A

APPENDIX A

Public Participation Materials

Presentation Outline

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

Onterra LLC Lake Management Planning

Onterra, LLC

- Founded in 2005
- Staff
  - Four full-time ecologists
  - One lead field technician
  - One technician
  - Four summer interns
- Services
  - Science and planning
- Philosophy
  - Promote realistic planning
  - Assist, not direct

Onterra LLC Lake Management Planning

Long Lake's Active Mgmt History

Onterra LLC Lake Management Planning

NR 107 – Aquatic Plant Management Conditions

(1) The department may stop or limit the application of chemicals to a body of water if at any time it determines that chemical treatment will be ineffective, or will result in unreasonable restrictions on current water uses, or will produce unnecessary adverse side effects on non-target organisms.

(4) Treatment of areas containing high value species of aquatic plants shall be done in a manner which will not result in adverse long–term or permanent changes to a plant community in a specific aquatic ecosystem.

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How do herbicides work?

- **2,4-D –** absorbed by plant tissue; inhibits plant growth and cell division (auxin hormone mimic)
- **Triclopyr –** absorbed by plant tissue; inhibits plant growth and cell division(auxin hormone mimic)
- **Endothall –** commonly referred to as a contact herbicide, inhibits respiration and protein synthesis, disrupts cell membranes
- **Fluridone –** inhibits plant-specific enzyme (carotene) which protects chlorophyll from UV (sun) damage
- **Diquat –** Inhibits photosynthesis & destroys cell membranes

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Are herbicides "safe?"

Registration by the EPA does not mean that the use of the herbicide poses no risk to humans or the environment, only that the benefits have been determined to outweigh the risks .

Because product use is not without risk, the EPA does not define any pesticide as "safe."

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Non-native Aquatic Plants

Curly-leaf Pondweed

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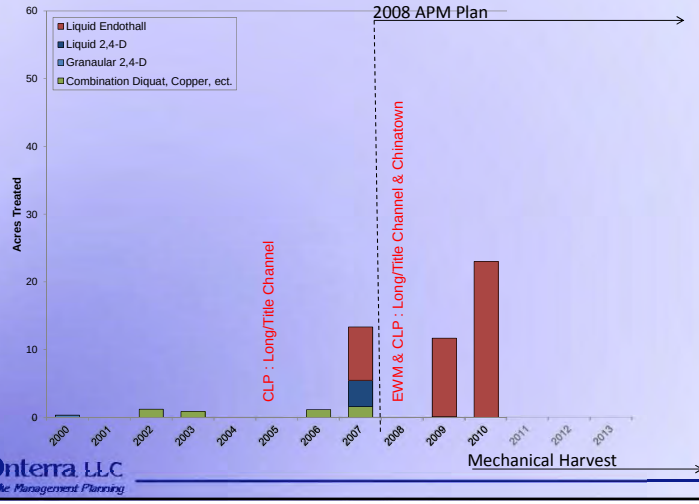
Lake Management Planning

Non-native Aquatic Plants

Eurasian Water Milfoil

Onterra LLC
Lake Management Planning

Long Lake's Active Mgmt History



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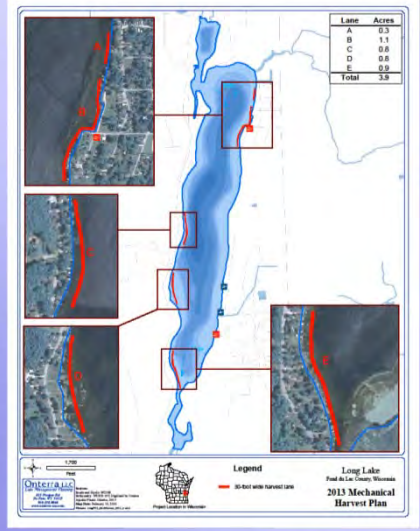
Lake Management Planning



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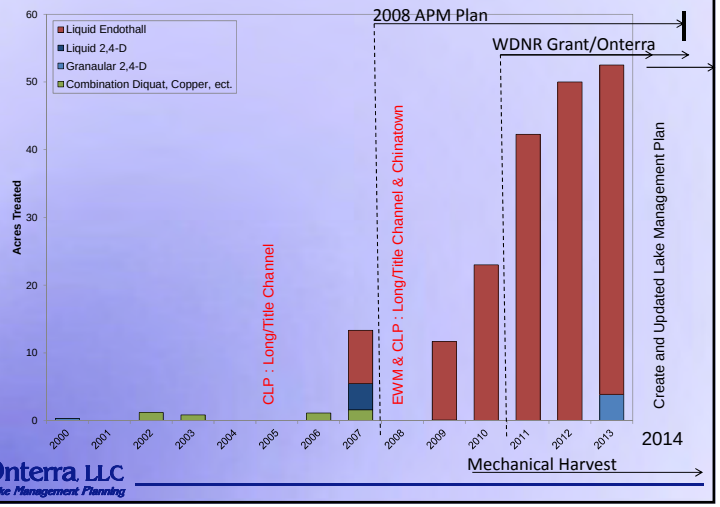
Long Lake's Active Mgmt History



Onterra LLC
Lake Management Planning

Why create a lake management plan?

- 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.
- To update ongoing management strategies, goals, expectations, and triggers.
- To foster realistic expectations and dispel myths.
- To create a snapshot of the lake for future reference and planning.

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Lake Management Planning

Elements of an Effective Lake Management Planning Project

Data and Information Gathering

Environmental & Sociological

Planning Process

Brings it all together

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Lake Management Planning

Data and information gathering

- Study Components
  - Water Quality Analysis
  - Watershed Assessment
  - Aquatic Plant Surveys
  - Assess Shoreland/CWH
  - Fisheries Data Integration
  - Stakeholder Survey

Task	2014												2015						
	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
Water Quality Sample																			
T2014 Pretreatment Survey																			
Kick-off Meeting																			
Early-Season AIS Survey																			
Community Mapping Survey																			
EWM Peak-Biomass Survey																			
Project Update																			
Shoreland Assessment Survey																			
Data Analysis																			
Planning Comm. Meeting																			
Report – First Draft																			
Report – Final Draft																			
Wrap-up Meeting																			

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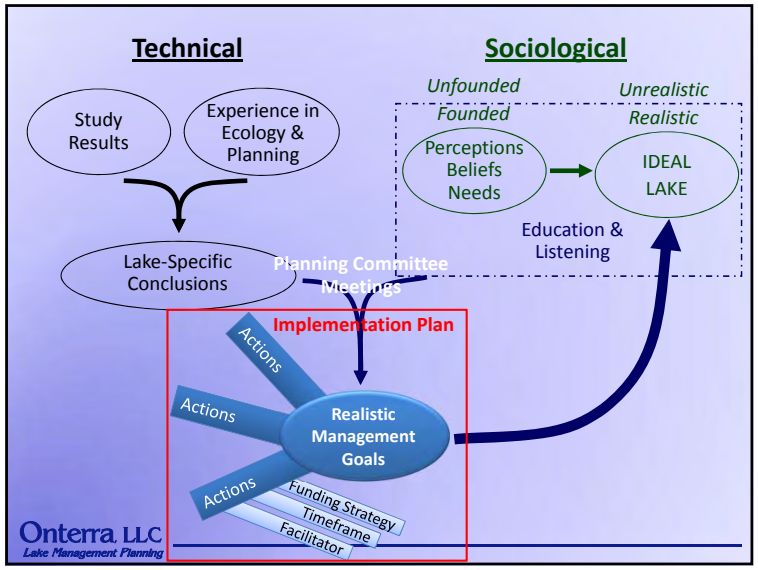
Lake Management Planning

The Planning Process

…it's not as easy as you may think.



Develop AIS Control Strategy & Monitoring Plan

Control Strategy

- Realistic and ecologically beneficial for the lake
- Inline with lake group's lake management goals
- Based upon lake group's support for various methods (e.g. drawdown, herbicide use)
- Prioritization based upon financial limitations and/or volunteerism
- Obtain support from additional management entities

Monitoring Plan

- Collection of Pretreatment & Post Treatment Data

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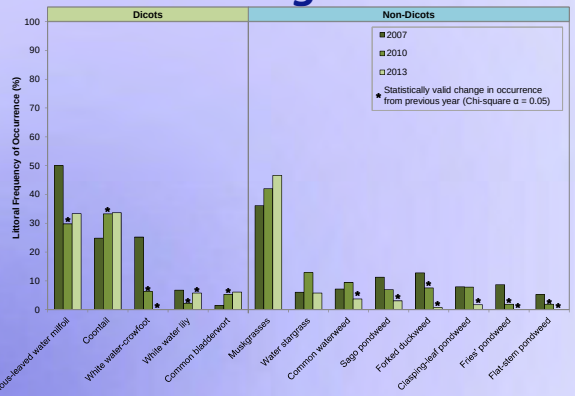
Preliminary Native Plant Monitoring Data



Onterra LLC
Lake Management Planning

Thank You

Many of the graphics used in this presentation were supplied by:

Wisconsin Lakes Partnership

UW Extension

Wisconsin Dept. of Natural Resources

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

Onterra LLC Lake Management Planning

Onterra, LLC

- Founded in 2005
- Staff
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  - One part-time ecologist
  - Two field technicians
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- Services
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- Philosophy
  - Promote realistic planning
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Onterra LLC Lake Management Planning

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- To discover ways to minimize the negative attributes and maximize the positive attributes.
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Onterra LLC Lake Management Planning

Elements of an Effective Lake Management Planning Project

Data and Information Gathering

Environmental & Sociological

Planning Process

Brings it all together

Onterra LLC Lake Management Planning

Data and information gathering

- Study Components
  - Water Quality Analysis
  - Watershed Assessment
  - Aquatic Plant Surveys
  - Fisheries Data Integration
  - Shoreline Assessment
  - Stakeholder Survey

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Water Quality Analysis

- General water chemistry (current & historic)
  - Citizens Lake Monitoring Network
- Nutrient analysis
  - Lake trophic state (Eutrophication)
  - Limiting plant nutrient
- Supporting data for watershed modeling

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Watershed Assessment

- Delineation of drainage basin
- Modeling
  - Land cover
  - Phosphorus loading
  - Scenario development

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Aquatic Plant Surveys

- Concerned with both native and non-native plants

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Lake Management Planning

Non-native Aquatic Plants

Curly-leaf Pondweed

Onterra LLC
Lake Management Planning

Non-native Aquatic Plants

Eurasian Water Milfoil & Hybrid Water Milfoil

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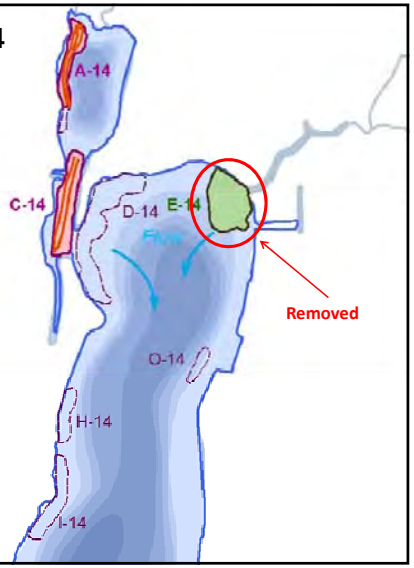
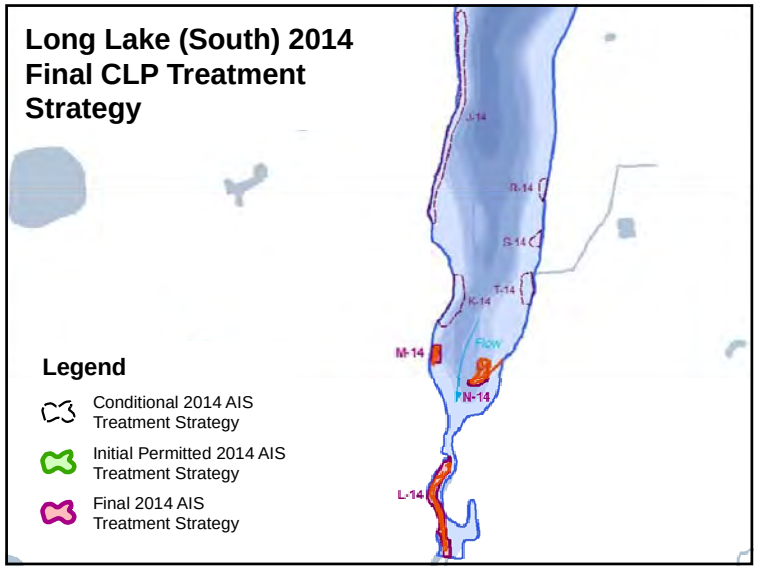
Lake Management Planning

Long Lake (North) 2014 Final CLP Treatment Strategy





Aquatic Plant Surveys

- Concerned with both native and non-native plants
- Multiple surveys used in assessment
  - Early-season AIS survey
  - Point-intercept survey

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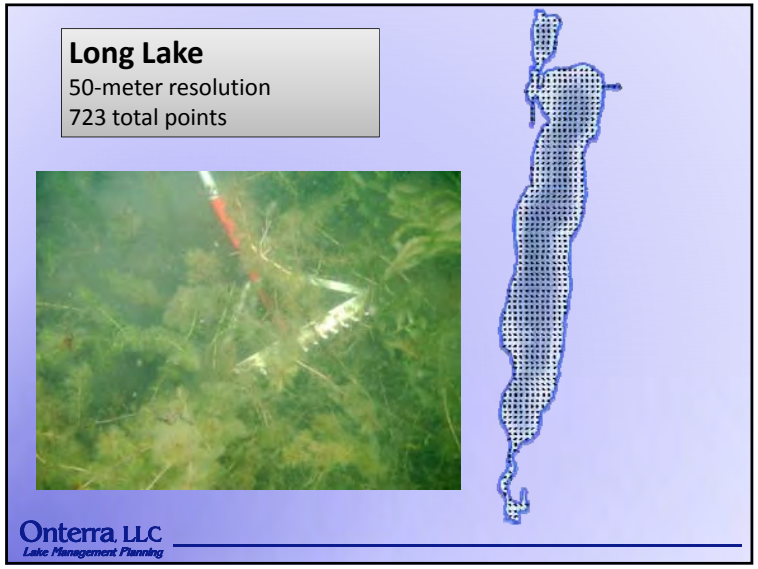
Lake Management Planning



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Lake Management Planning

Aquatic Plant Surveys

- Concerned with both native and non-native plants
- Multiple surveys used in assessment
  - Early-season AIS Survey
  - Point-intercept survey
  - Aquatic plant community mapping

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Lake Management Planning

Aquatic Plant Surveys

- Concerned with both native and non-native plants
- Multiple surveys used in assessment
  - Early-season AIS Survey
  - Point-intercept survey
  - Aquatic plant community mapping
  - Volunteer survey findings

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Fisheries Data Integration

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

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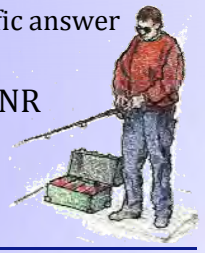
Stakeholder Survey

- 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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Lake Management Planning

Shoreland Assessment

- Shoreland area is important for buffering runoff and provides valuable habitat for aquatic and terrestrial wildlife.
- It does not look at lake shoreline on a property-by-property basis.
- Assessment ranks shoreland area from shoreline back 35 feet

Urbanized **Natural**

Range

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Lake Management Planning

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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Lake Management Planning

Thank You

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Lake Management Planning

Presentation Outline

- **Lake Management Planning Project Overview**
- **Study Results**
  - Water Quality
  - Watershed
  - Shoreland
  - Aquatic Plants
  - Fishery
  - AIS
- **"Big Picture"**

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Lake Management Planning

Study and Plan Goals

- Collect & Analyze Data
- Construct Long-Term & Useable Plan

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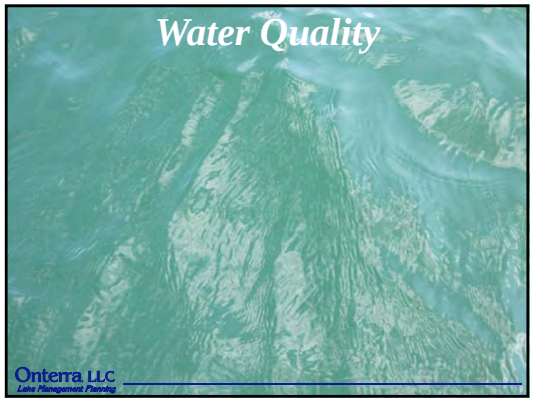
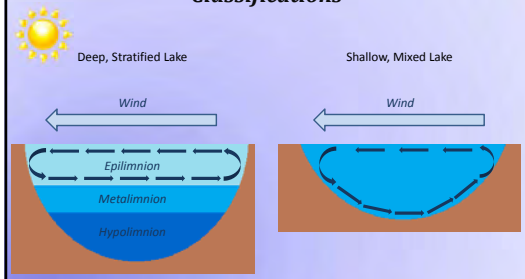


Wisconsin Lakes Natural Community Classifications



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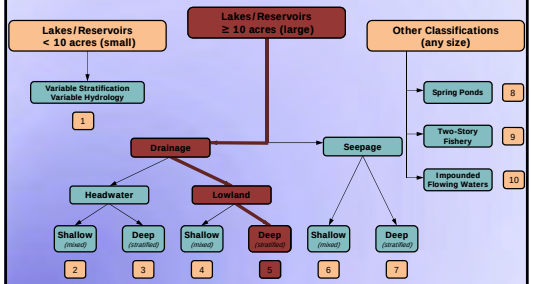
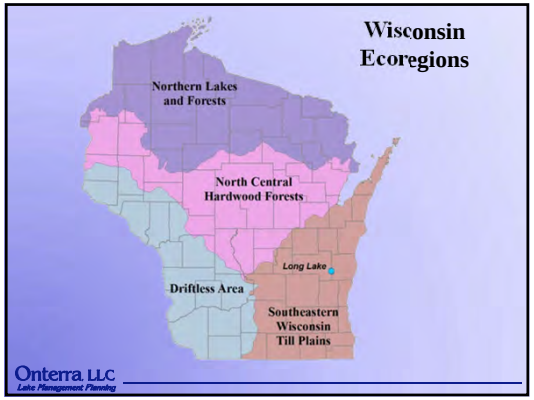
Lake Management Planning

Wisconsin Lakes Natural Community Types




Wisconsin Ecoregions
Northern Lakes and Forests
North Central Hardwood Forests
Driftless Area
Long Lake
Southeastern Wisconsin Till Plains
Onterra LLC
Lake Management Planning

Water Quality
Phosphorus (Limiting Plant Nutrient)
Lake is P limited (N:P = 29:1)
Chlorophyll-a (Algal Abundance)
Low abundance
Water Clarity (Secchi Disk)
Good-Excellent water clarity
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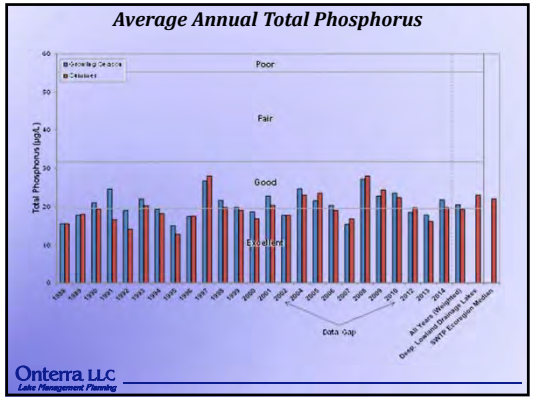
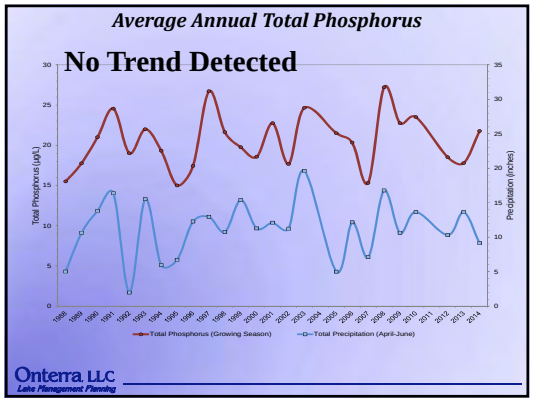

Average Annual Total Phosphorus
Poor
Fair
Good
Excellent
Data Gap
Onterra LLC
Lake Management Planning


Average Annual Total Phosphorus
No Trend Detected
Total Phosphorus (µg/L)
Precipitation (inches)
Total Phosphorus (Growing Season)
Total Precipitation (April-June)
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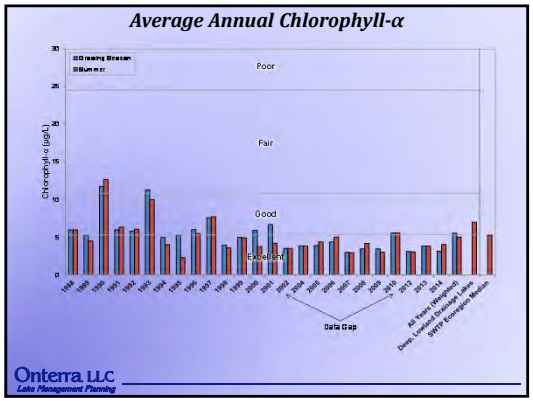
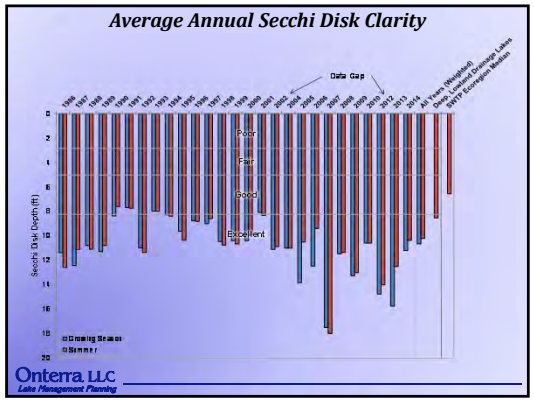
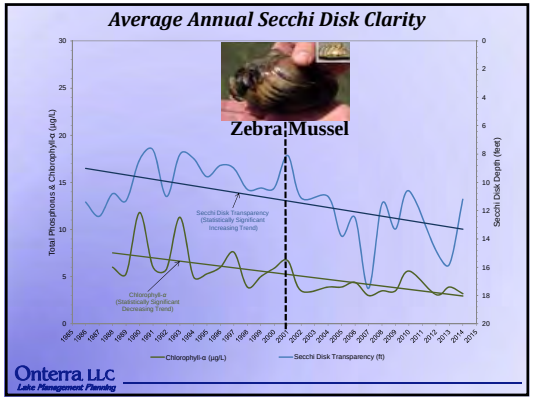
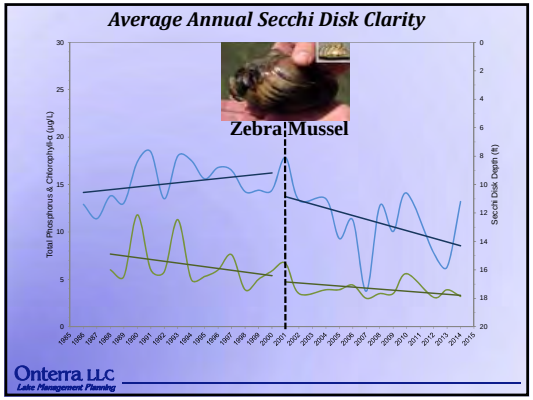
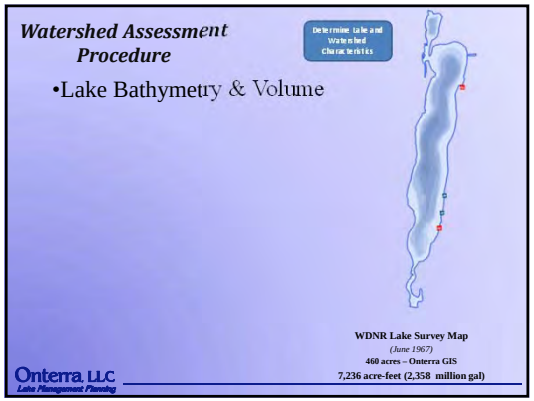

Average Annual Chlorophyll-α
Poor
Fair
Good
Excellent
Data Gap
Onterra LLC
Lake Management Planning


Average Annual Secchi Disk Clarity
Data Gap
Poor
Fair
Good
Excellent
Onterra LLC
Lake Management Planning


Average Annual Secchi Disk Clarity
Zebra Mussel
Total Phosphorus & Chlorophyll-a (µg/L)
Secchi Disk Depth (feet)
Secchi Disk Transparency (Statistically Significant Increasing Trend)
Chlorophyll-a (Statistically Significant Decreasing Trend)
Chlorophyll-a (µg/L)
Secchi Disk Transparency (ft)
Onterra LLC
Lake Management Planning


Average Annual Secchi Disk Clarity
Zebra Mussel
Total Phosphorus & Chlorophyll-a (µg/L)
Secchi Disk Depth (ft)
Onterra LLC
Lake Management Planning

Watershed
KETTLE MORAINE
STATE
FOREST


Watershed Assessment Procedure
Determine Lake and Watershed Characteristics
•Lake Bathymetry & Volume
WDNR Lake Survey Map
(June 1967)
460 acres – Onterra GIS
7,236 acre-feet (2,358 million gal)
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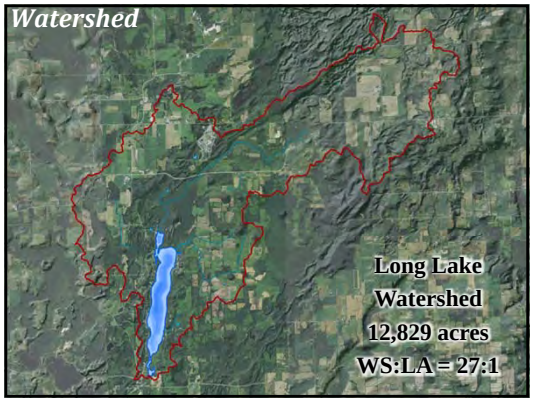
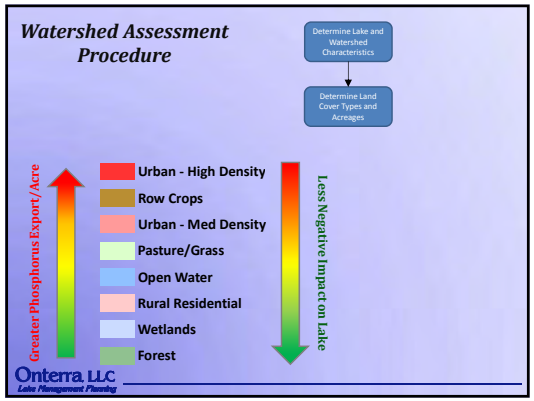
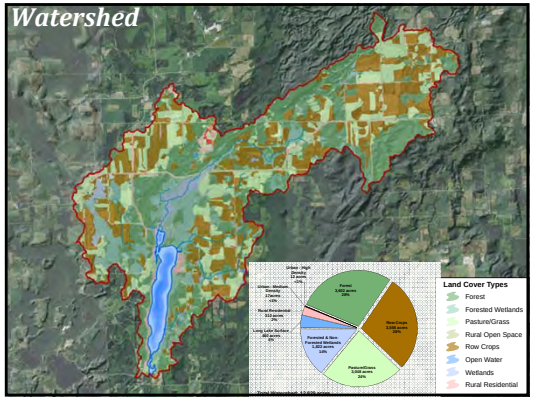
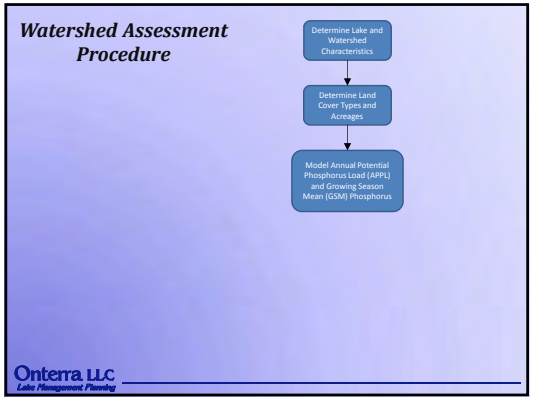
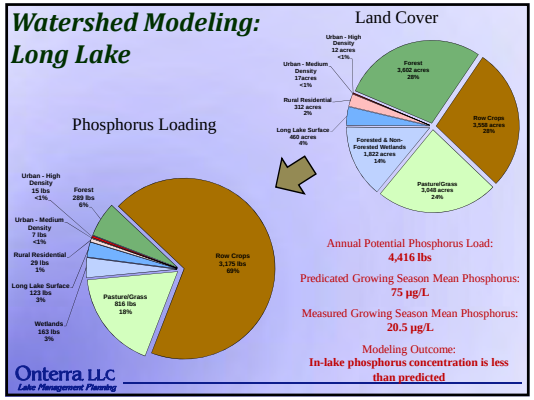
Lake Management Planning

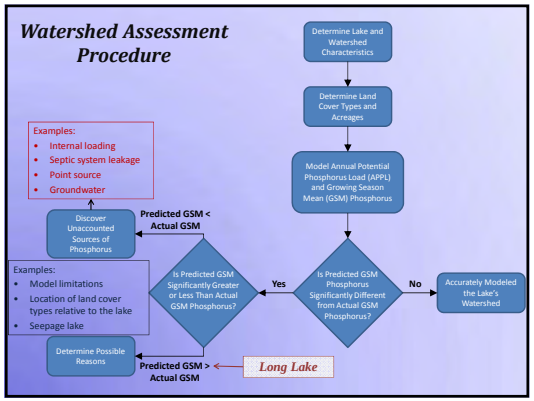

Watershed
Long Lake
Watershed
12,829 acres
WS:LA = 27:1


Watershed Assessment Procedure
Determine Lake and Watershed Characteristics
Determine Land Cover Types and Acreages
Greater Phosphorus Export/Acre
Urban - High Density
Row Crops
Urban - Med Density
Pasture/Grass
Open Water
Rural Residential
Wetlands
Forest
Less Negative Impact on Lake
Onterra LLC
Lake Management Planning


Watershed
Land Cover Types
Forest
Forested Wetlands
Pasture/Grass
Rural Open Space
Row Crops
Open Water
Wetlands
Rural Residential

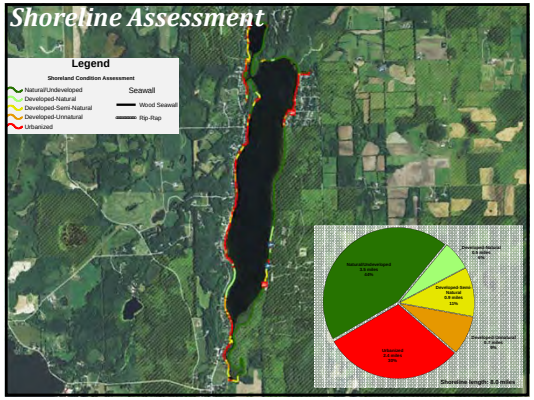

Watershed Assessment Procedure
Determine Lake and Watershed Characteristics
Determine Land Cover Types and Acreages
Model Annual Potential Phosphorus Load (APPL) and Growing Season Mean (GSM) Phosphorus
Onterra LLC
Lake Management Planning


Watershed Modeling: Long Lake
Land Cover
Phosphorus Loading
Annual Potential Phosphorus Load:
4,416 lbs
Predicated Growing Season Mean Phosphorus:
75 µg/L
Measured Growing Season Mean Phosphorus:
20.5 µg/L
Modeling Outcome:
In-lake phosphorus concentration is less than predicted
Onterra LLC
Lake Management Planning


Watershed Assessment Procedure
Determine Lake and Watershed Characteristics
Determine Land Cover Types and Acreages
Model Annual Potential Phosphorus Load (APPL) and Growing Season Mean (GSM) Phosphorus
Examples:
Internal loading
Septic system leakage
Point source
Groundwater
Discover Unaccounted Sources of Phosphorus
Predicted GSM < Actual GSM
Examples:
Model limitations
Location of land cover types relative to the lake
Seepage lake
Is Predicted GSM Significantly Greater or Less Than Actual GSM Phosphorus?
Yes
Is Predicted GSM Phosphorus Significantly Different from Actual GSM Phosphorus?
No
Accurately Modeled the Lake's Watershed
Determine Possible Reasons
Predicted GSM > Actual GSM
Long Lake

Shoreland Condition

Shoreland Assessment
Shoreland area is important for buffering runoff and provides valuable habitat for aquatic and terrestrial wildlife.
It does not look at lake shoreline on a property-by-property basis.
Assessment ranks shoreland area from shoreline back 35 feet
Urbanized
Natural
Range
Onterra LLC
Lake Management Planning



Coarse Woody Habitat

- Provides shoreland erosion control and prevents suspension of sediments.
- Preferred habitat for a variety of aquatic life.
  - Periphyton growth fed upon by insects.
  - Refuge, foraging and spawning habitat for fish.
  - Complexity of CWH important.
- Changing of logging and shoreland development practices = reduced CWH in Wisconsin lakes.
- Survey aimed at quantifying CWH in the Lake

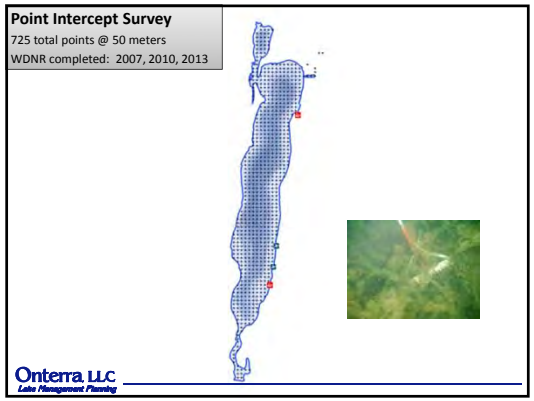
40 total pieces of emergent CWH located
Long Lake ratio = 5 CWH pieces per shoreland mile
"Natural" lakes = >300:1 ratio

Onterra LLC Lake Management Planning

Long Lake Fishery – Travis Motl, WDNR

- Managed for LMB, NP, Walleye, and Panfish
- Walleye
  - Small fingerling walleye stocked every-other year
  - Maintain a recreational opportunity as limited or no natural reproduction
- Northern Pike
  - Self-sustaining
  - High density
  - Slow Growing
  - Special Regulation to increase harvest and effort – no size limit

Onterra LLC Lake Management Planning

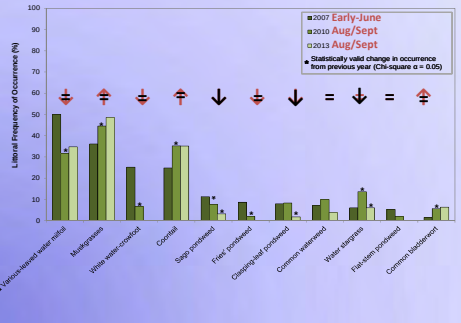


Aquatic Plant Summary

Long Lake

- 47 native species
- 4/5 non-native plant species
  - Eurasian/Hybrid water milfoil
  - Curly-leaf Pondweed
  - Purple Loosestrife
  - Reed Canary Grass
- Maximum depth of plants = ave of 17-19 feet

Littoral Frequency of Occurrence



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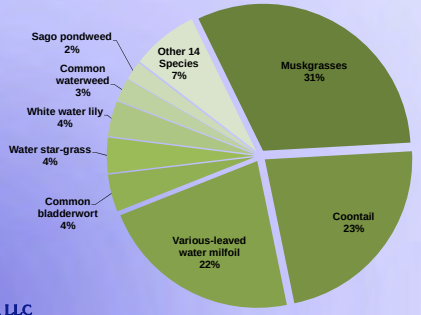
Relative Frequency of Occurrence



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Aquatic Invasive Species

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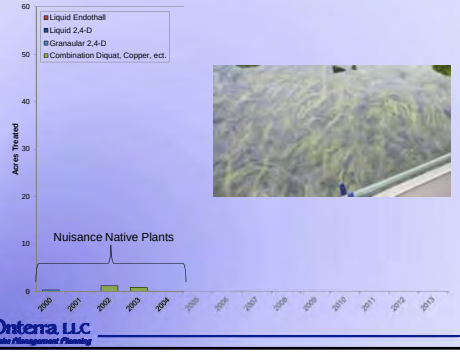
Long Lake's Active Mgmt History



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Non-native Aquatic Plants

Curly-leaf Pondweed

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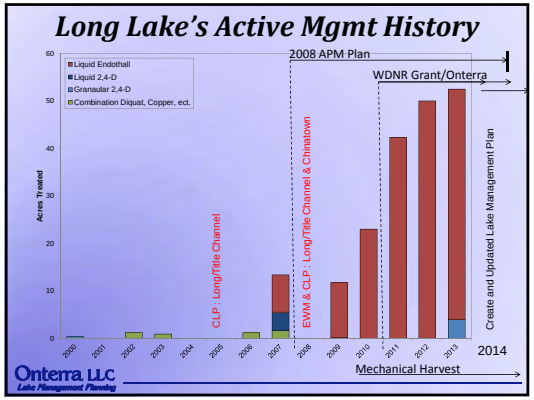
Long Lake's Active Mgmt History
Liquid Endothall
Liquid 2,4-D
Granular 2,4-D
Combination Diquat, Copper, ect.
Acres Treated
2008 APM Plan
WDNR Grant/Onterra
CLP - Long/Title Channel
EWM & CLP - Long/Title Channel & Chinatown
Create and Updated Lake Management Plan
2014
Mechanical Harvest
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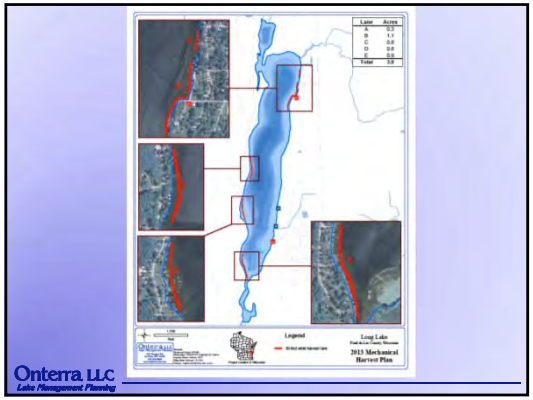
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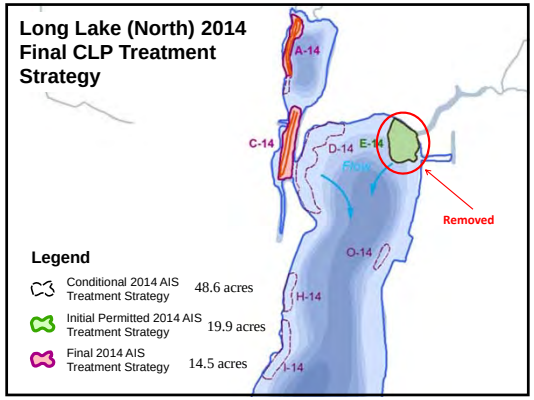
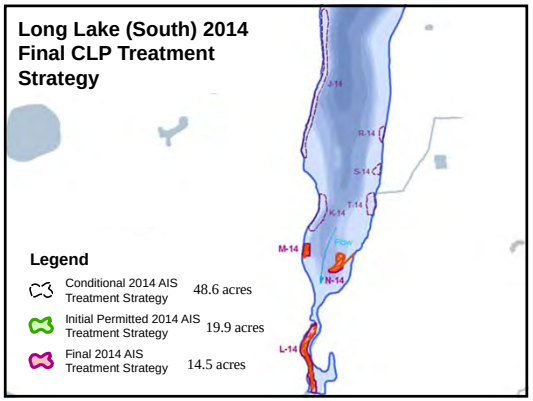
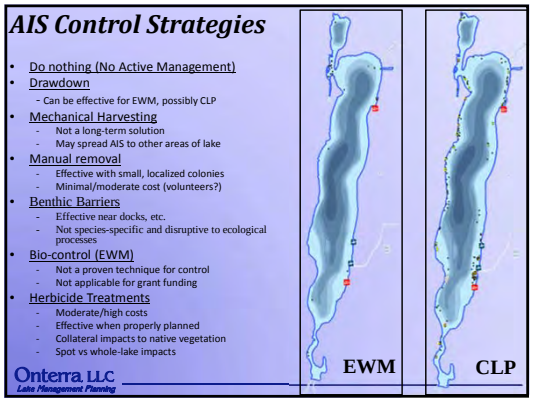

Long Lake (North) 2014 Final CLP Treatment Strategy
A-14
C-14
D-14
E-14
Flow
Removed
O-14
H-14
I-14
Legend
Conditional 2014 AIS Treatment Strategy
48.6 acres
Initial Permitted 2014 AIS Treatment Strategy
19.9 acres
Final 2014 AIS Treatment Strategy
14.5 acres


Long Lake (South) 2014 Final CLP Treatment Strategy
J-14
R-14
S-14
T-14
K-14
M-14
Flow
N-14
L-14
Legend
Conditional 2014 AIS Treatment Strategy
48.6 acres
Initial Permitted 2014 AIS Treatment Strategy
19.9 acres
Final 2014 AIS Treatment Strategy
14.5 acres


AIS Control Strategies
Do nothing (No Active Management)
Drawdown
- Can be effective for EWM, possibly CLP
Mechanical Harvesting
- Not a long-term solution
- May spread AIS to other areas of lake
Manual removal
- Effective with small, localized colonies
- Minimal/moderate cost (volunteers?)
Benthic Barriers
- Effective near docks, etc.
- Not species-specific and disruptive to ecological processes
Bio-control (EWM)
- Not a proven technique for control
- Not applicable for grant funding
Herbicide Treatments
- Moderate/high costs
- Effective when properly planned
- Collateral impacts to native vegetation
- Spot vs whole-lake impacts
EWM
CLP
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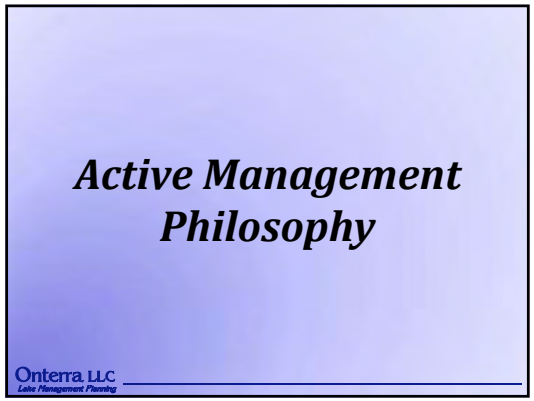
Active Management Philosophy
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Active Management Philosophy

Traditionally "we" thought that all AIS are bad and they need to be controlled at all costs.

But…is it really that simple?

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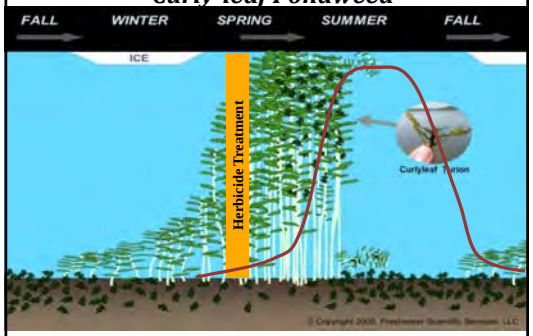
Curly-leaf Pondweed



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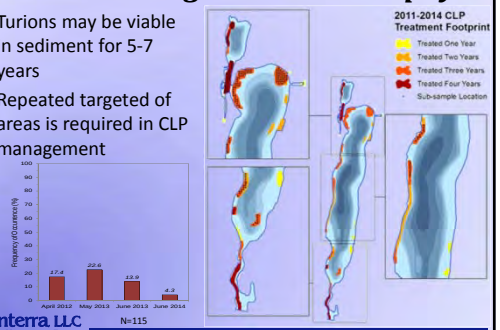
Active Management Philosophy

- Turions may be viable in sediment for 5-7 years
- Repeated targeted of areas is required in CLP management



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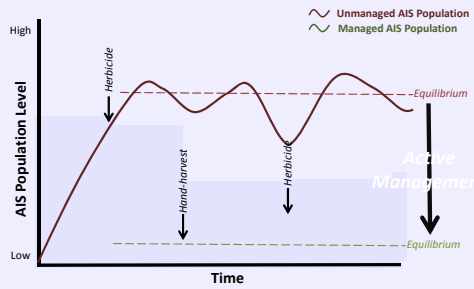
Hypothetical EWM Populations



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Active Management Discussion

Pros	Cons
• Keep AIS population low so native ecosystem can function as it did prior to AIS • Keep AIS population low so the lake is not a source population for other nearby lakes • Keep AIS population low so does not cause recreational, navigational, or aesthetic issues	• Management action itself may be ecological damaging to the lake, either through improper implementation or unintended/unknown impacts • Management action may not be fully supported by public • Equilibrium ***Unmanaged*** AIS population may be low enough to not cause large ecosystem or user conflicts

Herbicide Control 101

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How do they work?

- **2,4-D –** absorbed by plant tissue; inhibits plant growth and cell division (auxin hormone mimic)
- **Triclopyr –** absorbed by plant tissue; inhibits plant growth and cell division(auxin hormone mimic)
- **Endothall –** commonly referred to as a contact herbicide, inhibits respiration and protein synthesis, disrupts cell membranes
- **Fluridone –** inhibits plant-specific enzyme (carotene) which protects chlorophyll from UV (sun) damage
- **Diquat –** Inhibits photosynthesis & destroys cell membranes

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Are herbicides "safe?"

Registration by the EPA does not mean that the use of the herbicide poses no risk to humans or the environment, only that the benefits have been determined to outweigh the risks.

Because product use is not without risk, the EPA does not define any pesticide as "safe."

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WDNR Administrative Code (NR 107):

Aquatic Plant Management Conditions

(1) The department may stop or limit the application of chemicals to a body of water if at any time it determines that chemical treatment will be ineffective, or will result in unreasonable restrictions on current water uses, or will produce unnecessary adverse side effects on non-target organisms.

(4) Treatment of areas containing high value species of aquatic plants shall be done in a manner which will not result in adverse long–term or permanent changes to a plant community in a specific aquatic ecosystem.

Underscores the importance of proper planning and monitoring

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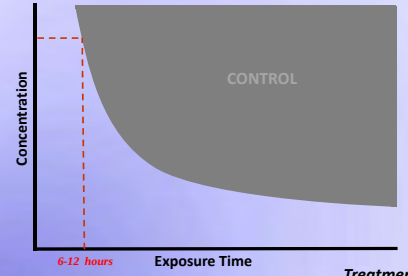
Early-season Herbicide Control Strategy

- Exotic species are small, actively growing, and most vulnerable
- Many native species are dormant
- Cool water temperatures result in slower microbial degradation
- Minimize biomass decomposition

Herbicide Use Patterns

- **Dissipation: horizontal and vertical movement of herbicide within the water column**
  - Water flow
  - Wind
  - Treatment area relative to lake
  - Water depth
- **Degradation: physical breakdown of herbicide into inert components**
  - Microbial
  - Photolytic

Herbicide Use Patterns



Treatment Type

Spot

High Concentration ► Short Exposure Time

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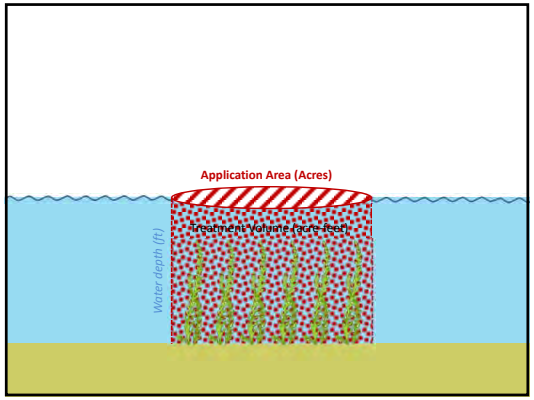
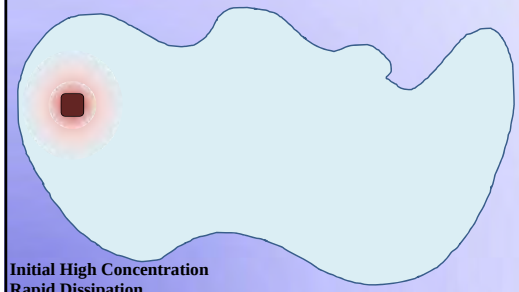


Spot Treatment Use Pattern



Initial High Concentration
Rapid Dissipation
Herbicide concentrations too low outside of Treatment Area to cause impact

Factors that Result in Increased CET

- **Large Treatment Sites**
  - Especially over 5 acres
- **Broad-shaped Sites**
  - Long, skinny shapes act like small sites
- **Physical Barriers**
  - Dilution doesn't occur in all directions
  - Eddy effects
- **Low Water Exchange**
  - Flow
  - Wave-action

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Conclusions

- Water quality is "Good"
  - Excellent historical data
  - Trends detected, likely as a result of ZM establishment
- Watershed is in "Fair" condition
  - Watershed contains a variety of land cover types, including approximately half in *Row Crop* or *Pasture/Grass*
  - Modeling was not effective, likely due to large state-owned area of buffer
  - Shoreland zone is polar mix of *Natural/Undeveloped* and *Urbanized*

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Conclusions continued

- Aquatic plant community
  - Based upon standard analysis, native plant community is of high quality
    - High diversity, number of species
    - Species present are of good quality
  - Aquatic plant community has changed little from 2007-2014
  - Concerns over AIS
- Fisheries
  - Not Yet Addressed – in progress
- Stakeholder Survey
  - Not Yet Addressed – in progress

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B

APPENDIX B

Stakeholder Survey Response Charts and Comments

Long Lake Property Owners Association - Anonymous Stakeholder Survey

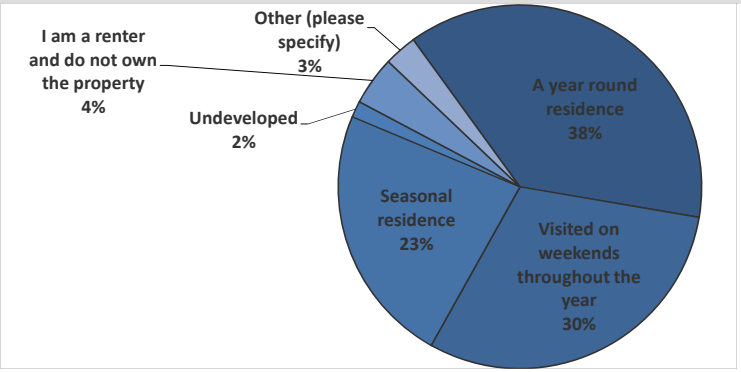
Surveys Distributed: 292
Surveys Returned: 69
Response Rate: 24%

Long Lake Property

1. How is your property on Long Lake utilized?

Answer Options	Response Percent	Response Count
A year round residence	37.7%	26
Visited on weekends throughout the year	30.4%	21
Seasonal residence (summer only)	23.2%	16
Undeveloped	1.4%	1
Resort property	0.0%	0
Rental property	0.0%	0
I am a renter and do not own the property	4.3%	3
Other (please specify)	2.9%	2
answered question		69
skipped question		0

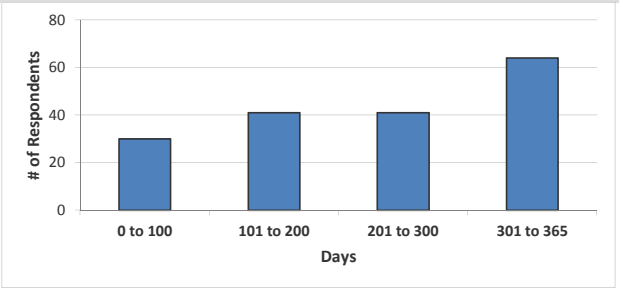
Number	Other (please specify)
1	Live in NC now. Was my year round residence from 1982 - 2006. Visit during the summer and at other times during the year.
2	Not a property owner



2. How many days each year is your property used by you or others?

Answer Options	Response Count
	64
answered question	64
skipped question	5

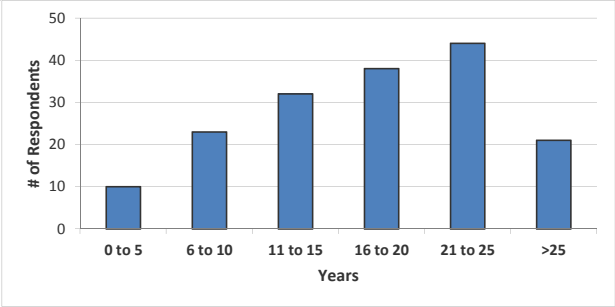
Category (# of days)	Responses	
0 to 100	30	17%
101 to 200	41	23%
201 to 300	41	23%
301 to 365	64	36%



3. How long have you owned or rented your property on Long Lake?

Answer Options	Response Count
	65
answered question	65
skipped question	4

Category (# of years)	Responses	% Response
0 to 5	10	6%
6 to 10	23	14%
11 to 15	32	19%
16 to 20	38	23%
21 to 25	44	26%
>25	21	13%

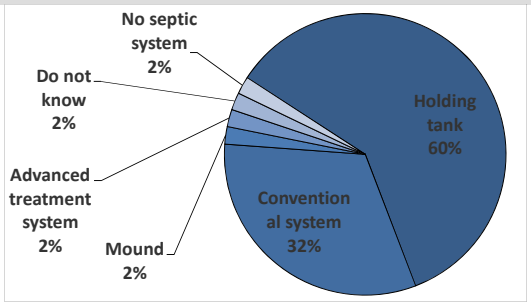


4. Is your property located on the shoreline of Long Lake (lakefront property) or not located on the lake's shoreline (not lakefront property)?

Answer Options	Response Percent	Response Count
Lakefront property	78.8%	52
Not lakefront property	21.2%	14
answered question		66
skipped question		3

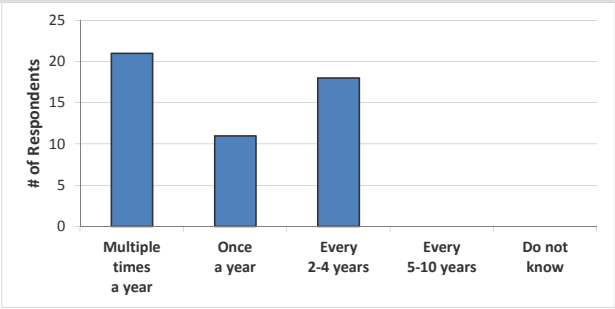
5. What type of septic system does your property utilize?

Answer Options	Response Percent	Response Count
Holding tank	60.0%	30
Conventional system	32.0%	16
Mound	2.0%	1
Advanced treatment system	2.0%	1
Municipal sewer	0.0%	0
Do not know	2.0%	1
No septic system	2.0%	1
answered question		50
skipped question		19



6. How often is the septic system on your property pumped?

Answer Options	Response Percent	Response Count
Multiple times a year	42.0%	21
Once a year	22.0%	11
Every 2-4 years	36.0%	18
Every 5-10 years	0.0%	0
Do not know	0.0%	0
answered question		50
skipped question		19

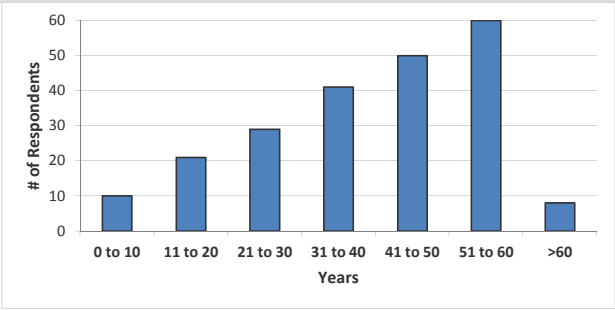


Recreational Activity on Long Lake

7. How many years ago did you first visit Long Lake?

Answer Options	Response Count
	68
answered question	68
skipped question	1

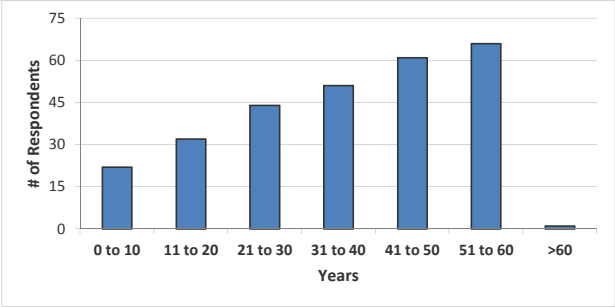
Category (# of days)	Responses	% Response
0 to 10	10	5%
11 to 20	21	10%
21 to 30	29	13%
31 to 40	41	19%
41 to 50	50	23%
51 to 60	60	27%
>60	8	4%



8. For how many years have you fished on Long Lake?

Answer Options	Response Count
	67
answered question	67
skipped question	2

Category (# of days)	Responses	% Response
0 to 10	22	8%
11 to 20	32	12%
21 to 30	44	16%
31 to 40	51	18%
41 to 50	61	22%
51 to 60	66	24%
>60	1	0%

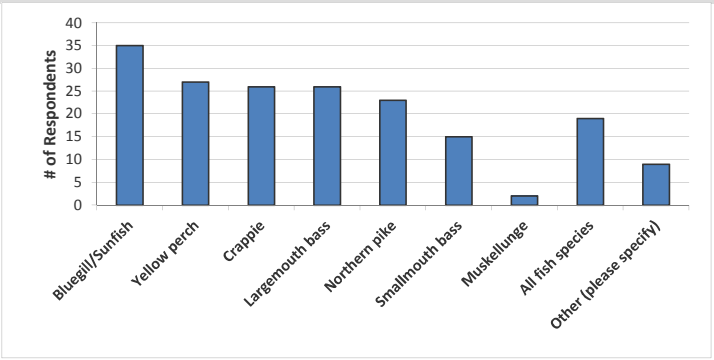


9. Have you personally fished on Long Lake in the past three years?

Answer Options	Response Percent	Response Count
Yes	83.6%	56
No	16.4%	11
answered question		67
skipped question		2

10. What species of fish do you like to catch on Long Lake?

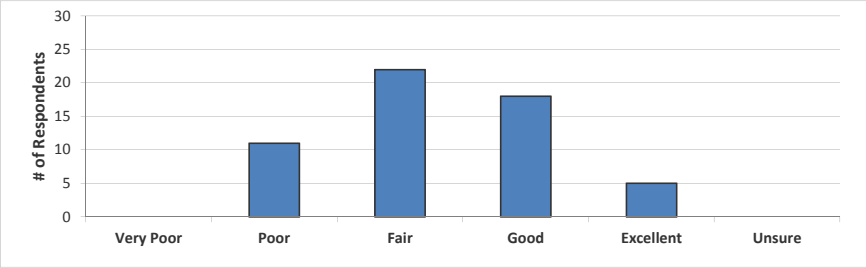
Answer Options	Response Percent	Response Count
Bluegill/Sunfish	62.5%	35
Yellow perch	48.2%	27
Crappie	46.4%	26
Largemouth bass	46.4%	26
Northern pike	41.1%	23
Smallmouth bass	26.8%	15
Muskellunge	3.6%	2
All fish species	33.9%	19
Other (please specify)	16.1%	9
answered question		56
skipped question		13



Number	Other (please specify)
1	Walleye
2	Walleye and Bullhead
3	Bullhead
4	walleye
5	Walleye
6	Walleye
7	walleye, rock bass, bull heads
8	walleye
9	walleye

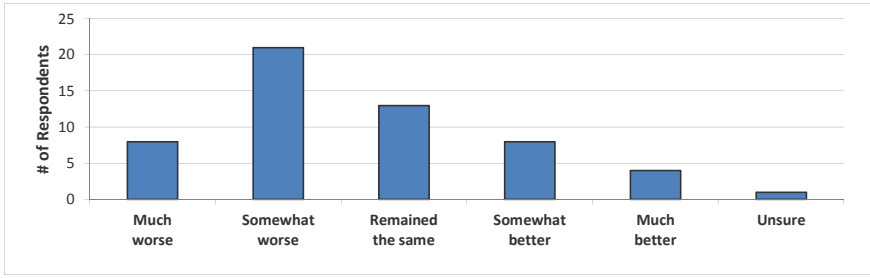
11. How would you describe the current quality of fishing on Long Lake?

Answer Options	Very Poor	Poor	Fair	Good	Excellent	Unsure	Response Count
	0	11	22	18	5	0	56
						answered question	*56*
						skipped question	*13*



12. How has the quality of fishing changed on Long Lake since you have started fishing the lake?

Answer Options	Much worse	Somewhat worse	Remained the same	Somewhat better	Much better	Unsure	Response Count
	8	21	13	8	4	1	55
						answered question	*55*
						skipped question	*14*



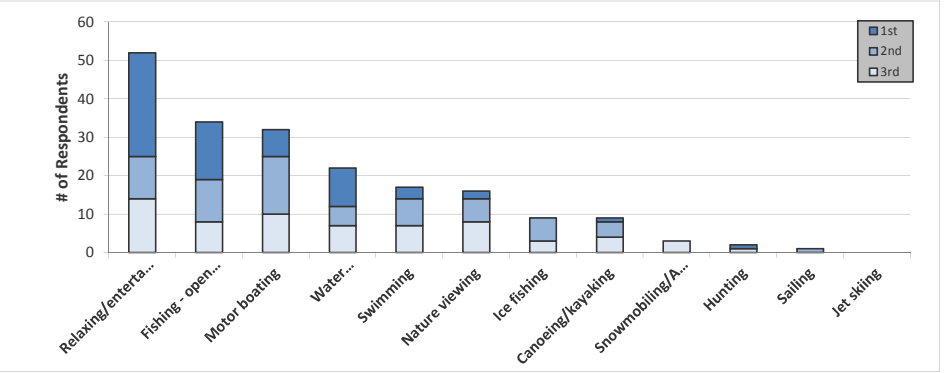
13. What types of watercraft do you currently use on Long Lake?

Answer Options	Response Percent	Response Count
Pontoon	59.7%	40
Canoe/kayak	43.3%	29
Motor boat with greater than 25 hp motor	41.8%	28
Motor boat with 25 hp or less motor	29.9%	20
Rowboat	22.4%	15
Paddleboat	20.9%	14
Jet ski (personal water craft)	13.4%	9
Sailboat	3.0%	2
Jet boat	0.0%	0
Do not use watercraft	3.0%	2
answered question		67
skipped question		2

14. For the list below, rank your top three activities that are important reasons for owning or renting your property on or near Long Lake, with 1 being the most important activity.

Answer Options	1st	2nd	3rd	Response Count
Relaxing/entertaining	27	11	14	52
Fishing - open water	15	11	8	34
Motor boating	7	15	10	32
Water skiing/tubing	10	5	7	22
Swimming	3	7	7	17
Nature viewing	2	6	8	16
Ice fishing	0	6	3	9
Canoeing/kayaking	1	4	4	9
Snowmobiling/ATV	0	0	3	3
Hunting	1	0	1	2
Sailing	0	1	0	1
Jet skiing	0	0	0	0
None of these activities are important to me	0	0	1	1
Other (please specify below)	1	0	0	1
answered question				67
skipped question				2

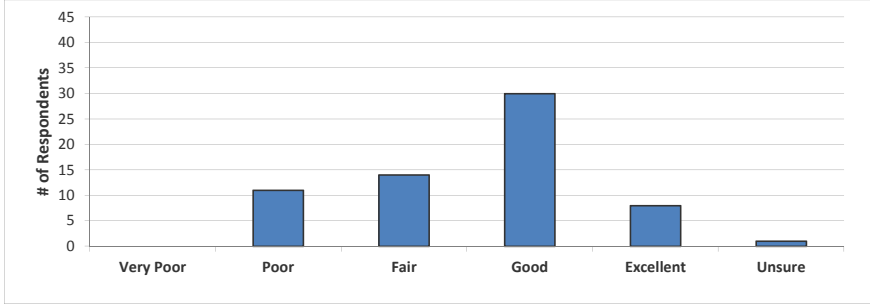
Number	"Other" responses
1	Family home
2	Hiking and Exploring the paths around the east side park...



Long Lake Current and Historic Condition, Health and Management

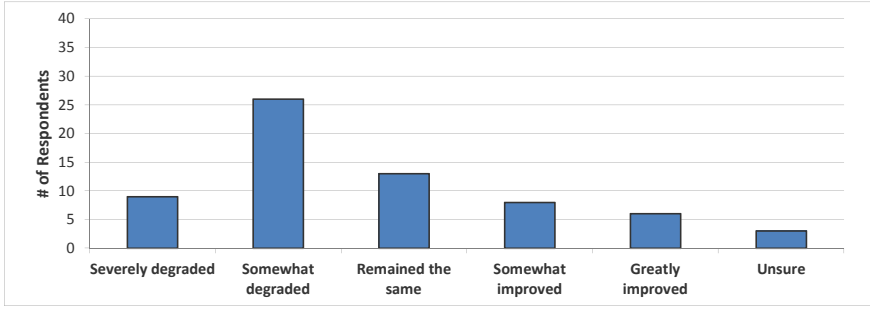
15. How would you describe the current water quality of Long Lake?

Answer Options	Very Poor	Poor	Fair	Good	Excellent	Unsure	Response Count
	0	11	14	30	8	1	64
						answered question	*64*
						skipped question	*5*



16. How has the current water quality changed in Long Lake since you first visited the lake?

Answer Options	Severely degraded	Somewhat degraded	Remained the same	Somewhat improved	Greatly improved	Unsure	Response Count
	9	26	13	8	6	3	65
						answered question	*65*
						skipped question	*4*



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

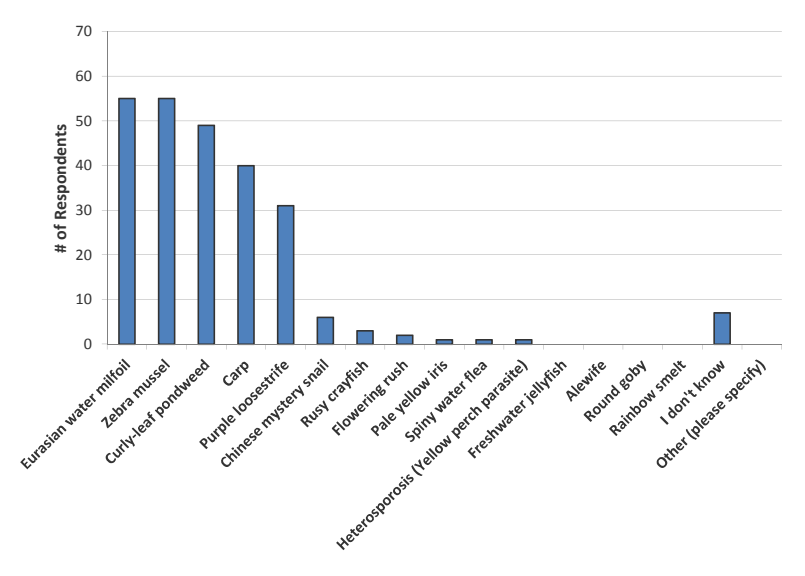
Answer Options	Response Percent	Response Count
Yes	97.0%	64
No	3.0%	2
	answered question	66

18. Do you believe aquatic invasive species are present within Long Lake?

Answer Options	Response Percent	Response Count
Yes	100.0%	65
No	0.0%	0
	answered question	65

19. Which aquatic invasive species do you believe are in Long Lake?

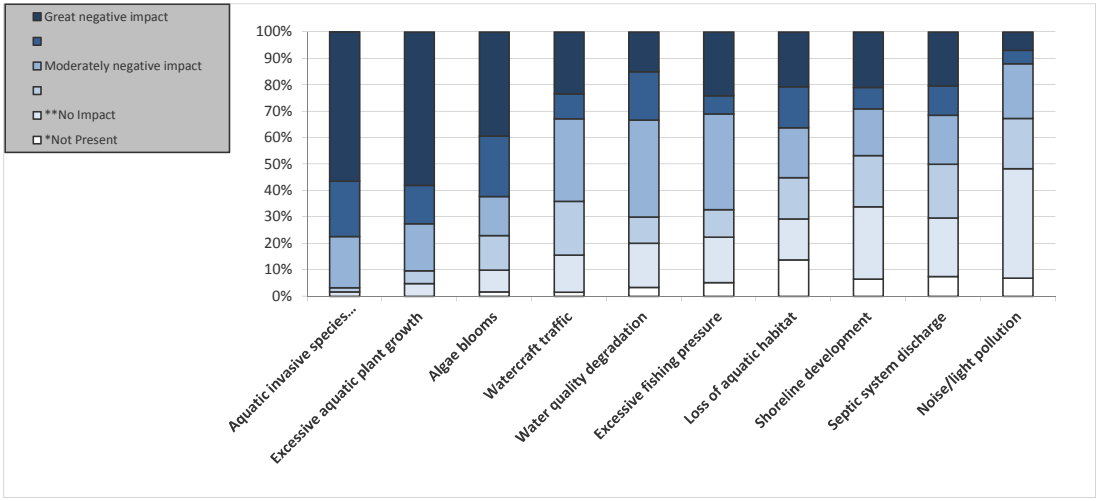
Answer Options	Response Percent	Response Count
Eurasian water milfoil	85.9%	55
Zebra mussel	85.9%	55
Curly-leaf pondweed	76.6%	49
Carp	62.5%	40
Purple loosestrife	48.4%	31
Chinese mystery snail	9.4%	6
Rusy crayfish	4.7%	3
Flowering rush	3.1%	2
Pale yellow iris	1.6%	1
Spiny water flea	1.6%	1
Heterosporosis (Yellow perch parasite)	1.6%	1
Freshwater jellyfish	0.0%	0
Alewife	0.0%	0
Round goby	0.0%	0
Rainbow smelt	0.0%	0
I don't know but presume that AIS are present in the lake	10.9%	7
Other (please specify)	0.0%	0
answered question		**64**
skipped question		**5**



20. To what level do you believe each of the following factors may currently be negatively impacting Long Lake?
*** Not Present means that you believe the issue does not exist on Long Lake.**
**** No Impact means that the issue may exist on Long Lake but it is not negatively impacting the lake.**

Answer Options	*Not Present	**No Impact		Moderately negative impact		Great negative impact	Unsure: Need more information	Rating Average	Response Count
Aquatic invasive species introduction	0	1	1	12	13	35	2	3.19	64
Excessive aquatic plant growth (excluding algae)	0	3	3	11	9	36	3	3.02	65
Algae blooms	1	5	8	9	14	24	3	2.56	64
Watercraft traffic	1	9	13	20	6	15	2	1.98	66
Water quality degradation	2	10	6	22	11	9	5	1.83	65
Excessive fishing pressure	3	10	6	21	4	14	6	1.81	64
Loss of aquatic habitat	8	9	9	11	9	12	6	1.66	64
Shoreline development	4	17	12	11	5	13	4	1.53	66
Septic system discharge	4	12	11	10	6	11	9	1.48	63
Noise/light pollution	4	24	11	12	3	4	6	0.94	64
Other (please specify)									5
								answered question	**67**
								skipped question	**2**

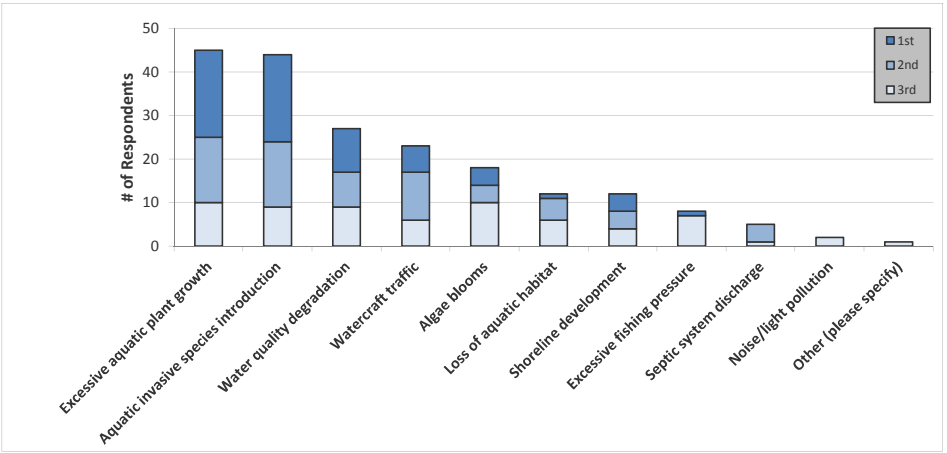
Number	Other (please specify)
1	Wash Water Discharge
2	groundwater runoff from roads and roof drains
3	people abusing fish limits & no size limit on northern -negative impact
4	chemical weed control in spawning areas
5	Runoff such as highway salt and fertilizer from the watershed



21. From the list below, please rank your top three concerns regarding Long Lake, with 1 being your greatest concern.

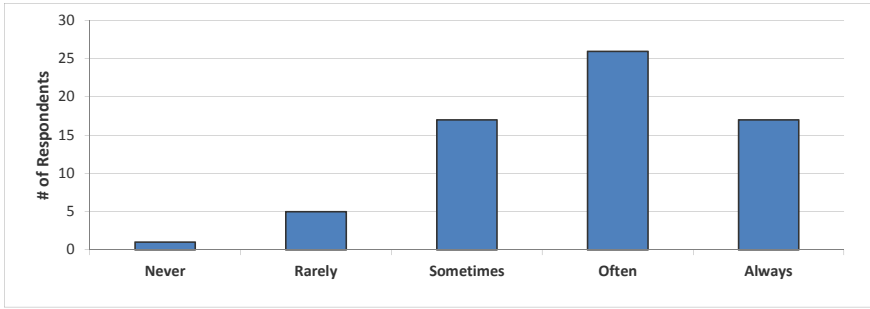
Answer Options	1st	2nd	3rd	Response Count
Excessive aquatic plant growth (excluding algae)	20	15	10	45
Aquatic invasive species introduction	20	15	9	44
Water quality degradation	10	8	9	27
Watercraft traffic	6	11	6	23
Algae blooms	4	4	10	18
Loss of aquatic habitat	1	5	6	12
Shoreline development	4	4	4	12
Excessive fishing pressure	1	0	7	8
Septic system discharge	0	4	1	5
Noise/light pollution	0	0	2	2
Other (please specify)	0	0	1	1
			answered question	67
			skipped question	2

Number	"Other" responses
1	This year many boaters broke no wake rule, worst I've seen in 35 yrs and drive boats closely to shore/raft. Little enforcement by water police
2	chemical weed control1st
3	The amount of Lily Pads and Muck in front of all cottages in our area



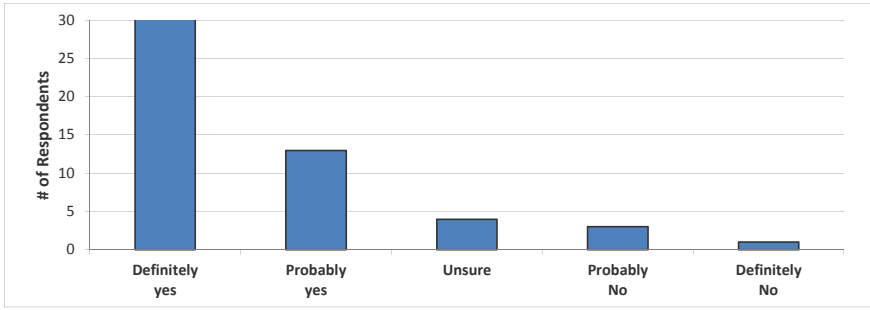
22. During open water season how often does aquatic plant growth, including algae, negatively impact your enjoyment of Long Lake?

Answer Options	Never	Rarely	Sometimes	Often	Always	Response Count
	1	5	17	26	17	66
					answered question	*66*
					skipped question	*3*



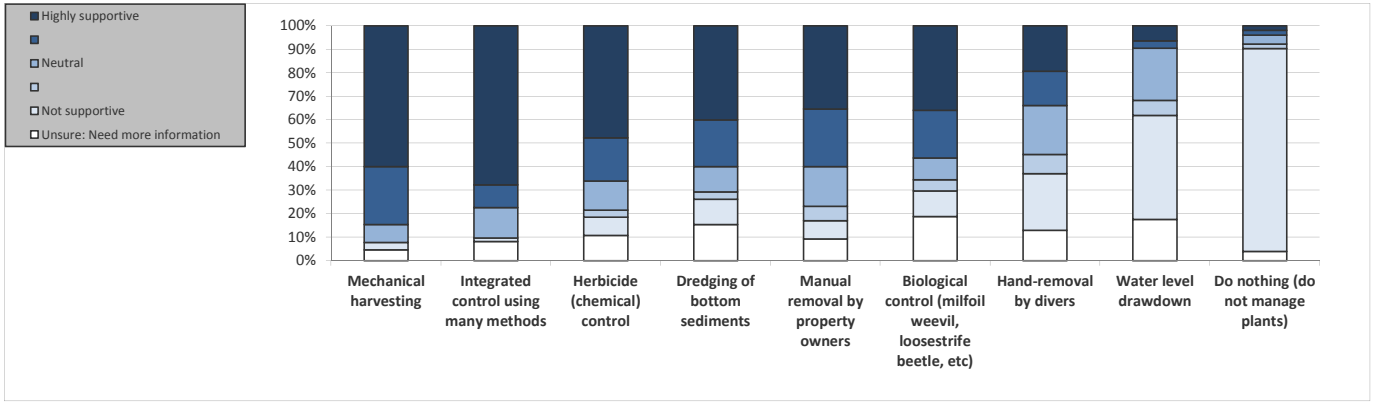
23. Considering your answer to the question above, do you believe aquatic plant control is needed on Long Lake?

Answer Options	Definitely yes	Probably yes	Unsure	Probably No	Definitely No	Response Count
	46	13	4	3	1	67
					answered question	*67*
					skipped question	*2*



24. Aquatic plants can be managed using many techniques. What is your level of support for the responsible use of the following techniques on Long Lake?

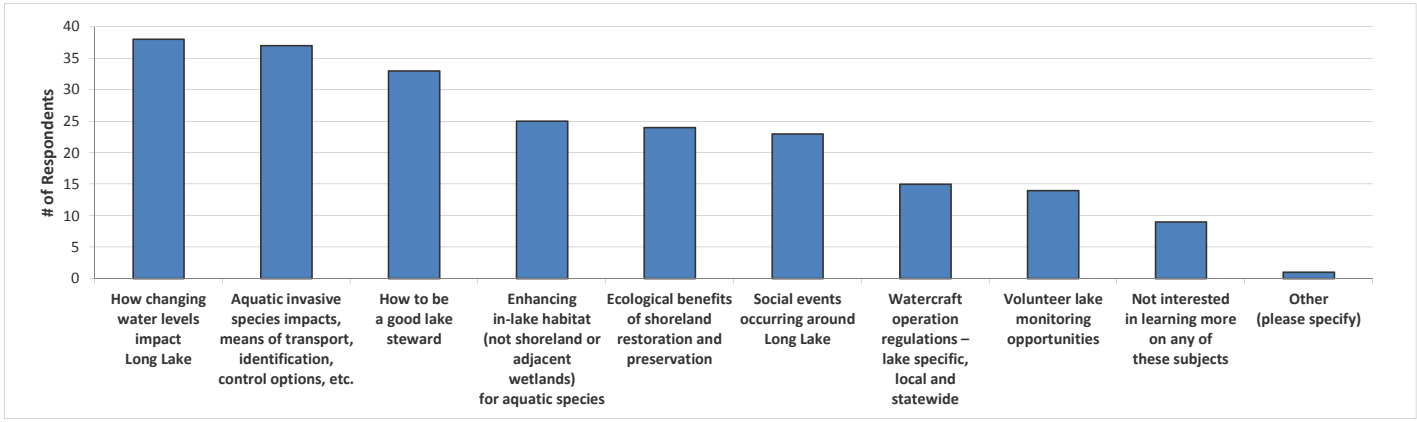
Answer Options	Not supportive		Neutral		Highly supportive	Unsure: Need more information	Rating Average	Response Count
Mechanical harvesting	2	0	5	16	39	3	3.17	65
Integrated control using many methods	1	0	8	6	42	5	3.02	62
Herbicide (chemical) control	5	2	8	12	31	7	2.60	65
Dredging of bottom sediments	7	2	7	13	26	10	2.37	65
Manual removal by property owners	5	4	11	16	23	6	2.35	65
Biological control (milfoil weevil, loosestrife beetle, etc)	7	3	6	13	23	12	2.25	64
Hand-removal by divers	15	5	13	9	12	8	1.61	62
Water level drawdown	28	4	14	2	4	11	0.92	63
Do nothing (do not manage plants)	45	1	2	1	1	2	1.04	52
							answered question	**67**
							skipped question	**2**



25. 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
How changing water levels impact Long Lake	58.5%	38
Aquatic invasive species impacts, means of transport, identification, control options, etc.	56.9%	37
How to be a good lake steward	50.8%	33
Enhancing in-lake habitat (not shoreland or adjacent wetlands) for aquatic species	38.5%	25
Ecological benefits of shoreland restoration and preservation	36.9%	24
Social events occurring around Long Lake	35.4%	23
Watercraft operation regulations - lake specific, local and statewide	23.1%	15
Volunteer lake monitoring opportunities (Clean Boats Clean Waters, Citizens Lake Monitoring	21.5%	14
Not interested in learning more on any of these subjects	13.8%	9
Other (please specify)	1.5%	1
	answered question	**65**
	skipped question	**4**

Number	Other (please specify)
1	Action being taken on other Wisconsin lakes that are similar in nature to Long Lake



Long Lake Preservation Association (LLPA)

26. Before receiving this mailing, have you ever heard of the LLPA?

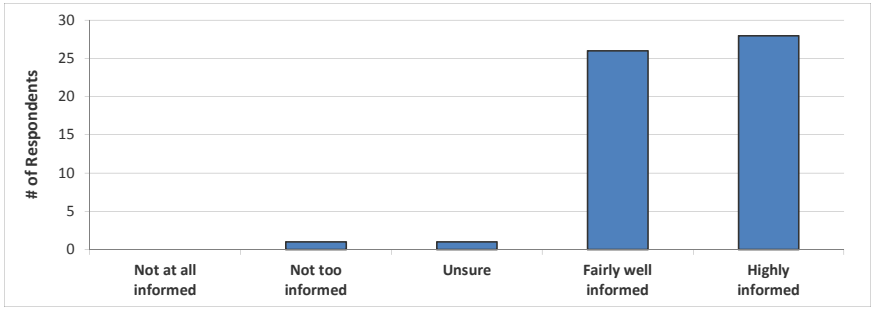
Answer Options	Response Percent	Response Count
Yes	100.0%	67
No	0.0%	0
answered question		**67**
skipped question		**2**

27. What is your membership status with the LLPA?

Answer Options	Response Percent	Response Count
Current member	83.6%	56
Former member	4.5%	3
Never been a member	11.9%	8
answered question		**67**
skipped question		**2**

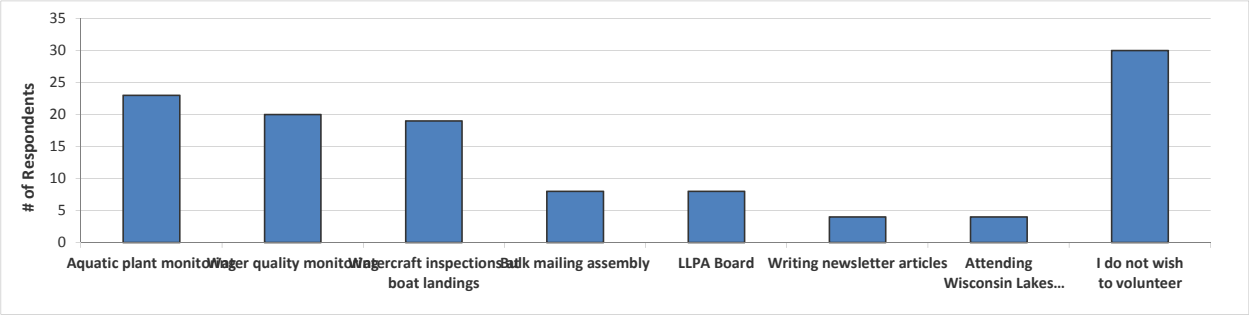
28. How informed has the LLPA kept you regarding issues with your lake and its management?

Answer Options	Not at all informed	Not too informed	Unsure	Fairly well informed	Highly informed	Response Count
	0	1	1	26	28	56
answered question						***56***
skipped question						***13***



29. The effective management of your lake will require the cooperative efforts of numerous volunteers. Please circle the activities you would be willing to participate in if the LLPA requires additional assistance.

Answer Options	Response Percent	Response Count
Aquatic plant monitoring	35.4%	23
Water quality monitoring	30.8%	20
Watercraft inspections at boat landings	29.2%	19
Bulk mailing assembly	12.3%	8
LLPA Board	12.3%	8
Writing newsletter articles	6.2%	4
Attending Wisconsin Lakes Convention	6.2%	4
I do not wish to volunteer	46.2%	30
answered question		65
skipped question		4



30. Please feel free to provide written comments concerning Long Lake, its current and/or historic condition and its management.

Answer Options	Response Count
	20
answered question	20
skipped question	49

Number	Response Text
1	Water quality is getting worse every year
2	I feel over the past few years, there seems to be more scum forming on the bottom of the lake. This fish seem to hide in this scum making fishing not as good as it used to be. The level of the scum seem to continue to grow, which I feel will impact the health of the lake if it is not monitored more closely.
3	We need to get the weeds under control. I cannot even get my boat out during the peak season without clearing my prop several times.
4	Thank you for all you're doing to help keep Long Lake a wonderful place for all to enjoy!
5	I do like seeing the weed patrol boat out trimming the weeds
6	who are you to Long Lake???
7	Almost never see fish, both along the shoreline and when on the water. Nothing like 10-15 years ago. Looks like there's not a fish in the lake! Clarity is pretty good except on weekends with the boat traffic and people coming too close to the shore. Too much boat traffic.
8	Keep up the god work! I am no longer a member of the fishing club!
9	The current LLPA has become a leader in trying to make the lake better for the property owners. I wish it would find a way to get more policing to enforce lake speeding rules.
10	I am in favor of aggressive, responsible control of weeds and invasive species. I have no concerns about what happened at Lake Ellwood affecting our lake.
11	I am answering this survey for my elderly mother based on what I believe her answers would be. Her primary residence was at Long Lake for almost 40 years. Over that time, her main concerns were the shoreline erosion and the thick weeds. During the last 15 years she lived there year round (1990- 2006) she did feel that the fishing wasn't as good as it had been in the past. I believe that the LLPA is doing a wonderful job in educating the property owners and working to protect and preserve the lake.
12	Seems that some areas of the lake get more attention than others (China Town), I don't believe the area around my property has been sprayed or harvested over the past two years, although the week growth is significant.
13	There needs to be a boat patrol present on the weekends.
14	Mu;ch improvement over the last few years.
15	You can see a major difference between the areas that are treated and not treated. Keep up the treating.
16	My opinion, LLPA has and is doing a magnificent job. Thank you LLPA. Too bad we can not get more volunteers to help out.
17	Managing weed control by chemical herbicide on another lake for seven years I saw the negative effects on the spawning fish and decline of the ability of fishing public to catch fish. Contrary to the DNR and the chemical applicators it does effect fishing. Look at the ditch and channel during spring south of Title lake here, The fishing has declined. The crappie have moved to other areas.
18	20+ years ago, I could catch fish off of my pier. I could also get my boat in and out without plugging the motor with mud and weeds. Today it is awful. I, more than likely will not re-join the association again this year because of these problems. I would spend a lot more time at the lake if these conditions were taken care of and would also be willing to pay my share. BUT the mud and the lily pads, and the weeds must go. Because I am stating facts, I am willing to state my name. It is Mike Schuler and I live in the channel. Thank you for the opportunity to voice my opinion.
19	As a child I could jump off the end of the pier and swim, weeds make that impossible now. Also, there is so much muck you sink into. I am thankful that the LLPA is working to better the lake conditions.
20	I'm very pleased to see the pro-active approach the LLPA is taking to ensure the longer-term health of Long Lake. In the same breath, I'm disappointed that Town Government is not more actively involved given the taxes generated by the landowners. I'm also disappointed the State is not stepping up in a larger manner financially given the huge piece of frontage owned by the state combined with the public use of the Lake.

C

APPENDIX C

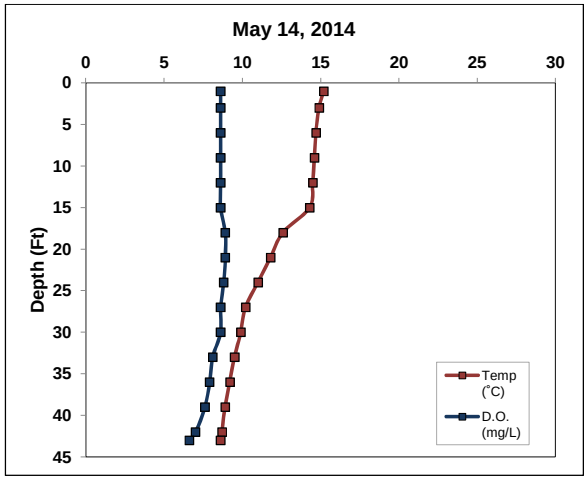
Water Quality Data

Long Lake

Date: 5/14/2014
Time: 14:15
Weather: 58F, breezy, overcast
Entry: EEH

Max Depth: 44.1
LOLS Depth (ft): 3.0
LOLB Depth (ft): 42.0
Secchi Depth (ft): 13.7

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	15.2	8.6		
3	14.9	8.6	8.3	
6	14.7	8.6		
9	14.6	8.6		
12	14.5	8.6		
15	14.3	8.6		
18	12.6	8.9		
21	11.8	8.9	8.2	
24	11.0	8.8		
27	10.2	8.6		
30	9.9	8.6		
33	9.5	8.1		
36	9.2	7.9		
39	8.9	7.6		
42	8.7	7.0	7.9	
43	8.6	6.6		



Parameter	LOLS	LOLB
Total P (µg/L)	28.10	18.60
Dissolved P (µg/L)	6.10	5.60
Chl-*a* (µg/L)	0.52	NA
TKN (µg/L)	555.00	410.00
NO_3 + NO_2-N (µg/L)	165.00	243.00
NH_3-N (µg/L)	16.50	41.40
Total N (µg/L)	720.00	653.00
Lab Cond. (µS/cm)	496.00	510.00
Lab pH	8.25	8.11
Alkalinity (mg/L $CaCO_3$)	225.00	230.00
Total Susp. Solids (mg/L)	ND	ND
Calcium (mg/L)	47.70	NA
Magnesium (mg/L)	29.90	NA
Hardness (mg/L)	242.00	NA
Color (SU)	20.00	NA
Turbidity (NTU)	NA	NA

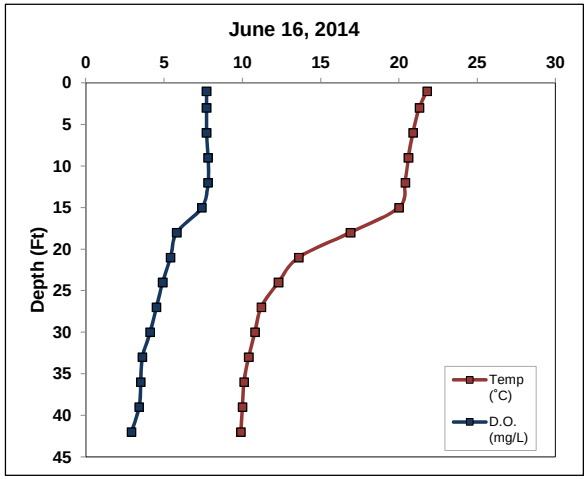
Data collected by DAC and EEH (Onterra)

Long Lake

Date: 6/16/2014
Time: 10:00
Weather: Clear, light breeze, 78F
Entry: EEH

Max Depth: 43.0
LOLS Depth (ft): 3.0
LOLB Depth (ft): 40.0
Secchi Depth (ft): 16.9

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	21.8	7.7		
3	21.3	7.7		
6	20.9	7.7		
9	20.6	7.8		
12	20.4	7.8		
15	20.0	7.4		
18	16.9	5.8		
21	13.6	5.4		
24	12.3	4.9		
27	11.2	4.5		
30	10.8	4.1		
33	10.4	3.6		
36	10.1	3.5		
39	10.0	3.4		
42	9.9	2.9		



Parameter	LOLS	LOLB
Total P (µg/L)	14.90	41.30
Dissolved P (µg/L)	NA	NA
Chl-*a* (µg/L)	1.83	NA
TKN (µg/L)	NA	NA
$NO_3 + NO_2$-N (µg/L)	NA	NA
NH_3-N (µg/L)	NA	NA
Total N (µg/L)	NA	NA
Lab Cond. (µS/cm)	NA	NA
Lab pH	NA	NA
Alkalinity (mg/L $CaCO_3$)	NA	NA
Total Susp. Solids (mg/L)	NA	NA
Calcium (mg/L)	NA	NA
Magnesium (mg/L)	NA	NA
Hardness (mg/L)	NA	NA
Color (SU)	NA	NA
Turbidity (NTU)	NA	NA

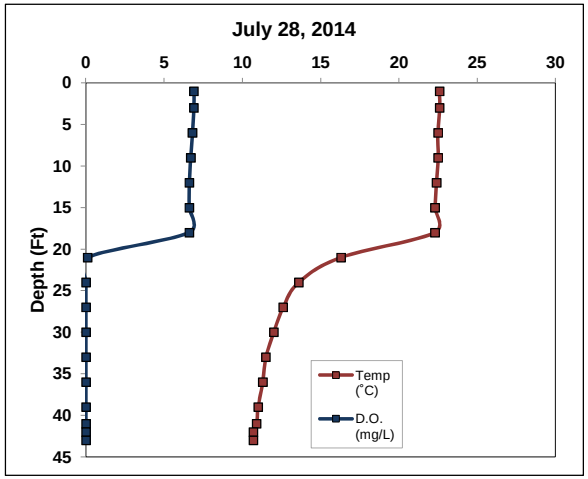
Data collected by TAH (Onterra)

Long Lake

Date: 7/28/2014
Time: 13:50
Weather: 25% clouds, 68F
Entry: EEH

Max Depth: 44.2
LOLS Depth (ft): 3.0
LOLB Depth (ft): 41.0
Secchi Depth (ft): 7.1

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	22.6	6.9		
3	22.6	6.9		
6	22.5	6.8		
9	22.5	6.7		
12	22.4	6.6		
15	22.3	6.6		
18	22.3	6.6		
21	16.3	0.1		
24	13.6	0.0		
27	12.6	0.0		
30	12.0	0.0		
33	11.5	0.0		
36	11.3	0.0		
39	11.0	0.0		
41	10.9	0.0		
42	10.7	0.0		
43	10.7	0.0		



Parameter	LOLS	LOLB
Total P (µg/L)	20.90	119.00
Dissolved P (µg/L)	ND	89.70
Chl-*a* (µg/L)	3.35	NA
TKN (µg/L)	614.00	878.00
$NO_3 + NO_2$-N (µg/L)	ND	31.90
NH_3-N (µg/L)	ND	311.00
Total N (µg/L)	614.00	909.90
Lab Cond. (µS/cm)	475.00	524.00
Lab pH	8.34	7.89
Alkalinity (mg/L $CaCO_3$)	219.00	239.00
Total Susp. Solids (mg/L)	2.50	ND
Calcium (mg/L)	46.00	NA
Magnesium (mg/L)	29.10	NA
Hardness (mg/L)	235.00	NA
Color (SU)	500.00	NA
Turbidity (NTU)	NA	NA

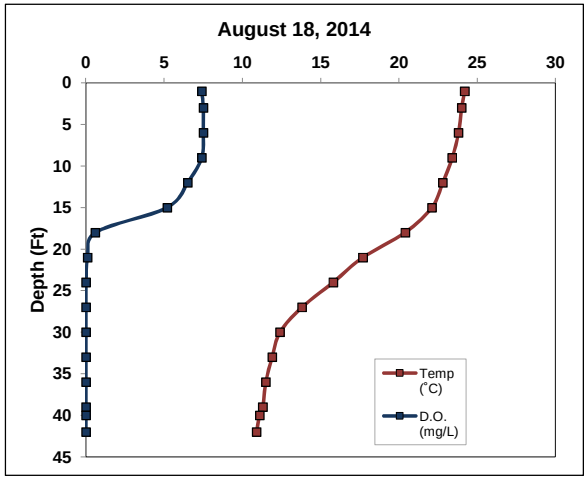
Data collected by TWH (Onterra)

Long Lake

Date: 8/18/2014
Time: 13:00
Weather: 80% clouds, 70F
Entry: EEH

Max Depth: 43.5
LOLS Depth (ft): 3.0
LOLB Depth (ft): 40.0
Secchi Depth (ft): 7.1

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	24.2	7.4		
3	24.0	7.5		
6	23.8	7.5		
9	23.4	7.4		
12	22.8	6.5		
15	22.1	5.2		
18	20.4	0.6		
21	17.7	0.1		
24	15.8	0.0		
27	13.8	0.0		
30	12.4	0.0		
33	11.9	0.0		
36	11.5	0.0		
39	11.3	0.0		
40	11.1	0.0		
42	10.9	0.0		



Parameter	LOLS	LOLB
Total P (µg/L)	23.20	159.00
Dissolved P (µg/L)	NA	NA
Chl-*a* (µg/L)	6.93	NA
TKN (µg/L)	NA	NA
NO_3 + NO_2-N (µg/L)	NA	NA
NH_3-N (µg/L)	NA	NA
Total N (µg/L)	NA	NA
Lab Cond. (µS/cm)	NA	NA
Lab pH	NA	NA
Alkalinity (mg/L $CaCO_3$)	NA	NA
Total Susp. Solids (mg/L)	NA	NA
Calcium (mg/L)	NA	NA
Magnesium (mg/L)	NA	NA
Hardness (mg/L)	NA	NA
Color (SU)	NA	NA
Turbidity (NTU)	NA	NA

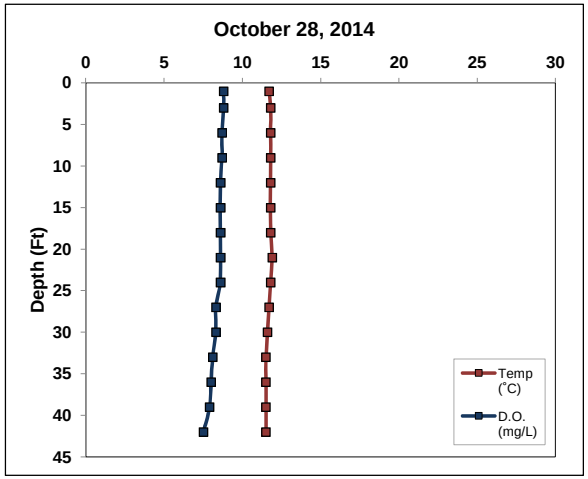
Data collected by TWH and EAT (Onterra)

Long Lake

Date: 10/28/2014
Time: 14:10
Weather: 80% clouds, 56F, windy
Entry: EEH

Max Depth: 44.5
LOLS Depth (ft): 3.0
LOLB Depth (ft): 42.0
Secchi Depth (ft): 12.2

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	11.7	8.8		
3	11.8	8.8	8.2	
6	11.8	8.7		
9	11.8	8.7		
12	11.8	8.6		
15	11.8	8.6		
18	11.8	8.6		
21	11.9	8.6	8.1	
24	11.8	8.6		
27	11.7	8.3		
30	11.6	8.3		
33	11.5	8.1		
36	11.5	8.0		
39	11.5	7.9		
42	11.5	7.5	7.6	



Parameter	LOLS	LOLB
Total P (µg/L)	28.40	28.70
Dissolved P (µg/L)	NA	NA
Chl-*a* (µg/L)	1.92	NA
TKN (µg/L)	NA	NA
$NO_3 + NO_2$-N (µg/L)	NA	NA
NH_3-N (µg/L)	NA	NA
Total N (µg/L)	NA	NA
Lab Cond. (µS/cm)	NA	NA
Lab pH	NA	NA
Alkalinity (mg/L $CaCO_3$)	NA	NA
Total Susp. Solids (mg/L)	ND	ND
Calcium (mg/L)	NA	NA
Magnesium (mg/L)	NA	NA
Hardness (mg/L)	NA	NA
Color (SU)	NA	NA
Turbidity (NTU)	NA	NA

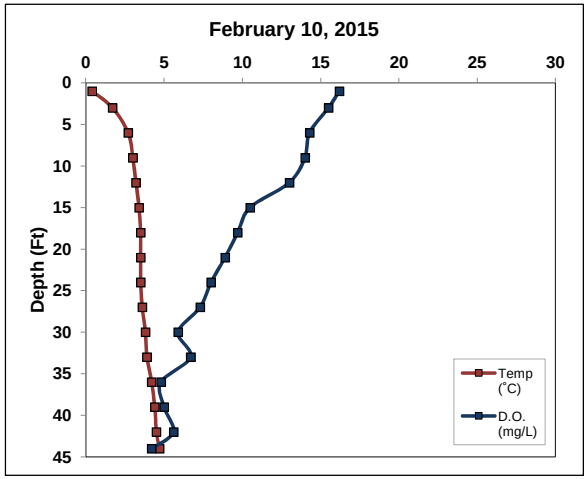
Data collected by TWH (Onterra)

Long Lake

Date: 2/10/2015
Time: 10:00
Weather: 100% clouds, 18F
Entry: EEH

Max Depth: 44.9
LOLS Depth (ft): 3.0
LOLB Depth (ft): 42.0
Secchi Depth (ft): 5.5

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	0.4	16.2		
3	1.7	15.5		
6	2.7	14.3		
9	3.0	14.0		
12	3.2	13.0		
15	3.4	10.5		
18	3.5	9.7		
21	3.5	8.9		
24	3.5	8.0		
27	3.6	7.3		
30	3.8	5.9		
33	3.9	6.7		
36	4.2	4.8		
39	4.4	5.0		
42	4.5	5.6		
44	4.7	4.2		



Parameter	LOLS	LOLB
Total P (µg/L)	24.50	50.50
Dissolved P (µg/L)	2.00	33.00
Chl-*a* (µg/L)	NA	NA
TKN (µg/L)	596.00	484.00
NO_3 + NO_2-N (µg/L)	137.00	847.00
NH_3-N (µg/L)	ND	139.00
Total N (µg/L)	733.00	1331.00
Lab Cond. (µS/cm)	NA	NA
Lab pH	NA	NA
Alkalinity (mg/L $CaCO_3$)	NA	NA
Total Susp. Solids (mg/L)	NA	NA
Calcium (mg/L)	NA	NA
Magnesium (mg/L)	NA	NA
Hardness (mg/L)	NA	NA
Color (SU)	NA	NA
Turbidity (NTU)	NA	NA

Data collected by BTB and TWH (Onterra). Ice thickness = 1.2 feet.

Water Quality Data

2014-2015	Surface		Bottom	
Parameter	Count	Mean	Count	Mean
Secchi Depth (feet)	6	10.4	NA	NA
Total P (µg/L)	6	23.3	6	69.5
Dissolved P (µg/L)	3	4.1	3	42.8
Chl a (µg/L)	5	2.9	0	NA
TKN (µg/L	3	588.3	3	590.7
NO3+NO2-N (µg/L)	3	151.0	3	374.0
NH3-N (µg/L)	3	16.5	3	163.8
Total N (µg/L)	3	689.0	3	964.6
Lab Cond. (µS/cm)	2	485.5	2	517.0
Lab pH	2	8.3	2	8.0
Alkal (mg/l CaCO3)	2	222.0	2	234.5
Total Susp. Solids (mg/l)	3	2.5	3	ND
Calcium (µg/L)	2	46.9	0	NA
Magnesium (mg/L)	2	29.5	0	NA
Hardness (mg/L)	2	238.5	0	NA
Color (SU)	2	260.0	0	NA
Turbidity (NTU)	0	NA	0	NA

Trophic State Index (TSI)

Year	TP	Chl-a	Secchi
1986			40.6
1987			42.4
1988	43.7	48.2	42.5
1989	45.8	45.4	42.8
1990	46.9	55.5	47.9
1991	44.7	48.7	47.6
1992	42.2	48.3	42.1
1993	47.5	53.2	47.2
1994	46.0	44.3	46.5
1995	40.9	38.8	43.4
1996	45.4	47.3	45.8
1997	52.2	50.7	46.1
1998	47.2	43.1	42.9
1999	46.6	46.2	43.0
2000	44.8	43.6	44.0
2001	47.6	44.8	46.6
2002	45.6	43.0	42.7
2003			
2004	49.4	43.9	42.6
2005	49.7	45.2	43.2
2006	46.6	46.5	44.8
2007	44.8	41.1	35.5
2008	52.2	44.6	42.1
2009	50.2	41.5	40.2
2010	49.0	47.5	43.1
2011			
2012	47.1	41.5	39.1
2013	44.2	43.9	40.7
2014	47.1	44.3	43.4
All Years (Weighted)	46.8	46.4	43.6
Deep, Lowland Drainage Lakes Median	49.4	49.7	46.2
SWTP Ecoregion Median	48.7	47.0	50.0

	Secchi (feet)				Chlorophyll-a (µg/L)				Total Phosphorus (µg/L)			
	Growing Season		Summer		Growing Season		Summer		Growing Season		Summer	
Year	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean
1986	6	11.4	3	12.6								
1987	19	12.4	12	11.1								
1988	18	10.8	12	11.1	3	6.0	3	6.0	2	15.5	2.0	15.5
1989	18	11.3	14	10.8	4	5.3	2	4.5	4	17.8	2.0	18.0
1990	20	8.4	15	7.6	4	11.8	3	12.7	5	21.0	3.0	19.3
1991	15	7.7	11	7.7	4	6.0	3	6.3	9	24.6	5.0	16.6
1992	14	11.0	9	11.4	4	5.8	3	6.1	7	19.0	4.0	14.0
1993	9	8.0	7	8.0	6	11.3	4	10.0	6	22.0	4.0	20.3
1994	8	8.3	6	8.4	9	5.0	6	4.0	9	19.3	6.0	18.2
1995	8	9.6	5	10.4	8	5.3	5	2.3	8	15.0	5.0	12.8
1996	15	8.8	14	8.8	7	6.0	6	5.5	7	17.4	6.0	17.5
1997	7	9.0	5	8.6	9	7.6	6	7.7	7	26.7	5.0	28.0
1998	8	10.5	6	10.8	9	3.9	7	3.6	8	21.6	6.0	19.8
1999	8	10.4	6	10.7	8	5.0	6	4.9	8	19.8	6.0	19.0
2000	10	10.4	8	9.9	7	5.9	5	3.8	7	18.6	5.0	16.8
2001	5	8.1	3	8.3	4	6.7	3	4.2	4	22.8	3.0	20.3
2002	5	11.1	4	10.9	3	3.5	3	3.5	3	17.7	3.0	17.7
2003												
2004	1	11.0	1	11.0	2	3.9	2	3.9	3	24.7	2.0	23.0
2005	3	13.8	1	10.5	3	3.9	2	4.4	4	21.5	2.0	23.5
2006	12	12.5	6	9.4	5	4.4	4	5.0	6	20.3	4.0	19.0
2007	8	17.5	6	18.0	5	3.0	4	2.9	6	15.3	4.0	16.8
2008	14	11.5	7	11.4	4	3.5	3	4.2	5	27.2	3.0	28.0
2009	4	13.3	3	13.0	4	3.5	3	3.0	4	22.8	3.0	24.3
2010	6	10.6	6	10.6	4	5.6	4	5.6	6	23.5	5.0	22.4
2011												
2012	4	14.8	2	14.0	4	3.1	3	3.0	6	18.5	3.0	19.7
2013	4	15.8	2	12.5	3	3.9	3	3.9	4	17.8	3.0	16.1
2014	5	11.4	3	10.4	5	2.9	3	4.0	5	23.1	3.0	19.7
All Years (Weighted)		10.7		10.2		5.6		5.0		20.5		19.2
Deep, Lowland Drainage Lakes SWTP Ecoregion Median				8.5				7.0				23.0
				6.6				5.3				22.0

D

APPENDIX D

Watershed Analysis WiLMS Results

Date: 10/16/2014 Scenario: Long Lake Watershed Current

Lake Id: LongFDL_Watershed_Current

Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 12371.0 acre
Total Unit Runoff: 7.9 in.
Annual Runoff Volume: 8144.2 acre-ft
Lake Surface Area <As>: 460 acre
Lake Volume <V>: 7237 acre-ft
Lake Mean Depth <z>: 15.7 ft
Precipitation - Evaporation: 3.1 in.
Hydraulic Loading: 8263.1 acre-ft/year
Areal Water Load <qs>: 18.0 ft/year
Lake Flushing Rate <p>: 1.14 1/year
Water Residence Time: 0.88 year
Observed spring overturn total phosphorus (SPO): 23.9 mg/m^3
Observed growing season mean phosphorus (GSM): 20.5 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre	Low	Most Likely	High	Loading %	Low	Most Likely	High
	(ac)	Loading (kg/ha-year)				Loading (kg/year)		
Row Crop AG	3558	0.50	1.00	3.00	68.8	720	1440	4320
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	3048	0.10	0.30	0.50	17.7	123	370	617
HD Urban (1/8 Ac)	12	1.00	1.50	2.00	0.3	5	7	10
MD Urban (1/4 Ac)	17	0.30	0.50	0.80	0.2	2	3	6
Rural Res (>1 Ac)	312	0.05	0.10	0.25	0.6	6	13	32
Wetlands	1822	0.10	0.10	0.10	3.5	74	74	74
Forest	3602	0.05	0.09	0.18	6.3	73	131	262
Lake Surface	460.0	0.10	0.30	1.00	2.7	19	56	186

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %

SEPTIC TANK DATA

Description		Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)		0.3	0.5	0.8	
# capita-years	0.0				
% Phosphorus Retained by Soil		98	90	80	
Septic Tank Loading (kg/year)		0.00	0.00	0.00	0.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	2252.6	4616.7	12137.7	100.0
Total Loading (kg)	1021.8	2094.1	5505.6	100.0
Areal Loading (lb/ac-year)	4.90	10.04	26.39	0.0
Areal Loading (mg/m^2-year)	548.89	1124.93	2957.53	0.0
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	2211.6	4493.6	11727.2	100.0
Total NPS Loading (kg)	1003.2	2038.3	5319.4	100.0

Phosphorus Prediction and Uncertainty Analysis Module

Date: 10/16/2014 Scenario: Long Lake Watershed Current
Observed spring overturn total phosphorus (SPO): 23.9 mg/m^3
Observed growing season mean phosphorus (GSM): 20.5 mg/m^3
Back calculation for SPO total phosphorus: 0.0 mg/m^3
Back calculation GSM phosphorus: 0.0 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 0 kg

Lake Phosphorus Model	Low Total P (mg/m^3)	Most Likely Total P (mg/m^3)	High Total P (mg/m^3)	Predicted -Observed (mg/m^3)	% Dif.
Walker, 1987 Reservoir	28	58	153	38	185
Canfield-Bachmann, 1981 Natural Lake	45	75	146	55	268
Canfield-Bachmann, 1981 Artificial Lake	38	59	100	39	190
Rechow, 1979 General	30	62	163	42	205
Rechow, 1977 Anoxic	78	161	422	141	688
Rechow, 1977 water load<50m/year	46	94	247	74	361
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	56	116	304	92	385
Vollenweider, 1982 Combined OECD	39	71	157	49	221
Dillon-Rigler-Kirchner	30	61	160	37	155
Vollenweider, 1982 Shallow Lake/Res.	33	62	145	40	180
Larsen-Mercier, 1976	52	106	279	82	343
Nurnberg, 1984 Oxic	36	74	195	54	263

Lake Phosphorus Model	Confidence Lower Bound	Confidence Upper Bound	Parameter Fit?	Back Calculation (kg/year)	Model Type
Walker, 1987 Reservoir	34	120	FIT	0	GSM
Canfield-Bachmann, 1981 Natural Lake	23	216	FIT	1	GSM
Canfield-Bachmann, 1981 Artificial Lake	18	170	FIT	1	GSM
Rechow, 1979 General	35	129	FIT	0	GSM
Rechow, 1977 Anoxic	95	329	FIT	0	GSM
Rechow, 1977 water load<50m/year	53	194	P	0	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	57	249	FIT	0	SPO
Vollenweider, 1982 Combined OECD	34	142	FIT	0	ANN
Dillon-Rigler-Kirchner	36	125	P	0	SPO
Vollenweider, 1982 Shallow Lake/Res.	30	126	FIT	0	ANN
Larsen-Mercier, 1976	65	216	P Pin	0	SPO
Nurnberg, 1984 Oxic	38	157	P	0	ANN