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
  - Three full-time ecologists
  - One part-time ecologist
  - Four field technicians
  - Four summer interns
- Services
  - Science and planning
- Philosophy
  - Promote realistic planning
  - Assist, not direct

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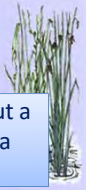
Lake Management Planning

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 foster realistic expectations and dispel myths.
- To create a snapshot of the lake for future reference and planning.



A goal without a plan is just a wish!

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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 – Each Lake
  - Water Quality Analysis
  - Watershed Assessment
  - Aquatic Plant Surveys
  - Shoreland Assessment
  - Fisheries Data Integration
  - 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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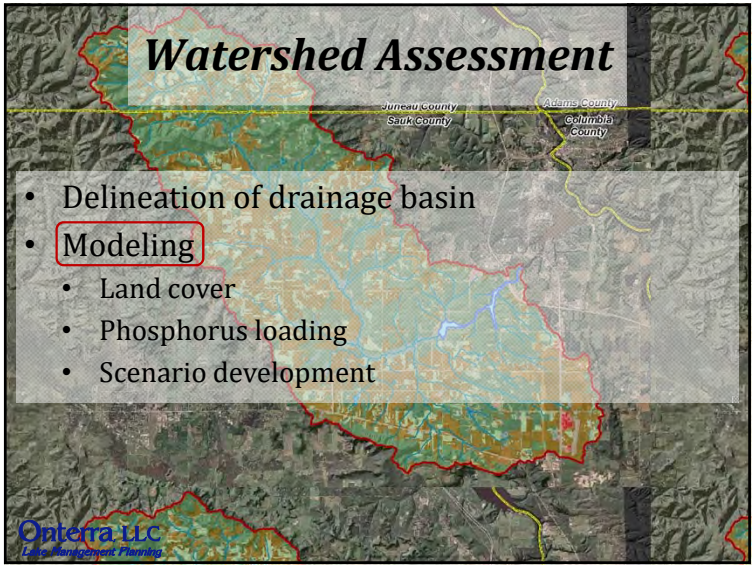
Watershed Assessment



- 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
- Multiple surveys used in assessment
  - Early-season AIS survey
  - Point-intercept survey
  - Aquatic plant community mapping

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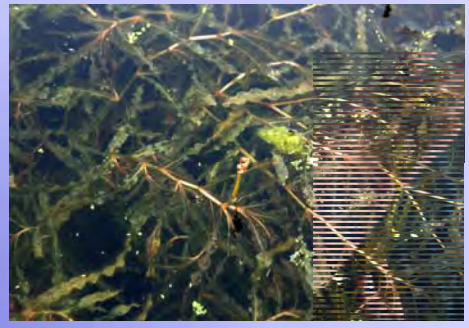
Non-native Aquatic Plants

Curly-leaf Pondweed



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Non-native Aquatic Plants

Eurasian Water Milfoil

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Non-native Aquatic Plants

Pale Yellow Iris

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Non-native Aquatic Plants

Purple Loosestrife

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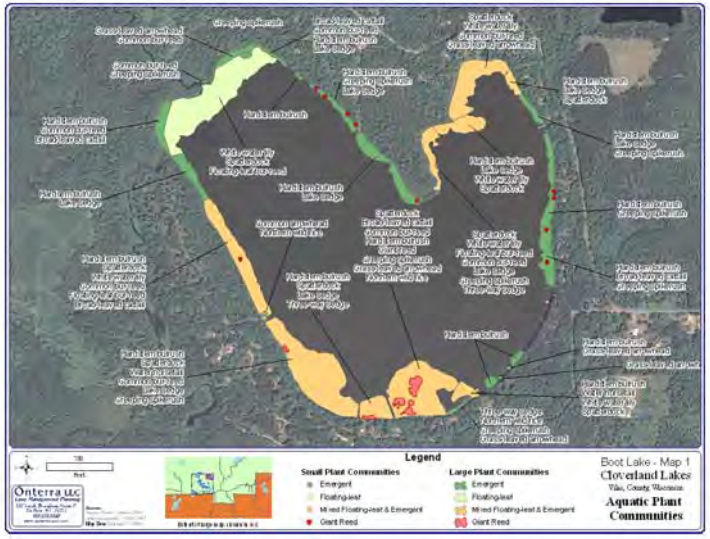
Point-Intercept Surveys

Little Star Lake
45-meter resolution
186 total points

Plum Lake
63-meter resolution
1078 total points

Star Lake
65-meter resolution
1184 total points

West Plum Lake
37-meter resolution
205 total points



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

Range

Natural

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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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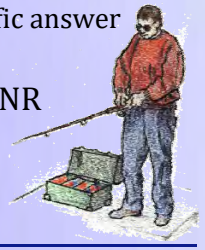
Stakeholder Survey
(Each Phase)

- Standard survey used as base
  - Planning committee 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

Planning Process

Planning Committee Meetings

Study Results
Conclusions & Initial Recommendations
Management Goals
Management Actions
  Timeframe
  Facilitator(s)

↓

Implementation Plan

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Town of Plum Lake Planning Process

- Town-wide project brings on unique situation
  - Cost savings are great
  - Providing attention to individual lakes is difficult
- Lake representatives
  - Communication link between stakeholders from individual lakes and Lakes Committee
- Stakeholder survey comments will be important

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Town of Plum Lake Management Plan Documents

- Multiple document types
  - Town of Plum Lake Management Plan
  - Lake-Specific Results and Conclusions
  - Lake-Specific Implementation Plan
  - Appendices (raw data, etc.)
- Town-wide Compilation
  - All documents
- Individual Lake Document
  - Town-wide management plan
  - Lake-specific documents

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Thank You

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

Wisconsin Lakes Partnership

UWEX Extension

Wisconsin Dept. of Natural Resources

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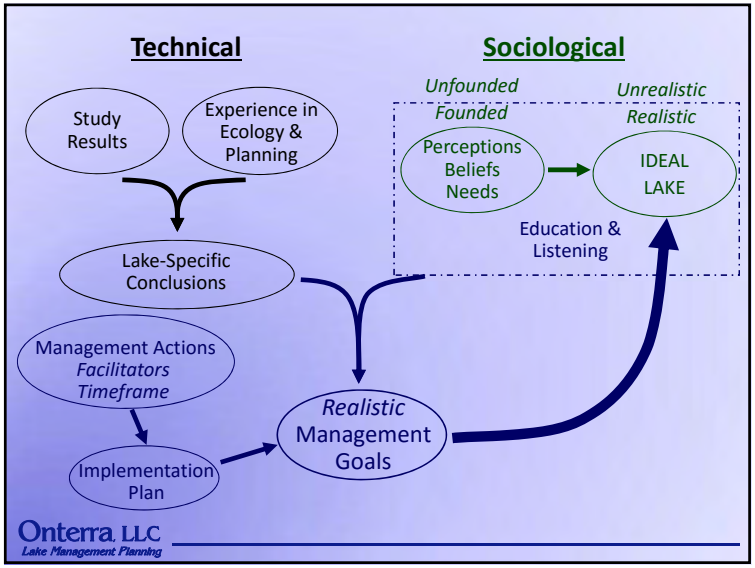
Lake Management Planning

The Planning Process

…it's not as easy as you may think.



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Town of Plum Lake

Phase I

Star, Little Star, Plum & West Plum Lakes Management Planning Project

Planning Meeting I

June 11, 2018

Tim Hoyman

Onterra LLC

Lake Management Planning

Presentation Outline

- Lake Management Planning Project Overview
- Study Results
  - Water Quality
  - Watershed
  - Shoreland Condition
  - Aquatic Plants
  - Fishery (Next Meeting)
- "Big Picture"
- Implementation Plan Development

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Meeting Objective

Planning Committee Meetings

Study Results
Conclusions & Initial Recommendations

Planning Meeting I

Management Goals
Management Actions
Timeframe
Facilitator(s)

Planning Meeting II

Implementation Plan

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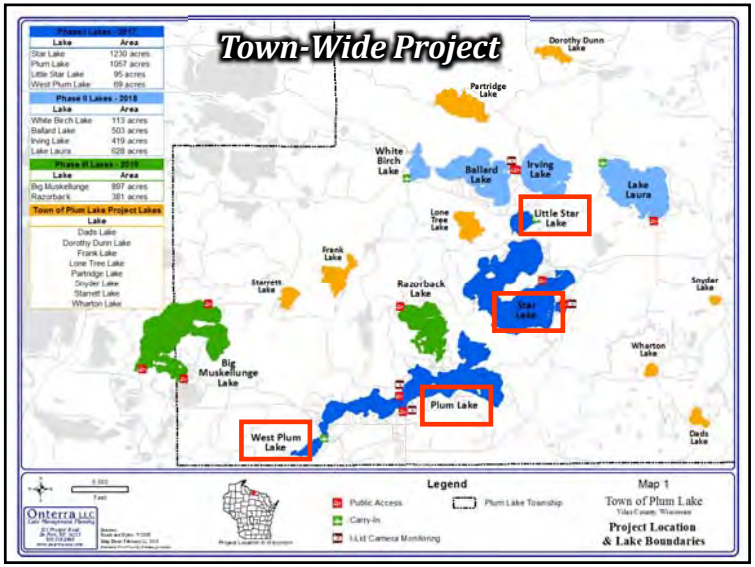
Town-Wide Project



Summary of Project Results

Water Quality

- Overall good, but Little Star Lake is experiencing symptoms from its past

Watershed & Immediate Shoreline

- Watersheds are in excellent condition and deliver low levels of nutrients to the lakes
- Shorelines are in very good shape overall, but there is always room for improvement

Aquatic Plant Community

- The aquatic plant communities are as expected for the lake types studies
- All four lakes have some non-native aquatic plants

Fisheries (Will discuss in more detail at next meeting)

- Some survey/stocking data available
- Tribal spear-harvest records for Star and Plum Lakes

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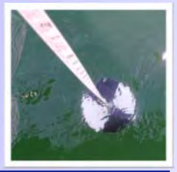
Introduction to Lake Water Quality

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

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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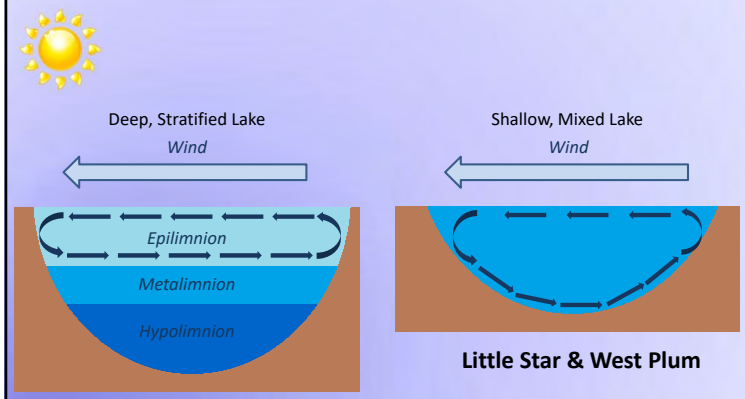
Wisconsin Lakes Classification



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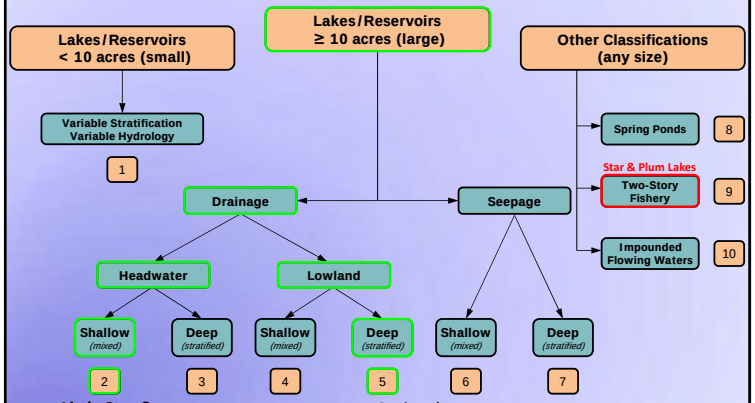
Wisconsin Lakes Natural Community Types



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Water Quality

Wisconsin Ecoregions

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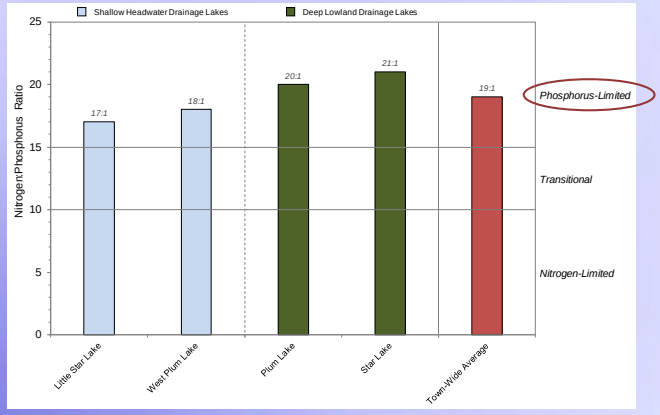
Town of Plum Lake
Mid-Summer Nitrogen:Phosphorus Ratios



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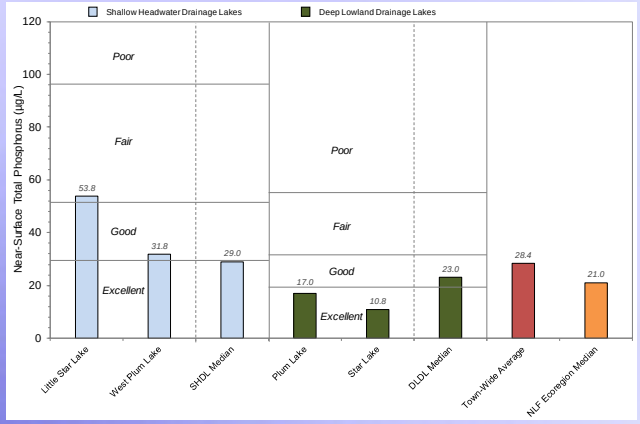
Town of Plum Lake
Near-Surface Summer Total Phosphorus



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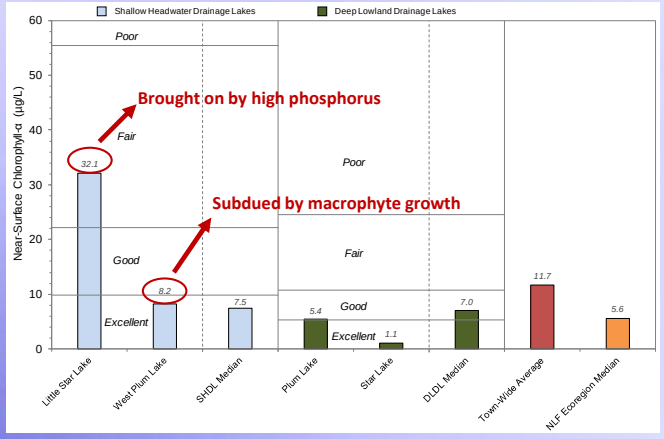
Town of Plum Lake
Chlorophyll-*a*



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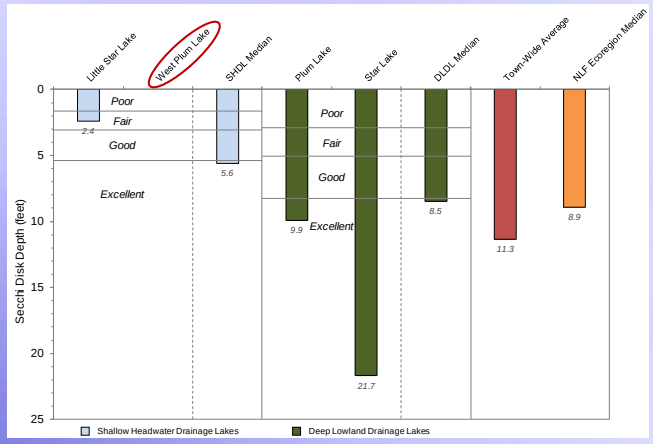
Town of Plum Lake Secchi Disk Transparency



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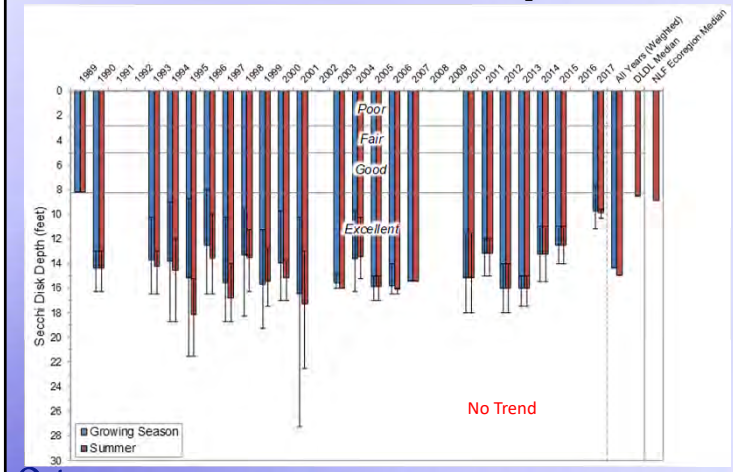
Plum Lake Secchi Disk Depth



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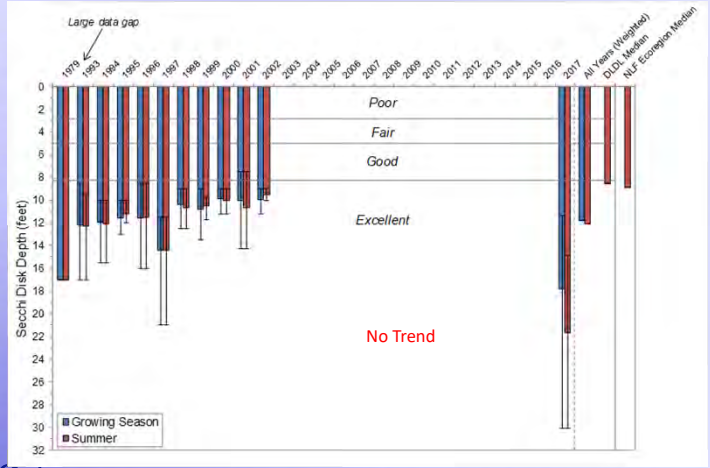
Star Lake Secchi Disk Depth



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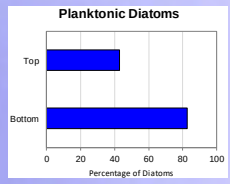
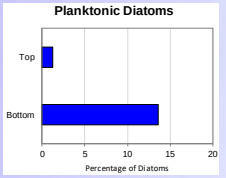
Town of Plum Lake Paleocore Analysis

Lakes	Phosphorus (µg/L)
Star Top	12
Star Bottom	11
Little Star Top	31
Little Star Bottom	36
Plum Top	14
Plum Bottom	10
West Plum Top	35
West Plum Bottom	14

Star Lake



Plum Lake



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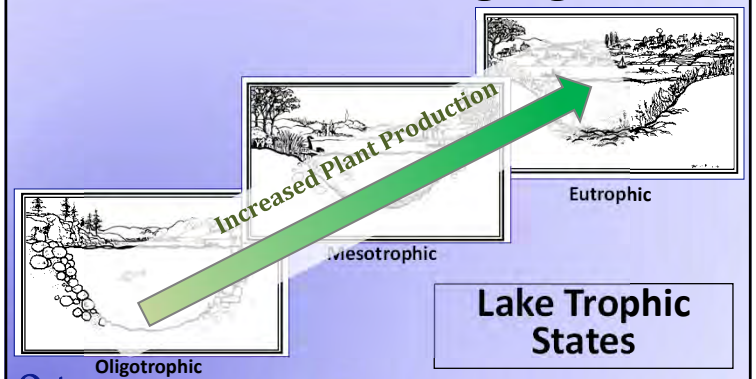
Eutrophication -Lake Aging



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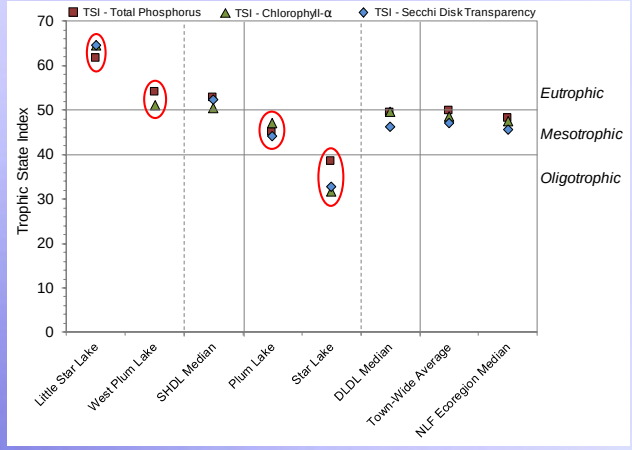
Town of Plum Lake Trophic State Index



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Additional Water Quality Parameters

Dissolved Oxygen

All lakes had sufficient DO during summer and fall

Star & Plum Lakes had sufficient DO during winter

Little Star and West Plum were not sampled during winter

Alkalinity

Star and Plum Lakes have high alkalinity

Star and Plum Lakes have high buffering capacity against acid rain

Calcium Content

Star and Plum Lakes have low calcium content

Star and Plum Lakes have very low susceptibility to zebra mussel establishment

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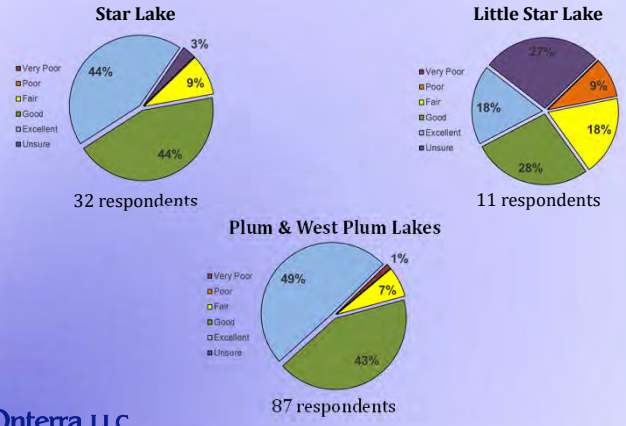
Stakeholder Perceptions of Water Quality

How would you describe the current water quality of your lake?



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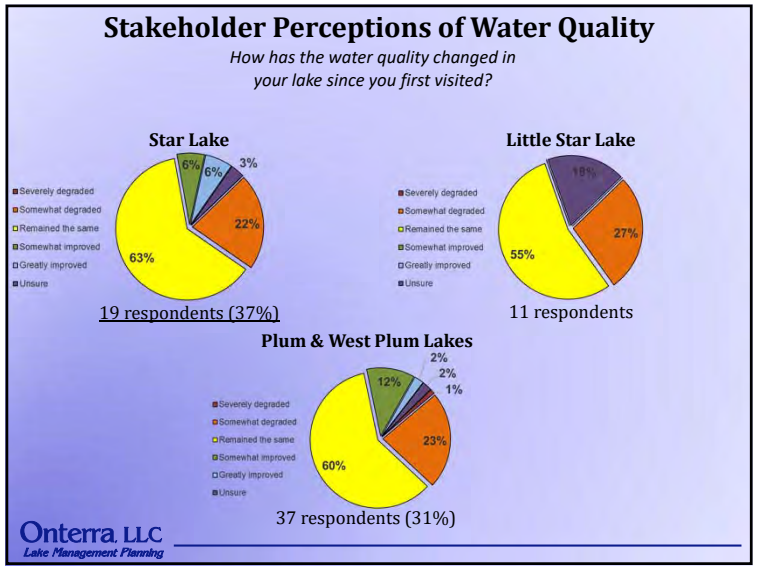
Stakeholder Perceptions of Water Quality
How has the water quality changed in your lake since you first visited?
Star Lake
Severely degraded
Somewhat degraded
Remained the same
Somewhat improved
Greatly improved
Unsure
6%
6%
3%
22%
63%
19 respondents (37%)
Little Star Lake
18%
27%
55%
11 respondents
Plum & West Plum Lakes
2%
2%
1%
12%
23%
60%
37 respondents (31%)
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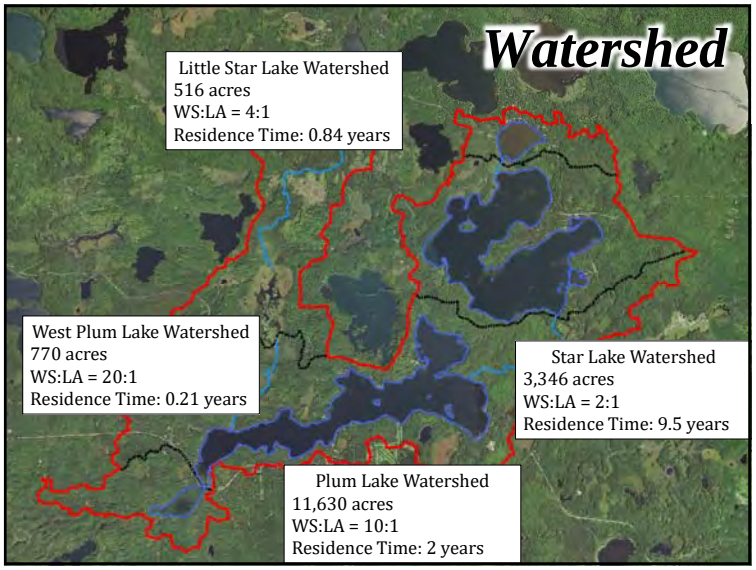
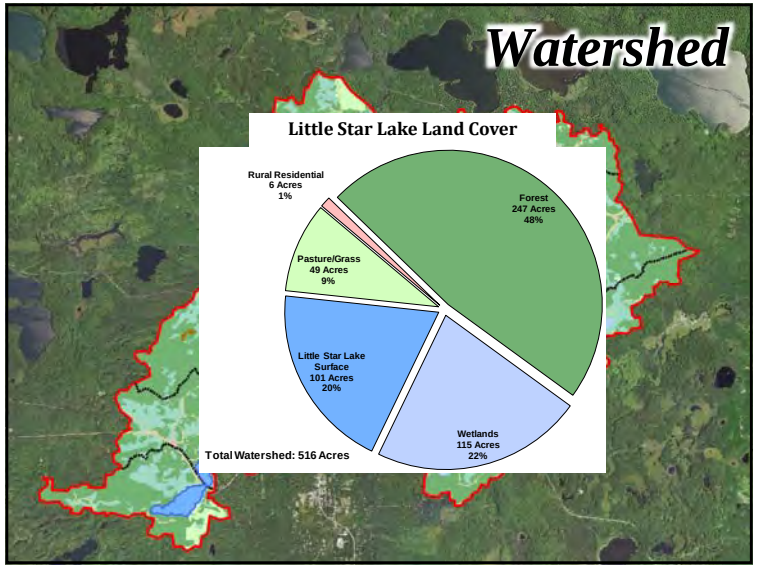
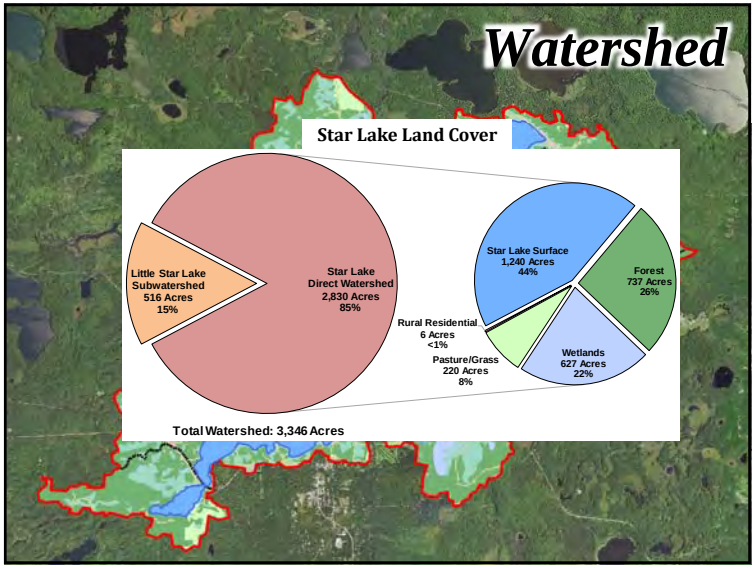
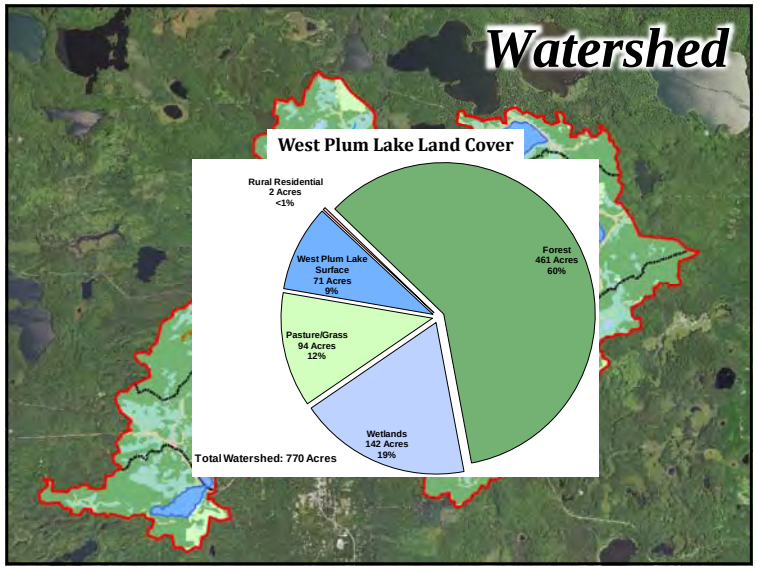
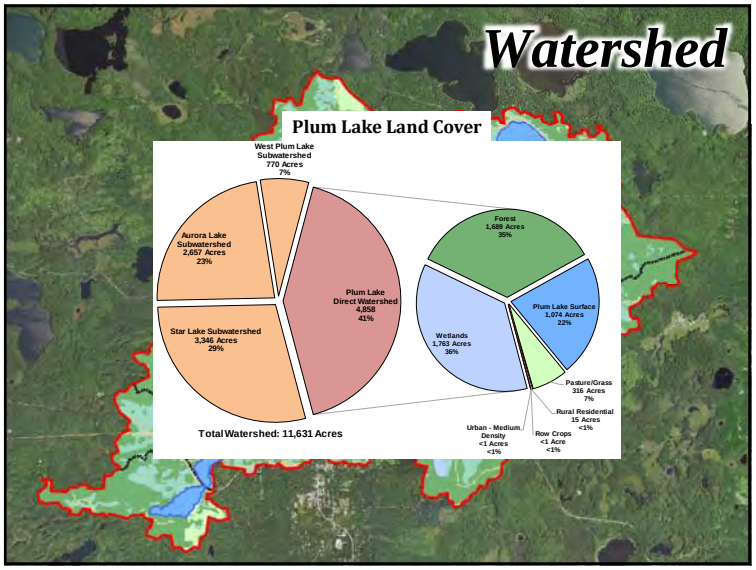
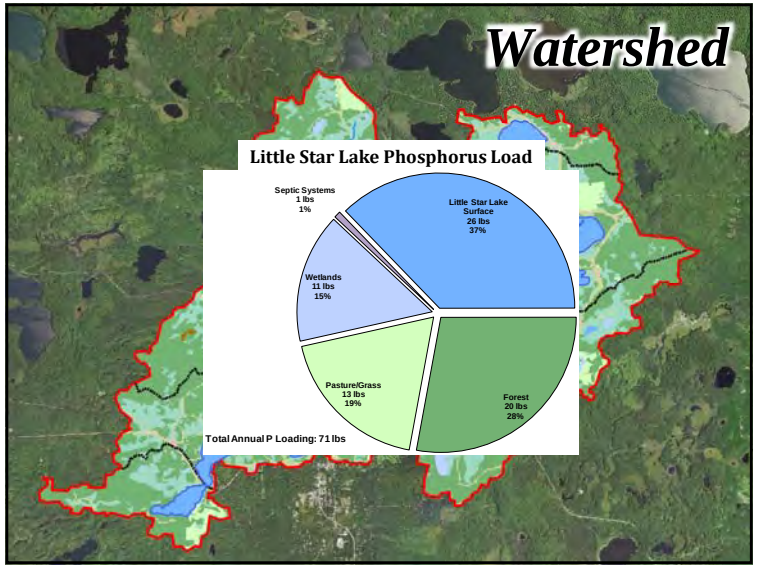

Watershed
Little Star Lake Watershed
516 acres
WS:LA = 4:1
Residence Time: 0.84 years
West Plum Lake Watershed
770 acres
WS:LA = 20:1
Residence Time: 0.21 years
Star Lake Watershed
3,346 acres
WS:LA = 2:1
Residence Time: 9.5 years
Plum Lake Watershed
11,630 acres
WS:LA = 10:1
Residence Time: 2 years

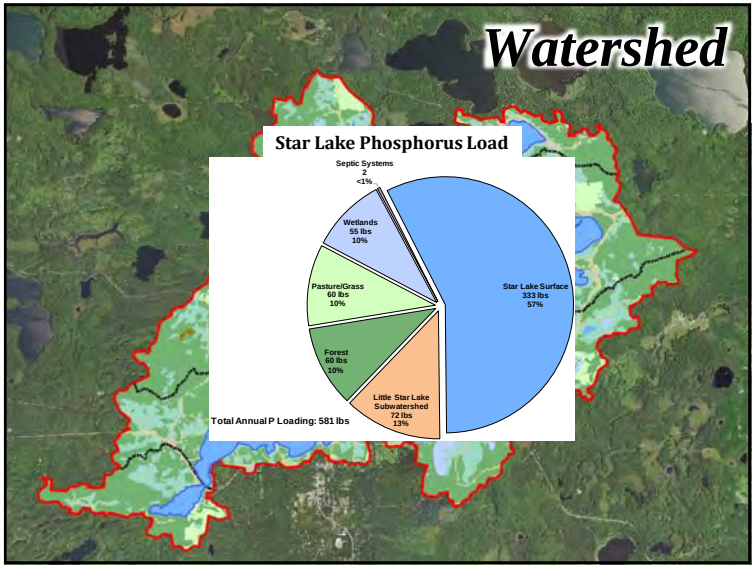

Watershed
Little Star Lake Land Cover
Rural Residential
6 Acres
1%
Forest
247 Acres
48%
Pasture/Grass
49 Acres
9%
Little Star Lake
Surface
101 Acres
20%
Wetlands
115 Acres
22%
Total Watershed: 516 Acres

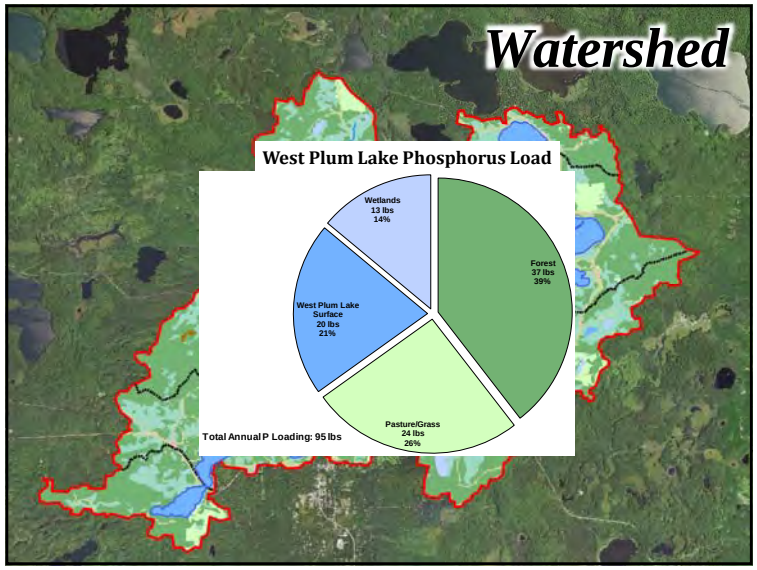

Watershed
Star Lake Land Cover
Little Star Lake
Subwatershed
516 Acres
15%
Star Lake
Direct Watershed
2,830 Acres
85%
Star Lake Surface
1,240 Acres
44%
Forest
737 Acres
26%
Rural Residential
6 Acres
<1%
Pasture/Grass
220 Acres
8%
Wetlands
627 Acres
22%
Total Watershed: 3,346 Acres

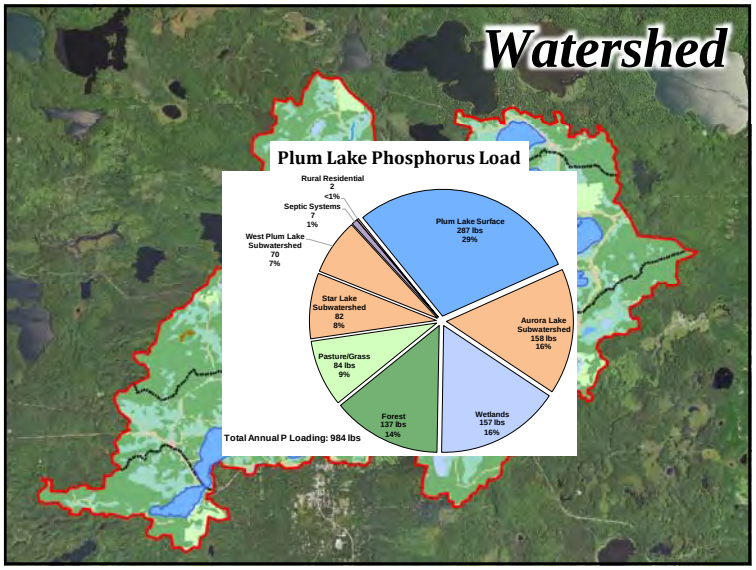

Watershed
West Plum Lake Land Cover
Rural Residential
2 Acres
<1%
West Plum Lake
Surface
71 Acres
9%
Forest
461 Acres
60%
Pasture/Grass
94 Acres
12%
Wetlands
142 Acres
19%
Total Watershed: 770 Acres

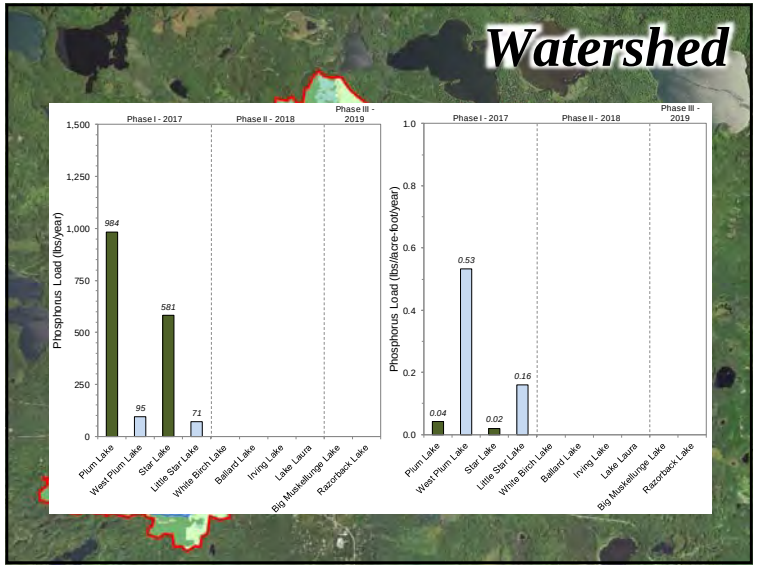

Watershed
Plum Lake Land Cover
West Plum Lake
Subwatershed
770 Acres
7%
Aurora Lake
Subwatershed
2,657 Acres
23%
Plum Lake
Direct Watershed
4,858
41%
Star Lake Subwatershed
3,346 Acres
29%
Forest
1,689 Acres
35%
Plum Lake Surface
1,074 Acres
22%
Wetlands
1,763 Acres
36%
Pasture/Grass
316 Acres
7%
Rural Residential
15 Acres
<1%
Row Crops
<1 Acre
<1%
Urban - Medium
Density
<1 Acres
<1%
Total Watershed: 11,631 Acres

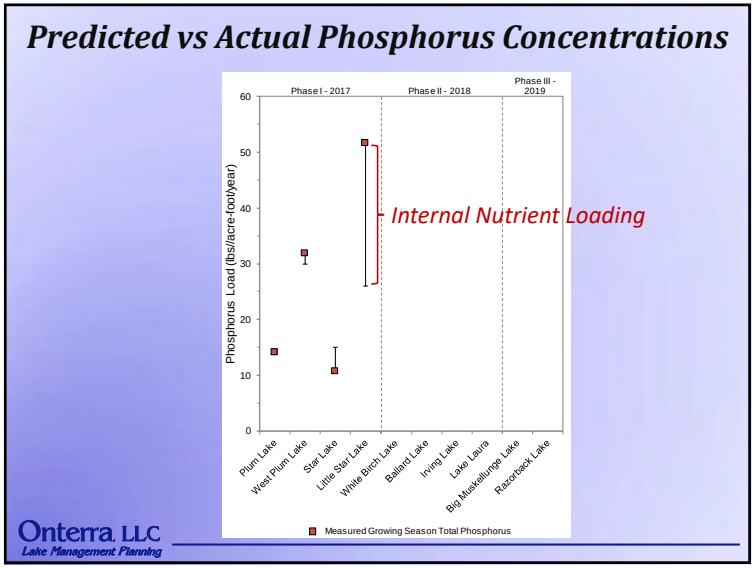

Watershed
Little Star Lake Phosphorus Load
Septic Systems
1 lbs
1%
Little Star Lake
Surface
26 lbs
37%
Wetlands
11 lbs
15%
Pasture/Grass
13 lbs
19%
Forest
20 lbs
28%
Total Annual P Loading: 71 lbs


Watershed
Star Lake Phosphorus Load
Septic Systems
2
<1%
Wetlands
55 lbs
10%
Star Lake Surface
333 lbs
57%
Pasture/Grass
60 lbs
10%
Forest
60 lbs
10%
Little Star Lake
Subwatershed
72 lbs
13%
Total Annual P Loading: 581 lbs


Watershed
West Plum Lake Phosphorus Load
Wetlands
13 lbs
14%
Forest
37 lbs
39%
West Plum Lake
Surface
20 lbs
21%
Pasture/Grass
24 lbs
26%
Total Annual P Loading: 95 lbs


Watershed
Plum Lake Phosphorus Load
Rural Residential
2
<1%
Septic Systems
7
1%
West Plum Lake
Subwatershed
70
7%
Plum Lake Surface
287 lbs
29%
Star Lake
Subwatershed
82
8%
Aurora Lake
Subwatershed
158 lbs
16%
Pasture/Grass
84 lbs
9%
Forest
137 lbs
14%
Wetlands
157 lbs
16%
Total Annual P Loading: 984 lbs


Watershed
Phase I - 2017
Phase II - 2018
Phase III - 2019
Phosphorus Load (lbs/year)
1,500
1,250
1,000
750
500
250
0
984
95
581
71
Phosphorus Load (lbs/acre-foot/year)
1.0
0.8
0.6
0.4
0.2
0.0
0.04
0.53
0.02
0.16
Plum Lake
West Plum Lake
Star Lake
Little Star Lake
White Birch Lake
Ballard Lake
Irving Lake
Lake Laura
Big Muskellunge Lake
Razorback Lake


Predicted vs Actual Phosphorus Concentrations
Phase I - 2017
Phase II - 2018
Phase III - 2019
Phosphorus Load (lbs/acre-foot/year)
60
50
40
30
20
10
0
Internal Nutrient Loading
Plum Lake
West Plum Lake
Star Lake
Little Star Lake
White Birch Lake
Ballard Lake
Irving Lake
Lake Laura
Big Muskellunge Lake
Razorback Lake
Measured Growing Season Total Phosphorus
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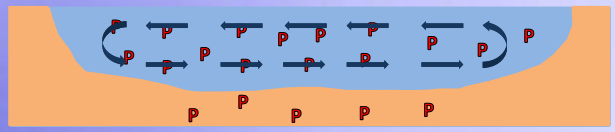
Internal Nutrient Loading

- Normally, the net movement of phosphorus is to the sediment in lakes.
- Under certain conditions, phosphorus (and other nutrients) get released from bottom sediments into the overlying water.
- Anoxic (devoid of oxygen) conditions cause phosphorus release.
- Becomes problematic if phosphorus is mobilized to surface in summer (polymictic lakes).
- Little Star Lake is polymictic, so process repeats over growing season



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Shoreland Assessment

- Shoreland area is important for buffering runoff and provides valuable habitat for aquatic and terrestrial wildlife.
- EPA National Lakes Assessment results indicate shoreland development has greatest negative impact to health of our nation's lakes.
- It does not look at lake shoreline on a property-by-property basis.
- Assessment ranks shoreland area from shoreline back 35 feet

Urbanized → Range → **Natural**

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Shoreline Assessment Category Descriptions

More Natural Habitat

Urbanized | Developed-Unnatural | Developed-Semi-Natural | Developed-Natural | Natural/Undeveloped

Greater Need for Restoration

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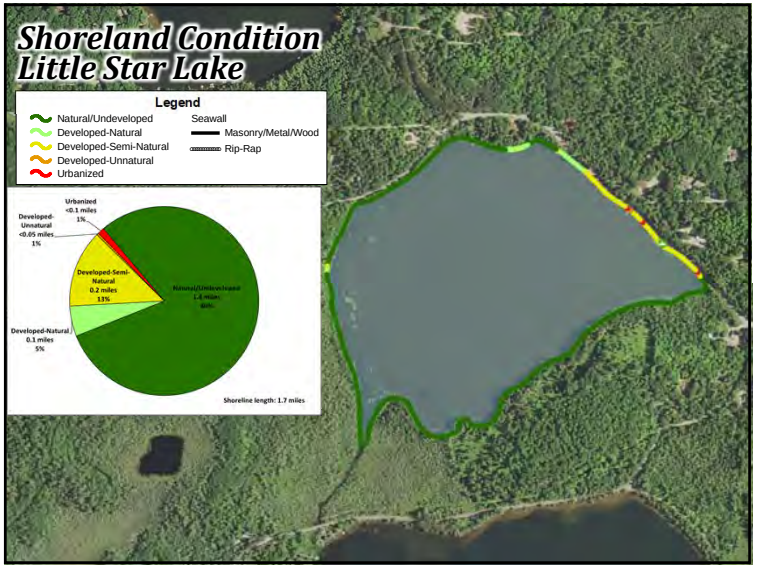
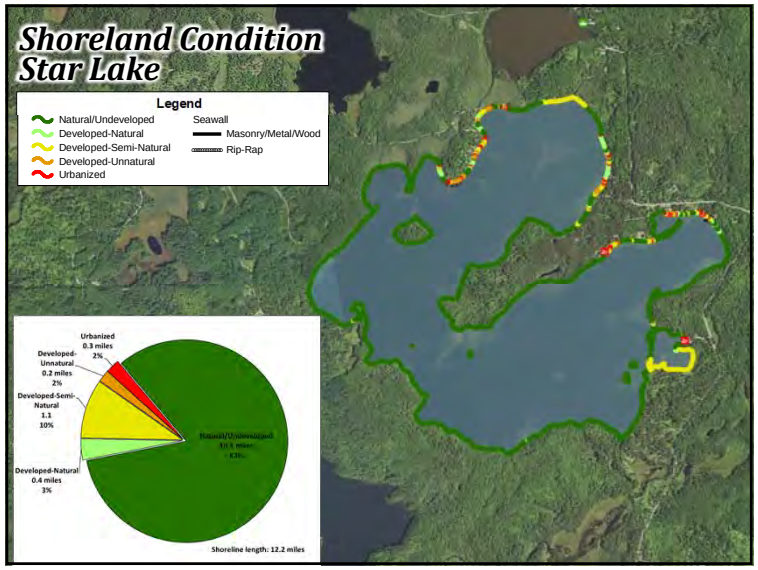
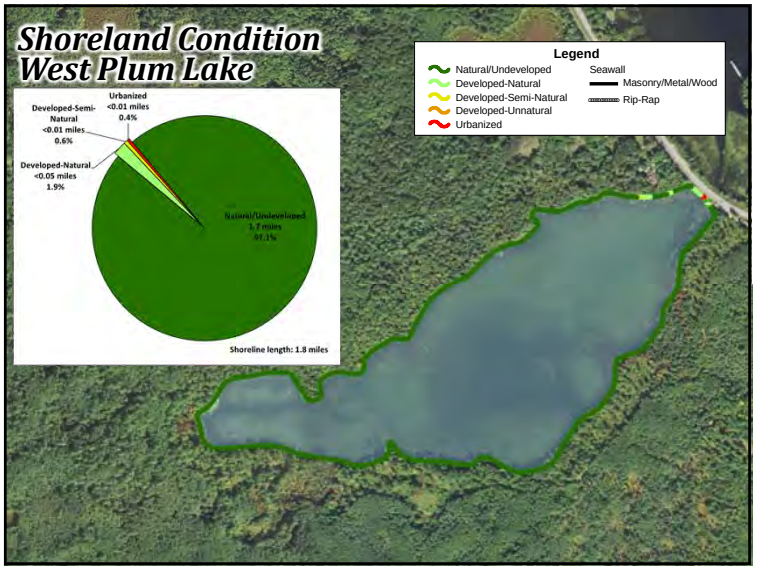
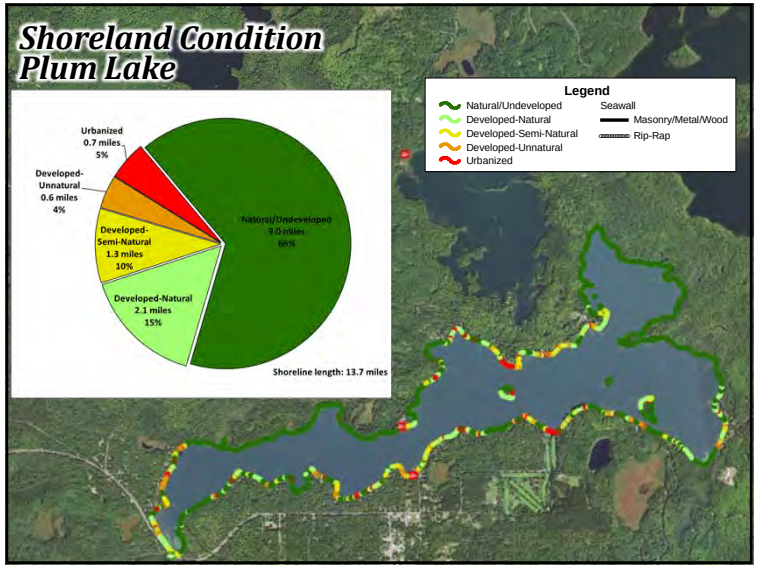
Shoreland Condition Little Star Lake









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 Town Lakes

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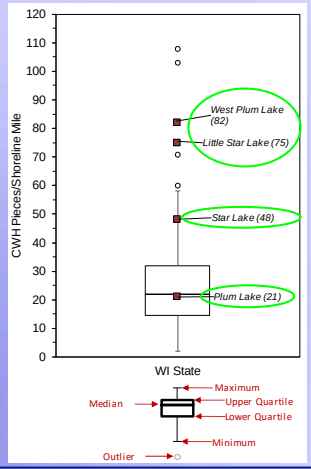
Town of Plum Lake Coarse Woody Habitat



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Aquatic Plant Surveys

- Assess both non-native & native species
- Four surveys completed in 2017
  - Early-Season AIS Survey
  - Whole-Lake Point-Intercept Survey
  - Emergent/Floating-Leaf Community Mapping Survey

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Whole-Lake Point-Intercept Survey

Little Star Lake
45-meter resolution
186 total points

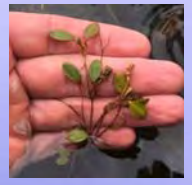
Star Lake
65-meter resolution
1184 total points

Plum Lake
63-meter resolution
1078 total points

West Plum
37-meter resolution
205 total points

Plant Data Overview

- 69 native plant species located to date
  - 1 listed as special concern: Vasey's pondweed



- 4 non-native plant species
  - Narrow-leaved cattail (West Plum)
  - Pale-yellow iris (Plum, West Plum, & Star)
  - Purple Loosestrife (Star)
  - Eurasian watermilfoil (Little Star)

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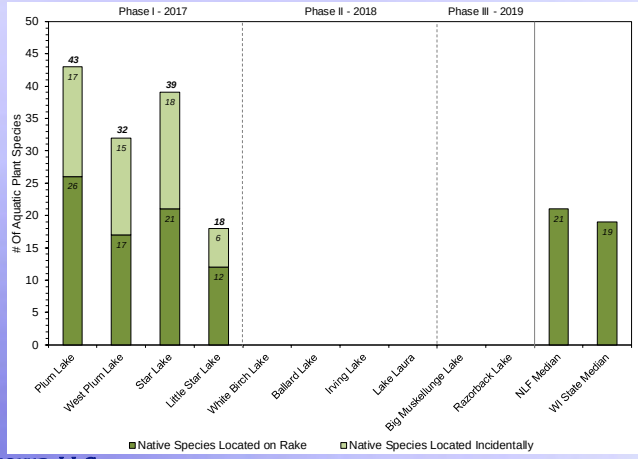
Native Species Richness



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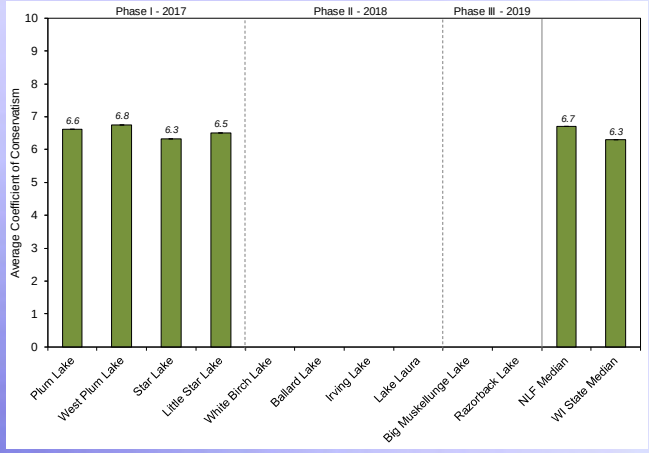
Average Conservatism



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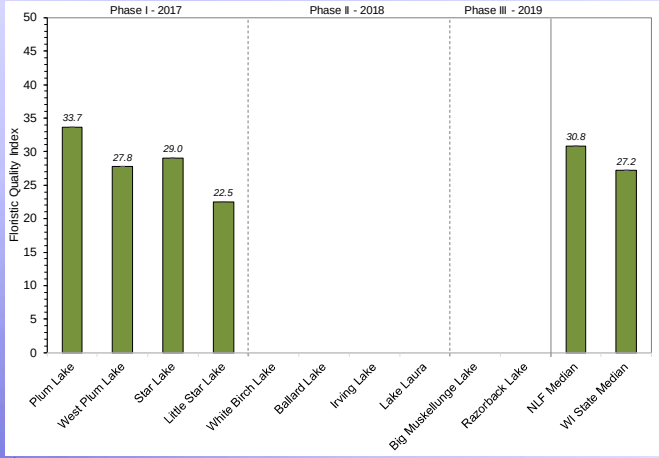
Floristic Quality



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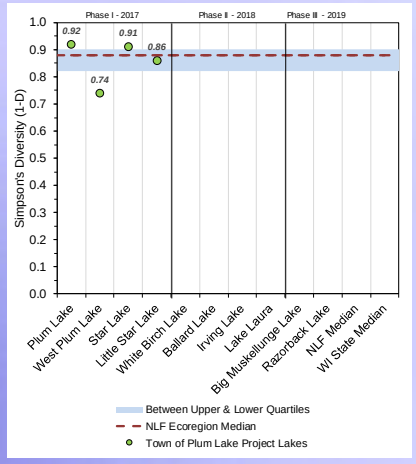
Simpson's Diversity Index



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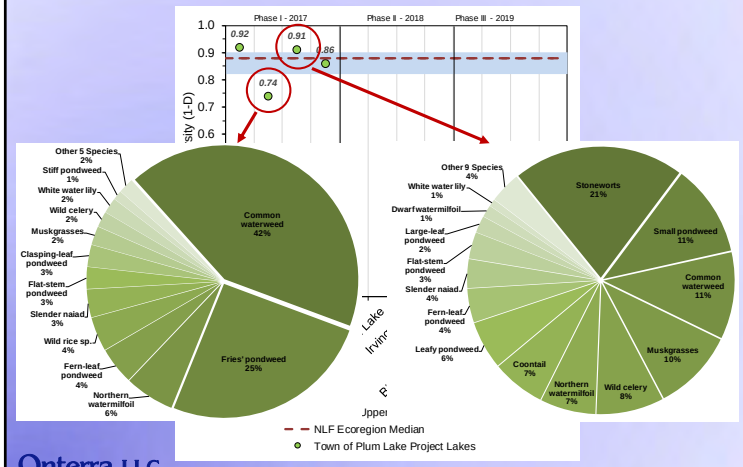
Simpson's Diversity Index



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Emergent & Floating-leaf Aquatic Plants

Plant Community	Phase I -2017				Phase II - 2018				Phase III - 2019	
	Plum Lake	West Plum Lake	Star Lake	Little Star Lake	White Birch Lake	Ballard Lake	Irving Lake	Lake Laura	Big Muskellunge Lake	Razorback Lake
Emergent Acres	6.1	18.7	3.5	0.0						
Floating-leaf Acres	2.1	4.0	8.2	16.1						
Mixed Emergent & Floating-leaf Acres	21.9	42.1	1.1	0.0						
Total Acres	**30.1**	**64.8**	**12.8**	**16.1**						
% Lake Area	**2.8**	**91.3**	**1.0**	**16.0**						

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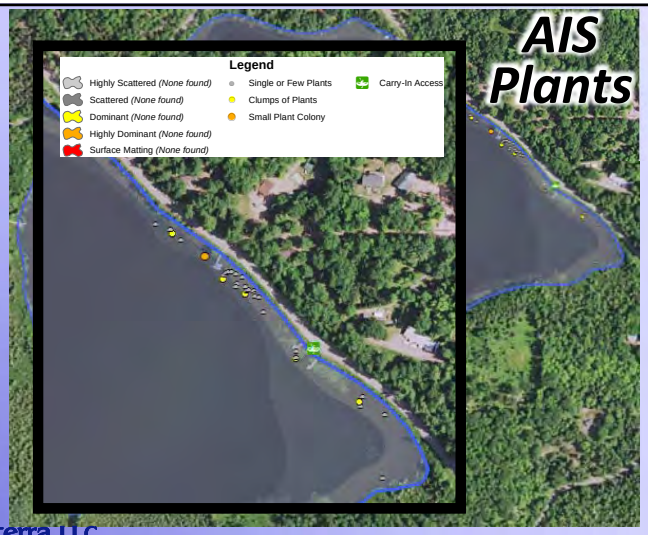
AIS Plants



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Other Aquatic Invasive Species

Type	Common name	Scientific name	Lake	Location within report
Plants	Eurasian watermilfoil	*Myriophyllum spicatum*	Little Star Lake	Section 3.5 – Aquatic Plants
	Pale-yellow iris	*Iris pseudacorus*	Plum Lake, West Plum Lake, Star Lake	Section 3.5 – Aquatic Plants
	Purple loosestrife	*Lythrum salicaria*	Star Lake	Section 3.5 – Aquatic Plants
	Narrow-leaved cattail	*Typha angustifolia*	West Plum Lake	Section 3.5 – Aquatic Plants
Invertebrates	Freshwater jellyfish	*Craspedacusta sowerbyi*	Plum Lake	Section 3.6 - Aquatic Invasive Species
	Rusty crayfish	*Orconectes rusticus*	Plum Lake, Star Lake, Little Star Lake	Section 3.6 - Aquatic Invasive Species
	Banded mystery snail	*Viviparus georgianus*	Plum Lake, Star Lake	Section 3.6 - Aquatic Invasive Species
	Chinese mystery snail	*Cipangopaludina chinensis*	Plum Lake, West Plum Lake, Star Lake	Section 3.6 - Aquatic Invasive Species
	Spiny waterflea	*Bythotrephes longimanus*	Star Lake	Section 3.6 - Aquatic Invasive Species

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Conclusions

Water Quality

- Plum, West Plum, and Star have very good to excellent water quality
- Little Star's water quality is unexpectedly fair
  - Likely brought on by internal nutrient loading of historic phosphorus loads that entered the lake during timber boom years
  - There are in-lake techniques that could reduce internal loading, but likely not feasible due to the current use level on lake

Watershed & Immediate Shoreline

- Watersheds in excellent shape – primarily forests & wetlands
- Majority of shoreland contains little to no harmful development, but always room for improvement

Aquatic Plant Community

- Plant communities are as expected for lake types and indicate overall good health of the lakes
- Concerning non-native species: Pale-yellow iris, purple loosestrife, & Eurasian watermilfoil

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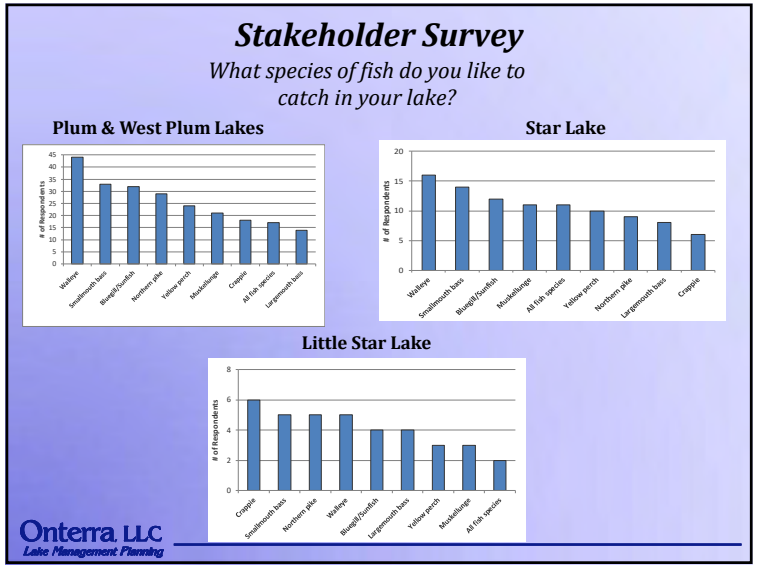
Town of Plum Lake
Phase I
Star, Little Star, Plum & West Plum Lakes
Management Planning Project
Planning Meeting II
July 16, 2018
Tim Hoyman
Onterra LLC
Lake Management Planning


Fisheries


Stakeholder Survey
What species of fish do you like to catch in your lake?
Plum & West Plum Lakes
Star Lake
Little Star Lake
# of Respondents
Walleye
Smallmouth bass
Bluegill/Sunfish
Northern pike
Yellow perch
Muskellunge
Crappie
All fish species
Largemouth bass
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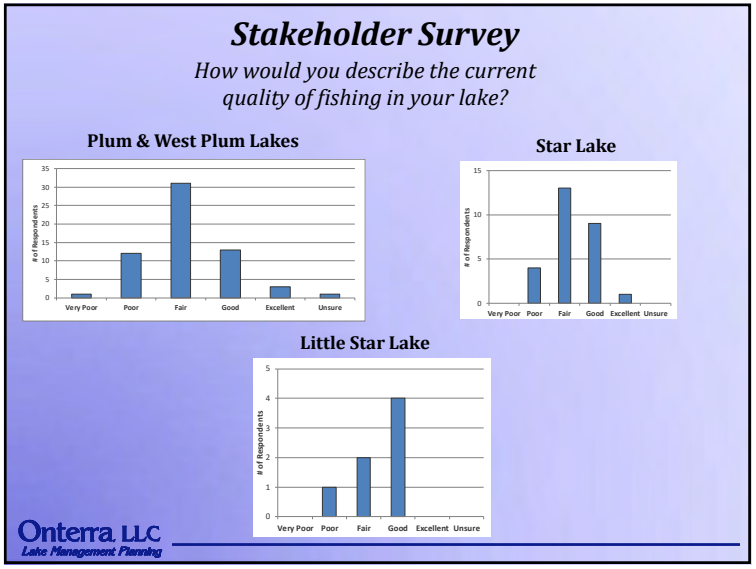
Stakeholder Survey
How would you describe the current quality of fishing in your lake?
Plum & West Plum Lakes
Star Lake
Little Star Lake
# of Respondents
Very Poor
Poor
Fair
Good
Excellent
Unsure
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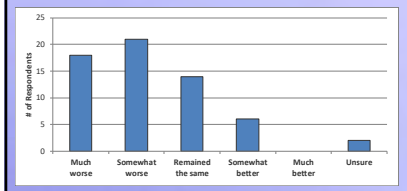
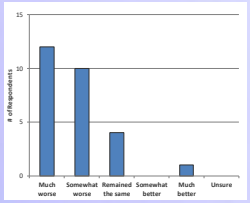
Stakeholder Survey

How has the quality of fishing changed since you first started fishing the lake?

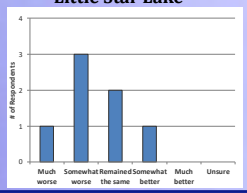
Plum & West Plum Lakes



Star Lake



Little Star Lake



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Native American Spear Harvest

- Town is within Treaty of 1842
- Tribal and State authorities establish *total allowable catch* based on population estimates (typically 35% for walleye & 27% for muskellunge)
- The total allowable catch number may be reduced based on confidence in population estimates: *safe harvest level*
- Tribal community claims percentage of safe harvest level, or *declaration*
- Bag limits for hook and line anglers set to accommodate declaration
- Can only harvest two walleye over 20 inches per night – one between 20 and 24" and one any size over 20"

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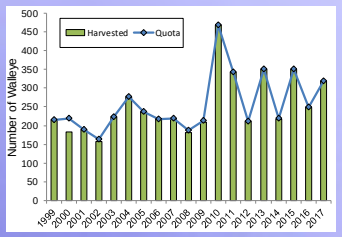
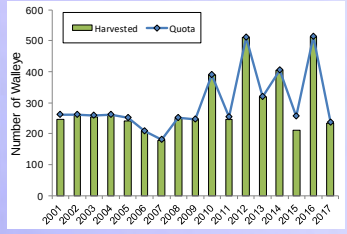
Plum and Star Lakes Walleye Spear Harvest

Plum Lake



Star Lake



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Conclusions

Water Quality

- Plum, West Plum, and Star have very good to excellent water quality
- Little Star's water quality is unexpectedly fair
  - Likely brought on by internal nutrient loading of historic phosphorus loads that entered the lake during timber boom years
  - There are in-lake techniques that could reduce internal loading, but likely not feasible due to the current use level on lake

Watershed & Immediate Shoreline

- Watersheds in excellent shape – primarily forests & wetlands
- Majority of shoreland contains little to no harmful development, but always room for improvement

Aquatic Plant Community

- Plant communities are as expected for lake types and indicate overall good health of the lakes
- Concerning non-native species: Pale-yellow iris, purple loosestrife, & Eurasian watermilfoil

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

Wisconsin Lakes Partnership

UW Extension

Wisconsin Dept. of Natural Resources

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Lake Management Planning

Town of Plum Lake
Lake Management Planning Project
Update to Lakes Committee

Phase I – Plum, West Plum, Star, and Little Star

Completed Tasks

- All fieldwork
- Draft report sections
- Planning Meeting I – June 11, 2018 (10 Plum Lake and Star Lake residents)

Tasks Remaining to Completed

- Planning Meeting II (not yet set)
- Creation of Draft Management Plan (late summer)
- Submittal of Draft Plan to Planning Committee (early fall)
- Submittal of Draft Plan to Lakes Committee (early fall)
- Submittal of Draft Plan to WDNR (winter 2019)

Interesting Conclusions

- Plum, West Plum, and Star have very good to excellent water quality
- Little Star's water quality is unexpectedly fair
  - Likely brought on by internal nutrient loading of historic phosphorus loads that entered the lake during timber boom years
  - There are in-lake techniques that could reduce internal loading, but likely not feasible due to the current use level on lake
- Watersheds in excellent shape – primarily forests & wetlands
- Majority of shoreland contains little to no harmful development, but always room for improvement
- Plant communities are as expected for lake types and indicate overall good health of the lakes
- Concerning non-native species: Pale-yellow iris, purple loosestrife, & Eurasian watermilfoil

Phase II – White Birch, Ballard, Irving, and Laura

Completed Tasks

- Spring water quality collections
- Kick-off Meeting set for July 27, 2018

Tasks Remaining to Completed

- Field studies through winter 2019
- Stakeholder survey (fall 2018)
- Planning process (2019)

Town-wide Project

Topics for Consideration during 2018

- Action plan for discovery of new invasive in town lake
- Little Star Lake Eurasian watermilfoil management (survey to be completed in early July)
  - Hand-harvesting during summer 2018?

Phase III – Big Muskellunge and Razorback

Project Considerations

Do not complete stakeholder survey due to low number of private properties?

Utilize Lakes Committee as the planning committee and invite private property owners?

Reduce other "stakeholder" components?

Combine Phase III & Town AIS prevention components in one AIS-Educ. Prev. and Plan Grant?

Project Costs – Phase III

	Cash Cost	Donated Value
Onterra Fees		
Project Administration & Communications	$1,495.00	
Stakeholder Participation - Onterra Facilitated	$2,945.00	
Watershed Assessment	$970.00	
Water Quality Assessment	$4,840.00	
Paleocore Collection & Analysis	$2,400.00	
Fishery Data Compilation & Integration	$755.00	
Shoreland & Coarse Woody Habitat Assessment	$1,910.00	
Early-Season AIS Survey	$3,455.00	
Point-Intercept Survey	$8,540.00	
Aquatic Plant Community Mapping	$3,615.00	
Data Analysis & Report/Plan Creation	$6,485.00	
Onterra Printing, Shipping & Voucher Materials	$325.00	
Travel (Lodging, Incidentals, & Mileage @ 0.58/mi)	$4,690.00	
Professional Dreissena Mussel Monitoring		$1,600.00
Subtotal	*$42,425.00*	*$1,600.00*
Other Cash Costs		
State Laboratory of Hygiene Fees	$2,600.00	
Stakeholder Survey - Third Party Contractor	$700.00	
TPL Project-Related Printing Costs	$200.00	
Subtotal	*$3,500.00*	
Volunteer & In-kind Match Opportunities		
Planning Comm. – Stakeholder Survey		$288.00
Planning Comm. – Plan Development		$576.00
Kick-off Mtg Attendance		$360.00
Wrap-up Mtg Attendance		$540.00
TPL Grant Project Administration		$600.00
Subtotal	*$45,925.00*	*$3,964.00*
Project Total	**$49,889.00**	

Lake Management Planning Grant Specifics	
WDNR Portion (67%)	$33,425.63
Local Match (33%)	$16,463.37
Actual Cash Cost to TPL	***$12,499.37***
WDNR Planning Grant Prepayment to TPL	$25,069.22
Total Cash Outlay by TPL During Project	$20,855.78
Final Reimbursement to TPL Following Project Completion	$8,356.41

Town of Plum Lake
Lake Management Planning Project
Update to Lakes Committee

Phase I – Plum, West Plum, Star, and Little Star

Completed Tasks

All planning meetings completed during summer 2018

Draft implementation plan provided to committee on May 14, 2019

Tasks Remaining to Completed

Integrate Phase I committee comments in draft

Create Official First Draft and provide to WDNR for comments

Phase II – White Birch, Ballard, Irving, and Laura

Completed Tasks

All fieldwork complete

Data has been compiled and standard analysis completed

Report sections are underway

Tasks Remaining to Completed

Planning meetings to be scheduled for summer 2019

Town-wide Project

Topics for Consideration during 2019

Action plan for discovery of new invasive in Little Star Lake

Little Star Lake Eurasian watermilfoil management (first survey to be completed in late-June or early-July)

Hand-harvesting during summer 2019?

AIS-Early Detection and Response Grant for monitoring and control in 2020 and beyond

Phase III – Big Muskellunge and Razorback

Phase Alterations from other phases

Will not complete stakeholder survey due to low number of private properties

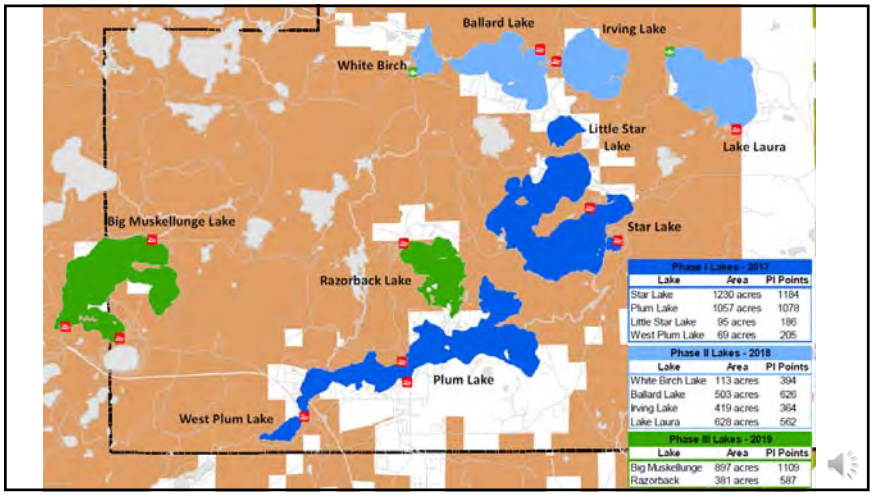
Will utilize Lakes Committee as the planning committee and invite private property owners

Water quality on Muskellunge completed as a part of Long-term Ecological Research program

Razorback has had water quality sample collected already

Fieldwork will continue through summer and fall

Planning meetings will occur during summer 2020



Management Planning Project Overview

Collect and compile information about lake

- *Includes both environmental & sociological data*
- *Historical & current information*
- *Past management actions*

Create a realistic and implementable management plan

- *Challenges facing lake and lake group*
- *Create goals that will address challenges*
- *Develop actions that will meet goals*
- *Assign timeframes & facilitators*

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Summary Results for Plum Lake

Overarching Conclusion: Plum Lake is ecologically healthy.

Water Quality

- Plum Lake has excellent water quality as expected for its lake type.

Watershed & Immediate Shoreline

- Watershed is in excellent shape and is largely responsible for water quality.
- Plum Lake has large areas with no or little shoreland development.

Aquatic Plant Community

- Aquatic plant community indicate that lake is healthy.
- No Eurasian watermilfoil or curly-leaf pondweed were found during surveys, but an emergent species called pale-yellow iris was mapped on the shoreline.

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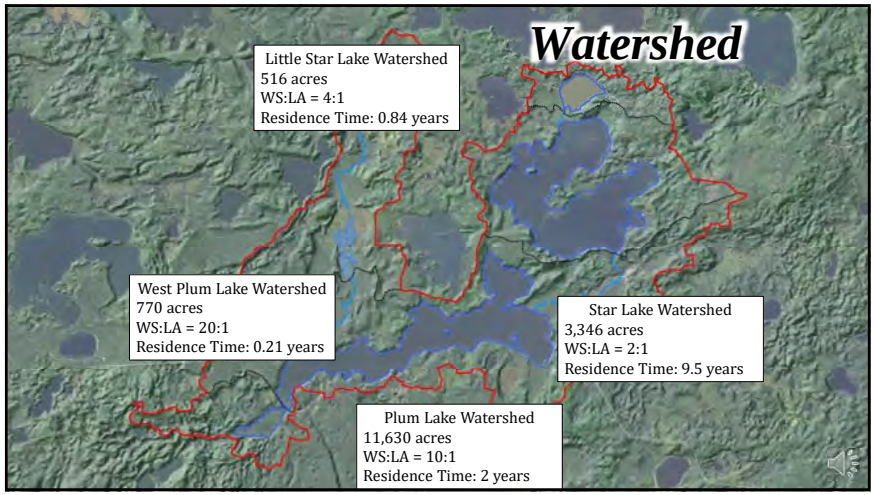
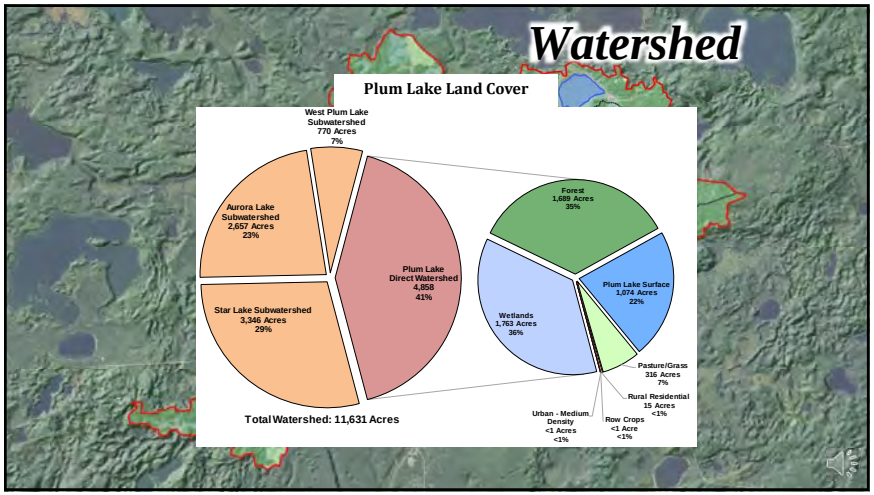
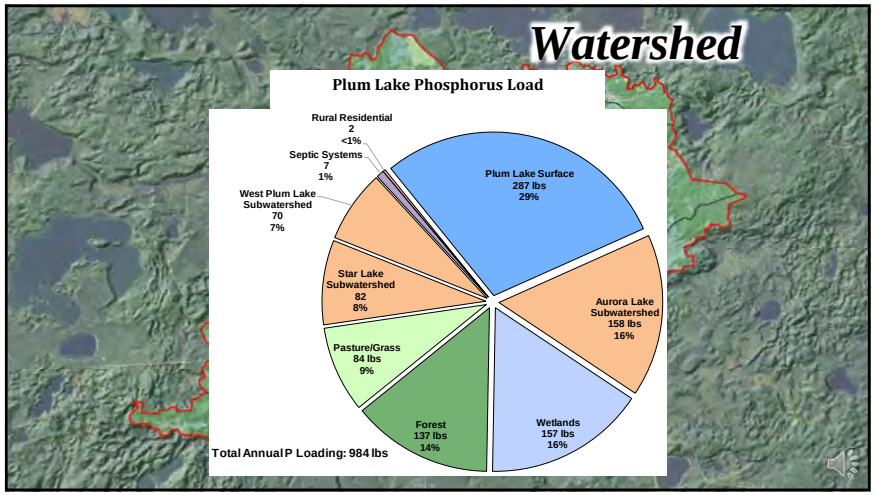
Watershed

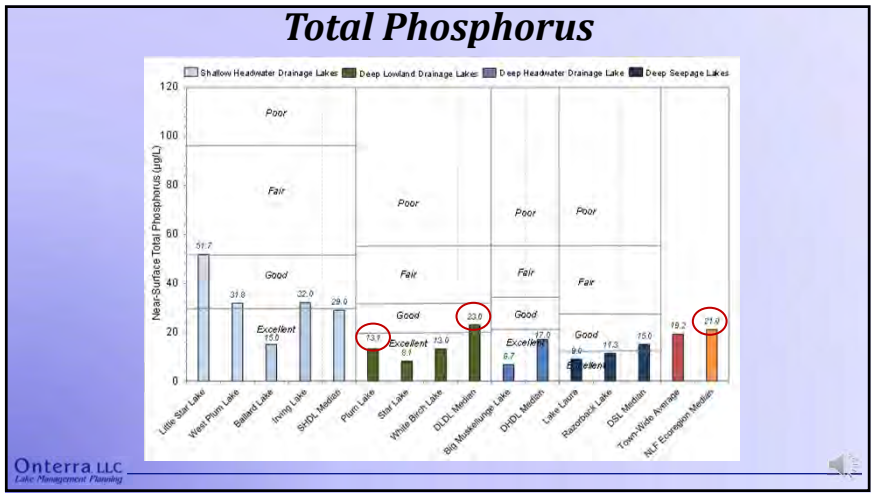

Watershed


Watershed
Little Star Lake Watershed
516 acres
WS:LA = 4:1
Residence Time: 0.84 years
West Plum Lake Watershed
770 acres
WS:LA = 20:1
Residence Time: 0.21 years
Star Lake Watershed
3,346 acres
WS:LA = 2:1
Residence Time: 9.5 years
Plum Lake Watershed
11,630 acres
WS:LA = 10:1
Residence Time: 2 years


Watershed
Plum Lake Land Cover
West Plum Lake Subwatershed 770 Acres 7%
Aurora Lake Subwatershed 2,657 Acres 23%
Plum Lake Direct Watershed 4,858 41%
Star Lake Subwatershed 3,346 Acres 29%
Forest 1,689 Acres 35%
Plum Lake Surface 1,074 Acres 22%
Wetlands 1,763 Acres 36%
Pasture/Grass 316 Acres 7%
Rural Residential 15 Acres <1%
Urban - Medium Density <1 Acres <1%
Row Crops <1 Acre <1%
Total Watershed: 11,631 Acres


Watershed
Plum Lake Phosphorus Load
Rural Residential
2
<1%
Septic Systems
7
1%
West Plum Lake
Subwatershed
70
7%
Plum Lake Surface
287 lbs
29%
Star Lake
Subwatershed
82
8%
Aurora Lake
Subwatershed
158 lbs
16%
Pasture/Grass
84 lbs
9%
Forest
137 lbs
14%
Wetlands
157 lbs
16%
Total Annual P Loading: 984 lbs


Water Quality


Total Phosphorus
Shallow Headwater Drainage Lakes
Deep Lowland Drainage Lakes
Deep Headwater Drainage Lake
Deep Seepage Lakes
Near-Surface Total Phosphorus (µg/L)
Poor
Fair
Good
Excellent
Little Star Lake
West Plum Lake
Ballard Lake
Irving Lake
SHDL Median
Plum Lake
Star Lake
White Birch Lake
DLDL Median
Big Muskellunge Lake
DHDL Median
Lake Laura
Razorback Lake
DSL Median
Town-Wide Average
NLF Ecoregion Median
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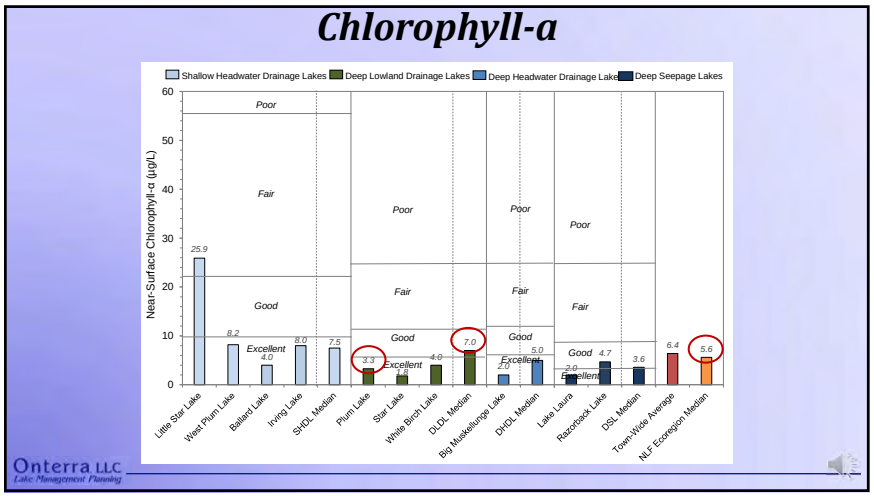
Lake Management Planning


Chlorophyll-a
Shallow Headwater Drainage Lakes
Deep Lowland Drainage Lakes
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Deep Seepage Lakes
Near-Surface Chlorophyll-a (µg/L)
Poor
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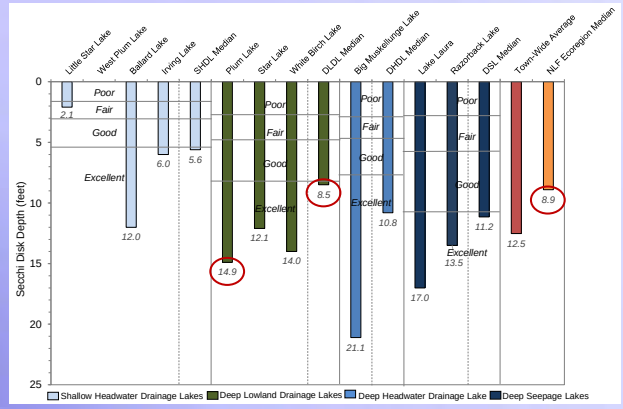
Onterra LLC
Lake Management Planning

Secchi Disk Transparency



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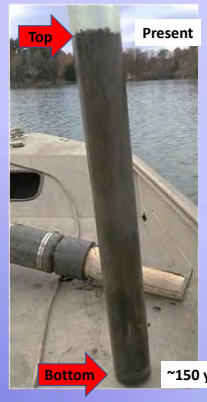
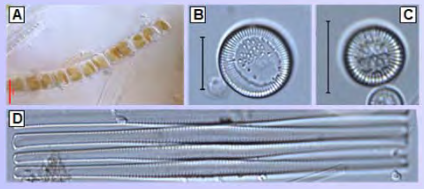
Paleoecology





~150 years

Onterra LLC
Lake Management Planning

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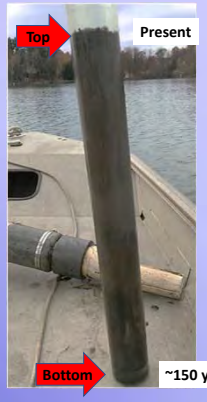

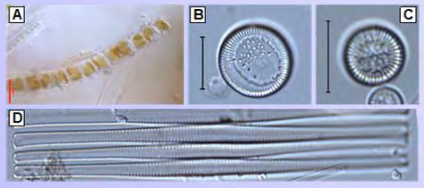

~150 years

Plum Lake

Lakes	Phosphorus (µg/L)
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Star Bottom	11
Little Star Top	31
Little Star Bottom	36
Plum Top	14
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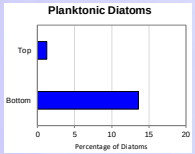

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Aquatic Plants

Aquatic Plant Surveys

- Assess both non-native & native species
- Three surveys completed in 2017
  - Early-Season AIS Survey
  - Whole-Lake Point-Intercept Survey
  - Emergent/Floating-Leaf Community Mapping Survey

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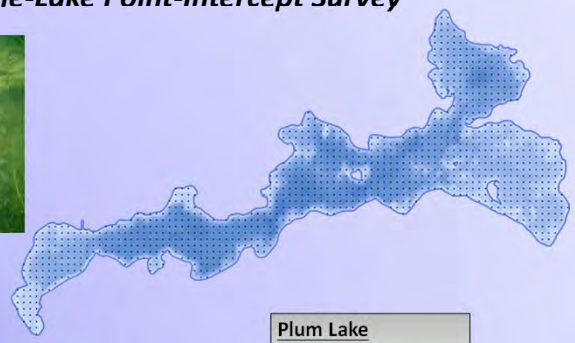
Whole-Lake Point-Intercept Survey



Plum Lake
63-meter resolution
1078 total points

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Lake Management Planning

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

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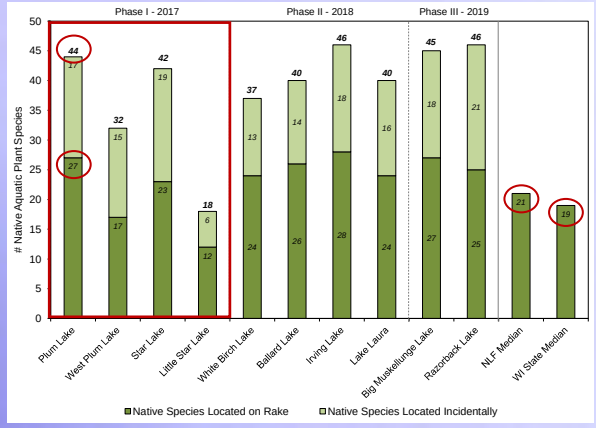
Native Species Richness



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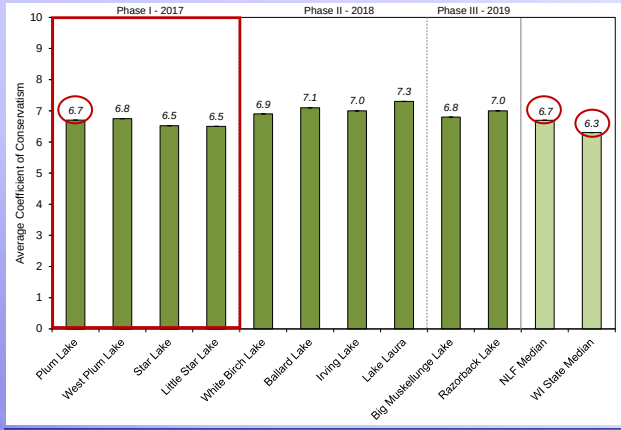
Average Coefficients of Conservatism



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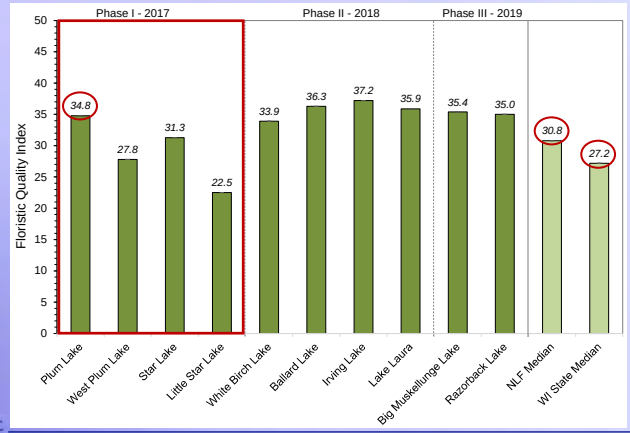
Floristic Quality



Onterra LLC
Lake Management Planning

Town of Plum Lake Implementation Plan

<u>Goal</u>: Maintain Lake Water Quality in the Town of Plum Lake

Action: Monitor water quality through CLMN or town-coordinated program.

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Onterra LLC
Lake Management Planning

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Onterra LLC Lake Management Planning

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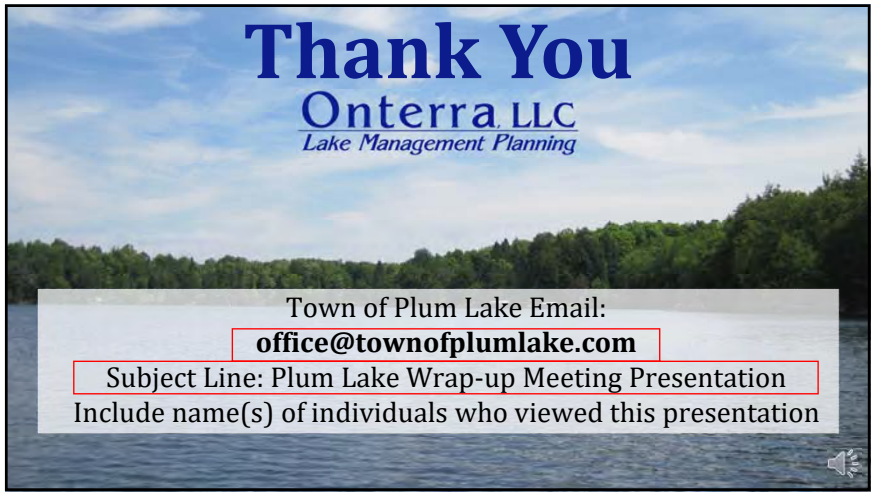
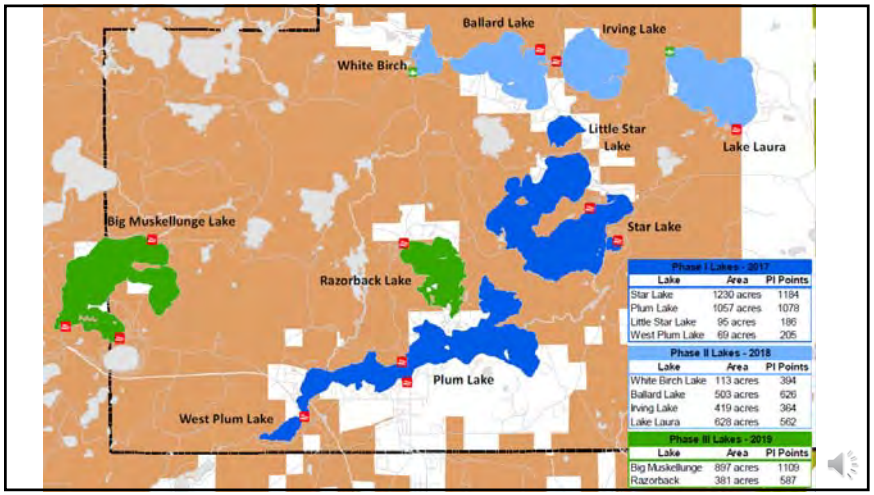
Onterra LLC Lake Management Planning





Management Planning Project Overview

Collect and compile information about lake

- *Includes both environmental & sociological data*
- *Historical & current information*
- *Past management actions*

Create a realistic and implementable management plan

- *Challenges facing lake and lake group*
- *Create goals that will address challenges*
- *Develop actions that will meet goals*
- *Assign timeframes & facilitators*

Onterra LLC Lake Management Planning

Summary Results for Star Lake

Overarching Conclusion: Star Lake is ecologically healthy.

Water Quality

- Star Lake has excellent water quality as expected for its lake type.

Watershed & Immediate Shoreline

- Watershed is in excellent shape and is largely responsible for water quality.
- Star Lake has large areas with little or no shoreland development.

Aquatic Plant Community

- Aquatic plant community indicate that lake is healthy.
- No Eurasian watermilfoil or curly-leaf pondweed were found during surveys, but two emergent species, pale-yellow iris and purple loosestrife were mapped on the Star Lake shoreline during the surveys.

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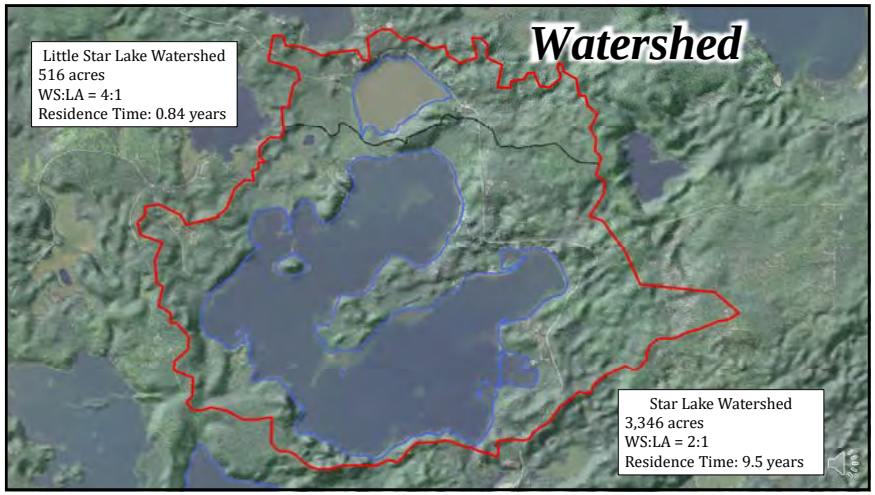
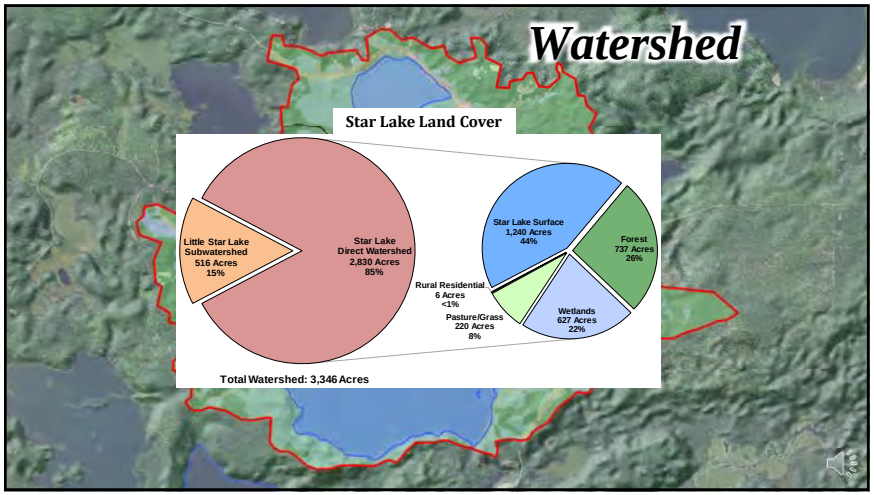
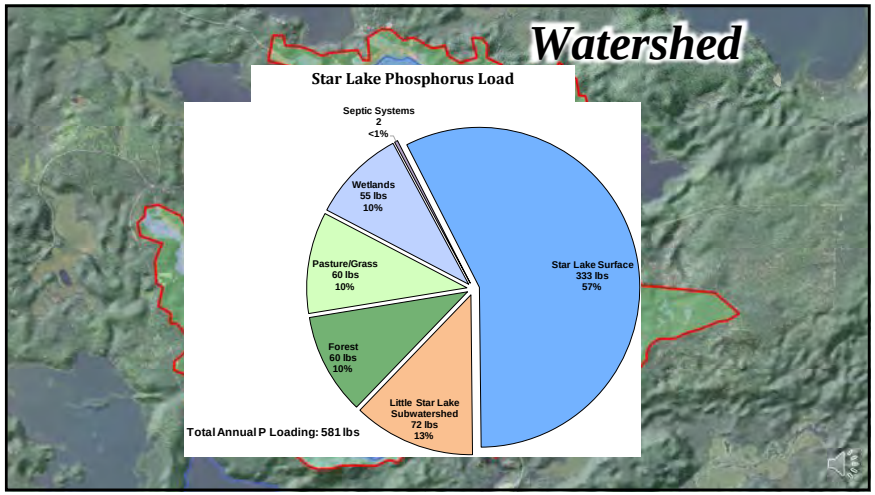
Watershed

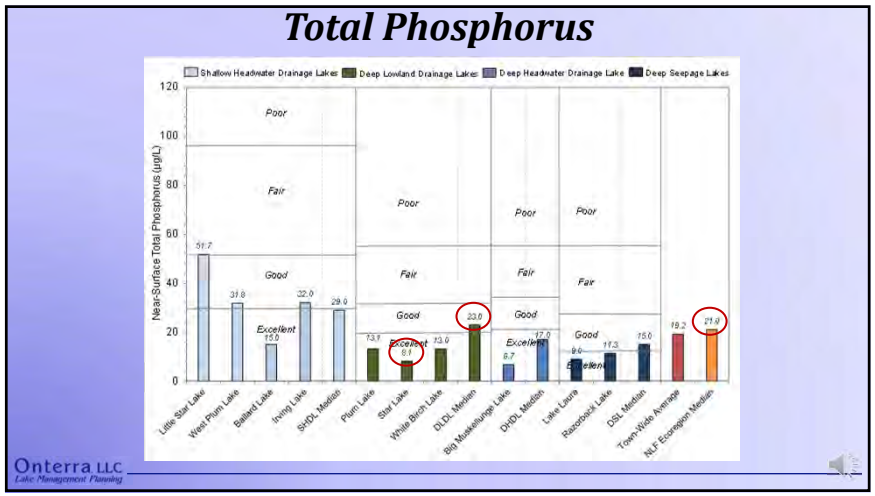

Watershed


Watershed
Little Star Lake Watershed
516 acres
WS:LA = 4:1
Residence Time: 0.84 years
Star Lake Watershed
3,346 acres
WS:LA = 2:1
Residence Time: 9.5 years


Watershed
Star Lake Land Cover
Little Star Lake Subwatershed 516 Acres 15%
Star Lake Direct Watershed 2,830 Acres 85%
Star Lake Surface 1,240 Acres 44%
Forest 737 Acres 26%
Rural Residential 6 Acres <1%
Pasture/Grass 220 Acres 8%
Wetlands 627 Acres 22%
Total Watershed: 3,346 Acres


Watershed
Star Lake Phosphorus Load
Septic Systems
2
<1%
Wetlands
55 lbs
10%
Pasture/Grass
60 lbs
10%
Forest
60 lbs
10%
Little Star Lake
Subwatershed
72 lbs
13%
Star Lake Surface
333 lbs
57%
Total Annual P Loading: 581 lbs


Water Quality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Near-Surface Total Phosphorus (µg/L)
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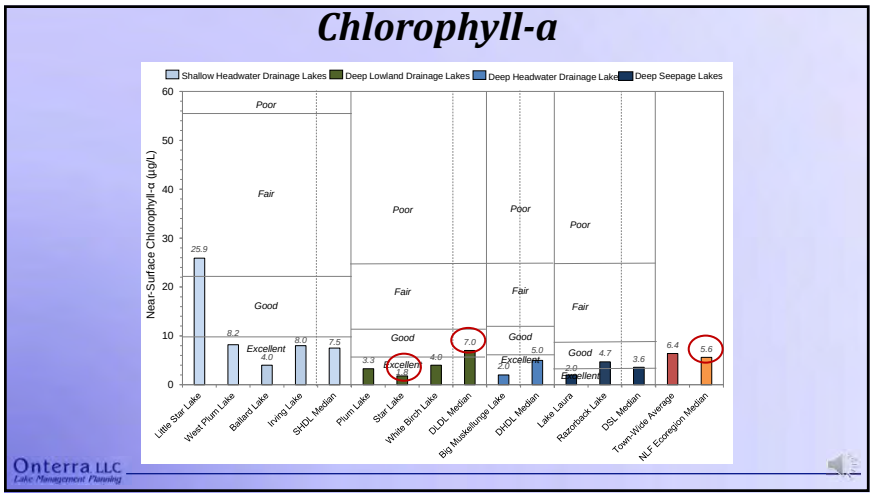
Onterra LLC
Lake Management Planning


Chlorophyll-a
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Lake Management Planning

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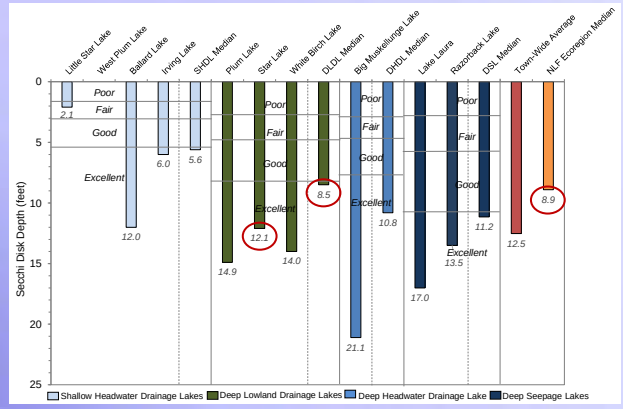

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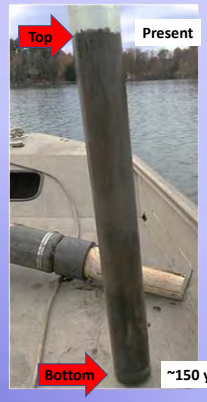
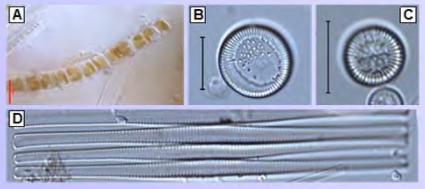
Paleoecology



~150 years



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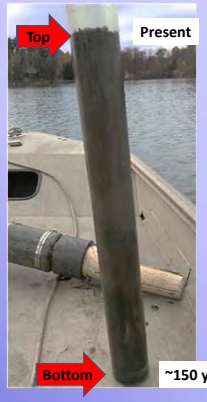

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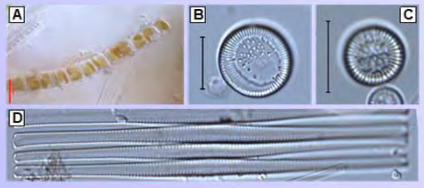

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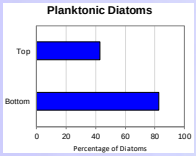

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Lake Management Planning

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Onterra LLC

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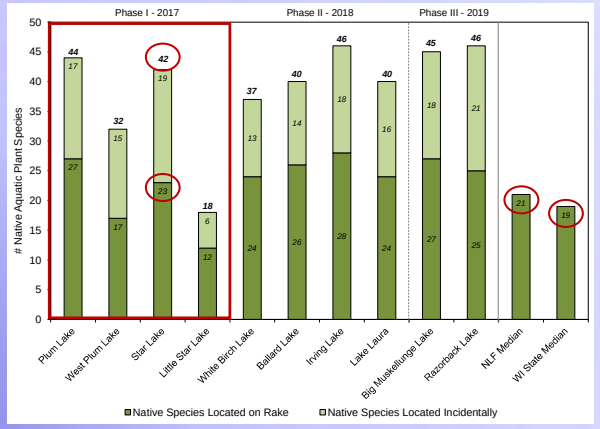

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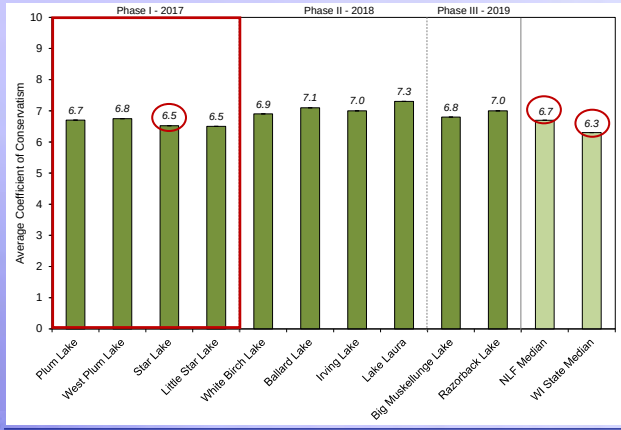
Average Coefficients of Conservatism



Onterra LLC
Lake Management Planning

Floristic Quality

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Lake Management Planning

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