A

APPENDIX A

Public Participation Materials

Waupaca Inland Lakes Protection & Rehabilitation District & Friends of Mirror & Shadow Lakes

Mirror-Shadow Lakes Management Planning Project Kick-off Meeting
Spring 2020

Todd Hanke
Onterra LLC
Lake Management Planning

Presentation Outline

- Onterra, LLC
- Why Create a Management Plan?
- Elements of a Lake Management Planning Project
  - Data & Information
  - Planning Process

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Onterra, LLC

- Founded in 2005
- Staff
  - Three full-time ecologists
  - One part-time paleoecologist
  - Five full-time field technicians
  - Four summer interns
- Services
  - Science and planning
- Philosophy
  - Promote realistic planning
  - Assist, not direct

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Why create a lake management plan?

- Preserve/restore ecological function to ensure cultural services
- To create a better understanding of lake's positive and negative attributes.
- To discover ways to minimize the negative attributes and maximize the positive attributes.
- Snapshot of lake's current status or health.
- Foster realistic expectations and dispel any misconceptions.

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Elements of an Effective Lake Management Planning Project

Data and Information Gathering
Environmental & Sociological

Planning Process
Brings it all together

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Data and information gathering

- Study Components
  - Water Quality Analysis
  - Watershed Assessment
  - Paleocore Collection & Analysis
  - Aquatic Plant Surveys
  - Shoreland & CWH Assessment
  - Fisheries Data Integration
  - Stakeholder Survey

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Water Quality Analysis

Phosphorus
Naturally occurring & essential for all life
Regulates phytoplankton biomass in most WI lakes
Most often 'limiting plant nutrient' (shortest supply)
Human development often increases P delivery to lakes

Chlorophyll-*a*
Pigment used in photosynthesis
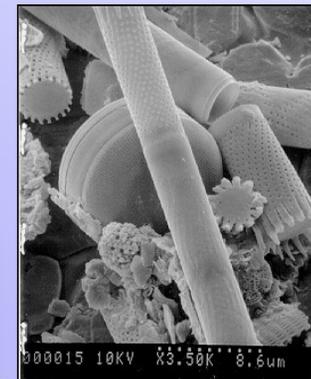Used as surrogate for phytoplankton biomass

Secchi Disk Transparency
Measure of water clarity
Measured using a Secchi disk

Secchi Disk

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Paleocore Collection & Analysis

Sediment core

Diatoms

000015 10KV X3.50K 8.6um

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Watershed Assessment

- Delineation of Watershed
- Watershed Modeling
  - Land cover
  - Phosphorus loading
  - Scenario development

Native Aquatic Plants

- Foundation of the lake ecosystem
- Provide oxygen, food, and shelter
- Improve water quality
- Stabilize bottom and shoreline sediments

Lake   *Grasslands*   *Forest*

Aquatic Plant Point-Intercept Survey

Mirror Lake:
15-meter Resolution
244 Total Points

Shadow Lake:
31-meter Resolution
185 Total Points

Mirror Lake

Shadow Lake

Point-Intercept Survey

Emergent & Floating-leaf Plant Communities

Community Mapping Survey

- Important communities for habitat, water quality, and shoreland stabilization
- Often negatively impacted by shoreland development

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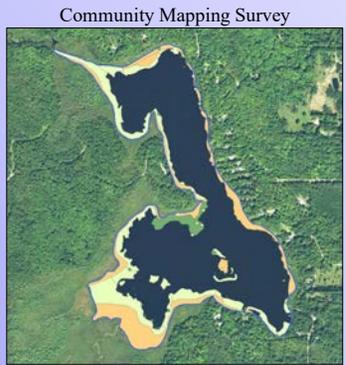
Non-Native Aquatic Plants

Eurasian Watermilfoil

Curly-leaf Pondweed

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Non-Native Aquatic Plants

Pale-yellow Iris

Purple Loosestrife

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Shoreland Assessment

- Shoreland area is important for buffering runoff and provides valuable habitat for aquatic and terrestrial wildlife.
- Assessment ranks shoreland area from shoreline back 35 feet
- Assess shoreland development and habitat
  - Coarse woody habitat

Urbanized

Range

Natural

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Fisheries Data Integration

- No fish sampling completed
- Assemble data from WDNR, USGS, & USFWS
- Fish survey results summaries (if available)
- Use information in planning as applicable

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Stakeholder Survey

- Survey includes Friends of Mirror-Shadow Lake members & riparian property owners
- Standard survey used as base
  - Planning committee potentially develops additional questions and options
  - Must not lead respondent to specific answer through a "loaded" question
- Survey must be approved by WDNR

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Planning Process

Planning Committee Meetings

Study Results (including a stakeholder survey)
Conclusions & Initial Recommendations
Management Goals
Management Actions
  Timeframe
  Facilitator(s)

Implementation Plan

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Thank You

Authorized Representative Email:
awhitman@cityofwaupaca.org
Subject Line: Information Meeting Presentation
Include name(s) of individuals who viewed this presentation

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Mirror and Shadow Lakes, Waupaca County
Project Update
January 2021
Submitted by: Heather Lutzow, Onterra, LLC

With the help of a Lake Management Planning Grant totaling over $28,000 through the Wisconsin Department of Natural Resources, a project is underway to create an updated lake management plan for Mirror and Shadow lakes. The lake management plan update will contain historical and current data from the lakes as well as provide guidance for their management by integrating stakeholder perceptions and goals with what is ecologically beneficial for the lakes. Onterra, LLC, a lake management planning firm out of De Pere and Madison, assisted the Waupaca Inland Lakes Protection & Rehabilitation District (WILPRD) and the Friends of Mirror and Shadow Lakes (FMSL) in applying for the grant and will guide them through the planning process.

Figure 1. Mirror Lake, Waupaca County, Wisconsin. Photo credit: Onterra

Studies were completed in 2020 aimed at assessing the health of Mirror and Shadow lakes, and were focused on evaluating the lakes' aquatic plant communities, water quality, and watersheds. In addition, perceptions of lake stakeholders were gathered through the distribution of a stakeholder survey. While all of the study results cannot be presented here, some of the highlights from the completed surveys are discussed. A wealth of data were collected over the year, and analyses of these data are currently underway. This project update intends to bring the WILPRD and FMSL up-to-speed on the scientific studies that have occurred, provide some initial observations on the ecology of the lakes, and provide a rough timeline for the remaining actions that will be taken as a part of this planning project.

As part of the Citizen's Lake Monitoring Network, a volunteer collected water quality samples and clarity data on four occasions during 2020 on Mirror and Shadow lakes, while Onterra collected samples on one occasion during the summer. Figure 2 displays Summer 2020 (June-August) average values for near-surface total phosphorus (primary nutrient controlling algal growth), chlorophyll-*a* (a measure of free-floating algal abundance), and Secchi disk depth (a measure of water clarity). Also displayed are the long-term averages calculated using available historical data going back to 1977. The average values for these three parameters collected in the summer of 2020 along with the long-term averages for both lakes fall within the *excellent* category for Wisconsin's deep headwater drainage lakes (Figure 2).
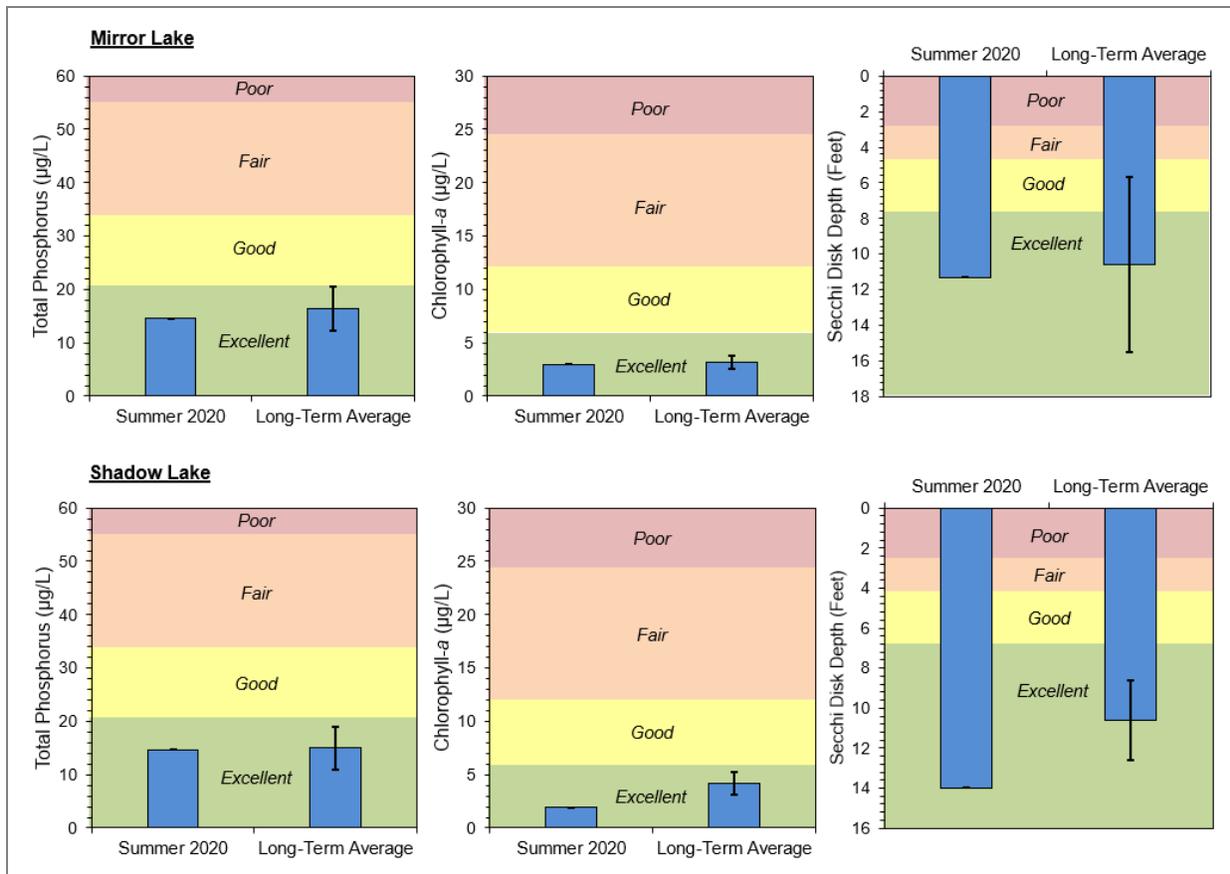
Figure 2. Mirror and Shadow Lake average 2020 summer (June – August) and long-term summer average values for total phosphorus, chlorophyll-α, and Secchi disk depth. Index thresholds are for Wisconsin's deep headwater drainage lakes. Error bars represent one standard deviation. Created using data collected by both Onterra and CLMN volunteer monitors. Long-term average calculated using historical data from 1977-2020.

On July 27, 2020 Onterra ecologists collected a sediment core on Shadow Lake (Figure 3). The purpose of this core collection is to analyze fossilized diatom communities present in the top and bottom layers of the sample which indicate if and how Shadow Lake's environment, like nutrient levels and aquatic plant abundance, may have changed over time. This analysis allows for comparisons that can be made between present day and pre-settlement times. This is a useful tool for identifying changes that are human-related, and is unique in allowing for a glimpse at conditions during a time before data was collected and recorded. The results of this core analysis from Shadow Lake will be included within the full comprehensive report. A sediment core had previously been collected and analyzed from Mirror Lake, so this study was not repeated in 2020.

Figure 3. Sediment core collected on Shadow Lake. Photo credit: Onterra.

Several different aquatic plant studies also took place during Onterra's field season of 2020. In late-July, Onterra ecologists completed whole-lake point-intercept surveys on Mirror and Shadow lakes. The point-intercept (PI) survey is a grid-based survey designed to assess the aquatic plant community at a lake-wide level, and allows for comparisons to other lakes and within the same lake over time. Emergent and floating-leaf aquatic plant community mapping surveys were completed by Onterra at the same time as the PI surveys. The purpose of the aquatic plant community mapping surveys is to map the floating-leaf (e.g., water lilies)

and emergent species (e.g., cattails and bulrushes) that grow within the lake and are typically under-represented in the point-intercept survey. Preliminary data from these surveys indicate that the floristic quality, an index of integrity, of Mirror and Shadow lakes is relatively similar to that of other lakes within the North Central Hardwood Forests ecoregion. This will be discussed in further detail in the full report. Some of the most frequently encountered native aquatic plant species found in Mirror and Shadow lakes in 2020 are displayed in Figure 4.
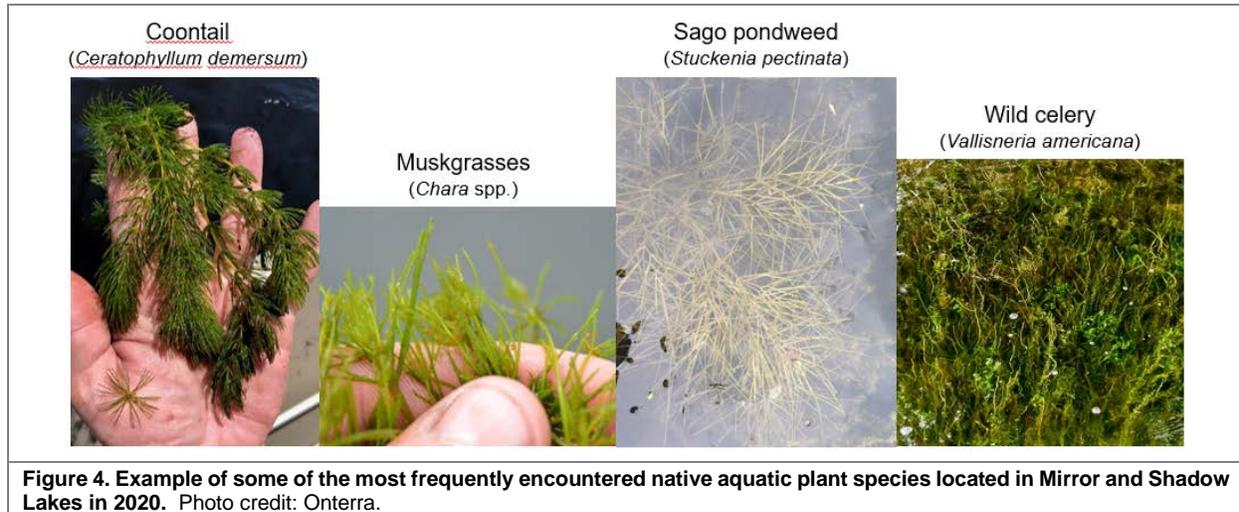
Figure 4. Example of some of the most frequently encountered native aquatic plant species located in Mirror and Shadow Lakes in 2020. Photo credit: Onterra.

A number of non-native aquatic plant species were observed in both Mirror and Shadow lakes during these plant surveys as well (Figure 5). Pale-yellow iris, purple loosestrife, reed canary grass, Eurasian watermilfoil, and curly-leaf pondweed were all observed in or around both of the lakes. These non-native species were previously known to exist in the lakes and are not new occurrences.
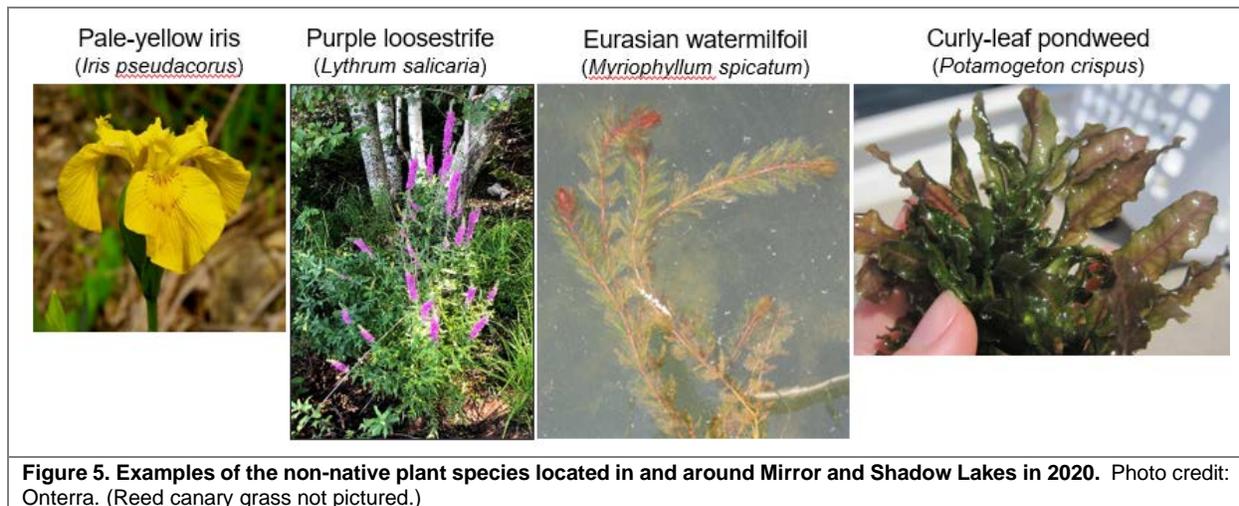

Figure 5. Examples of the non-native plant species located in and around Mirror and Shadow Lakes in 2020. Photo credit: Onterra. (Reed canary grass not pictured.)

Onterra ecologists are currently in the process of analyzing data and drafting the management plan report sections. The planning committee will meet with Onterra staff, likely in spring or early summer 2021, to learn more about the lakes and assemble a management plan aimed at protecting these important resources. The resulting plan will include management goals and actions for the lakes to be implemented by the WILPRD and/or FMSL.

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Waupaca Inland Lakes Protection & Rehabilitation District & Friends of Mirror & Shadow Lakes

**Mirror & Shadow Lakes
Management Planning Project
Planning Meeting I**
July 26, 2021

**Brenton Butterfield
&
Todd Hanke**
Onterra LLC
Lake Management Planning

Planning I Meeting Agenda

- Management Planning Project Overview
- Study Results
  - Water Quality
  - Watershed
  - Paleoecology
  - Shoreland Condition
  - Aquatic Plants
  - Fisheries Data Integration
- "Big Picture" Conclusions
- Planning Meeting II: Implementation Plan Framework - Goal Development

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Management Planning Project Overview

- Last management plan was completed in 2012 by UWSP
- Current project designed to assess the overall status of the lake
- Collect & analyze data – completed
  - Technical & sociological
- Construct long-term & useable plan

Management Plan Outline

DRAFT

Mirror and Shadow Lakes
Waupaca County, Wisconsin
Comprehensive Management Plan
Draft May 2021

- 1.0 Introduction
- 2.0 Stakeholder Participation
- 3.0 Study Results
  - 3.1 Water Quality
  - 3.2 Watershed
  - 3.3 Shoreland Condition
  - 3.4 Aquatic Plants
  - 3.5 Aquatic Invasive Species
  - 3.6 Fisheries Data Integration
- 4.0 Summary & Conclusions
- 5.0 Implementation Plan
- 6.0 Methods
- 7.0 Literature Cited

Planning Meeting I

Planning Meeting II

Summary of General Project Results

<u>Water Quality</u>
- Overall, water quality is *excellent* for Deep Headwater drainage lakes in Wisconsin
- Paleocore analysis shows increases in nutrients (phosphorus) in last century
- Increasing trend in chloride concentrations

<u>Watershed & Immediate Shoreline</u>
- Watersheds are relatively small
- Storm drains and wetlands re-direct waters and nutrients
- Shoreland mostly in good condition, many vegetated buffers present, few areas could be considered for restoration
- Modeling predicted lower P in Mirror Lake than measured – internal nutrient loading
- Modeling predicted higher P in Shadow Lake

<u>Aquatic Plant Community</u>
- Overall of good quality, signs of recent degradation
- Purple loosestrife, yellow iris, narrow-leaf cattail, and reed canary grass present around margins of lake
- EWM and CLP present in low to moderate levels

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Water Quality

Wisconsin Lakes Natural Community Types

Drainage Lakes

Seepage Lakes

Watershed Size:
Mirror – 42 acres
Shadow – 284 acres

Mirror Lake   Shadow Lake

Depth & Stratification
Deep Stratified
Wind
Epilimnion
Metalimnion
Hypolimnion

Shallow Mixed
Wind

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Natural Community Types

Categorization of lakes with similar features that influence water quality

Lakes/Reservoirs
≥ 10 acres (large)

Drainage   Seepage

Headwater   Lowland

Shallow *(mixed)* Deep *(stratified)* Shallow *(mixed)* Deep *(stratified)* Shallow *(mixed)* Deep *(stratified)*

2   3   4   5   6   7
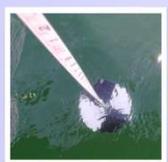
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Ecoregions

An area containing similar geology, physiography, hydrology, climate, and soils. As well as common terrestrial and aquatic fauna.

Northern Lakes and Forests

North Central Hardwood Forests

Mirror-Shadow Lakes

Driftless Area

Southeastern Wisconsin Till Plains

Introduction to Lake Water Quality

Phosphorus
Naturally occurring & essential for all life
Regulates phytoplankton biomass in most WI lakes
Most often 'limiting plant nutrient' (shortest supply)
Human development often increases P delivery to lakes
N:P Ratio: 33:1 (Mirror) 27:1 (Shadow)

Chlorophyll-*a*
Pigment used in photosynthesis
Used as surrogate for phytoplankton biomass

Secchi Disk Transparency
Measure of water clarity
Measured using a Secchi disk

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Near-Surface Total Phosphorus – Mirror Lake
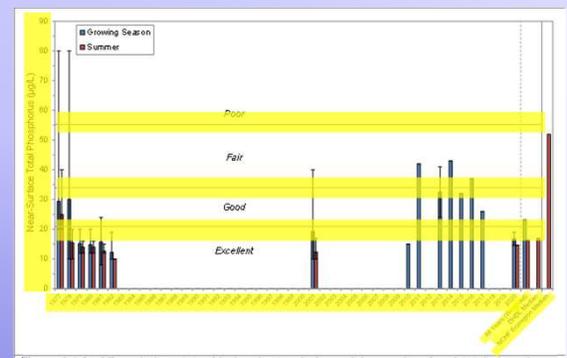
Figure 3.1-3. Mirror Lake, statewide headwater drainage lakes and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

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Near-Surface Total Phosphorus – Shadow Lake
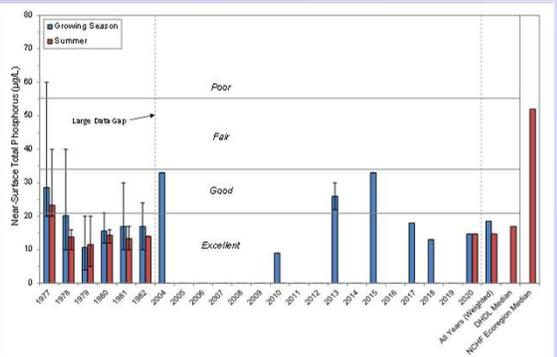
Figure 3.1-11. Shadow Lake, statewide headwater drainage lakes and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

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### Top & Bottom Phosphorus– Shadow Lake
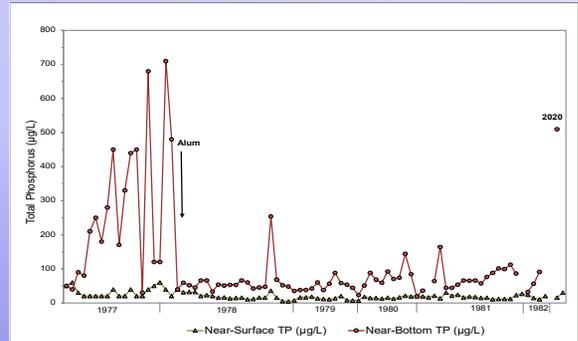
Figure 3.1-12. Shadow Lake total phosphorus concentrations in the top and bottom waters. Concentrations in the bottom samples were greatly reduced following the alum treatment in 1978 but were near pre-alum concentrations in 2020.

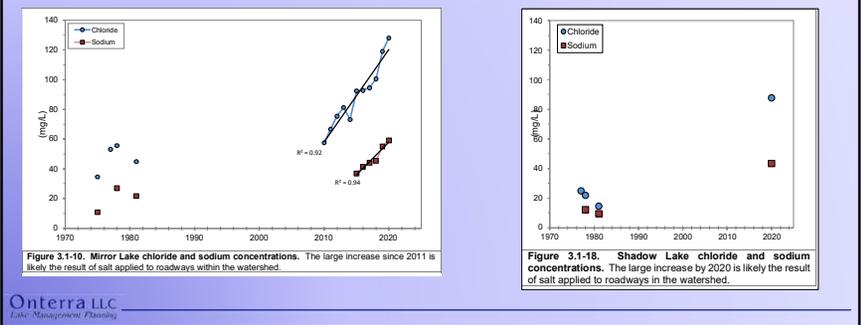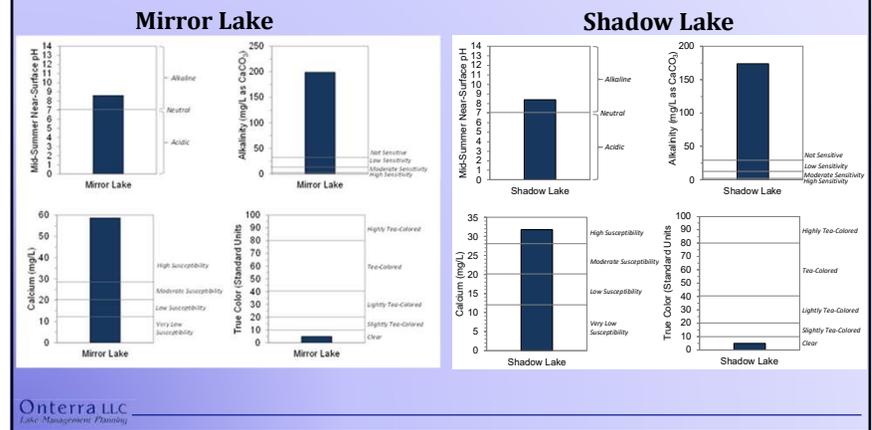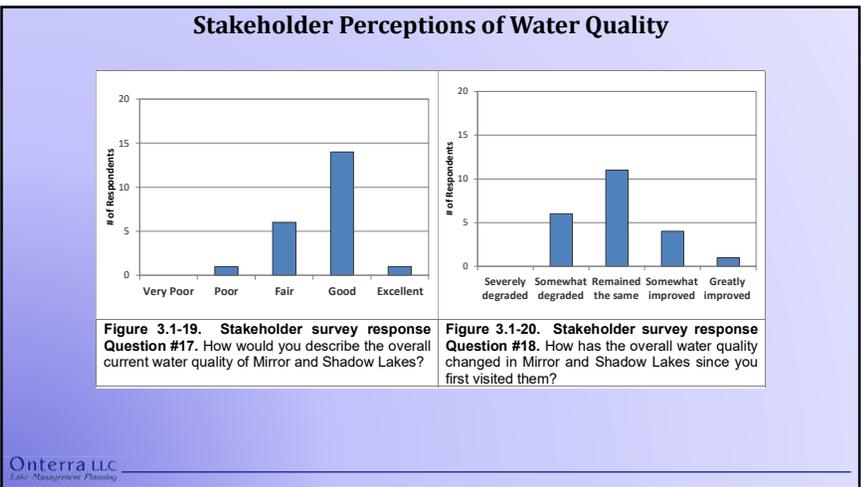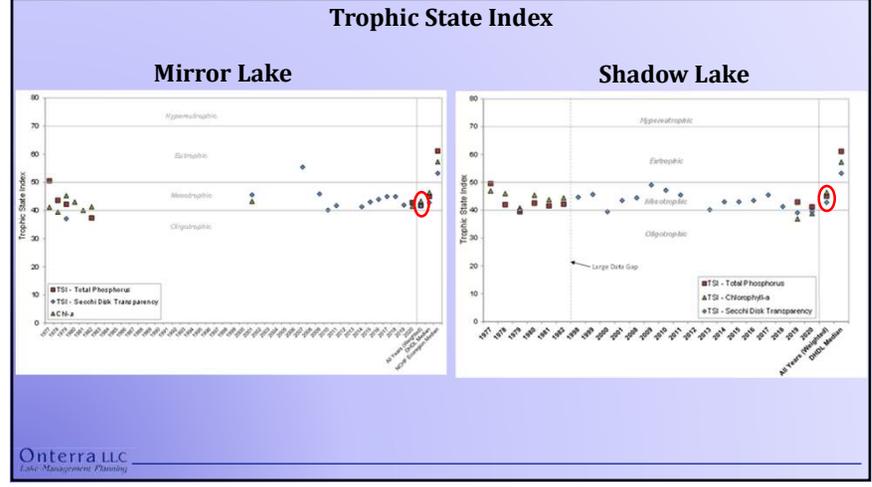Onterra LLC
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Chlorophyll-α

Mirror Lake

Shadow Lake

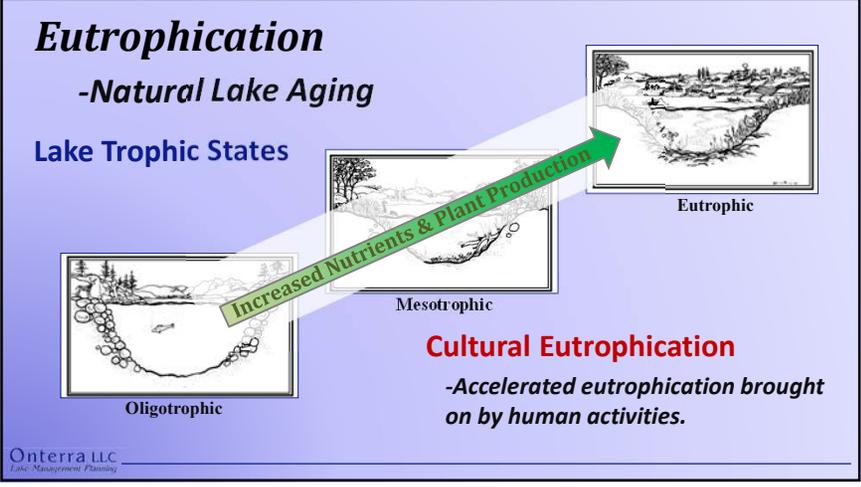## Secchi Disk Depth

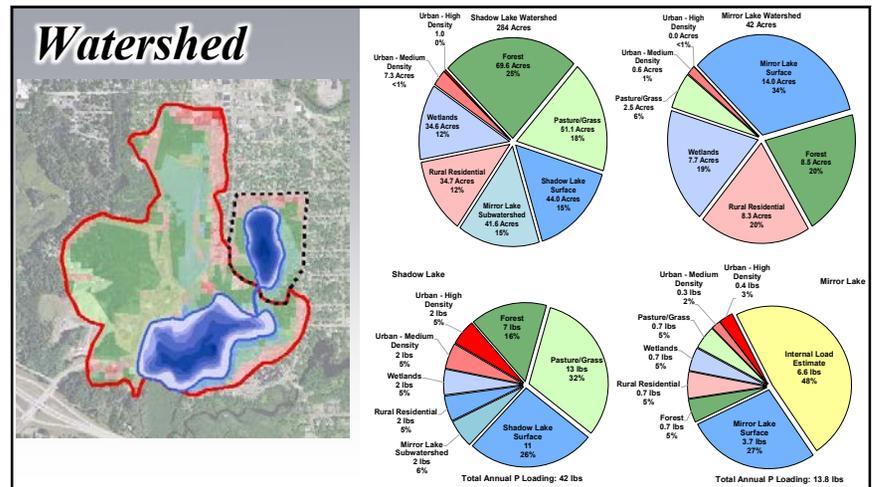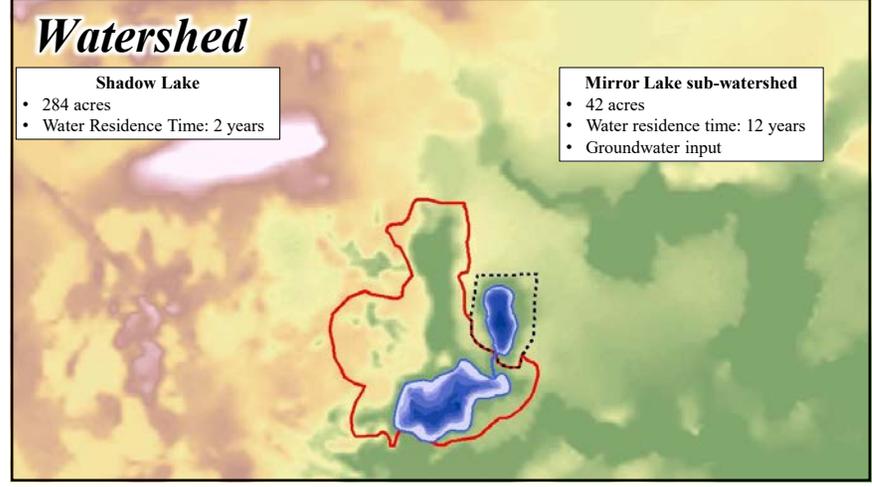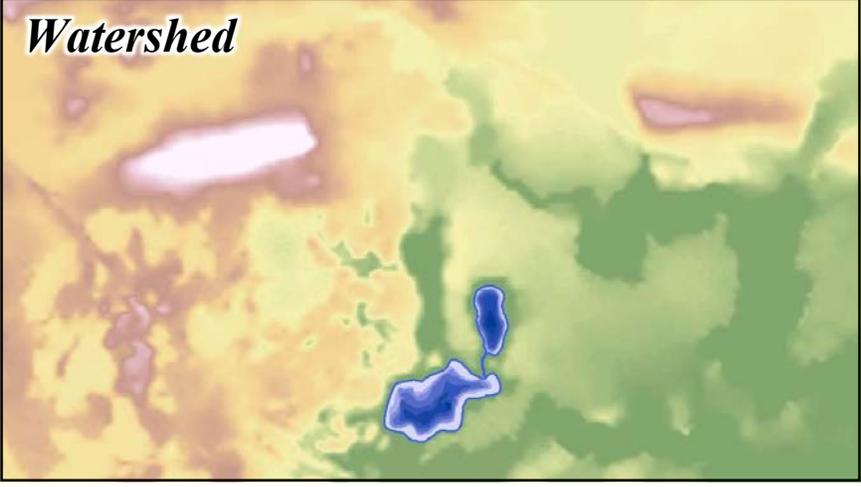### Mirror Lake

Shadow Lake
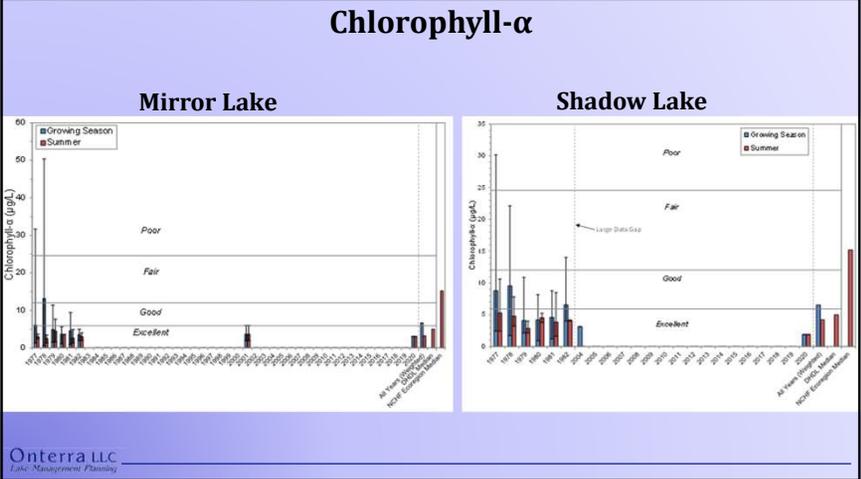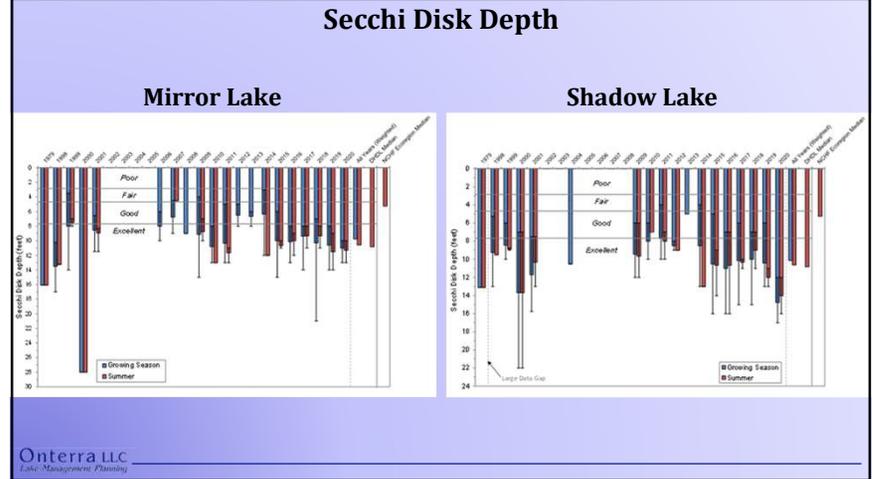
Chlorides

- Naturally occurs in waters at low levels (0-2 mg/L)
- High levels associated with road salts in watershed.
- Can cause ecological impacts
- The WDNR has set the chronic toxicity criterion for chloride at 395 mg/L

Figure 3.1-10. Mirror Lake chloride and sodium concentrations. The large increase since 2011 is likely the result of salt applied to roadways within the watershed.

Figure 3.1-18. Shadow Lake chloride and sodium concentrations. The large increase by 2020 is likely the result of salt applied to roadways in the watershed.

Additional Water Quality Parameters
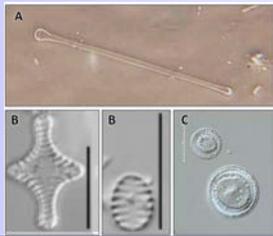
Mirror Lake

Shadow Lake

Paleoecology

- Shadow Lake core collected in 2020, Mirror Lake core from 1977 integrated into results.
- Fossilized diatoms in sediment core used to determine if and how water quality has changed over ~100+ years
- Diatom communities in top and bottom were different indicating an increase in nutrients including phosphorus

- Alum layer deposited in 1978 is visible.

- Mirror Lake core shows greatest change around 1950 when storm sewers discharged into lake and increased nutrients to the lake.

Alum Layer

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Shoreland Condition

Shoreline Development

Canopy
Shrub
Herbaceous

Canopy Cover
- 81-100
- 61-80
- 41-60
- 21-40
- 0-20

0.2 miles 11%
0.4 miles 21%
0.1 miles 6%
0.6 miles 29%
0.6 miles 32%

Shrub & Herbaceous Layer
- 81-100
- 61-80
- 41-60
- 21-40
- 0-20

0.1 miles 3%
0.4 miles 19%
0.4 miles 22%
0.2 miles 9%
0.9 miles 47%

Impervious Surface
- 75-100
- 50-74
- 25-49
- 1-24
- 0

0.2 miles 9%
0.02 miles 1%
0.9 miles 45%
0.9 miles 45%

Manicured Lawn
- 76-100
- 51-75
- 26-50
- 1-25
- 0

0.1 miles 2%
0.2 miles 10%
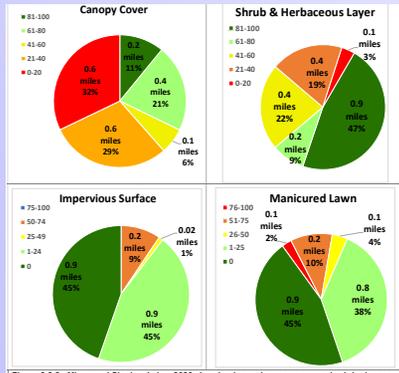0.1 miles 4%
0.9 miles 45%
0.8 miles 38%

Figure 3.3-2. Mirror and Shadow Lakes 2020 shoreland parcel canopy cover, shrub-herbaceous cover, manicured lawn, and impervious surface. Data from Onterra 2020 Survey.

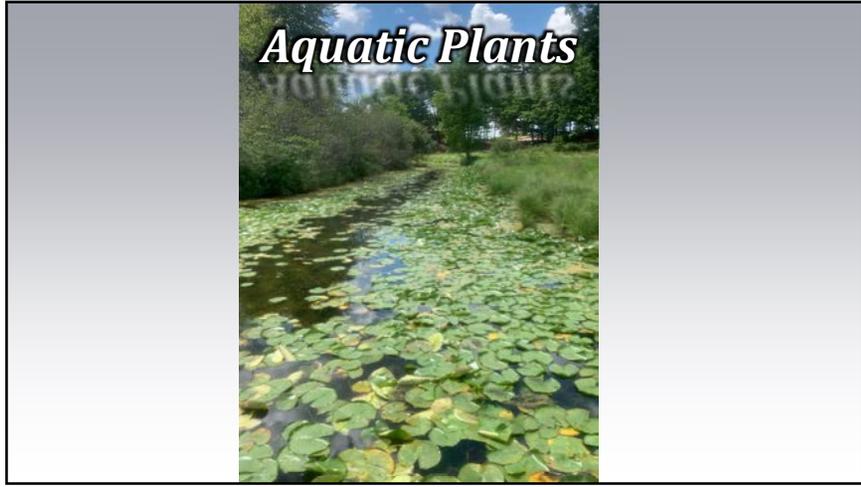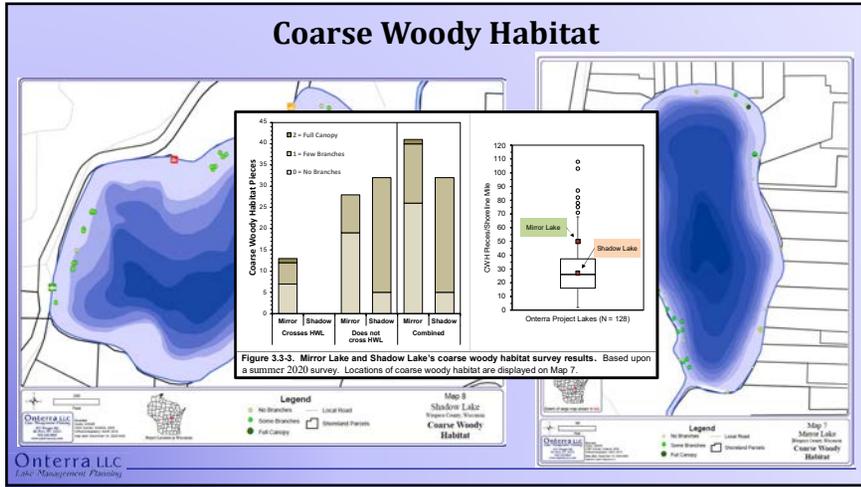Onterra LLC
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Shoreline Development

2012 Plan Goal: maintain 30' vegetated buffers

Evidence of restoration efforts observed in 2020

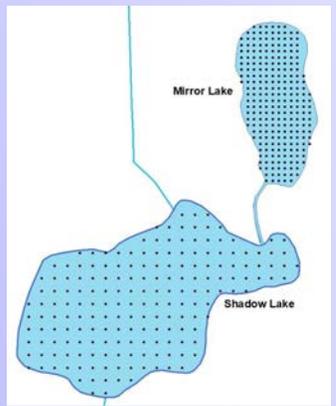
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Aquatic Plant Point-Intercept Survey

Mirror Lake:
15-meter Resolution
244 Total Points

Shadow Lake:
31-meter Resolution
185 Total Points

Plant Data Overview – Mirror Lake

- 2020 PI comparable to 2011 & 2018 data
- 41 total aquatic plant species recorded
- 15 native species on rake in 2020 survey
- 6 non-native plant species recorded
  - Purple loosestrife
  - Pale-yellow iris
  - Reed canary grass
  - Narrow-leaf cattail
  - Eurasian watermilfoil
  - Curly-leaf pondweed
- Max Rooting Depth: 16 feet

Plant Data Overview – Shadow Lake

- 2020 PI comparable to 2011 & 2018 data
- 39 total aquatic plant species recorded
- 20 native species on rake in 2020 survey
- 6 non-native plant species recorded
  - Purple loosestrife
  - Pale-yellow iris
  - Reed canary grass
  - Eurasian watermilfoil
  - Curly-leaf pondweed
  - Narrow-leaf cattail
- Max Rooting Depth: 25 feet

Substrate Types

Littoral Frequency of Occurrence – Mirror Lake
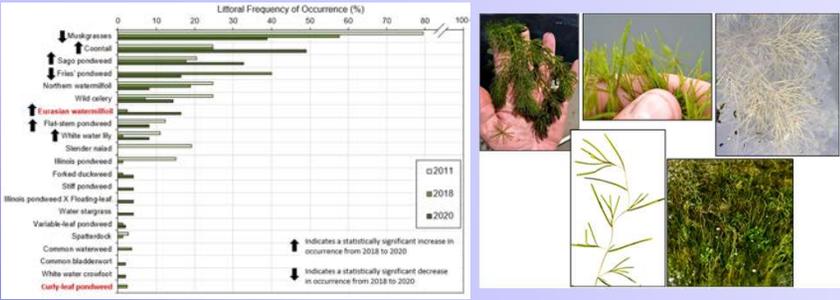
Littoral Frequency of Occurrence – Shadow Lake
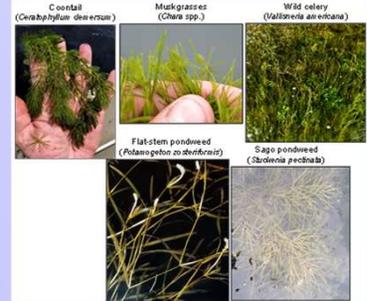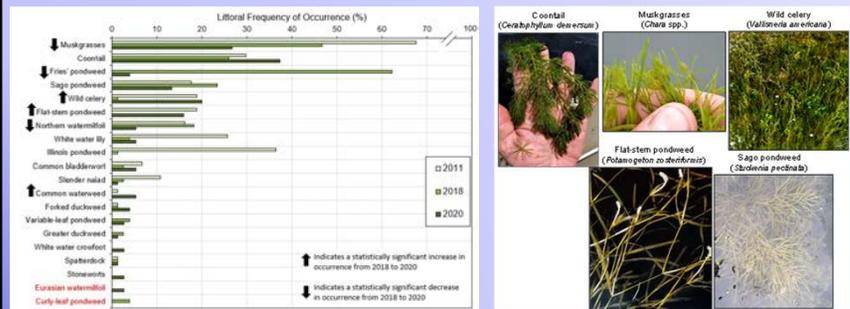
Vegetation Analysis Matrices

Floristic Quality Analysis

Evaluates the closeness of an area's flora to undisturbed conditions.

$$I = \bar{C} \times \sqrt{N}$$

I Floristic Quality Index

$\bar{C}$ Average Species Conservatism
1 – 10, higher number requires less disturbed condition

N Number of Native Species
Only species encountered on the rake are used (no incidentals)

Floristic Quality Analysis
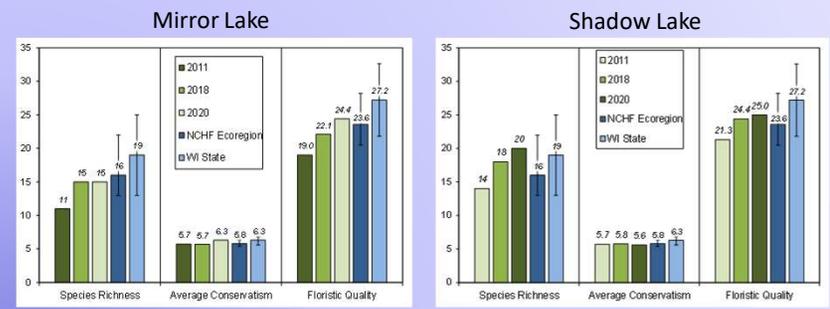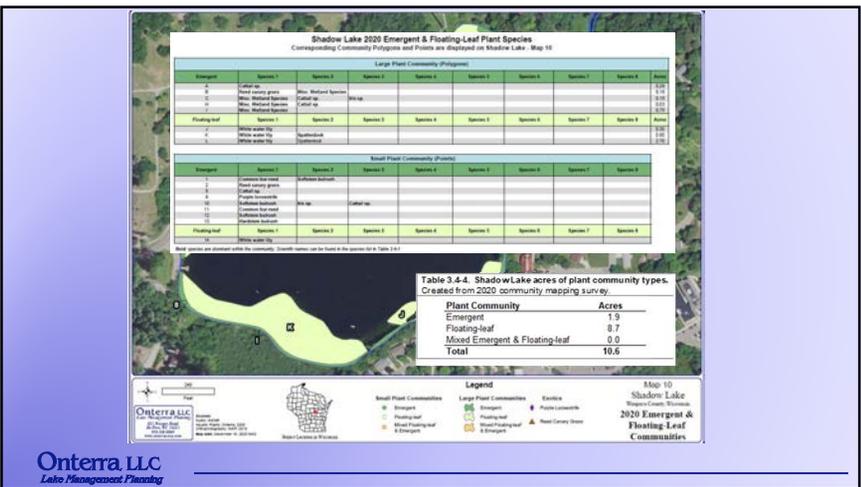
Professional AIS Mapping

Point-Based Mapping

- Single plants to colonies or areas less than 40-feet in diameter
- Abundance descriptions:
  - ○ Single or Few Plants
  - ● Clumps of Plants
  - ● Small Plant Colony

Professional AIS Mapping

Polygon-Based Mapping

- Colonies or areas over 40-feet diameter
- Boundary at target plant extent or morphological feature (depth contour, shoreline)
- Density ratings:

May not represent true colonies or "beds"

Increase in Ecological Impact

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting

June 2020 CLP Survey Results

CLP verified in Mirror-Shadow in 2011

2020 CLP Acreage

Mirror Lake	
Scattered	0.46
D = 1	0.04
Total:	0.5
Shadow Lake	
Highly Scattered	0.26
Scattered	2.4
Total:	2.66
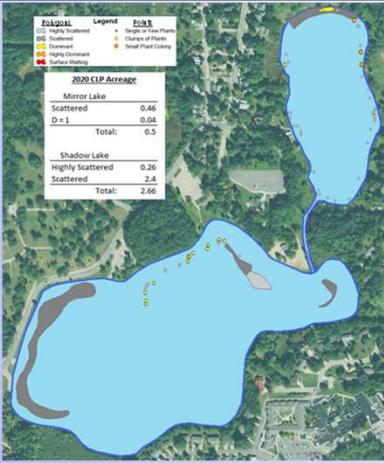
Purple Loosestrife & Pale-Yellow Iris

Shadow Lake
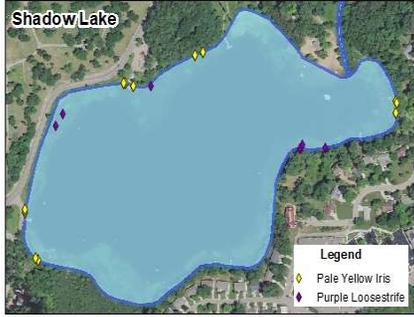
Mirror Lake

Legend
- ◆ Pale Yellow Iris
- ◆ Purple Loosestrife

Eurasian watermilfoil – Mirror Lake
EWM verified in Mirror-Shadow in 2011

Eurasian watermilfoil – Shadow Lake
Golden Sands RCD EWM hand harvesting efforts in recent years.

Aquatic Plants– Stakeholder Survey
Have aquatic plants ever had a negative impact on your enjoyment of Mirror and/or Shadow Lake?
Aquatic plants can be managed using many techniques. What is your level of support for the responsible use of the following techniques on Mirror and Shadow Lakes?

Fisheries

Fisheries – Stakeholder Survey

What species of fish do you like to catch in Mirror & Shadow Lakes?

How would you describe the current quality of fishing on Mirror & Shadow Lakes?

How has the quality of fishing changed on Mirror & Shadow Lakes since you have started fishing the lake?
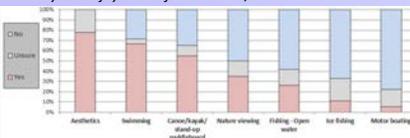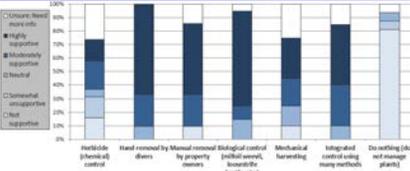
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Lake Management Planning
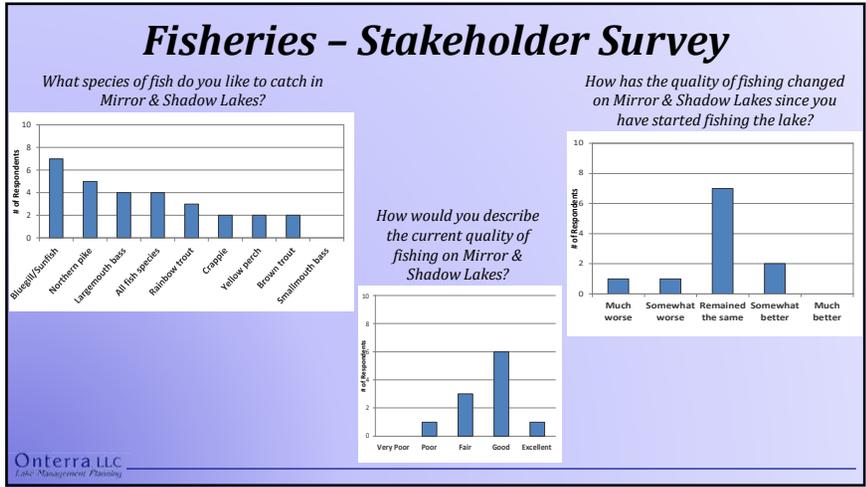
Fisheries

- Most recent WDNR comprehensive survey in 2016.

- Trout stocked in Mirror Lake regularly since 1990. Walleye, LMB, NOP stocked in Shadow Lake in early 1970's.

- WDNR managing to increase bluegill size. Special panfish regulations enacted in 2016.

- Habitat enhancement through past installation of "fish sticks".

angler

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Lake Management Planning

Big Picture Conclusions

Water Quality & Watershed
- Water quality overall in good condition
- Evidence of higher nutrient levels
- Increasing concentrations of chloride, possibly resulting in declines in aquatic plant species

Aquatic Plant Community
- Native aquatic community overall of good quality, however evidence of degradation in recent years
- Eurasian watermilfoil and curly-leaf pondweed present in low to moderate levels
- Purple loosestrife, Pale yellow iris, narrow-leaf cattail, reed canary grass present around margins of the lake, could be considered for management

Shorelands & Fisheries
- Shoreland overall in good condition, some areas identified for restoration opportunities
  Fishery managed for trout and panfish by WDNR

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Lake Management Planning

Planning Meeting II

Primary Objective: Create implementation plan framework

Steps to Achieve Objective:
1. Discuss challenges facing the lake and the lake group
2. Convert challenges to management goals
3. Create management actions to meet management goals
4. Determine timeframes and facilitators to carry out actions

Assignment for Planning Meeting II
1. Create list of challenges facing lake and lake group – keep for meeting
2. Review stakeholder survey results
3. Send potential report section edits and questions to Brenton

Onterra LLC
Lake Management Planning

Mirror and Shadow Lakes - Anonymous Stakeholder Survey

Surveys Distributed: 58
Surveys Returned: 22
Response Rate: 38%

Mirror and Shadow Lakes Property

1. Which lake is your property located on? If you own more than one property, please refer to the property you have owned the longest.

Answer Options	Response Percent	Response Count
Mirror Lake	59.1%	13
Shadow Lake	31.8%	7
Not on either lake	9.1%	2
answered question		22
skipped question		0

2. How many years have you owned or rented your property on or near Mirror and Shadow Lakes?

Answer Options	Response Count
	22
answered question	22
skipped question	0

Category (# of years)	Responses	% Response
0 to 5	5	23%
6 to 10	3	14%
11 to 25	9	41%
>25	5	23%
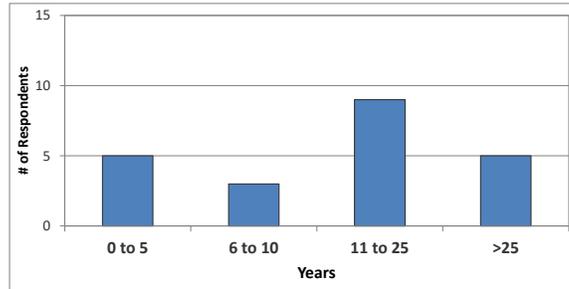
3. How is your property on or near Mirror and Shadow Lakes used?

Answer Options	Response Percent	Response Count
Full-time Residence	86.4%	19
Part-time Residence	4.5%	1
Vacation Property	0.0%	0
Resort property	0.0%	0
Rental property	0.0%	0
Other (please specify)	9.1%	2
answered question		22
skipped question		0

Number	Other (please specify)
1	I don't own property on either lake.
2	Community
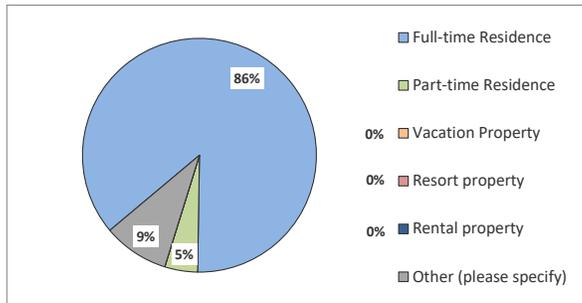
4. Considering the past three years, how many days each year is your property used by you or others?

Answer Options	Response Count
	22
answered question	22
skipped question	0

Category (# of days)	Responses	%
0 to 30	6	27%
31 to 90	1	5%
91 to 120	0	0%
121 to 210	1	5%
211 to 300	2	9%
301 to 365	12	55%
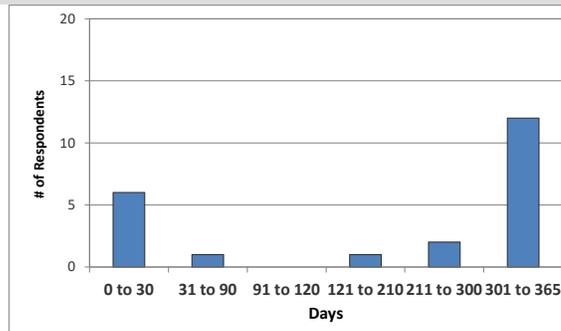
5. What type of septic system does your property have?

Answer Options	Response Percent	Response Count
Holding tank	0.0%	0
Mound/Conventional system	0.0%	0
Municipal sewer	95.5%	21
Advanced treatment system	0.0%	0
Do not know	4.5%	1
No septic system	0.0%	0
	answered question	22
	skipped question	0
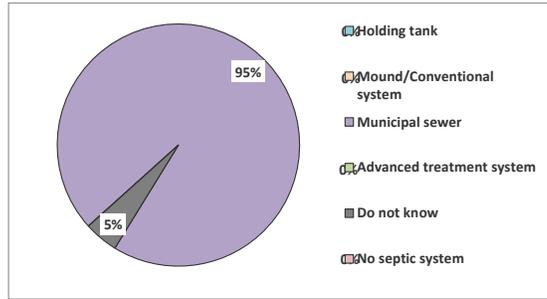
6. How often is the septic system on your property pumped?

Answer Options	Response Percent	Response Count
Multiple times a year	0.0%	0
Once a year	0.0%	0
Every 2-4 years	0.0%	0
Every 5-10 years	0.0%	0
Do not know	100.0%	1
	answered question	1
	skipped question	21
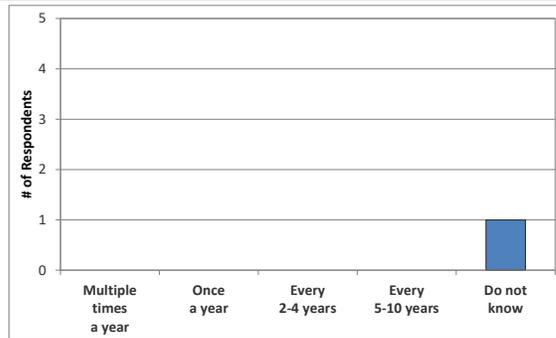
Recreational Activity on Mirror and Shadow Lakes

7. How many years ago did you first visit Mirror and Shadow Lakes?

Answer Options	Response Count
	22
answered question	22
skipped question	0

Category (# of years)	Responses	% Response
0 to 10	5	23%
11 to 30	5	23%
31 to 50	8	36%
>50	4	18%
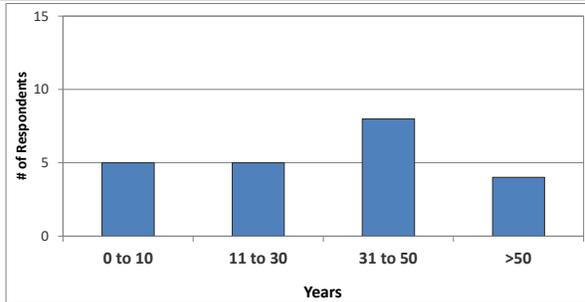
8. Have you personally fished on Mirror and Shadow Lakes in the past three years?

Answer Options	Response Percent	Response Count
Yes	57.1%	12
No	42.9%	9
	answered question	21
	skipped question	1

9. What species of fish do you like to catch on Mirror and Shadow Lakes?

Answer Options	Response Percent	Response Count
Bluegill/Sunfish	63.6%	7
Northern pike	45.5%	5
Largemouth bass	36.4%	4
All fish species	36.4%	4
Rainbow trout	27.3%	3
Crappie	18.2%	2
Yellow perch	18.2%	2
Brown trout	18.2%	2
Smallmouth bass	0.0%	0
Other	0.0%	0
	answered question	11
	skipped question	11
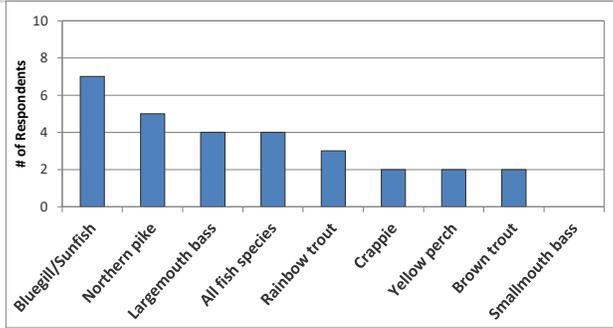
10. How would you describe the current quality of fishing on Mirror and Shadow Lakes?

Answer Options	Very Poor	Poor	Fair	Good	Excellent	Response Count
	0	1	3	6	1	11
					answered question	11
					skipped question	11
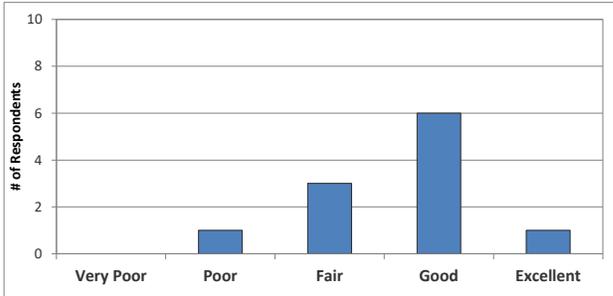
11. How has the quality of fishing changed on Mirror and Shadow Lakes since you have started fishing the lake?

Answer Options	Much worse	Somewhat worse	Remained the same	Somewhat better	Much better	Response Count
	1	1	7	2	0	11
					answered question	11
					skipped question	11
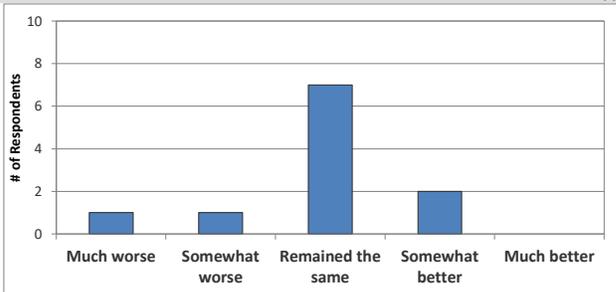
12. What types of watercraft do you currently use on Mirror and Shadow Lakes?

Answer Options	Response Percent	Response Count
Canoe/kayak/stand-up paddleboard	81.8%	18
Paddleboat	45.5%	10
Rowboat	9.1%	2
Do not use watercraft on Mirror & Shadow Lake	9.1%	2
Motor boat with 25 hp or less motor	4.6%	1
Pontoon	4.6%	1
Motor boat with greater than 25 hp motor	0.0%	0
Sailboat	0.0%	0
Do not use watercraft on any waters	0.0%	0
answered question		22
skipped question		0
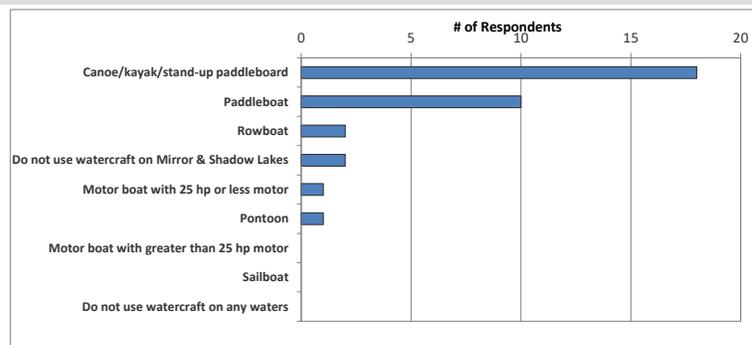
13. Do you use your watercraft on waters other than Mirror and Shadow Lakes?

Answer Options	Response Percent	Response Count
Yes	31.8%	7
No	68.2%	15
answered question		22
skipped question		0

14. What is your typical cleaning routine after using your watercraft on waters other than Mirror and Shadow Lakes?

Answer Options	Response Percent	Response Count
Remove aquatic hitchhikers (ex. plant material, clams, mussels)	50.0%	3
Drain bilge	0.0%	0
Rinse boat	16.7%	1
Power wash boat	0.0%	0
Apply bleach	0.0%	0
Air dry boat for 5 or more days	66.7%	4
Do not clean boat	0.0%	0
Other		1
answered question		6
skipped question		16

Number	Other (please specify)
1	Spray with garden hose water pumped from private well

15. Please rank up to three activities that are important reasons for owning your property on or near Mirror and Shadow Lakes, with 1 being the most important.

Answer Options	1st	2nd	3rd	Weighted Average	Response Count
Canoeing / kayaking / stand-up paddleboard	6	6	4	1.88	16
Relaxing / entertaining	5	5	6	2.06	16
Swimming	6	3	3	1.75	12
Nature viewing	3	3	2	1.88	8
Fishing - open water	1	0	1	2	2
Other (please specify below)	0	1	1	2.5	2
Ice fishing	0	0	1	3	1
Sailing	0	1	0	2	1
None of these activities are important to me	1	0	0	1	1
Motor boating	0	0	0	0	0
Jet skiing	0	0	0	0	0
Hunting	0	0	0	0	0
Water skiing / tubing	0	0	0	0	0
Snowmobiling / ATV	0	0	0	0	0
				answered question	22
				skipped question	0

Number	"Other" responses
1	Snowshoeing (2nd); Boat Rowing (3rd)
2	Cross country skiing & snow shoeing
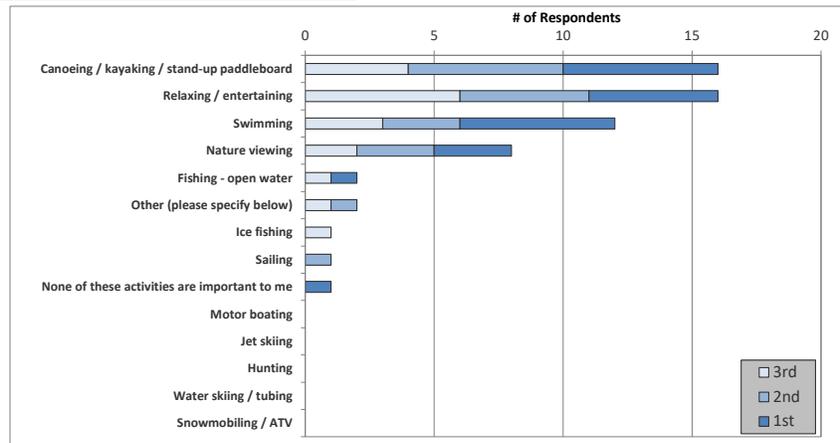
Mirror and Shadow Lakes Current and Historic Condition, Health and Management

16. From the list below, please rank your top three concerns regarding Mirror and Shadow Lakes, with 1 being your top concern.

Answer Options	1st	2nd	3rd	Response Count
Aquatic invasive species introduction	7	7	6	20
Water quality degradation	6	4	1	11
Excessive aquatic plant growth (excluding algae)	3	4	1	8
Algae blooms	2	1	5	8
Loss of aquatic habitat	1	1	2	4
Shoreline development	1	1	0	2
Excessive fishing pressure	0	0	2	2
Noise/light pollution	0	1	1	2
Shoreline erosion	0	0	1	1
Excessive watercraft traffic	1	0	0	1
Unsafe watercraft pratices	0	1	0	1
Other (please specify)	1	0	0	1
Septic system discharge	0	0	0	0
		answered question		22
		skipped question		0

Number	"Other" responses
1	Geese
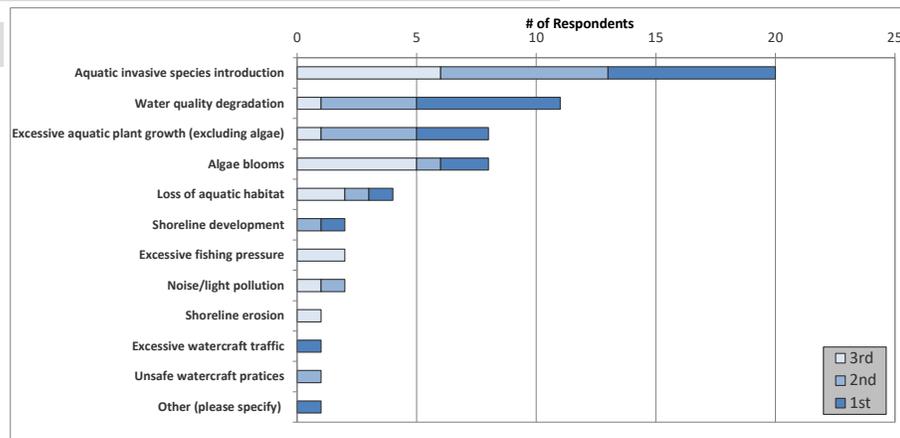
17. How would you describe the overall current water quality of Mirror and Shadow Lakes?

Answer Options	Very Poor	Poor	Fair	Good	Excellent	Response Count
	0	1	6	14	1	22
				answered question		22
				skipped question		0
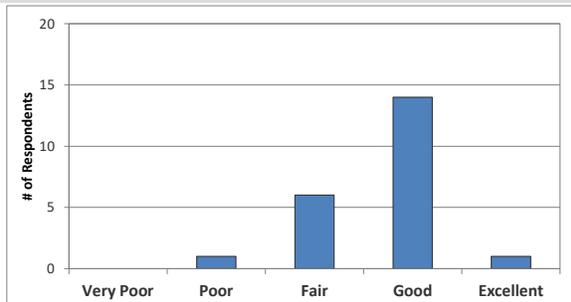
18. How has the overall water quality changed in Mirror and Shadow Lakes since you first visited them?

Answer Options	Severely degraded	Somewhat degraded	Remained the same	Somewhat improved	Greatly improved	Response Count
	0	6	11	4	1	22
					answered question	22
					skipped question	0
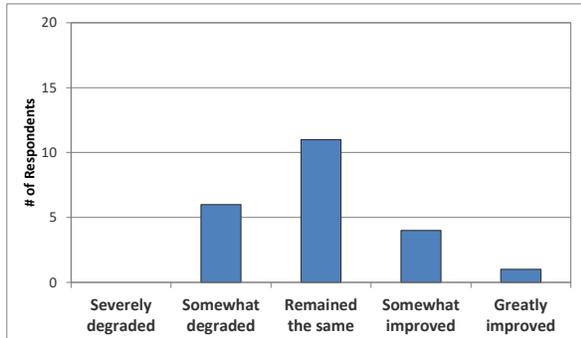
19. Which of the following would you say is the single most important aspect when considering water quality?

Answer Options	Response Percent	Response Count
Water clarity (clearness of water)	36.4%	8
Water color	0.0%	0
Aquatic plant growth (not including algae blooms)	13.6%	3
Algae blooms	27.3%	6
Smell	4.5%	1
Water level	0.0%	0
Fish kills	0.0%	0
Other	18.2%	4
answered question		22
skipped question		0

Number	"Other" responses
1	Biogeochemistry
2	Shoreline Habitat
3	Winter oxygen levels
4	IAS

Aquatic invasive species (AIS) are non-native plants and animals that are introduced into our lakes and streams and can potentially upset the natural balance of a lake ecosystem while decreasing recreational opportunities. Examples of AIS include animals such as carp, zebra mussels, rusty crayfish, round goby, and spiny waterflea; and plants such as Eurasian watermilfoil, purple loosestrife, and curly-leaf pondweed.

20. Before reading the statement above, had you ever heard of aquatic invasive species?

Answer Options	Response Percent	Response Count
Yes	100.0%	21
No	0.0%	0
answered question		21
skipped question		1

21. Do you believe aquatic invasive species are present within Mirror and Shadow Lakes?

Answer Options	Response Percent	Response Count
Yes	95.5%	21
I think so but am not certain	4.5%	1
No	0.0%	0
answered question		22
skipped question		0

22. Which aquatic invasive species do you believe are present in or immediately around Mirror and Shadow Lakes?

Answer Options	Response Percent	Response Count
Eurasian watermilfoil	81.8%	18
Curly-leaf pondweed	77.3%	17
Zebra mussels	77.3%	17
Purple loosestrife	68.2%	15
Pale-yellow iris	31.8%	7
Other	13.6%	3
Carp	9.1%	2
Faucet snail	4.6%	1
Banded/Chinese mystery snail	4.6%	1
Rusty crayfish	4.6%	1
Round goby	4.6%	1
Flowering rush	0.0%	0
Giant reed (Phragmites)	0.0%	0
Starry stonewort	0.0%	0
Reed canary grass	0.0%	0
Freshwater jellyfish	0.0%	0
Spiny waterflea	0.0%	0
Rainbow smelt	0.0%	0
Unsure, but presume AIS to be present	0.0%	0
answered question		22
skipped question		0

23. Have aquatic plants ever had a negative impact on your enjoyment of Mirror and/or Shadow Lakes?

Answer Options	Yes	Unsure	No	Response Count
Aesthetics	14	4	0	18
Swimming	14	1	6	21
Canoeing/kayaking/stand-up paddleboard	11	2	7	20
Nature viewing	7	3	10	20
Fishing - Open water	5	3	11	19
Ice fishing	2	4	12	18
Motor boating	1	3	14	18
Other (please specify)				
answered question				22
skipped question				0
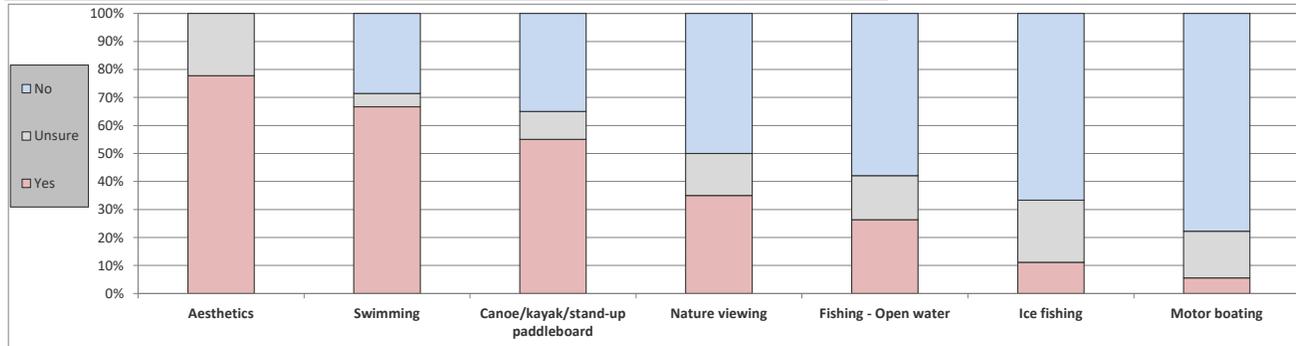
24. Aquatic plants can be managed using many techniques. What is your level of support for the responsible use of the following techniques on Mirror and Shadow Lakes?

Answer Options	Not supportive	Somewhat unsupportive	Neutral	Moderately supportive	Highly supportive	Unsure: Need more info	Weighted Average	Response Count
Herbicide (chemical) control	3	3	1	4	3	5	2.26	19
Hand-removal by divers	0	0	2	5	14	0	4.57	21
Manual removal by property owners	2	0	0	5	11	3	3.67	21
Biological control (milfoil weevil, loosestrife beetle, etc.)	0	0	3	2	14	1	4.35	20
Mechanical harvesting	2	0	3	4	6	5	2.85	20
Integrated control using many methods	0	0	2	6	9	3	3.75	20
Do nothing (do not manage plants)	13	1	1	0	0	1	1.13	16
						answered question		**21**
						skipped question		**1**
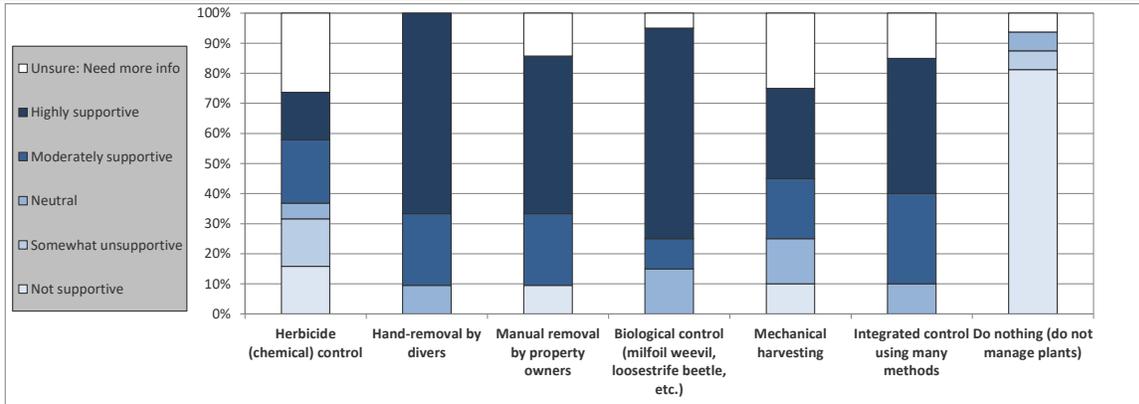
The City of Waupaca has run an aerator in Mirror Lake over the past 15+ years to help prevent winter fish kills. Each year, the aerator is typically turned on in October until ice begins to form, and then again in spring for about a month when the ice starts getting thin near the shoreline.

25. Before reading the statement above, were you aware of the aerator being run in Mirror Lake?

Answer Options	Response Percent	Response Count
Yes	95.5%	21
No	4.5%	1
answered question		**22**
skipped question		**0**

26. Do you understand the purpose of the aerator being run?

Answer Options	Response Percent	Response Count
Yes	100.0%	22
No	0.0%	0
answered question		**22**
skipped question		**0**

27. Do you support this action of running the aerator in Mirror Lake each year?

Answer Options	Response Percent	Response Count
Yes	100.0%	22
No	0.0%	0
Unsure		0
answered question		**22**
skipped question		**0**

28. Would you support ordinances that help protect lakes and keep them healthy if it meant having to make changes on your property?

Answer Options	Response Percent	Response Count
Yes	28.6%	6
Maybe - need more information	57.1%	12
No	14.3%	3
answered question		**21**
skipped question		**1**

Waupaca Inland Lakes Protection & Rehabilitation District (WILPRD) and Friends of Mirror & Shadow Lakes (FMSL)

The Waupaca Inland Lakes Protection & Rehabilitation District (WILPRD) includes the residents of the City of Waupaca and is overseen by Waupaca Parks & Recreation whose vision is to create a strong community through lifelong recreation.

The Friends of Mirror & Shadow Lakes (FMSL) are a group of concerned neighbors that work together to promote the health of the lakes. The FMSL formed through a lake study grant in 2003. This grant recommended that a citizen's group form to continue to monitor and watch the overall health of the lakes, as well as addressing new concerns and issues.

29. Before receiving this, had you ever heard of the WILPRD?

Answer Options	Response Percent	Response Count
Yes	68.2%	15
No	31.8%	7
answered question		**22**
skipped question		**0**

30. How informed has (or had) the WILPRD kept you regarding issues with Mirror and Shadow Lakes and their management?

Answer Options	Not at all informed	Not too informed	Neither informed or uninformed	Fairly well informed	Highly informed	Response Count
	0	2	5	6	3	16
answered question						**16**
skipped question						**6**
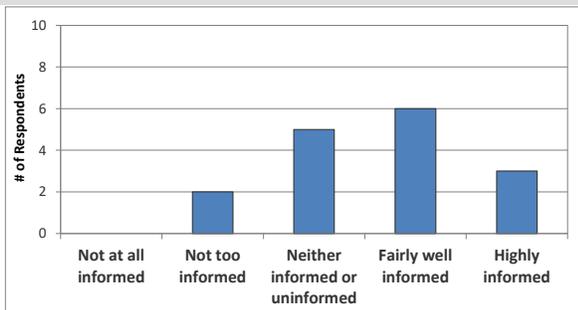
31. Before receiving this, had you ever heard of the Friends of Mirror & Shadow Lakes?

Answer Options	Response Percent	Response Count
Yes	100.0%	22
No	0.0%	0
answered question		**22**
skipped question		**0**

32. What is your membership status with the Friends of Mirror & Shadow Lakes?

Answer Options	Response Percent	Response Count
Current member	63.6%	14
Former member	13.6%	3
Never been a member	22.7%	5
answered question		**22**
skipped question		**0**

33. Stakeholder education is an important component of every lake management planning effort. Which of these subjects would you like to learn more about?

Answer Options	Response Percent	Response Count
Aquatic invasive species impacts, means of transport, indentification, control options, etc.	60.0%	12
How to be a good lake steward	70.0%	14
How changing water levels impact Mirror and Shadow Lakes	60.0%	12
Social events occurring around Mirror and Shadow Lakes	45.0%	9
Enhancing in-lake habitat (not shoreland or adjacent wetlands) for aquatic species	60.0%	12
Ecological benefits of shoreland restoration and preservation	40.0%	8
Watercraft operation regulations - lake specific, local, and statewide	15.0%	3
Volunteer lake monitoring and citizen science opportunities	15.0%	3
Not interested in learning more on any of these subjects	5.0%	1
Some other topic	0.0%	0
	answered question	20
	skipped question	2
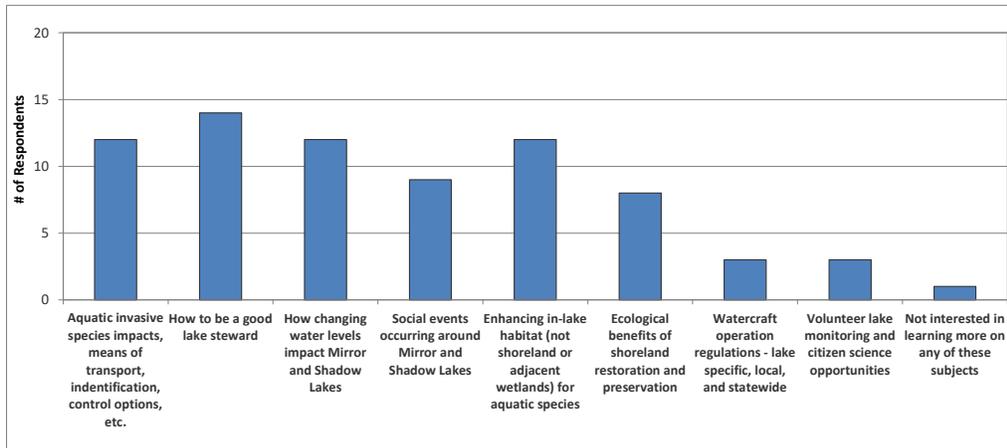
34. The effective management of Mirror and Shadow Lakes will require the cooperative efforts of numerous volunteers. Please circle the activities you would be willing to participate in if additional assistance was required.

Answer Options	Response Percent	Response Count
Watercraft inspections at boat landings	9.5%	2
Fundraising events	23.8%	5
Writing newsletter articles	19.1%	4
Attending WI Lakes Convention	14.3%	3
Serve on WILPRD Board	19.1%	4
Join/assist FMSL	47.6%	10
Aquatic plant monitoring	23.8%	5
Water quality monitoring	28.6%	6
Wildlife monitoring	28.6%	6
Managing social media account(s) and/or webs	14.3%	3
Bulk mailing assembly	42.9%	9
I do not wish to volunteer	28.6%	6
Another activity	0.0%	0
answered question		21
skipped question		1
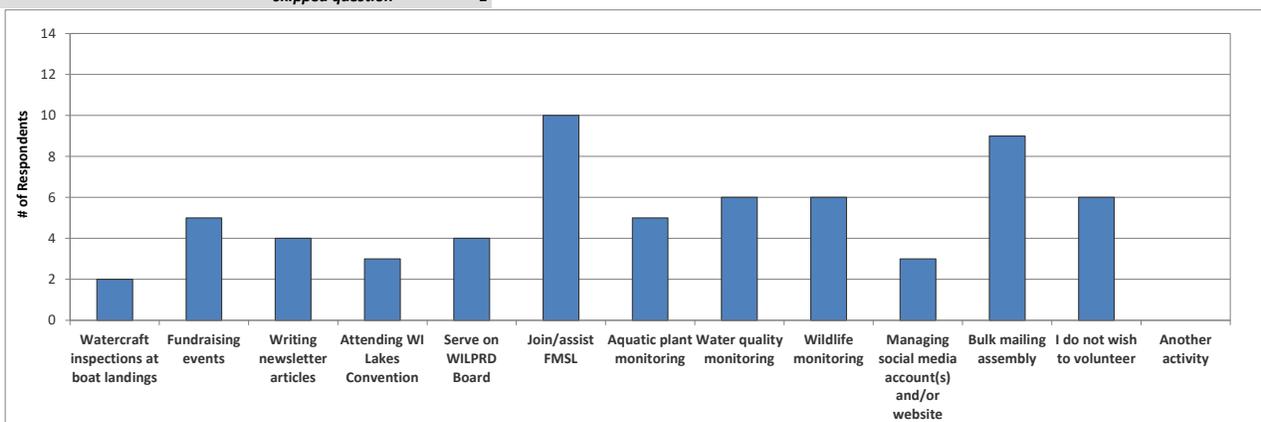
35. Please feel free to provide written comments concerning Mirror and Shadow Lakes, its current and/or historic condition and its management.

Answer Options	Response Count
answered question	10
skipped question	12

Number	Response Text
1	I noticed white foam building up on the easterly shores of Shadow Lake this fall when there are strong westerly winds. Does this possibly mean the lake is accumulating detergent chemicals?
2	concern about silting and the algae blooms. I understand the lakes drain perhaps 30-40% of all the stormwater generated in the City. If this is correct than some type of regulation, public information campaign about phosphorus seems appropriate. Also, I think there is the feeling that any investment in the lakes should be borne by the property owners living on the lakes. Why the case might seem easy to make the lakes are open to all residents and visitors so burdening property owners with the costs to maintain and improve the lakes is not equitable. Perhaps allocating 10 - 15% of overall costs to property owners is defensible but certainly not much more given who uses and enjoys this important natural resource in our city.
3	More community involvement is needed to keep our city lakes beautiful and healthy,so everyone can continue to enjoy them. You don't know what you have until it's gone and if we don't take care of our lakes, they will deteriorate.
4	We love Mirror and Shadow Lakes and feel honored to live on Mirror Lake. We gaze upon it every day and are very thankful to all who work to keep it beautiful. Thanks you
5	Aquatic invasive plants along the northern shoreline of Mirror Lake have GREATLY increased over the past two years. Without intervention, these plants will have a large negative impact on overall water quality.
6	The weird algae blooms and floating scum have become worse every year. I'd be in favor of some type of treatment to reduce them. We've also pulled a lot of zebra mussels out this year.
7	Increase in phosphorous content from underground flow over past 20 years which caused increase of algae blooms and degrades water quality.
8	water quality over last 28 years I have been here has varied by year. Last 2 years have been improvement. but invasive plants are moving farther into lake and making swimming from dock more difficult
9	FOMSL has done a tremendous job in improving the quality of the lakes and life on them, entirely due tp Carol Elvery's efforts. She has been a tireless advocate for the lakes and I am personally grateful to her. I've never been contacted by the other organization you reference here which tells me all I need to know about them.
10	I miss the quality of fish both lakes used to have.

C

APPENDIX C

Water Quality Data

Mirror Lake

Year	Secchi (feet) Growing Season Count	Mean	Summer Count	Mean	Chlorophyll-*a* (µg/L) Growing Season Count	Mean	Summer Count	Mean	Total Phosphorus (µg/L) Growing Season Count	Mean	Summer Count	Mean
1975	0		0						0		0.0	
1976	0		0						0		0.0	
1977	0		0		15	6.0	7	2.9	16	29.4	8.0	25.0
1978	0		0		18	13.2	6	2.5	22	30.0	7.0	15.4
1979	1	16.1	1	16.1	13	4.9	6	4.5	10	15.2	5.0	14.0
1980	0		0		10	3.6	2	3.6	8	14.9	3.0	14.0
1981	0		0		13	4.6	5	2.6	14	15.7	6.0	12.7
1982	0		0		4	3.5	2	3.0	4	12.3	1.0	10.0
Data Gap												
1998	3	13.5	1	13.3	0		0		0		0.0	
1999	6	8.0	2	7.5	0		0		0		0.0	
2000	1	28.0	1	28.0	0		0		0		0.0	
2001	6	8.5	5	8.9	3	3.6	3	3.6	4	19.3	3.0	12.3
2002	0		0		0		0		0		0.0	
2003	0		0		0		0		0	22.7	0.0	17.0
2004	0		0		0		0		0		0.0	
2005	0		0		0		0		0		0.0	
2006	2	8.0	0		0		0		0		0.0	
2007	2	6.8	1	4.5	0		0		0		0.0	
2008	1	9.0	0		0		0		0		0.0	
2009	9	9.1	4	8.8	0		0		0		0.0	
2010	5	10.8	1	13.0	0		0		1	15.0	0.0	
2011	6	10.3	3	11.7	0		0		1	42.0	0.0	
2012	2	6.5	0		0		0		0		0.0	
2013	3	6.7	0		0		0		2	32.5	0.0	
2014	3	6.3	1	12.0	0		0		1	43.0	0.0	
2015	7	10.0	3	10.7	0		0		1	32.0	0.0	
2016	8	10.1	3	10.0	0		0		1	37.0	0.0	
2017	8	9.4	3	9.3	0		0		1	26.0	0.0	
2018	7	10.3	3	9.3	0		0		0		0.0	
2019	5	10.6	2	11.5	0		0		0		0.0	
2020	4	11.0	3	11.3	1	3.0	1	3.0	3	11.2	1.0	14.6
All Years (Weighted)		9.7		10.6		6.7		3.2		22.9		16.4
DHDL Median				10.8				5.0				17.0
NCHF Ecoregion Median				5.3				15.2				52.0

Shadow Lake

Year	Secchi (feet) Growing Season Count	Mean	Summer Count	Mean	Chlorophyll-a (µg/L) Growing Season Count	Mean	Summer Count	Mean	Total Phosphorus (µg/L) Growing Season Count	Mean	Summer Count	Mean
1977	0		0		15	8.8	7	5.3	14	28.6	6.0	23.3
1978	0		0		16	9.5	6	4.8	18	20.2	6.0	13.8
1979	1	13.1	1	13.1	11	4.1	5	2.8	18	10.7	12.0	11.6
1980	0		0		9	4.2	3	4.5	7	15.6	3.0	14.3
1981	0		0		13	4.6	5	3.8	13	17.0	5.0	13.4
1982	0		0		4	6.5	2	4.1	4	17.0	1.0	14.0
Data Gap	0		0		0		0		0		0.0	
1998	3	9.3	1	9.5	0		0		0		0.0	
1999	4	8.4	2	8.9	0		0		0		0.0	
2000	3	13.7	3	13.7	0		0		0		0.0	
2001	4	11.7	3	10.3	0		0		0		0.0	
2002	0		0		0		0		0		0.0	
2003	0		0		0		0		0	21.3	0.0	14.0
2004	3	10.5	0		1	3.1	0		1	33.0	0.0	
2005	0		0		0		0		0		0.0	
2006	0		0		0		0		0		0.0	
2007	0		0		0		0		0		0.0	
2008	0		0		0		0		0		0.0	
2009	7	9.4	3	9.7	0		0		0		0.0	
2010	4	8.0	1	7.0	0		0		1	9.0	0.0	
2011	6	7.7	3	8.0	0		0		0		0.0	
2012	2	8.5	1	9.0	0		0		0		0.0	
2013	1	5.0	0		0		0		2	26.0	0.0	
2014	2	8.5	1	13.0	0		0		0		0.0	
2015	6	10.5	3	10.7	0		0		1	33.0	0.0	
2016	7	11.0	3	10.7	0		0		1	17.0	0.0	
2017	7	10.1	3	10.3	0		0		1	18.0	0.0	
2018	7	10.0	3	9.0	0		0		2	13.0	0.0	
2019	5	10.4	2	12.0	0		0		0		0.0	
2020	4	14.8	3	14.0	1	1.9	1	1.9	2	22.3	1.0	14.7
All Years (Weighted)		10.1		10.6		6.5		4.2		18.7		14.7
DHDL Median				10.8				5.0				17.0
NCHF Ecoregion Median				5.3				15.2				52.0

D

APPENDIX D

Point-Intercept Aquatic Macrophyte Survey Data

Mirror Lake

	Scientific Name	Common Name	LFOO (%)		
			2011	2018	2020
Dicots	*Ceratophyllum demersum*	Coontail	24.7	24.7	49.0
	Myriophyllum sibiricum	Northern watermilfoil	24.7	18.8	8.2
	Myriophyllum spicatum	Eurasian watermilfoil	0.0	2.4	16.3
	Nymphaea odorata	White water lily	11.0	1.2	8.2
	Nuphar variegata	Spatterdock	2.7	1.2	0.0
	Utricularia vulgaris	Common bladderwort	0.0	0.0	2.0
	Ranunculus aquatilis	White water crowfoot	0.0	0.0	2.0
	Nuphar advena	Yellow pondlily	1.4	0.0	0.0
	Myriophyllum heterophyllum	Various-leaved watermilfoil	0.0	1.2	0.0
Non-dicots	*Chara spp.*	Muskgrasses	79.5	57.6	38.8
	Stuckenia pectinata	Sago pondweed	20.5	17.6	32.7
	Potamogeton friesii	Fries' pondweed	0.0	40.0	16.3
	Vallisneria americana	Wild celery	24.7	7.1	14.3
	Potamogeton zosteriformis	Flat-stem pondweed	12.3	0.0	8.2
	Najas flexilis	Slender naiad	19.2	0.0	0.0
	Potamogeton illinoensis	Illinois pondweed	15.1	1.2	0.0
	Lemna trisulca	Forked duckweed	0.0	1.2	4.1
	Potamogeton strictifolius	Stiff pondweed	0.0	0.0	4.1
	Potamogeton illinoensis X P. natans	Illinois pondweed X Floating-leaf pond	0.0	0.0	4.1
	Heteranthera dubia	Water stargrass	0.0	0.0	4.1
	Potamogeton gramineus	Variable-leaf pondweed	0.0	1.2	2.0
	Elodea canadensis	Common waterweed	0.0	3.5	0.0
	Potamogeton crispus	Curly-leaf pondweed	0.0	2.4	0.0

Shadow Lake

	Scientific Name	Common Name	LFOO (%)		
			2011	2018	2020
Dicots	*Ceratophyllum demersum*	Coontail	29.7	26.0	37.3
	Myriophyllum sibiricum	Northern watermilfoil	16.2	18.2	5.3
	Nymphaea odorata	White water lily	25.7	3.9	5.3
	Utricularia vulgaris	Common bladderwort	6.8	2.6	5.3
	Ranunculus aquatilis	White water crowfoot	0.0	0.0	2.7
	Nuphar variegata	Spatterdock	1.4	1.3	1.3
	Myriophyllum spicatum	Eurasian watermilfoil	0.0	0.0	2.7
Non-dicots	*Chara spp.*	Muskgrasses	67.6	46.8	26.7
	Potamogeton friesii	Fries' pondweed	0.0	62.3	4.0
	Stuckenia pectinata	Sago pondweed	17.6	23.4	13.3
	Vallisneria americana	Wild celery	18.9	1.3	20.0
	Potamogeton zosteriformis	Flat-stem pondweed	18.9	0.0	16.0
	Potamogeton illinoensis	Illinois pondweed	36.5	1.3	0.0
	Najas flexilis	Slender naiad	10.8	2.6	1.3
	Elodea canadensis	Common waterweed	1.4	0.0	5.3
	Lemna trisulca	Forked duckweed	1.4	1.3	4.0
	Potamogeton gramineus	Variable-leaf pondweed	0.0	3.9	2.7
	Spirodela polyrhiza	Greater duckweed	0.0	2.6	1.3
	Nitella spp.	Stoneworts	0.0	0.0	2.7
	Potamogeton crispus	Curly-leaf pondweed	0.0	3.9	0.0
	Wolffia spp.	Watermeal spp.	0.0	0.0	1.3
	Potamogeton richardsonii	Clasping-leaf pondweed	0.0	0.0	1.3
	Potamogeton illinoensis X P. natans	Illinois pondweed X Floating-leaf pond	0.0	0.0	1.3
	Heteranthera dubia	Water stargrass	2.7	0.0	0.0
	Fissidens spp. & Fontinalis spp.	Aquatic Moss	0.0	0.0	1.3
	Wolffia columbiana	Common watermeal	0.0	1.3	0.0
	Potamogeton nodosus	Long-leaf pondweed	0.0	1.3	0.0
	Lemna minor	Lesser duckweed	0.0	1.3	0.0

E

APPENDIX E

Fisheries Reports and Data Summaries

2016 Fall Electrofishing Summary Report
Shadow Lake (WBIC 258600)
Waupaca County

Introduction and Survey Objectives

In 2016, the Department of Natural Resources conducted a one night electrofishing survey of Shadow Lake in order to provide insight and direction for the future fisheries management of this water body. Primary sampling objectives of this survey were to characterize panfish species composition, relative abundance, and size structure as an experimental panfish regulation study. The following report is a brief summary of the survey, general status of the fish populations and future management options.

Acres: 44
Shoreline Miles: 1.14
Maximum Depth (feet): 38
Lake Type: Drainage
Public Access: 1 public access
Regulations: During May and June, 15 panfish may be kept, but only 5 of any one species. During the remainder of the season, 25 panfish may be kept

WISCONSIN DNR CONTACT INFO.

Elliot Hoffman - Fisheries Technician

Wisconsin Dept. of Natural Resources
647 Lakeland Rd.
Shawano, WI 54166

Elliot Hoffman Phone: 715-526-4231
E-mail: elliot.hoffman@wisconsin.gov

Survey Information

Site location	Survey Date	Water Temp. (F)	Target Species	Total Miles Shocked	No. of Stations	Gear	Dippers
Shadow Lake	10/4/2016	64.2	Panfish	1.02	2	Boomshocker	2

Survey Method

- The primary objective for this survey was to count and measure panfish populations. Other gamefish may be sampled but are considered by-catch as part of this survey. In this particular survey we were collecting panfish data for the special panfish regulations that have gone into effect for roughly 100 lakes throughout Wisconsin. Shadow Lake has a regulation that during May and June, 15 panfish may be kept, but only 5 of any one species. During the remainder of the season 25 panfish may be kept.

- The entire shoreline was sampled with a boomshocker. All fish captured were identified to species and measured for length. A subsample of fish were weighed and age structures collected for age and growth analysis.

- Fish metrics used to describe fish populations include proportional stock density, catch per effort, length frequency distribution, and mean age at length.

Fish Metric Descriptions
PSD, CPUE, LFD and Growth

Proportional Stock Density (PSD) is an index used to describe size structure of fish. It is calculated by dividing he number of quality size fish by the number of stock size fish for a given species. PSD values in the 40 to 60 percent range generally describe a balanced fish population.

Catch per unit effort (CPUE) is an index used to measure fish population relative abundance which simply refers to the number of fish captured per unit of distance or time. For electrofishing surveys we typically quantify CPUE by the number and size of fish per mile of shoreline. CPUE indexes are compared to statewide data by percentiles and within lake trends. For example, if a CPUE is in the 90th percentile, it is higher than 90% of the other CPUEs in the state.

Length frequency distribution (LFD) is a graphical representation of the percentage or number of fish captured by one inch size intervals. Smaller fish (or younger age classes) may not always be represented in the length frequency due to different habitat usage or sampling gear limitations.

Mean Age at Length is an index used to assess fish growth. Growth structures (otoliths, spines, or scales) are collected from a specified length bin of interest (e.g. 7.0-7.5 inches for bluegill). Mean age is compared to statewide data by percentile with growth characterized by the following benchmarks: slow (<33rd percentile); moderate (33rd to 66th percentile); and fast (>66th percentile).

Size Structure Metrics

| Species	Total	Average Length (inches)	Length Range (inches)	Stock and Quality Size (inches)	Stock No	Quality No	PSD	Percentile Rank	Size Rating
BLUEGILL	195	5.7	2.4 - 8.2	3.0 and 6.0	182	98	54%	75th	Moderate - High
YELLOW PERCH	14	5.8	3.5 - 8.8	5.0 and 8.0	7	3	43%	93rd	High
LARGEMOUTH BASS	81	11.4	4.1 - 19.5	8.0 and 12.0	58	43	74%	72nd	Moderate - High
PUMPKINSEED	17	4.6	3.7 - 6.6	5.0 and 8.0	17	1	6%	15th	Low

Abundance Metrics

Species	CPUE Total (no per mile)	Percentile Rank	Overall Abundance Rating	Length Index	Length Index CPUE	Percentile Rank	Abundance Rating
BLUEGILL	262.7	85th	Moderate - High	≥ 7.0	66.0	96th	High
YELLOW PERCH	13.7	60th	Moderate	≥ 8.0	2.9	89th	Moderate - High
LARGEMOUTH BASS	79.4	93rd	High	≥ 14.0	20.5	97th	High
PUMPKINSEED	16.7	71st	Moderate - High	≥ 7.0	0	-	Low

WISCONSIN DEPT. OF NATURAL RESOURCES

Bluegill Length Distribution   N = 195
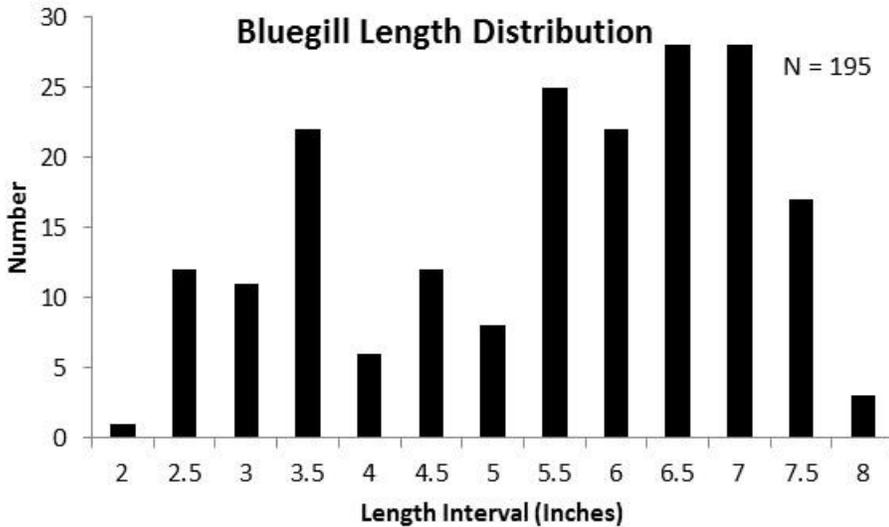
Growth Metrics						
Species	Total (N)	Length Bin (inches)	Mean Age (years)	Age Range (years)	Percentile Rank	Growth Rating
BLUEGILL	9	6.0	5.1	4 - 7	38th	Moderate – Slow
BLUEGILL	13	7.0	5.8	5 - 7	31st	Moderate - Slow

Summary

- A total of 404 fish in 8 species were collected during our surveys. The most frequently encountered and common species were bluegill (268), largemouth bass (81), pumpkinseed (17), yellow perch (14), and warmouth (13).

- Other fish species sampled in low abundance included greater redhorse (2), white sucker (6), and the invasive species common carp (3).

- Largemouth bass was the dominant gamefish species captured in our survey. Size structure and abundance metrics were found at moderate to high levels. The largest bass sampled was 19.5 inches and 36% of bass caught were greater than the minimum legal size limit of 14.0 inches.

- Panfish populations were comprised mainly of bluegill, pumpkinseed, and yellow perch. Moderate to high numbers of these species were captured.

- Bluegill were found in moderate to high density and showed average size structure with 54% of our catch greater than 6.0 inches and 26% greater than 7.0 inches.

- Bluegill and black crappie growth in Shadow Lake was moderate to slow when compared to data from other lakes statewide.

Management Options

This survey was primarily intended to assess panfish populations. Other species are captured but different survey techniques are typically used to better assess their population metrics. Therefore, management recommendations below are focused on bluegill and black crappie.

Panfish

- Panfish size structure was found at moderate levels and growth rates were moderate to slow.

- Management Objective: Continue monitoring the fishery. Bluegill size structure in Shadow lake has the potential to increase if the larger individuals are protected from over harvest.

- Management Action: A special panfish regulation was put in place in the spring of 2016 to better protect some of the larger spawning stock.

- Fish sticks were placed on the west shore of Shadow Lake in (2014 and 2017) to provide habitat for panfish species.

Other Management Objectives:

- Currently, Shadow Lake is on an 8 year rotation for sampling. The lake was sampled to gather pre-regulation panfish data prior to the experimental panfish regulations that went into effect in the spring of 2016. The DNR will survey the lake again in the next 5 - 6 years to evaluate the effects of the new panfish regulations that were put into place.

F

APPENDIX F

Comment Response Document for the Official First Draft

Comments to Mirror & Shadow Lakes Comprehensive Management Plan (5/13/2022)

WDNR Official Comments: Ted Johnson (Water Resources Management Specialist)

Comment Key:
Responses in blue by Todd Hanke (Onterra)

The plan is well written and I do not have many comments.

Here are my comments on the plan.

1. When you state that something had a significant change please include the confidence interval (E.G. EWM significantly increased). I added the confidence interval (chi square 0.05) for two figures that display significant changes in plant populations.

2. The intermittent inlet to Shadow Lake (across South Main St). I think that you could be underestimating how much phosphorus is being delivered to the lake from the wetlands draining to the "ditch" - then into the lake. There has been a lot of concern about this in the past. Did you sample this discharge at all during your studies? A study of this nature was not within the scope of this project. Watershed modeling predicted higher phosphorus concentrations in Shadow Lake than was measured, therefore we do not believe potential inputs from the ditch, or other sources, are substantially impacting the lake. In general, we would expect the surrounding wetlands to be intercepting phosphorus from reaching the lake, however perhaps detectable amounts would be measurable following high precipitation events that flush the wetlands. No changes made to the text.

3. Please change my phone number to 920-362-0181. Change made on Table on page 118

Thanks, Ted