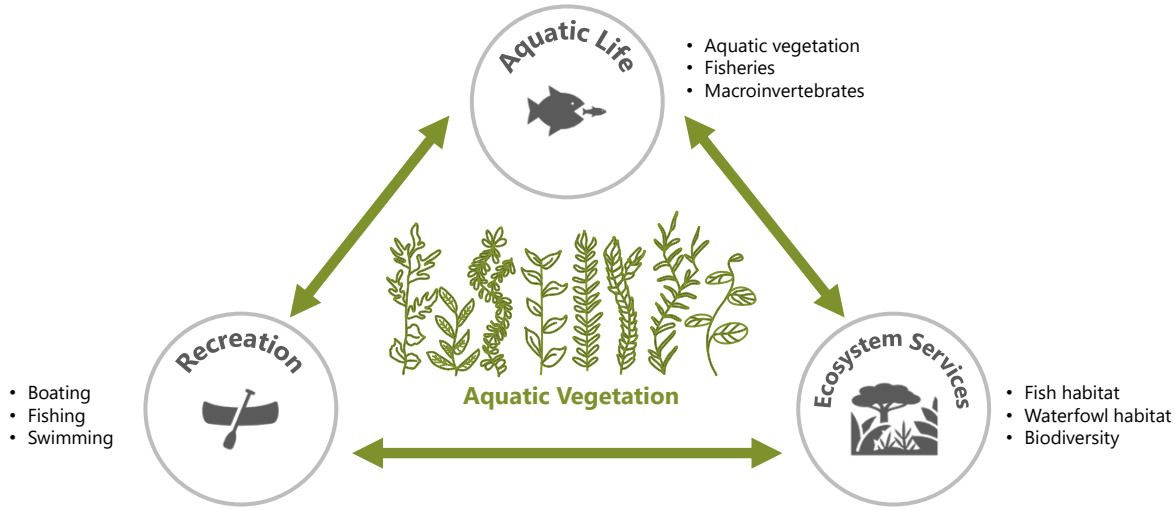
Balancing Aquatic Vegetation and Recreation in Shallow Lakes
Why the plant dominated state?



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Shallow Lake Targets: A dichotomy of choices

Algae Dominated State

Limits:

- Contact recreation
  - nuisance and harmful algal blooms
- Poor recreational fishery
- Minimal wildlife habitat
- User-specific aesthetics

Supports:

- Minimal inhibition of recreational boating

Photo credit: Vadnais Lakes Watershed Management Organization

Plant Dominated State

Limits:

- recreational boating
- User-specific aesthetics

Supports:

- Contact recreation
  - Minimal nuisance and harmful algal blooms
- Recreational fishery
- Wildlife habitat

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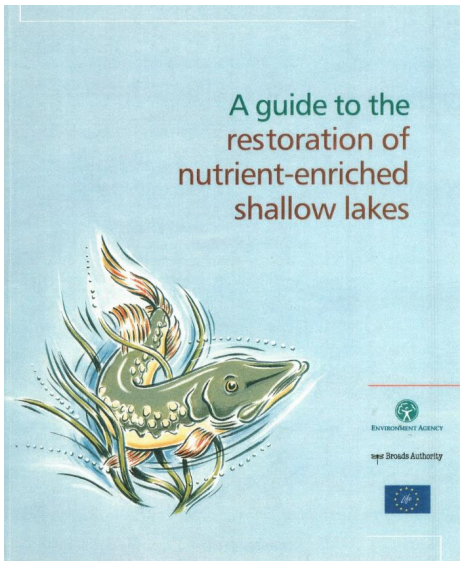
Strategy for Restoring Shallow Eutrophic Lakes



Stage Setting

Identify and Remove Stressors
- Aquatic invasive species (Curly-leaf pondweed, common carp)
- Hydrologic alteration
- Unbalanced fishery (rough fish, stunted fish)

Nutrient Control
- Watershed nutrient reductions
- Internal phosphorus cycling

SHIFT

Turbid to Clear Lake Shift (biomanipulation)
- Whole lake drawdown
- Large scale fish removal
- Force clear-lake phase (alum treatment)

Management

Aquatic Plant Establishment
- Aquatic invasive species management
- Establish aquatic plant nursery areas
- Transplant native aquatic plants

Shallow Lake Stabilization and Management
- Increasing biodiversity and health of native aquatic plants
- Minimizing invasive plants and fish (population control)
- Balance recreational uses

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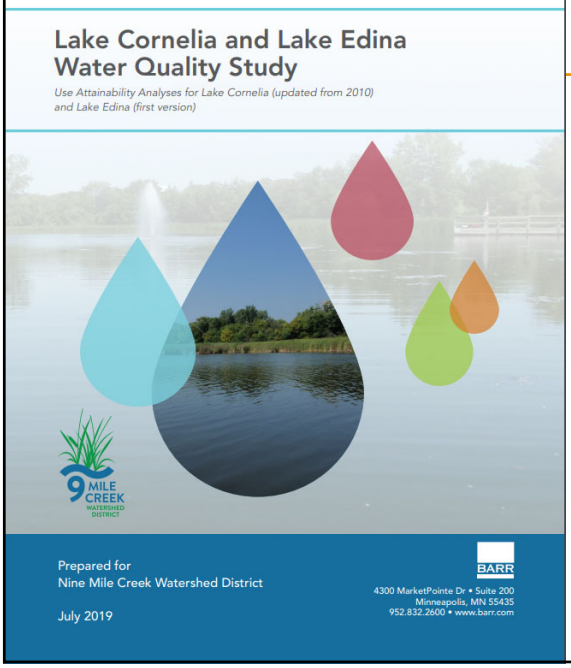

Diagnostic Study for Stressor Detection

- Water Quality Diagnostic Study
  - Total Maximum Daily Load (TMDL)
- Biological Structure
  - Fisheries assessment
  - Aquatic vegetation assessment
  - Aquatic invasive species
- Hydrologic alteration
  - Water level controls and fluctuations
  - Hydrologic changes in the watershed
    - Impervious surfaces (roads, roof tops, etc.)

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Diagnostic Study

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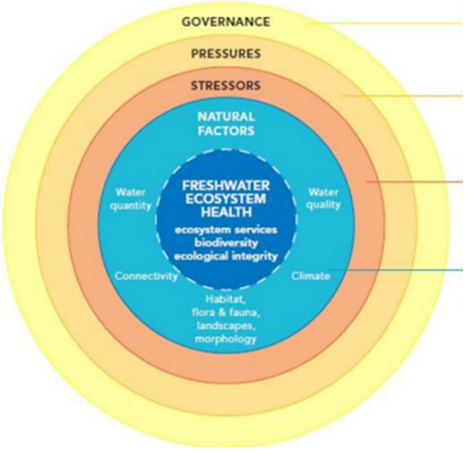
Management Objectives

Identify key issues to be addressed

- Examples: Curly-leaf pondweed (CLP) infestation, watershed sediment loading, recreational uses

Establish management goals or targets

- Reduce CLP to less than 10% occurrence
- Maintain 250 acres open water through aquatic plant harvesting
- Reduce stormwater sediment loading by 50%



Bogardi et al. 2020.

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Key Planning Aspects

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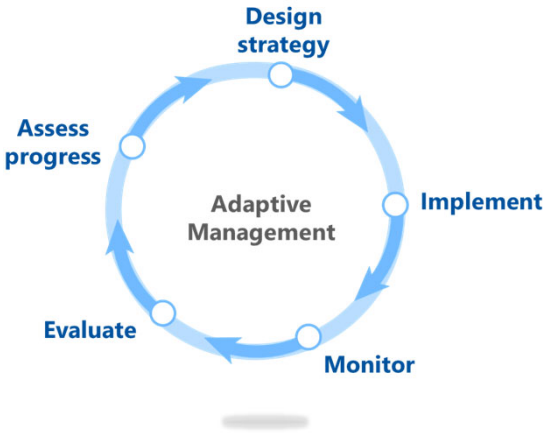
Adaptive Management in Lake Management

Stabilize and Manage the Lake



- Managing lakes for multiple uses requires **active management**
  - Monitoring (aquatic plants, water quality, fisheries)
  - Aquatic invasive species control
  - Maintain balanced fishery
  - Maintain native plants population
    - Balance with recreational uses
  - Naturalized shorelines
  - Periodic drawdown

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What are your desires for Goose Lake? Concerns? Primary Issues?

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Questions?

Joe Bischoff, jbischoff@barr.com

Photo: Edina Realty

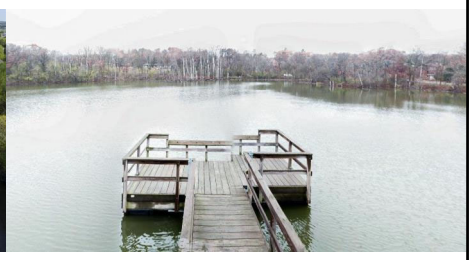

Photo: Tucker Richard, Google Maps

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