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

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

A goal without a plan is just a wish!

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.

Elements of an Effective Lake Management Planning Project

Data and Information Gathering

Environmental & Sociological

Planning Process

Brings it all together

Data and information gathering

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

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

(Phases IV & V)

- Delineation of drainage basins
- Modeling
  - Lakes are modeled in series
  - 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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Waterbody	Point-Intercept Resolution (m)	Total Points
Rice Creek ✓ (WDNR)	-	-
Island Lake ✓ (WDNR)	73	655
Spider Lake ✓	35	913
Clear Lake	62	543
Fawn Lake	37	207
Wild Rice Lake	61	418
Alder Lake	55	354
Manitowish Lake	39	1315
Little Star Lake	36	808
Stone Lake	40	345
Rest Lake/Papoose Creek ✓	55/25	964
Vance Lake	30	124
Sturgeon Lake	30	172
Benson Lake	30	123

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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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Lake Management Planning

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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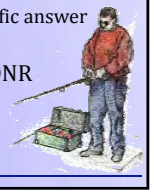
Stakeholder Survey

(Phase III – 2014)

- 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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Planning Process

Planning Committee Meetings

Study Results
Conclusions & Initial Recommendations

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Manitowish Planning Process

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

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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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Manitowish Chain Management Plan Documents

- Multiple document types
  - Manitowish Chain Management Plan
  - Lake-Specific Results and Conclusions
  - Lake-Specific Implementation Plan
  - Appendices (raw data, etc.)
- Chain-wide Compilation
  - All documents
- Individual Lake Document
  - Chain-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

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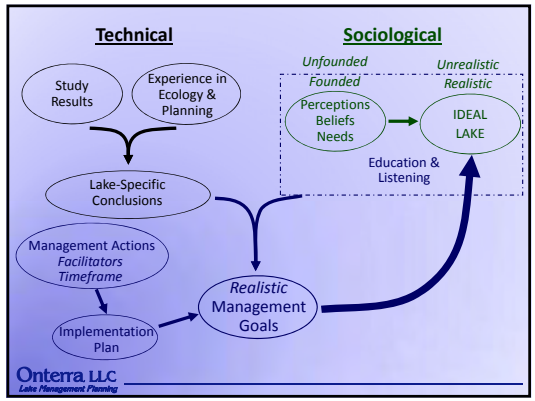
The Planning Process

…it's not as easy as you may think.



Current Funding Overview

- Lake Management Planning Grant
  - Received Aug 2011
- AIS Education, Prevention and Planning Grants
  - Received Feb 2012, Aug 2012 and Feb 2013
- AIS Early Detection and Response Grants
  - Received Feb 2012 & 2013

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Project Components

Scientific Studies

- Aquatic Plant Surveys
  - Native
  - Non-Native
- Water Quality Monitoring
- Watershed Delineation/Modeling
- Fishery Data Compilation and Integration
- Shoreland Development Surveys

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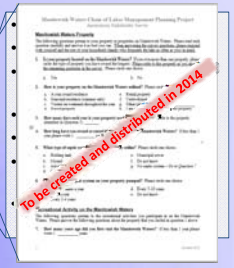
Project Components

Public Participation & Engagement

- Public meetings
- Anonymous stakeholder survey
- Volunteer Activities
- Educational Campaign



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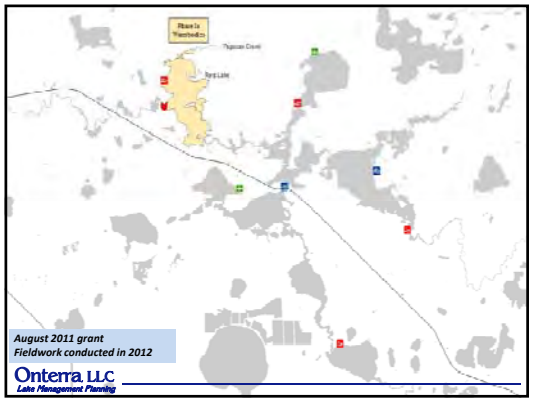
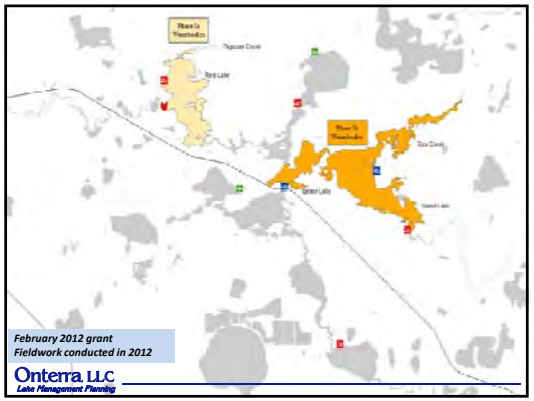
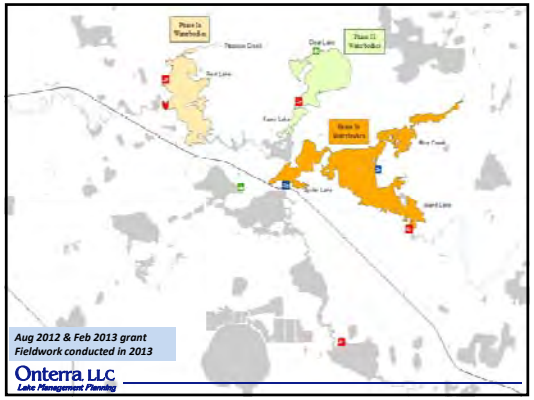
Lake Management Planning

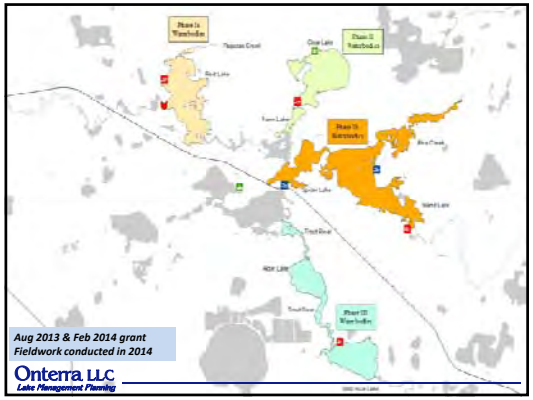


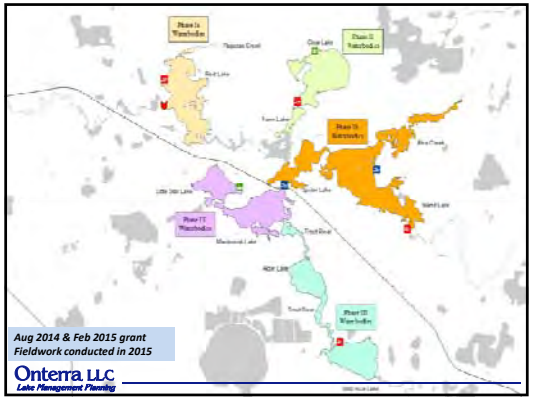
Onterra LLC
Lake Management Planning

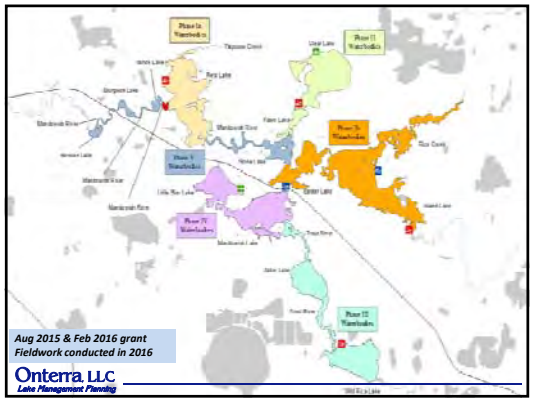


Onterra LLC
Lake Management Planning









Next Steps in Planning Process

- August 1 AIS-EPP grant submittal
- AIS-EDR grant to fund further CLP treatments
- Proceed with 2013 summer surveys
  - Water quality monitoring
  - Aquatic plant studies
  - Shoreland development surveys
- Phase I & II Planning Process

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Curly-leaf Pondweed Monitoring

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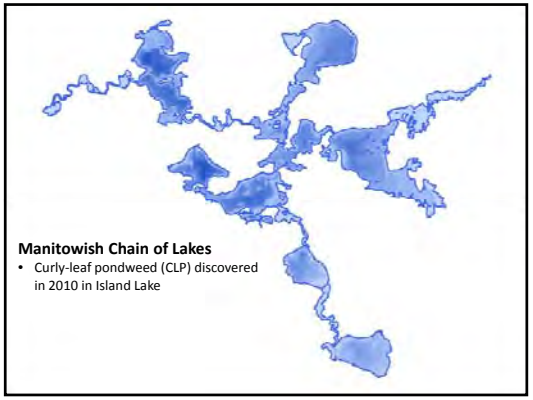
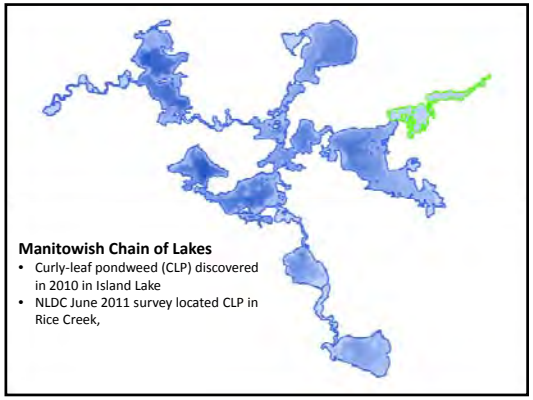

Manitowish Chain of Lakes
• Curly-leaf pondweed (CLP) discovered in 2010 in Island Lake


Manitowish Chain of Lakes
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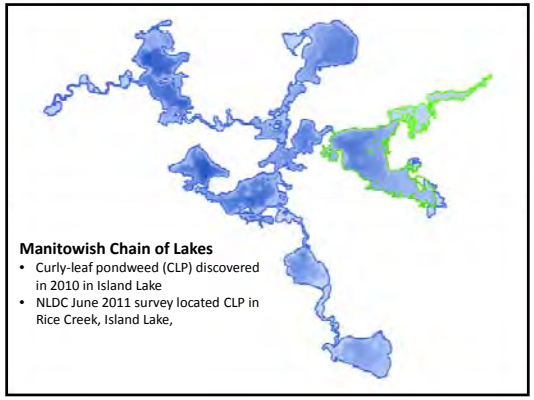
• NLDC June 2011 survey located CLP in Rice Creek,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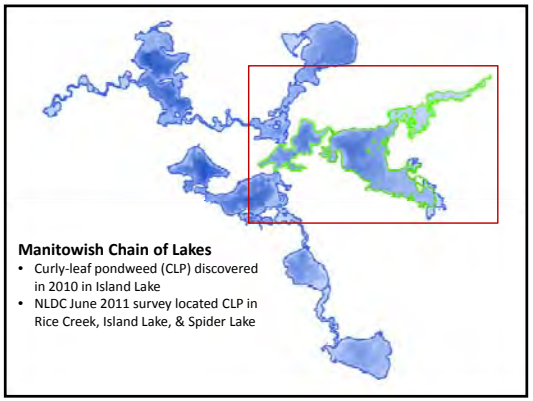
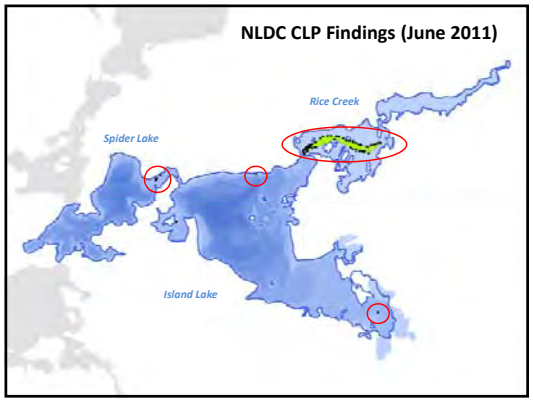
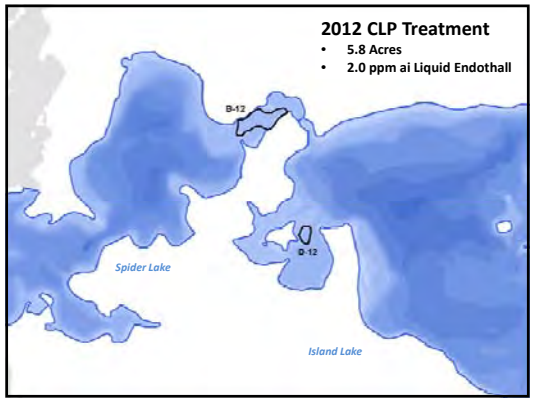
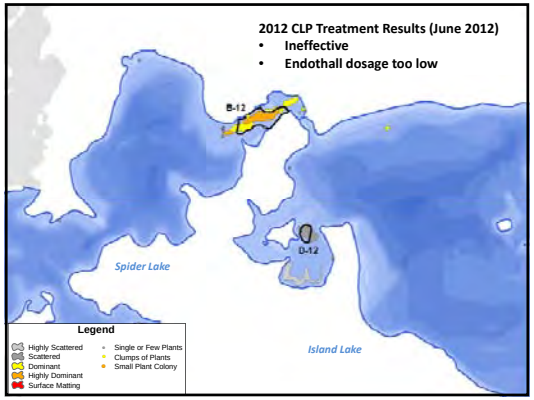
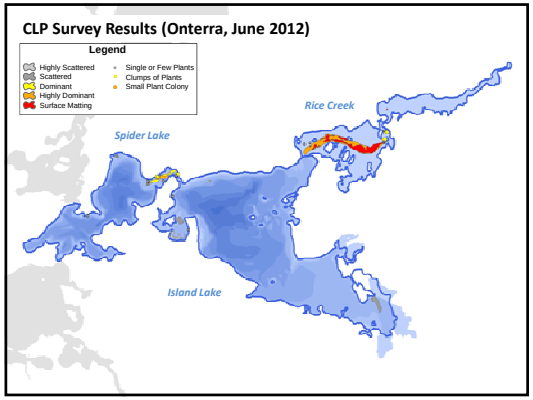
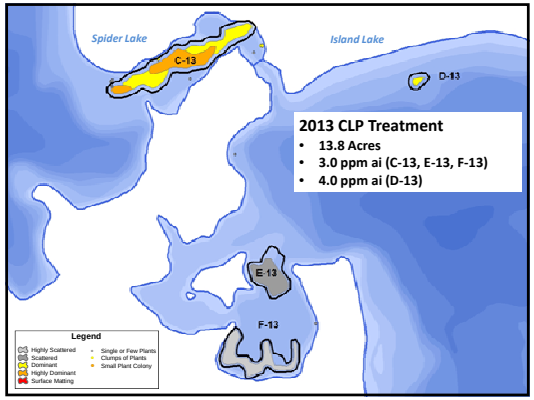

Manitowish Chain of Lakes
• Curly-leaf pondweed (CLP) discovered in 2010 in Island Lake
• NLDC June 2011 survey located CLP in Rice Creek, Island Lake, & Spider Lake

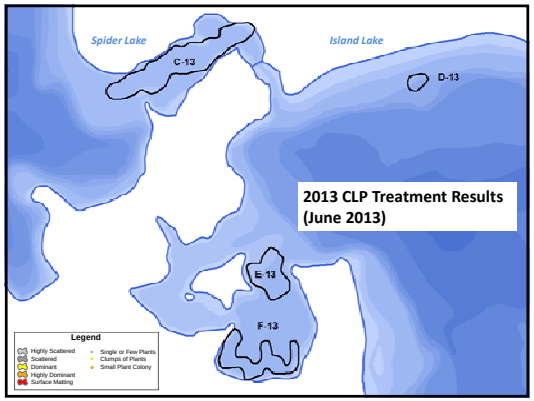

NLDC CLP Findings (June 2011)
Rice Creek
Spider Lake
Island Lake

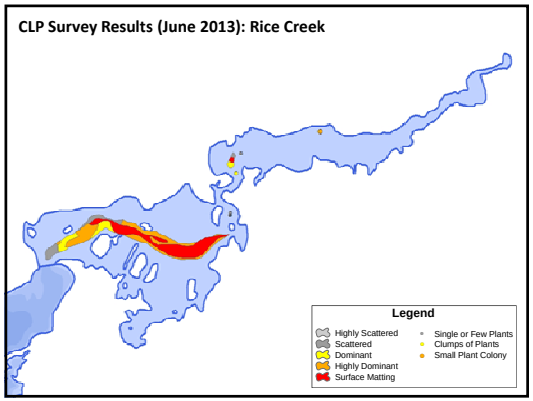

2012 CLP Treatment
• 5.8 Acres
• 2.0 ppm ai Liquid Endothall
B-12
B-12
Spider Lake
Island Lake

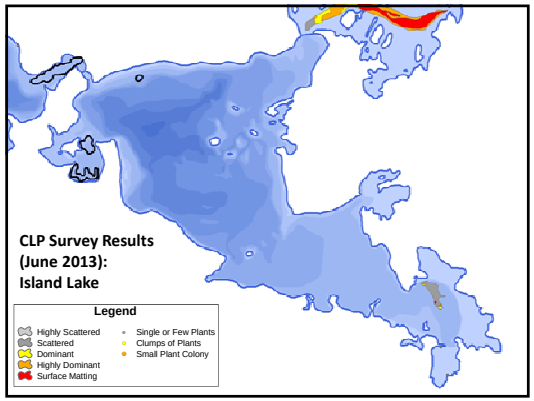

2012 CLP Treatment Results (June 2012)
• Ineffective
• Endothall dosage too low
B-12
D-12
Spider Lake
Island Lake
Legend
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony

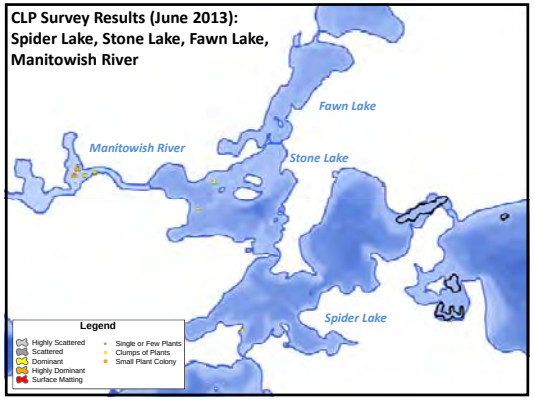

CLP Survey Results (Onterra, June 2012)
Legend
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony
Rice Creek
Spider Lake
Island Lake

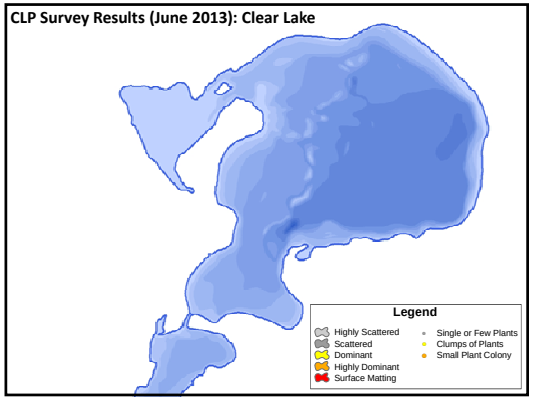

Spider Lake
Island Lake
C-13
D-13
E-13
F-13
2013 CLP Treatment
• 13.8 Acres
• 3.0 ppm ai (C-13, E-13, F-13)
• 4.0 ppm ai (D-13)
Legend
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony

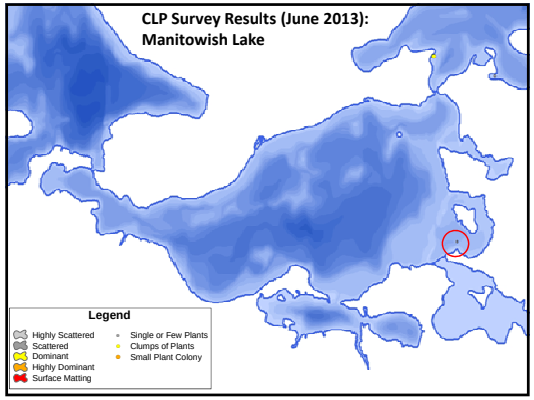

Spider Lake
Island Lake
C-13
D-13
E-13
F-13
2013 CLP Treatment Results
(June 2013)
Legend
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony


CLP Survey Results (June 2013): Rice Creek
Legend
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony


CLP Survey Results
(June 2013):
Island Lake
Legend
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony


CLP Survey Results (June 2013):
Spider Lake, Stone Lake, Fawn Lake,
Manitowish River
Fawn Lake
Manitowish River
Stone Lake
Spider Lake
Legend
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony


CLP Survey Results (June 2013): Clear Lake
Legend
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony


CLP Survey Results (June 2013):
Manitowish Lake
Legend
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony


Thank You
Many of the graphics used in this presentation were supplied by:
Wisconsin
Lakes
Partnership
UW
Extension
Onterra LLC
Lake Management Planning

Presentation Outline

- Current Project Overview
  - Planning Process
  - Phase I Lakes Study Results
    - Water Quality
    - Watershed
    - Shoreland Assessment
    - Aquatic Plants
    - Fisheries
  - Chain-wide AIS Discussion
  - Wild-rice Discussion
- Next Steps

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Lake Management Planning

Manitowish Chain Lakes Management Planning Process

- Chain-wide project brings on unique situation
  - Cost savings are great
  - Providing attention to individual lakes can be difficult
- Board of Directors & other representatives
  - Communication link for lake stakeholders
- Stakeholder survey information will be important

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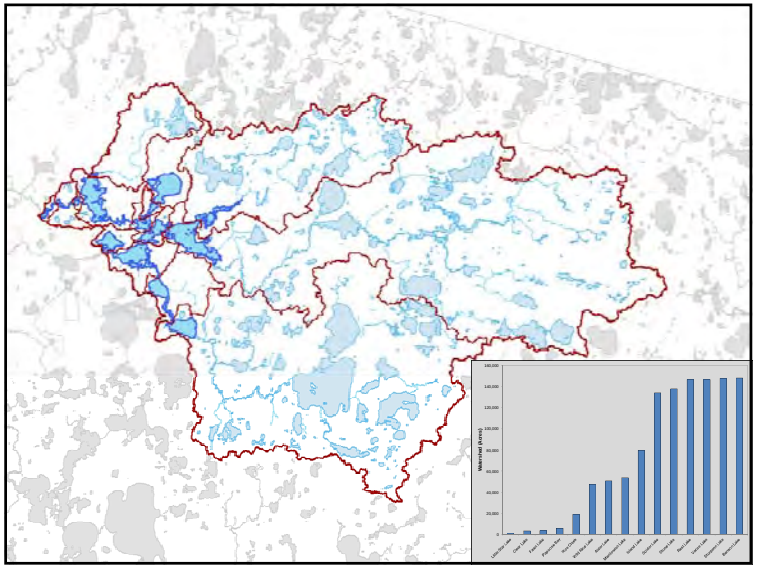

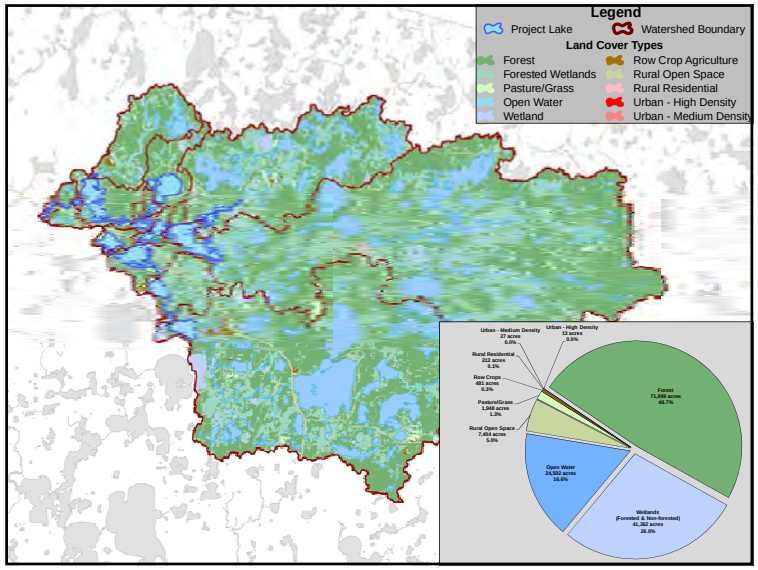

Shoreland Assessment

- 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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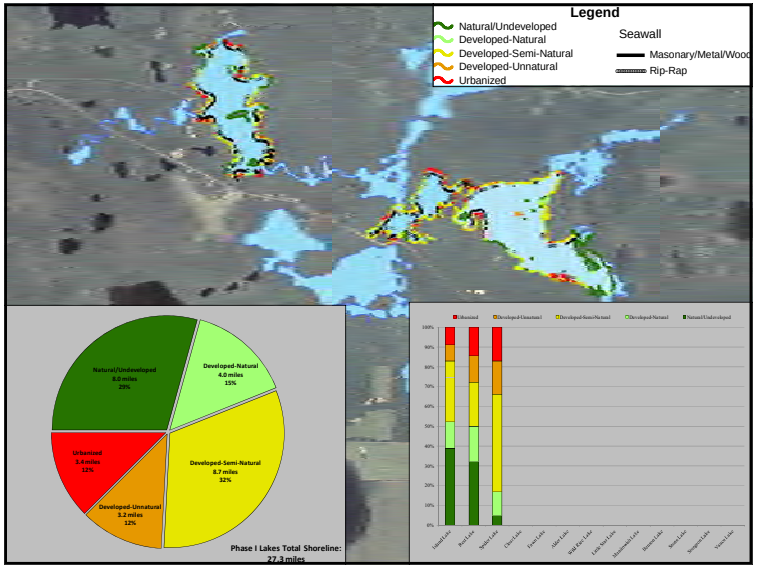

Coarse Woody Habitat

- 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 Manitowish Chain

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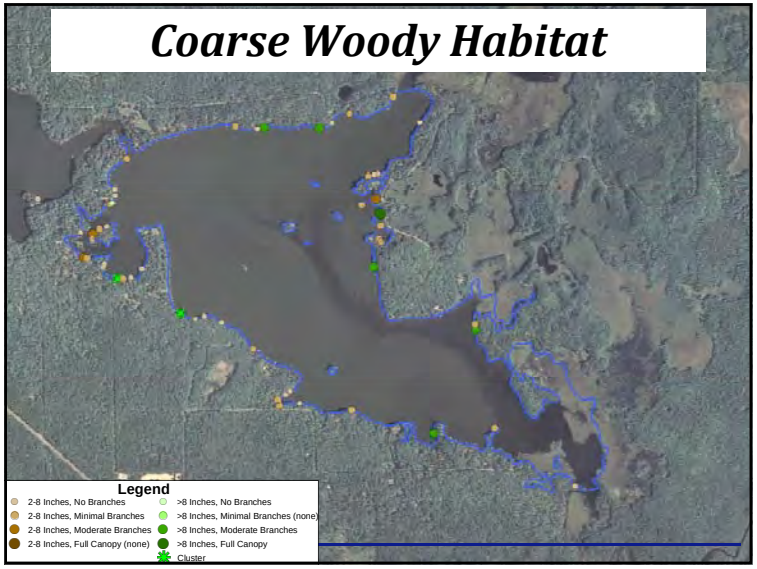
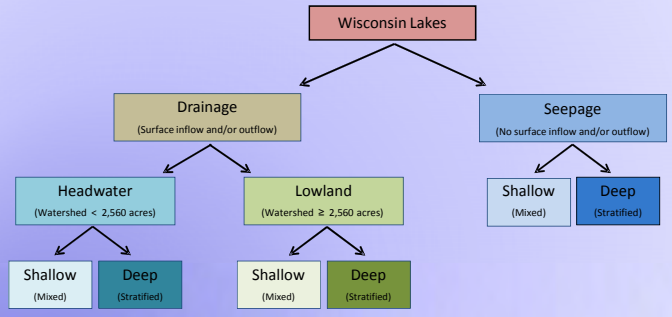
Coarse Woody Habitat



Wisconsin Lakes Classification*



Rest Lake
Island Lake
Spider Lake

**Phase I Lakes*

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Water Quality

↑ Phosphorus (Limiting Plant Nutrient)

↑ Chlorophyll-*a* (Algal Abundance)

↓ Water Clarity (Secchi Disk)

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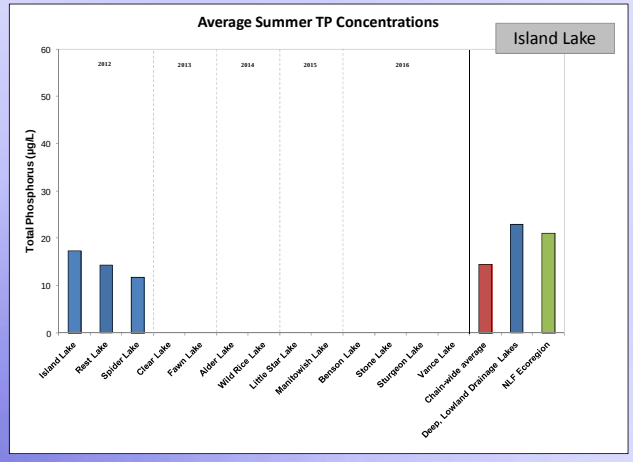
Total Phosphorus



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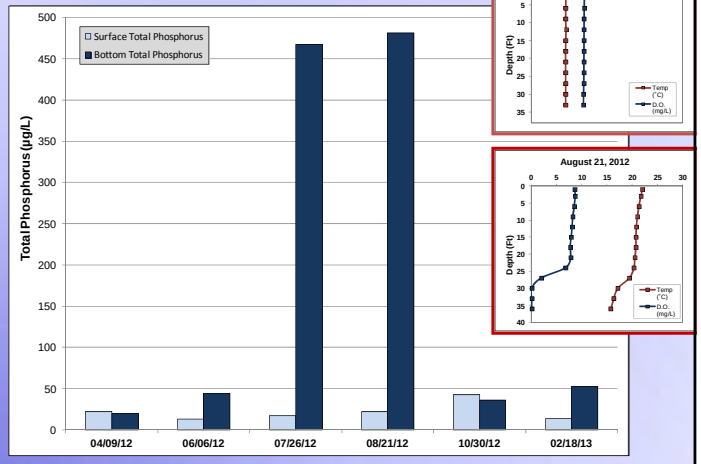
Lake Management Planning

Total Phosphorus



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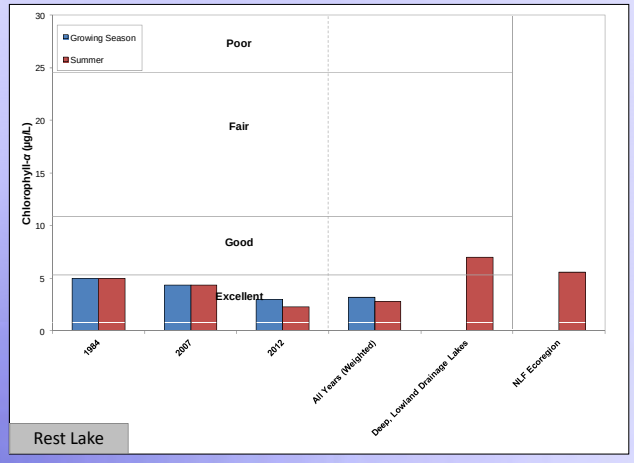
Chlorophyll-*a*



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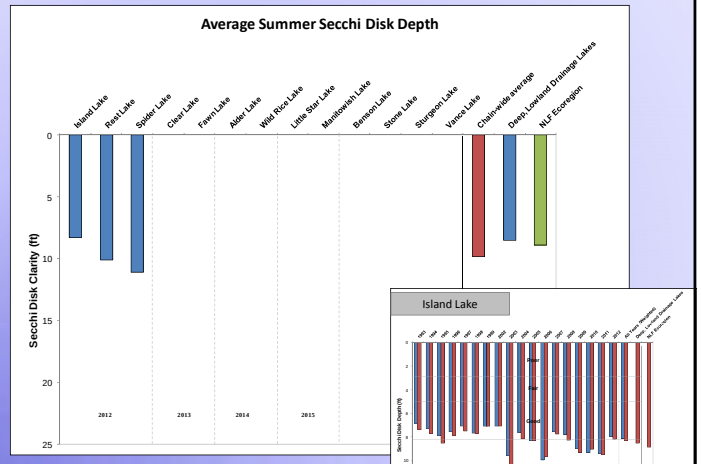
Secchi Disk Clarity



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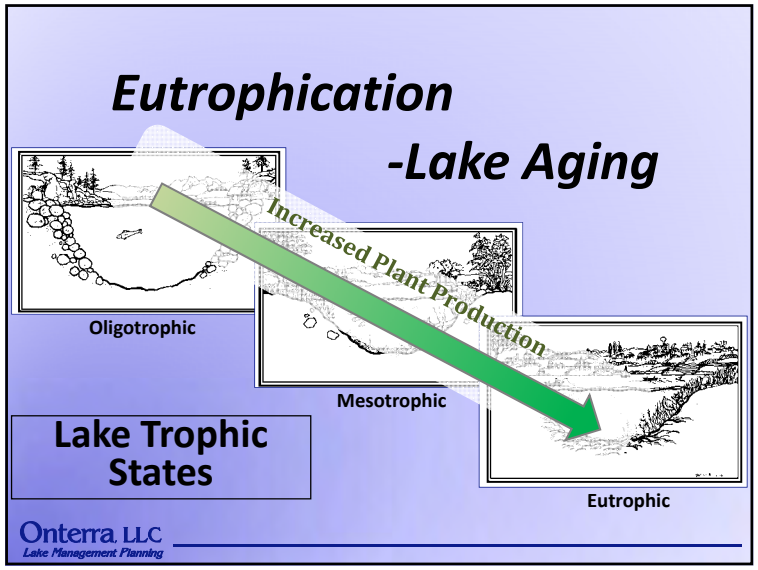
Lake Management Planning


Eutrophication
-Lake Aging
Increased Plant Production
Oligotrophic
Mesotrophic
Eutrophic
Lake Trophic States
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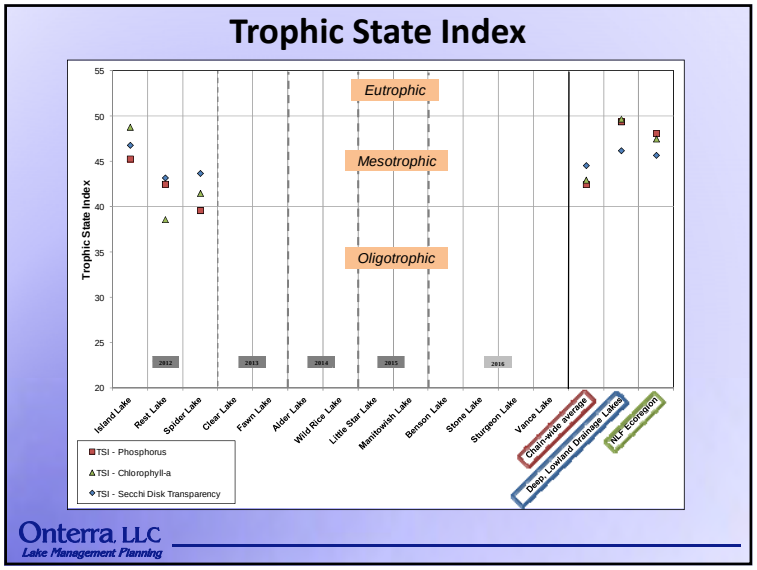
Lake Management Planning


Trophic State Index
Trophic State Index
Eutrophic
Mesotrophic
Oligotrophic
Island Lake
Rest Lake
Spider Lake
Clear Lake
Fawn Lake
Alder Lake
Wild Rice Lake
Little Star Lake
Manitowish Lake
Benson Lake
Stone Lake
Sturgeon Lake
Vance Lake
Chain-wide average
Deep, Lowland Drainage Lakes
NLF Ecoregion
TSI - Phosphorus
TSI - Chlorophyll-a
TSI - Secchi Disk Transparency
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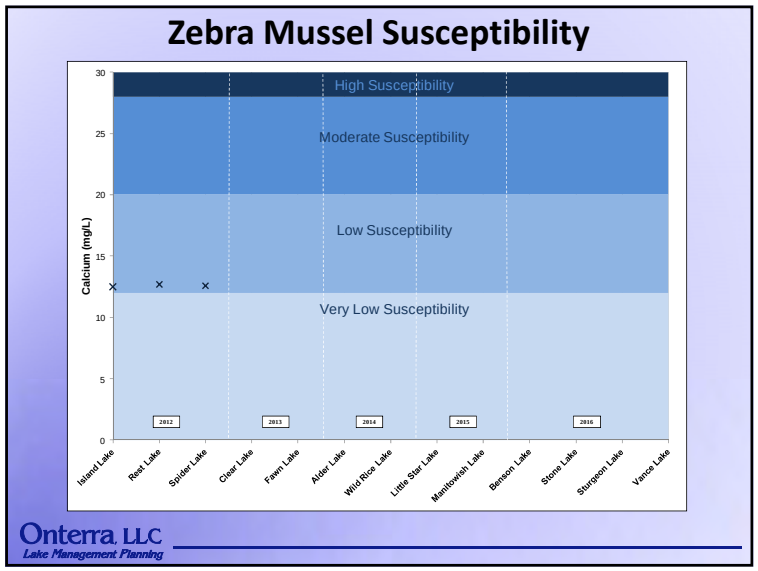
Zebra Mussel Susceptibility
High Susceptibility
Moderate Susceptibility
Low Susceptibility
Very Low Susceptibility
Calcium (mg/L)
Island Lake
Rest Lake
Spider Lake
Clear Lake
Fawn Lake
Alder Lake
Wild Rice Lake
Little Star Lake
Manitowish Lake
Benson Lake
Stone Lake
Sturgeon Lake
Vance Lake
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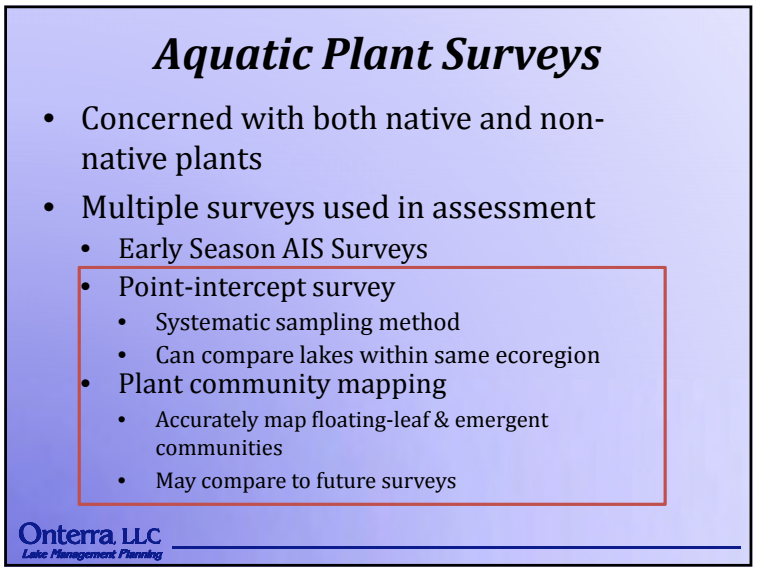
Aquatic Plant Surveys
• Concerned with both native and non-native plants
• Multiple surveys used in assessment
• Early Season AIS Surveys
• Point-intercept survey
• Systematic sampling method
• Can compare lakes within same ecoregion
• Plant community mapping
• Accurately map floating-leaf & emergent communities
• May compare to future surveys
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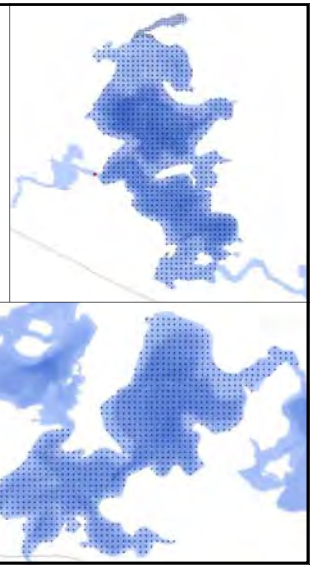
Point-intercept Surveys

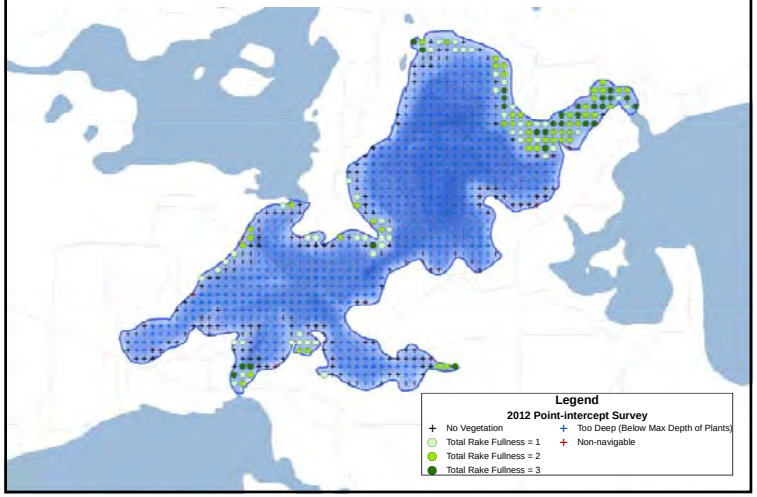
Rest Lake & Papoose Bay: WDNR (2008), Onterra (2012)

Island Lake: WDNR (2011)

Spider Lake: Onterra (2012)



Understanding aquatic plant distribution



Plant Data Overview

- 62 Native plants
  - 28 Submergent
  - 21 Emergent
  - 4 Floating-leaf
  - 4 Floating-leaf/Emergent
  - 3 Submergent/Emergent
  - 2 Free-floating
- 5 Non-native plant species
  - Curly-leaf pondweed
  - Purple loosestrife
  - Reed canary grass
  - Common forget-me-not
  - Pale yellow iris

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Aquatic Plants

Wisconsin Ecoregions

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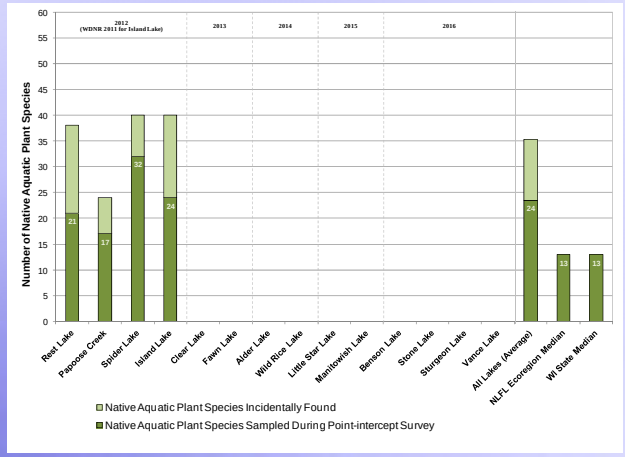
Species Richness



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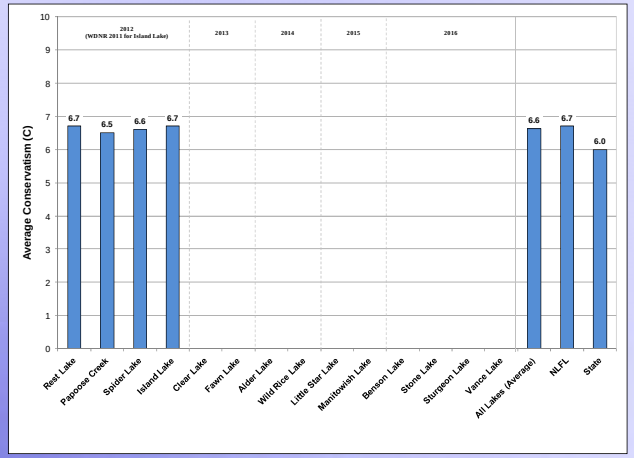
Average Conservatism



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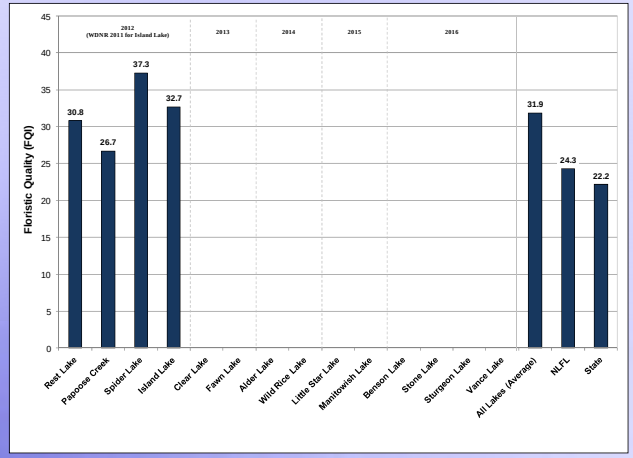
Floristic Quality



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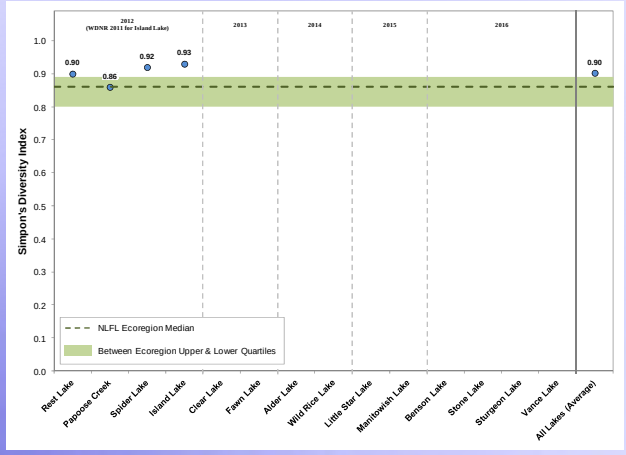
Simpson's Diversity



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Community Mapping

Understand locations and types of emergent, floating-leaf species
- Spawning habitat
- Food source
- Shoreline stabilization

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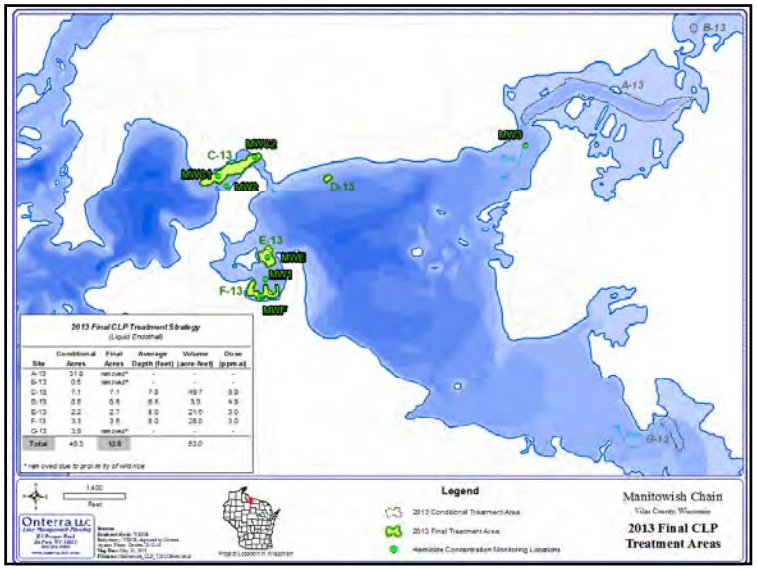

Herbicide Use Patterns

- **Dissipation/Dilution: 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

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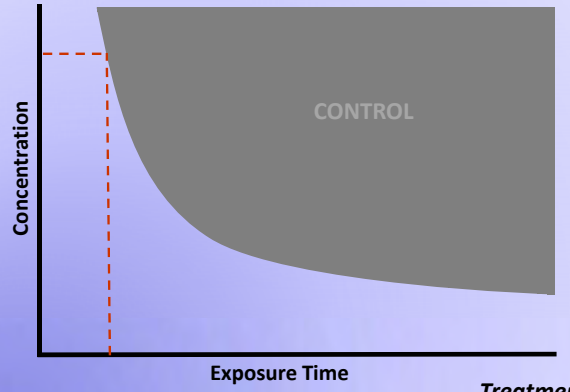
Herbicide Use Patterns



Treatment Type
Spot

High Dose ► Short Exposure Time

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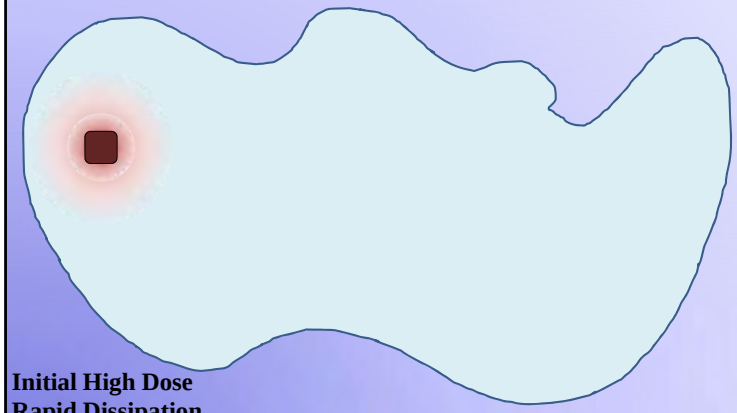
Spot Treatment Use Pattern



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

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 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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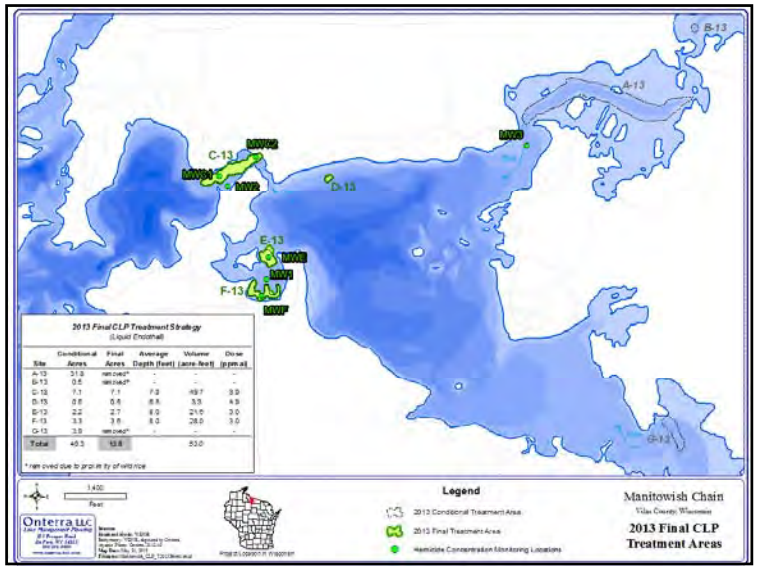
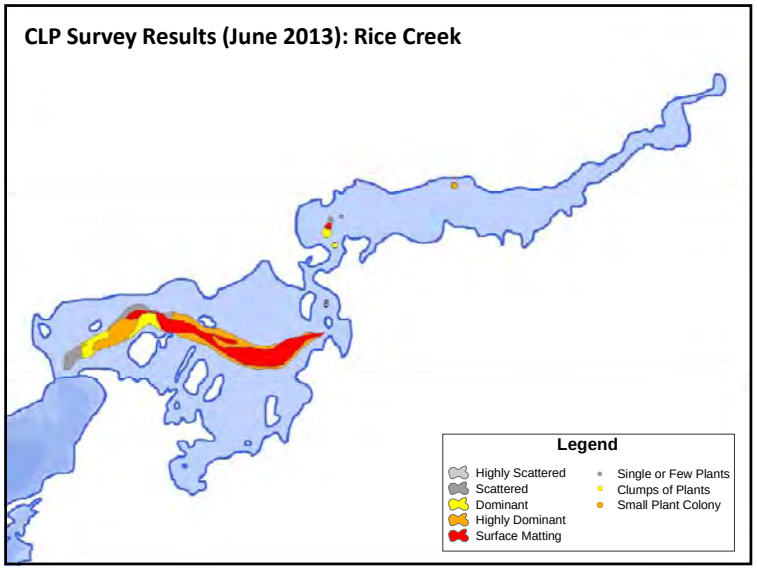
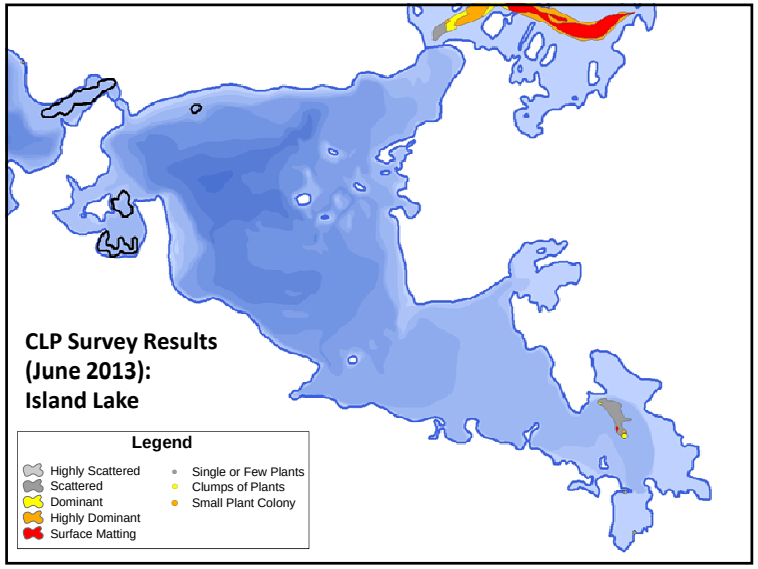
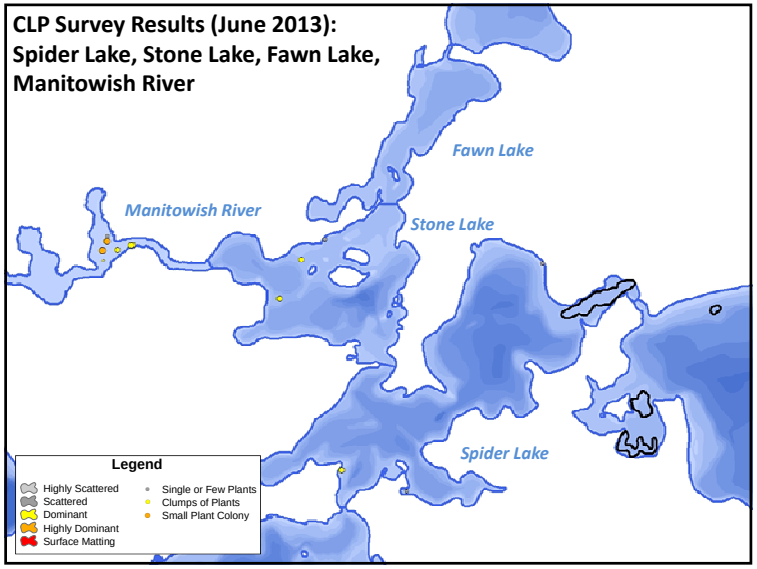
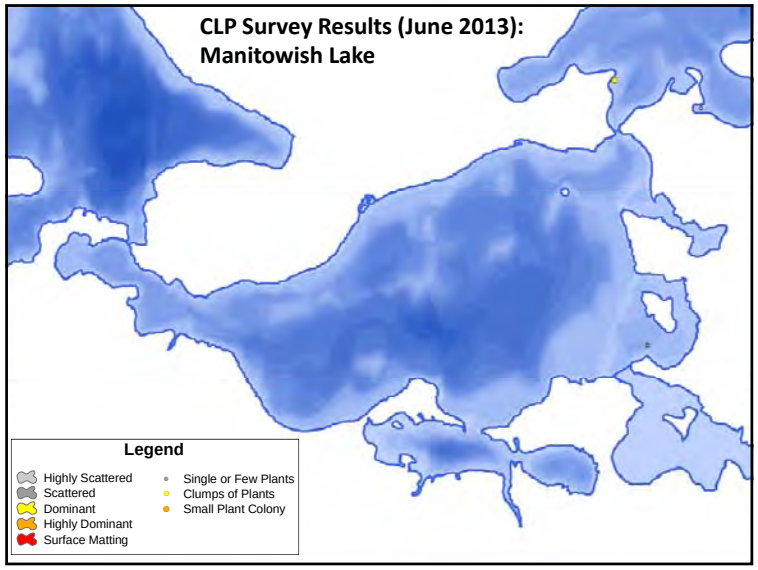

Legend
Manitowish Chain
2013 Final CLP Treatment Areas


CLP Survey Results (June 2013): Rice Creek
Legend
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony


CLP Survey Results
(June 2013):
Island Lake
Legend
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony


CLP Survey Results (June 2013):
Spider Lake, Stone Lake, Fawn Lake,
Manitowish River
Fawn Lake
Manitowish River
Stone Lake
Spider Lake
Legend
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony


CLP Survey Results (June 2013):
Manitowish Lake
Legend
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony


Northern Wild Rice (Zizania palustris)
Optimal Habitat
•Flowing water (Rivers & Flowages)
•Clear Water; Depth of 0.5-3 feet; pH 6.0-8.0
•Periodic Water Level Fluctuations
•Stable/Slight Decline Growing Season
•Winter drawdown
•Soft Organic Muck
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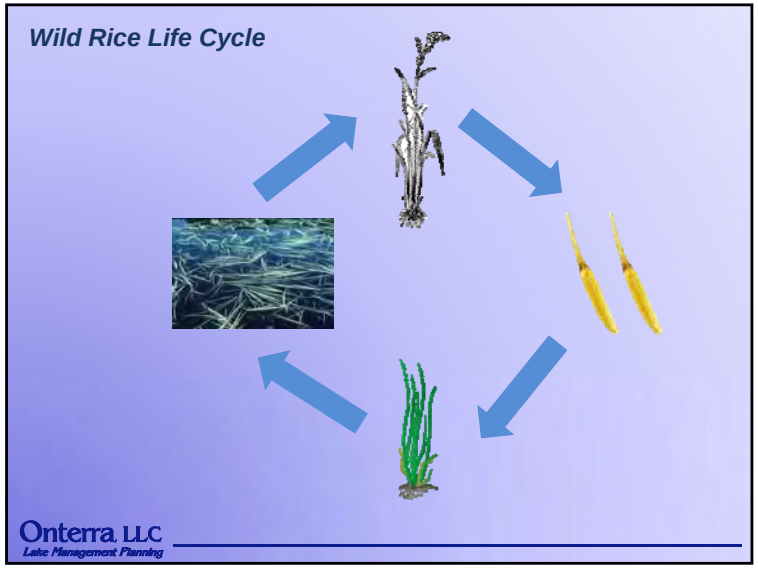
Wild Rice Life Cycle
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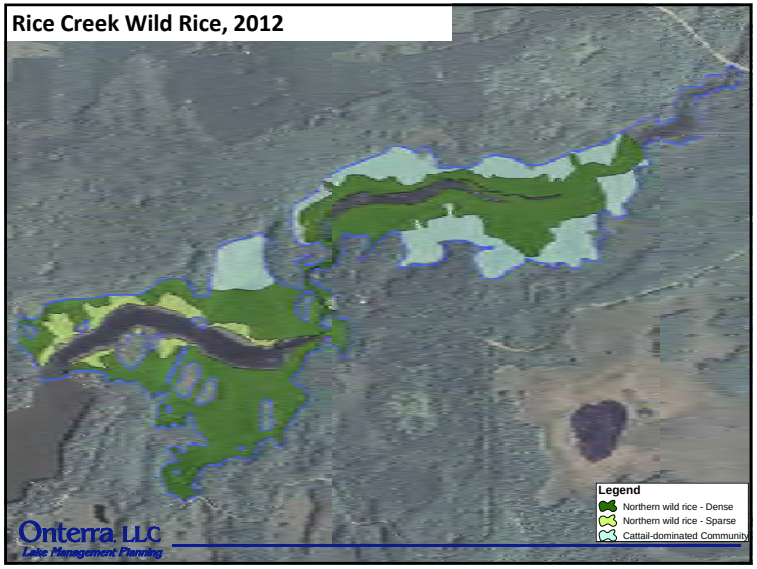
Rice Creek Wild Rice, 2012
Legend
Northern wild rice - Dense
Northern wild rice - Sparse
Cattail-dominated Community
Onterra LLC
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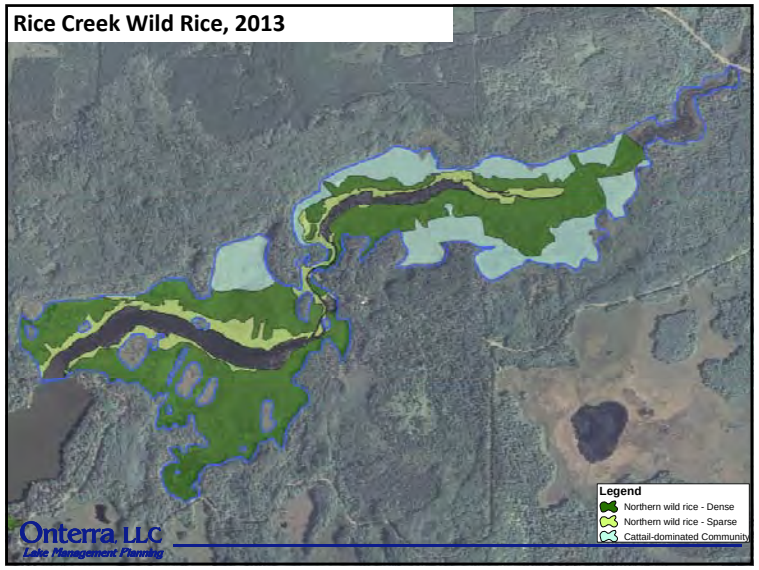
Rice Creek Wild Rice, 2013
Legend
Northern wild rice - Dense
Northern wild rice - Sparse
Cattail-dominated Community
Onterra LLC
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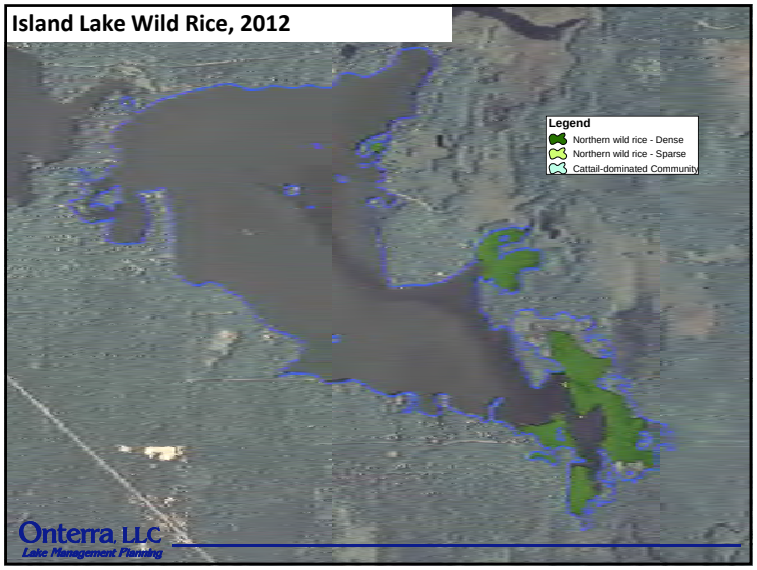
Island Lake Wild Rice, 2012
Legend
Northern wild rice - Dense
Northern wild rice - Sparse
Cattail-dominated Community
Onterra LLC
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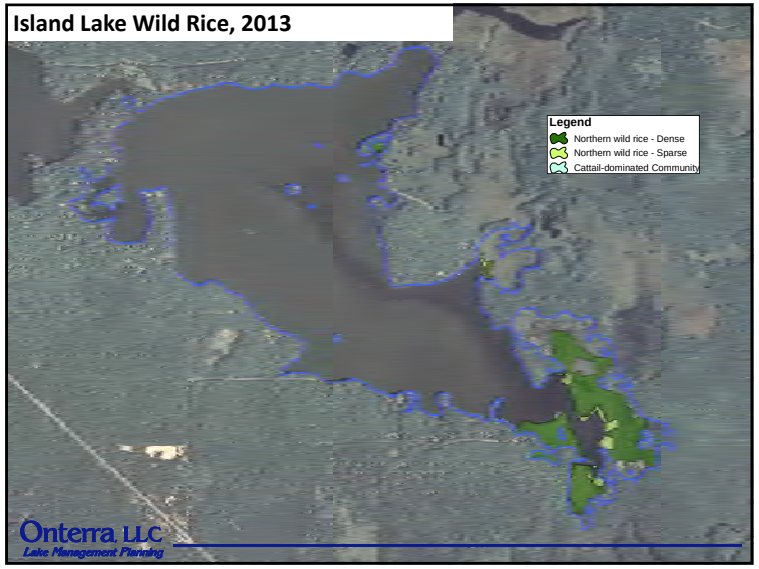
Island Lake Wild Rice, 2013
Legend
Northern wild rice - Dense
Northern wild rice - Sparse
Cattail-dominated Community
Onterra LLC
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Papoose Bay, 2012
Legend
Northern Wild Rice
Dense Plant Community
Sparse Plant Community
Onterra LLC
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Papoose Bay, 2012
Legend
Mechanical Harvest Plan
Common Use Lane
(30-ft width, 1.0 total acres)
Riparian Acess Lane
(15-ft width, 0.7 total acres)
Northern Wild Rice
Dense Plant Community
Sparse Plant Community
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Native American Spear Harvest
Manitowish Chain
Treaty of 1837
Treaty of 1842
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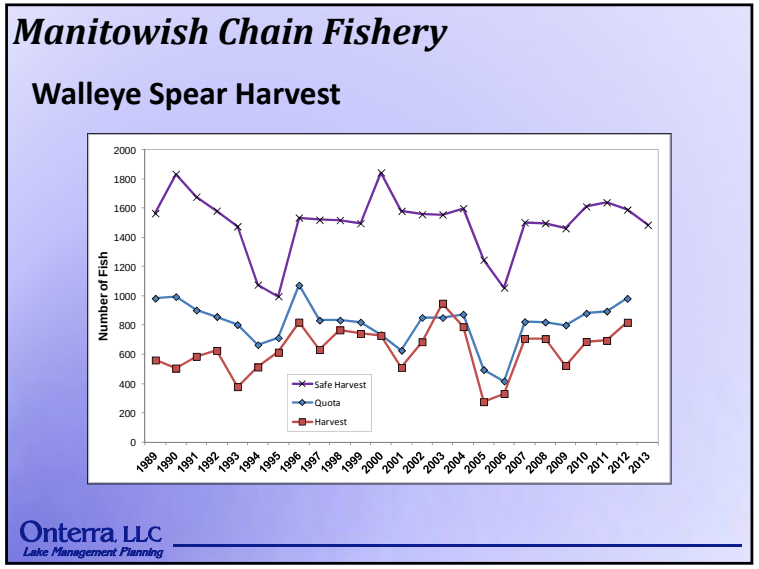
Manitowish Chain Fishery
Walleye Spear Harvest
Number of Fish
Safe Harvest
Quota
Harvest
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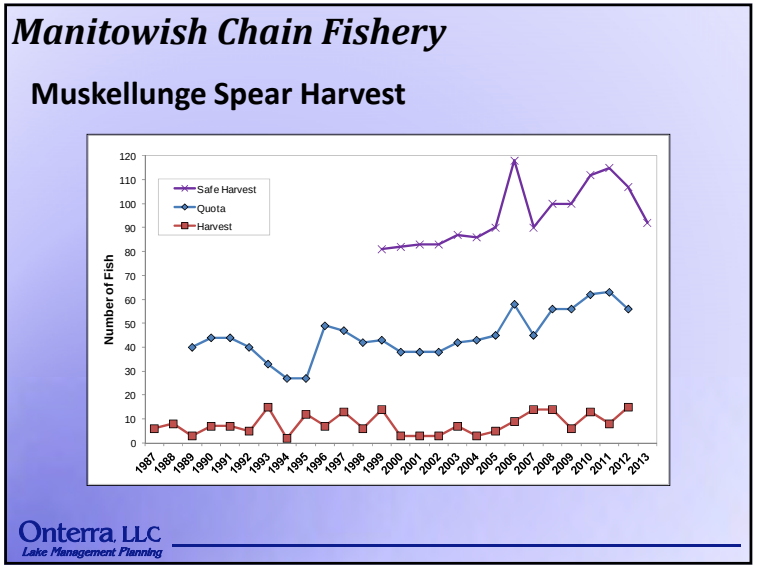
Manitowish Chain Fishery
Muskellunge Spear Harvest
Number of Fish
Safe Harvest
Quota
Harvest
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Manitowish Chain Fishery

Diverse and unique fishery exists

- 35 fish species documented upstream of dam
  - Three species of special concern (threatened)
    - Greater redhorse, pugnose shiner, longear sunfish
  - Lake herring and lake whitefish present
    - Inland lake populations rare within the USA, WI
- 42 fish species documented downstream of dam
  - Lake sturgeon is a special concern/heritage species in WI

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Conclusions

- Watershed is in great condition
  - Land cover is of high quality
  - Large, heavily forested watershed is responsible for stained waters
- Water quality is great
  - Limited data show water quality is better than expected for lakes of this type, within this region
  - Lakes are considered in a mesotrophic state
- Aquatic plant community
  - Based upon standard analysis, native community is of high quality
  - AIS discovered on several lakes
    - Curly-leaf pondweed poses biggest threat to ecosystem

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Next Steps…

1. **Develop Phase I Implementation Plan framework**
   - Management Goals for entire chain
   - Specify applicability to individual lakes
   - Specific lake issues
2. **Submit Phase I plan to WDNR**
3. **Complete Phase IIIb grant for February 1, 2014 deadline**
4. **Proceed with Phase III studies, AIS monitoring and AIS educational activities in 2014**
5. **Meet regarding Phase II lakes, revise Implementation Plan as needed**

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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

North Lakeland Discovery Center
PO Box 237, Manitowish Waters, WI 54545 (715) 543-2085 water@discoverycenter.net www.DiscoveryCenter.net

Enriching lives and inspiring an ethic of care for Wisconsin's Northwoods through the facilitation of connections among people, nature, and community.

2018 Town Aquatic Invasive Species Partnership Report

Submitted by: Emily Heald, Water Program Coordinator, North Lakeland Discovery Center

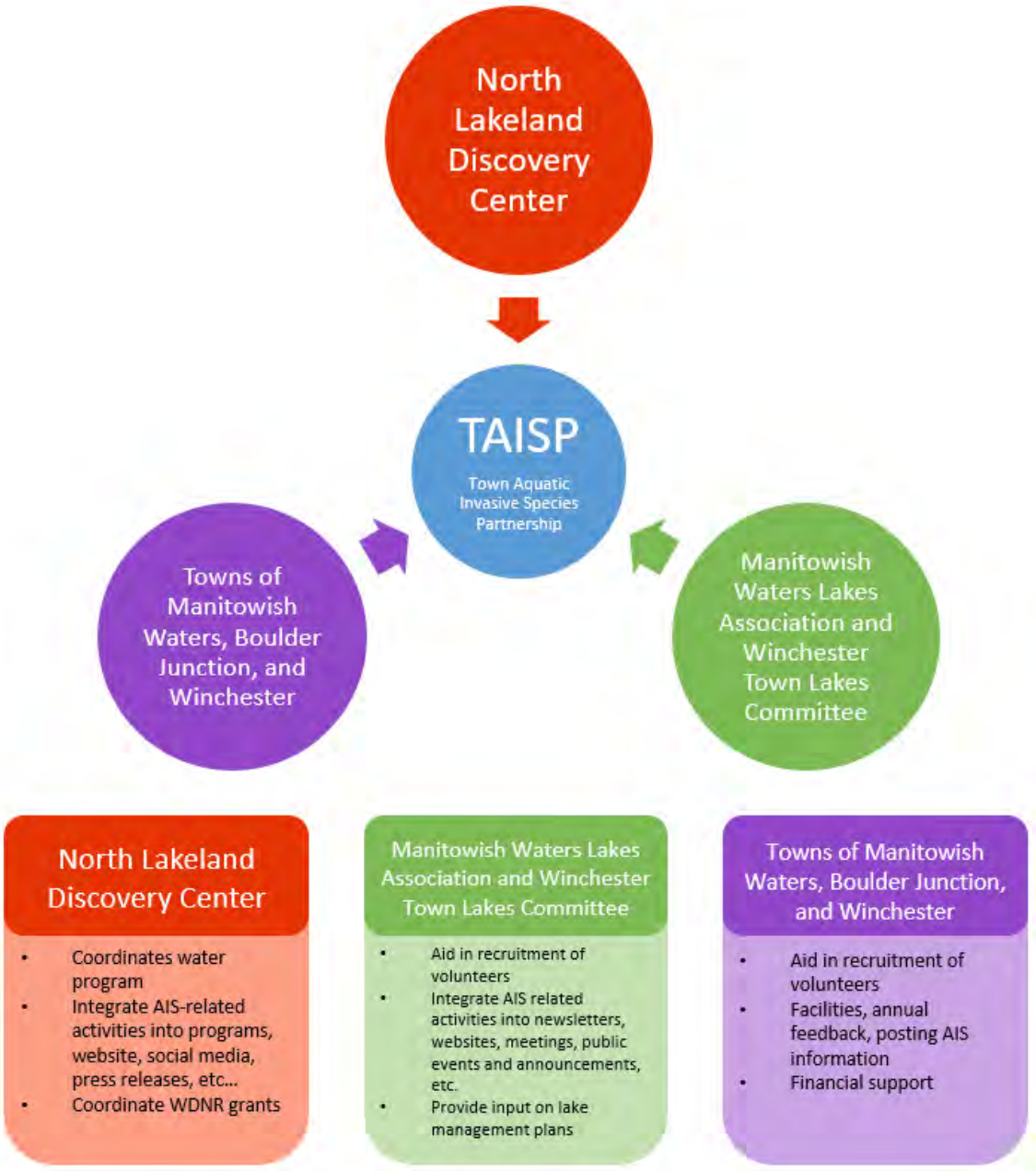

Figure 1. Model of the Town Aquatic Invasive Species Partnership (TAISP), consisting of the North Lakeland Discovery Center, Manitowish Waters Lakes Association, Winchester Town Lakes Committee, and the Towns of Manitowish Waters, Boulder Junction, and Winchester.

Table of Contents

Background of TAISP Partnership

The Town Aquatic Invasive Species Partnership (TAISP, Figure 1), consisting of the North Lakeland Discovery Center (NLDC), the Manitowish Waters Lakes Association (MWLA), the Winchester Town Lakes Committee (WTLC), and the Towns of Manitowish Waters, Boulder Junction, and Winchester, undertook efforts in 2018 to prevent introduction, minimize spread, and manage existing populations of aquatic invasive species (AIS) in area waters and wetlands. 2018 was a very successful year, with all goals and objectives of Town Agreements met or exceeded.

NLDC coordinated the Water Program with staffing of Emily Heald, Water Program Coordinator; Braden Westerhoff, Water Monitoring Intern; Colby Durre, Water Monitoring Intern; and Johnny Behrendt, Water Monitoring Intern. Heather Platt, Research Technician for the Dead Pike Lake project in Manitowish Waters, also intermittently provided assistance. Funding was provided by the Towns of Manitowish Waters, Boulder Junction, and Winchester, and through grants received from the Wisconsin Department of Natural Resources (WDNR). All grants awarded through the WDNR require a match from the TAISP in the form of either cash match or volunteer hours, with each grant usually utilizing a combination of both.

NLDC integrated AIS-related activities into programming, website content, social media, press releases, and via other appropriate activities and venues. The Towns aided in the recruitment of volunteers, provided other support such as facilities, provided feedback to partners regarding management plans, posted AIS information on bulletin boards, boat landings, and other Town-owned facilities, and disseminated information at appropriate venues. The Manitowish Waters Lakes Association and Winchester Town Lakes Committee (and associated lake associations) aided in the recruitment of volunteers, and integrated AIS-related activities into their newsletters, websites, meetings, and public announcements.

Curly-Leaf Pondweed Update

Towns of Manitowish Waters and Boulder Junction

Each year NLDC monitors the Chain and associated inflowing/outflowing rivers with the goal of mapping current populations of AIS, and to look for any new infestations. Curly-leaf pondweed has been the main AIS of concern, but NLDC also treats and maps purple loosestrife infestations, and monitors for other AIS such as Eurasian-water milfoil, spiny water flea, rusty crayfish, mystery snails, and yellow iris.

A timeline of significant curly leaf pondweed (CLP) detection and treatment events in the Manitowish Waters Chain of Lakes is as follows:

2010: CLP first detected on Island Lake and Rice Creek by NLDC volunteers and staff

2011: CLP detected in the Spider-Island Lake Channel, Rice Creek population mapped by NLDC and Vilas County staff, Onterra, LLC surveyed Rice Creek, Island Lake, Spider Lake, Spider-Island Channel, and Spider Lake (>500 total acres of CLP)

2012: NLDC received grant funding for treatment and additional surveys, chemical treatment of Island Lake and the Spider-Island channel was unsuccessful due to use of low concentrations of endothall treatments, few plants found in Spider and Stone Lakes by NLDC staff and volunteers, NLDC hand pulled small areas of CLP

2013: Detected CLP in Manitowish Lake (few plants) and the Rest-Stone channel (3.9 acres total), received grant funding for treatment and surveys, chemical treatment of Island Lake and the Spider-Island channel successful with higher endothall concentrations, NLDC continued to hand pull small areas, NLDC increased education to include presentations to chambers, libraries, lake associations, clubs, and schools

2014: Received grant funding for surveys, chemical treatment, and professional hand harvesting, continued to hand pull small areas, continued community education
2015: Received grant funding for surveys, chemical treatment, and professional hand harvesting, continued to hand pull small areas, continued community education
2016: Received grant funding for surveys, chemical treatment, and professional hand harvesting, continued to hand pull small areas, continued community education
2017: Received grant funding for surveys, professional hand harvesting, continued to hand pull small areas, continued community education. No chemical treatment. After several years of chemical treatments, it was recommended to take an "observation" year to provide more insight into the turion seed bank. NLDC continued locally-based efforts, including AIS species monitoring through the "Captain and Deckhand" program and watercraft inspections. Onterra recommends professional hand harvesting in future years, as well as continued partnership with NLDC and volunteers to monitor and hand harvest CLP.
2018: We did not apply for state funding assistance for 2018, as 2017 was the final grant year to complete the 5-phase Manitowish Chain project. With some remaining grant funding in addition to Town contributions, we continued professional hand harvesting, NLDC hand pulling of small CLP areas, and continued community education.
Please see Onterra management plan reporting for details more specific to each year.

NLDC used GPS data gathered in early-season 2018 AIS surveys to guide professional hand harvesters from Aquatic Plant Management (APM, Minocqua, WI) in hand harvesting areas of CLP. APM pulled CLP on the Spider-Island Channel (6 cubic feet), single plants on Spider (0.5 cubic feet) and Stone Lakes (0.5 cubic feet), and patches of CLP on Rest (3 cubic feet) and Fawn Lakes.

NLDC Water Program Coordinator and interns also discovered the population of CLP on Fawn Lake was much more extensive than 2017. 3 NLDC interns spent 8 hours (24 person-hours) pulling CLP on Fawn. We were unable to complete pulling before CLP senescence, and therefore the professional divers assisted with remaining pulling on Fawn (0.5 cubic feet).

A population of CLP continues to persist in Rice Creek, feeding into Island Lake. In past years, CLP was extensively mapped in Rice Creek. However, in 2018 extreme water staining and flow from recent rains made it impossible to effectively map CLP within the Creek. The flow was such that 5-foot tall CLP plants were lying flat along the substrate, as seen with submersible camera investigations. The absence of a single year of data is likely not to impact the understanding of this population in the future. This population is unable to be treated due to its coexistence with culturally significant wild rice. NLDC and Onterra monitor the Rice Creek CLP populations for potential spread into Island Lake.

In 2019, NLDC plans to partner again with Onterra and APM to monitor and control CLP.

Town of Winchester

Harris Lake is the only known lake in the Town of Winchester containing populations of CLP. The Harris Lake Association (HLA) contracted with Onterra in the fall of 2008 to develop a strategy for CLP management. After the monitoring and assessment surveys in 2009 and 2010, herbicide was applied on approximately 10.4 acres in the spring of 2011. CLP was treated again in 2012 (4.1 acres) and 2013 (2 acres). Smaller patches of CLP not treated with herbicide were hand pulled by HLA volunteers. CLP was not found in 2014. In 2015, Harris Lake joined Onterra and NLDC in the first phase of the Town of Winchester Lake Management Planning Project. CLP was not found in 2015. Onterra located and removed 3 small plants in 2016. In 2017, NLDC Water Program Coordinator located several more plants in the same area as 2016. NLDC staff and volunteers removed the plants. Please see Onterra reporting for additional information and maps of the Harris Lake CLP.

In 2018, NLDC staff located CLP on Harris Lake in the same area as 2017. The plants were considerably shorter than 2017, suspected to be growing short due to unusually late ice-out followed by rapid increases in surface water temperature. NLDC staff hand pulled CLP (details in Appendix).

Purple Loosestrife Update

Purple loosestrife is a hardy, rapidly spreading wetland invasive species that causes sharp declines in biodiversity, and can dramatically disrupt water flow in rivers and waterways. One single purple loosestrife plant produces up to 2.7 million pinhead-sized seeds that are easily spread by wind, water, and human activity. Our focus with this ongoing project is to combat purple loosestrife in the most natural ways possible, by using biocontrol method of *Galerucella* beetles, rather than using non-selective herbicide treatments that could potentially harm other plants and organisms.

Each spring, the NLDC collaborates with the MWLA and the North Lakeland School teachers to lead 7th graders in beginning our biocontrol beetle rearing project. On May 9, 2018, 17 students, two teachers, an MWLA volunteer, and the NLDC Water Program Coordinator dug up purple loosestrife rootstock at a local infestation site. The roots were carefully transported to the NLDC, where the team planted the roots into pots, taped nets around them, and placed the pots into pools of water. One month later, the WDNR supplied NLDC with over 700 beetles to place into the netted pots for propagation. Each pot of an initial 8-10 beetles resulted in a pot of over 100 beetles within 2-3 months. In 2018 we potted over 50 plants, therefore resulting in a total of over 5,000 beetles to be released into infested wetland areas, where they feed on purple loosestrife plants, damaging them enough to dramatically reduce height and seed production in the following years.

We released beetles on 5 sites in Manitowish Waters, with larger infestations receiving more beetles and smaller infestations receiving fewer beetles. At each infestation site, regardless of receipt of beetles, NLDC staff and volunteers clipped purple loosestrife flower heads to prevent the spread of seeds.

Sites that have received beetles for multiple years are responding very positively to the biocontrol efforts. One of our sites on the Manitowish Waters Chain of Lakes on private property has seen a dramatic reduction in purple loosestrife density, as well as a decrease in overall height and number of stems per remaining plants. This site is now at the point where, next year, we will begin to dig up and remove remaining purple loosestrife, and start to reseed the area with native wetland plants that will be able to compete with the dwindling number of purple loosestrife plants. It is our hopes that combining these two forms of biocontrol, beetle release and reseeding of natives, can dramatically reduce or eradicate purple loosestrife from our region.

Towns of Manitowish Waters and Boulder Junction

Our extensive purple loosestrife surveys on the Manitowish Waters Chain of Lakes and incoming/outflowing rivers and wetlands helped us to identify several areas of concern. Rice Creek flowing into Island Lake, and the Manitowish River from the intersection of Highways H and K flowing into Island Lake, are the two most heavily infested locations. In 2019, NLDC plans to focus most of our beetle release and clipping efforts in these areas.

There are also smaller populations of purple loosestrife on Vance Lake, a wetland on the western side of Rest Lake, Stone Lake, Stepping Stone Lake number 1, Spider Lake, the Spider-Island Lake channel, and a wetland near the boat landing on Wild Rice Lake.

A previously undocumented patch of purple loosestrife was discovered on Wool Lake in Boulder Junction by volunteers. These volunteers had attended an NLDC free AIS training, and used their newly developed identification skills to locate the PL. They consulted with NLDC on how to remove the plants, and will now monitor the location next year.

Town of Winchester

There was a small patch of purple loosestrife located in close proximity to South Turtle Lake, but volunteers removed it in 2016. NLDC did not observe any purple loosestrife on South Turtle in 2017 or 2018. There is a very small population of purple loosestrife near the Birch Lake boat landing in a wetland across the street. A volunteer clipped flowers from the small plants in 2017. Plants were found in the same location in 2018, and hand removed by an NLDC intern. No populations of loosestrife in Winchester are large enough to warrant a beetle release, and NLDC will continue to monitor.

Internship Program

The NLDC hosts 2-3 water monitoring interns each summer to assist with monitoring surveys, removal work, and education. This internship opportunity is extremely well rounded, as interns are exposed to: identification and treatment of multiple types of invasive species; talking with people of different educational backgrounds, ages, and interests; formal and informal educational events; use and towing of boats; fundraising; and the inner workings of an environmental non-profit.

This summer, our interns were Colby Durre, Johnny Behrendt, and Braden Westerhoff. Colby returned to the University of Wisconsin Steven's Point in the fall of 2018 to complete his senior year as an Aquatic Sciences and Fisheries Management major. Colby's personal project over the summer was to make small mechanical/tool improvements to our field equipment. He re-wired the boat trailer so we have working turn signals and running lights, changed out the old fraying tie-off ropes on the pontoon, added PVC pipes to the boat trailer to act as trailer guides, changed the safety chains (old ones were very rusty and corroded) and created a new tool to grab submerged aquatic plants while in a kayak.

Johnny Behrendt, with a family history in Manitowish Waters, returned to the University of Wisconsin Steven's Point in the fall to continue his degree as a sophomore in Fisheries and Aquatic Sciences. For Johnny's personal project, he created the book, "Fishing Northern Wisconsin," in which he details the game fish in Wisconsin, and how to catch them. The book includes an introduction detailing responsible fishing behaviors, including cleaning and draining boats after use, and responsible fish handling. His book is available for viewing and borrows in NLDC's Nature Nook.

Braden Westerhoff, also with a family history in Manitowish Waters, returned to Marquette University to finish his degree in Biological Sciences and Environmental Studies. Braden designed an aquaponics system for his personal project. He used a pre-existing fish tank, and fitted a tubing system to it to run water through a small vegetable garden. In this way, the fish water fertilizes the plants, the plants use the nutrients, which in turn helps to keep the fish tank clean.

We also received assistance from Heather Platt, a Water Monitoring Intern during the summer of 2017. Heather returned to the Discovery Center in Spring of 2018 as a Research Technician on the Dead Pike Lake project. In her spare time, Heather assisted in curly-leaf pondweed surveys and hand removal, purple loosestrife monitoring and removal, and provided pivotal assistance in data entry and grant reporting.

Fulfillment of Town Agreement Goals and Objections

1. **Prevent AIS Infestations through Education**

   Please see Appendix I for an all-inclusive list of educational activities

   a. Provided a multitude of opportunities for AIS and general lake ecology education to the public
   b. Delivered youth AIS education as a part of the Discovery Center's Eco-Discoverers (ages 4-7) and Eco-Explorers (ages 7-10) programs

c. Developed new water quality program for school groups
d. Developed new adult programming: Life Under the Ice, Hidden Lake Creatures, and Native Shorelines and Fish Sticks
e. Conducted multiple training sessions to teach volunteers how to identify aquatic invasive species and their native look alikes (6 public trainings at Koller Park in Manitowish Waters, 2 trainings for the Pardee Lake Association, 1 training for the Boulder Lake Association- all filled to capacity)
f. Conducted Clean Boats, Clean Waters watercraft inspector trainings (1 public at NLDC, 1 for Winchester residents)
g. Conducted spontaneous AIS trainings for walk-in visitors to the NLDC
h. Identified aquatic plants and invertebrates for walk-in visitors and volunteers who brought samples to the NLDC
i. Improved and maintained NLDC Nature Nook and Tadpole Classroom public AIS displays and activities through a touch tank, fish tank, interpretive signage, and additional informational displays
j. Educational outreach booths at community events such as the Manitowish Waters 4th of July celebration, MWLA Annual Meeting, Vilas County Lakes and Rivers Association Annual Meeting, the Musky Jamboree, and Winchester Picnic in the Park
k. Provided educational AIS booths and materials for inclusion in packets at fishing tournaments such as the Musky Classic in September
l. Attended the Wisconsin Lakes Convention, April 18-20, 2018, and other statewide AIS Coordinator meetings throughout the year.

2. **Prevent AIS Infestations through Lake, Connected River, and Wetland Monitoring**
   a. Promoted volunteer monitoring in workshop trainings and through various communications (website, social media, lake association newsletters and websites, flyers, etc), and the WDNR Citizen Lake Monitoring Network
   b. Maintained contact with volunteers, and frequently reported new findings
   c. NLDC staff and volunteers identified and GPS-mapped AIS infestations
   d. Submitted all collected data to the WDNR statewide database Surface Water Integrated Monitoring System (SWIMS)

   Towns of Manitowish Waters and Boulder Junction
   a. Monitored all shorelines, littoral zone, and wetlands, targeting areas considered most suitable for AIS on the entire Manitowish Waters Chain of Lakes, and associated river sections and wetlands (river sections connecting lakes on the Chain, Manitowish River below the Rest Lake dam to the Highway 51 wayside, the Trout River from Highway H to Wild Rice Lake, the wetland on northern Wild Rice Lake, wetlands west of Rest Lake, the Manitowish River from Hwys H/K into Island Lake, Rice Creek from Hwy K into Island Lake, and Stepping Stones 1-3)
      i. Identified a more extensive population of CLP on Fawn Lake
   b. Hand pulled populations of CLP on Fawn, Rest, Stone, Spider, and the Spider-Island channel
   c. Assisted members of the Boulder Lake Association in monitoring for AIS – found purple loosestrife, yellow iris, and rusty crayfish.

   Town of Winchester
   a. Monitored all shorelines, littoral zone, and wetlands, targeting areas considered most suitable for AIS on Harris, Hiawatha, Rainbow, Birch, Tamarack, South Turtle, North Turtle, Rock, Pardee, Circle Lily, Helen and Adelaide Lakes

a. Hand pulled populations of CLP on Harris Lake, hand pulled PL near Birch Lake

3. **Prevent AIS Infestations through Boat Landing Inspections**
    a. Applied for and obtained funding through the WDNR Clean Boats Clean Waters (CBCW) Program for Rest and Clear Lakes in Manitowish Waters. Completed a combined total of 200 boat inspection hours, where interns inspected watercraft for invasive species and educated boaters on Wisconsin statutes as they related to invasive species
    b. Volunteers on South Turtle, North Turtle, Rock, Pardee and Circle Lily Lakes completed CBCW hours as mandated by WDNR grants
    c. NLDC contracted with Big, Van Vliet, and Presque Isle Lakes to complete 300 hours of CBCW inspections
    d. Entered all inspection data into the SWIMS database
4. **Prevent AIS Infestations through Communication and Public Relations**
    a. Maintained frequent contact with TAISP members and involved lake associations through NLDC public programs, websites, displays, email updates, libraries, and presentations at lake association meetings
    b. Provided reports and updates at each MWLA and WTLC meeting, as well as several Town Board presentations for Manitowish Waters, Boulder Junction, and Winchester
    c. Supplied and updated AIS printed materials to the Chambers of Commerce and Libraries throughout the season for distribution to visitors of the area
    d. Designed and produced AIS materials such as pamphlets, flyers, backboard display materials, and interpretive signage
    e. Regularly ensured boat landing signage was in good repair
    f. Participated in WDNR statewide programs: Bait Shop Program, Ice Your Catch Initiative, Drain Campaign, and Landing Blitz
    g. Provided newsletter articles and information for lake associations
    h. Provided frequent updates and informational nuggets on Facebook and Instagram (social media)
    i. Interviewed on Rhinelander's Newswatch 12 sports segment regarding aquatic invasive species and how to prevent their spread
    j. NLDC Water Program Coordinator designed and developed several new interpretive signs for the NLDC campus including AIS, purple loosestrife biocontrol, and shoreline restoration. NLDC Water Program Coordinator also developed AIS and natural shorelines programs
    k. Thoroughly updated NLDC's Aquatic Invasive Species website section: https://discoverycenter.net/programs-events/aquatic-invasive-species/
    l. Hosted volunteer appreciation reception dinner: rusty crayfish boil at NLDC
5. **Manage Infestations through Action and Rapid Response Plans for CLP and Purple Loosestrife**

    Town of Manitowish Waters
    a. Surveyed all shorelines and littoral areas on the entire Manitowish Waters Chain of Lakes, associated river sections, and river sections leading into/out of the chain for CLP and purple loosestrife. Please see Appendix I for dates of monitoring
    b. Updated statewide inventories of purple loosestrife and CLP infestations
    c. Coordinated and deployed purple loosestrife and CLP control methods
    d. Purple loosestrife *Galerucella* beetles were released on the wetland west of Rest Lake, Stepping Stone Lake Number 1, Rice Creek, the wetland on northern Wild Rice Lake,

Vance Lake, and the Manitowish River running into Island Lake. Purple loosestrife flower heads were also clipped at these locations

e. CLP was pulled by professional divers on Rest Lake, the Spider-Island channel, Spider, and Stone Lakes. CLP was hand pulled by NLDC staff on Fawn and Rest Lakes
f. Coordinated project planning, tracking, and reporting for grants
g. Actively engaged partners to encourage collaboration on the issue of AIS

Town of Winchester

a. Surveyed all shorelines and littoral areas on Harris, Hiawatha, Birch, Rainbow, Tamarack, South Turtle, North Turtle, Rock, Helen, Adelaide, Pardee, and Circle Lily Lakes for CLP and purple loosestrife. Please Appendix I for dates of monitoring
b. Updated statewide inventories of purple loosestrife and CLP infestations
c. Coordinated and deployed purple loosestrife and CLP control methods
d. Populations of purple loosestrife in Winchester are not large enough to warrant beetle release, but known populations have been hand harvested on South Turtle, and in a wetland near Birch Lake
e. CLP was hand pulled by NLDC staff and volunteers on Harris Lake
f. Obtained WDNR grants, assisted in grant writing, project planning, tracking, and reporting
g. Actively engaged partners to encourage collaboration on the issue of AIS

Town of Boulder Junction

a. A previously undocumented patch of purple loosestrife was discovered on Wool Lake by volunteers. These volunteers had attended an NLDC free AIS training, and used their newly developed identification skills to locate the PL. They consulted with NLDC on how to remove the plants, and will now monitor the location next year.

6. **Conduct Lake Level Monitoring**

The NLDC, in partnership with volunteer concerned citizens and other area scientists, formed a 38-lake level monitoring network in 2008 designed to monitor lake levels via citizen science. Now in its 10th year, the network has provided standardized data collection that is vital for understanding the effects of climate change on lakes in the Northern Highland Lake District region. Lake level monitoring projects are therefore listed on the WI-CBM Priority Programs List.

This long-term monitoring project partners with several groups, including the Lac du Flambeau Tribal Natural Resources Department (assists in lake gauge installation and monitoring), and UW Madison Trout Lake Research Station (technical guidance and data analysis). The project also works with Vilas County Lakes and Rivers Association, individual lake associations, and many dedicated volunteers. The partnership formed after concerns for record low lake levels spurred local citizens to form the citizen scientist lake level monitoring network, spearheaded by the NLDC. This monitoring network was the first of its kind in Wisconsin, addressing a lack of long-term lake level data. NLDC has since managed a data-rich program that gathers empirical data, and compares how different lake types respond to precipitation events, both spatially and temporally. An established, highly standardized monitoring network committed to consistent monitoring and statistically sound data collection allows scientists to develop and test lake level models, and to examine the differences between lake types over time. Consistent and continual monitoring will lead to a valuable data set that could be used to inform adaptive management decisions influencing water resources into the future.

Town of Winchester

There are volunteer lake level monitors on Hiawatha, Harris, Birch, Rainbow, Tamarack, and Pardee Lakes. Tamarack was new as of spring 2017. Our data contradict with the hypothesis that different lake types (i.e. seepage, drainage, and drained) respond differently to precipitation events.

Our dataset indicates different lakes respond similarly. The dataset must be continued in order to obtain long-term data necessary to draw scientific conclusions. For now, lake levels clearly reflect annual changes in precipitation and beaver activity.

The University of North Carolina, with funding provided by NASA, is using lake level information from both Wisconsin and North Carolina to relate high quality satellite imagery to total lake water volume. By understanding changes in lake height (the information you collect) and changes in lake surface area (collected via satellite imagery) researchers can understand how the volume of water in a given lake changes over time. They are hoping to use information collected from Wisconsin, Minnesota, Washington, the New England area, along with Bangladesh, France, India, and Pakistan.

Researchers from the Wisconsin DNR and University of Wisconsin are also using lake level data to create models to predicate lake levels using precipitation information from years prior. They have also interestingly found that northern lakes exhibit opposite patterns from southern lakes in Wisconsin. While the north has experienced drought and low lake levels, the south was very wet with high water levels.

7. **Administer AIS Program Efficiently and Effectively**
    a. Continued work with the TAISP on management recommendations for the Manitowish Waters Chain of Lakes and Winchester Lakes through planning documents and strategic planning meetings
    b. Administer grants and track volunteer hours, financial tracking
    c. Submit reimbursement requests and biannual activity reports to the WDNR
    d. Acts as a liaison to contracted lake management planning group (Onterra, LLC)
    e. Provides diverse opportunities for AIS education to the public

Appendix I. Water Program-Related Activities, Education/Outreach and Monitoring: January 1, 2018-December 31, 2018

January 9, 2018
Attended Manitowish Waters town meeting to provide updates on 2017 and begin 2018 planning.

January 23, 2018
Attended Boulder Junction town meeting to provide updates on 2017 and begin 2018 planning.

January 25, April 26, June 29, July 26, August 23, September 27 2018
Attended Winchester Town Lakes Committee meetings to provide updates.

February 3, 2018
Guided "Winter Waterfall" trip for Discovery Center members. Discussion topics included watersheds, water movement throughout a watershed, and effects of human development on water within a watershed.

February 7, 2018
"Life Under the Ice" presentation at the Boulder Junction library to teach about lake life adaptations to cold water.

February 8, 2018
Attended University of Wisconsin Steven's Point career fair to promote internships at the Discovery Center.

February 15, 2018
"Secret Love Lives of Animals" program – a Jeopardy-style program about the mating habits of animals, including a category on invasive species.

February 17, 2018
"Wisconsin Ice Fishing Basics" program – a program designed to teach beginner fishermen how to ice fish, including laws and regulations around bait transportation, and responsible fishing behaviors to prevent the spread of AIS.

March 7, 2018
"Turtles of Wisconsin" program about the adaptations and lifecycle of Wisconsin's turtles, including habitat requirements.

March 8, 2018
"Wisconsin's Lake Sturgeon" program about the unique history and biology of sturgeon in the area.

March 12, 2018
Provided a two-sided flyer for the Manitowish Water Chamber of Commerce "May Mailer" regarding AIS and how to become involved in the Discovery Center's AIS monitoring program.

March 29, 2018
Meeting with John Hanson, Town Chair of Manitowish Waters, to begin planning of interpretive signage to be placed at the Rest Lake boat landing

April 4, 2018
"Duck, Duck, Goose – The World of Waterfowl" program about migration, adaptations, behavior, and habitat of Wisconsin's waterfowl.

April 7, 2018
Attended Regional Citizen Science meeting at Moon Beach to discuss a network of citizen science in the Northwoods. Included projects such as AIS monitoring and lake level monitoring.

April 14, 2018
"Humanity for Habitats Series: Waterfowl Habitat"- A program designed to teach the community about habitat requirements of waterfowl, and ideas for preserving private property to appeal to waterfowl. Included building a wood duck box for each participant.

April 17, 2018
Attended Boulder Junction town meeting to discuss plans for summer 2018.

April 18-20, 2018
Attended the Wisconsin Lakes Convention in Steven's Point, WI to network and stay up to date with Wisconsin water issues. Water Program Coordinator, Emily Heald, was also nominated for the Wisconsin Lake Stewardship Award.

April 28, 2018
"Humanity for Habitats Series: Fish Sticks/Native Shoreline Gardens" – A program designed to teach riparian owners the importance of native shorelines, and ways to improve shorelines.

May 3, 2018
"Hidden Lake Creatures" program about the invisible life within lakes.

May 5, 2018
"Meandering the Manitowish" canoe river trip designed to discuss the ways rivers change over time, and abundant wildlife viewing.

May 9, 2018
7th graders from North Lakeland Elementary School assisted in digging up purple loosestrife roots for beetle rearing project.

May 11, 12, 16, 2018
Lake gauge installation to monitor lake levels in Vilas County.

May 14, June 18, July 16, August 20, September 17 2018
Attended MWLA meetings to provide updates

May 18, 2018
Winchester Phase 3 (Turtle Chain) meeting where Onterra, the consulting company we work with, provided updates on the 2017 field season, and Emily Heald provided an update on volunteer hour progress and the upcoming field season.

May 19, 2018
Winchester Phase 2 (Birch, Rainbow, Tamarack) wrap up meeting with Onterra to present final management plans for each lake.

May 19, 2018
Winchester Phase 4 (Pardee, Circle Lily, Helen, Adelaide) kick off meeting where Onterra and NLDC provided a project overview for what volunteers can expect with the project, as well as an overview of required volunteer hours.

May 21, 2018
Interns arrived, NLDC training day.

May 24, 2018
Interns completed early season AIS meander survey of the Trout River from Hwy H into Wild Rice Lake.

May 25, 2018
Interns attended Clean Boats, Clean Waters training with Vilas County AIS Coordinator in Eagle River.

May 29, 2018
Winchester Phase 2 Wrap Up meeting to present the final lake management plans for Rainbow, Birch, and Tamarack Lakes.

May 29, 2018
Winchester Phase 4 Kick Off meeting to meet and greet with Circle Lily and Pardee Lakes, and to provide an overview of the lake management planning process.

May 31, 2018
Installed lake gauge at Crab Lake.

June 1-3, 2018
Interns participated in DNR's Drain Campaign during CBCW hours to further promote draining of all water in boats before moving away from the lake. Included free ice pack hand out for icing fish and to promote draining of live wells.

June 2, 2018
Construction of fences for shoreline restoration projects.

June 4, 2018
67 Arbor-Vitae Woodruff kindergarteners assisted in planting shoreline restoration gardens.

June 8, 2018
NLDC hosted Vilas County Aquatic Invasive Species Coordinator, Cathy Higley, to host a CBCW training open to the public.

June 9, 2018
Presque Isle River Canoe Trip – a paddle on the scenic Presque Isle River to view songbirds, nesting waterfowl, and shorebirds.

June 9, 2018
Attended Rainbow Lake Association annual meeting to present on lake management plan.

June 10, 2018
Attended Pardee Lake Association picnic to introduce lake management planning project.

June 12, 2018
Provided specialty classes and training to Center for Conservation Leadership about water ecology, including portions about aquatic invasive species.

June 12, 2018
Early season AIS survey completed on Fawn Lake in Manitowish Waters

June 13, 2018
Purple loosestrife beetles arrived and were placed on netted plants.

June 13, 2018
Early season AIS survey completed on Rainbow and Hiawatha Lakes in Winchester. No AIS found.

June 13, 2018
Early season AIS survey started on Rest Lake in Manitowish Waters.

June 14, 2018
Early season AIS survey completed on Rest and Clear Lakes, and the channel between the two. CLP found on Rest.

June 14, 2018
Early season AIS survey completed on Harris Lake in Winchester. CLP located in Northwest corner (same location as 2017)

June 16, 2018
Clean Boats, Clean Waters training for Winchester residents

June 16, 2018
Attended Van Vliet Lake Association annual meeting to provide AIS updates.

June 19-20, 2018
Onterra, LLC on Manitowish Chain of Lakes

June 19, June 29, July 14, July 24, August 4, August 14 2018
"Aquatic Invasive Species Identification Training" at Koller Park in Manitowish Waters to teach participants how to identify and report locally relevant aquatic invasive species.

June 19, 2018
Early season AIS survey completed on the Manitowish River from the Rest Lake dam to the Highway 51 wayside.

June 20, 2018
Early season AIS survey completed on Little Star, Alder, and Wild Rice Lakes. No CLP found.

June 20, 2018
Curly-leaf pondweed hand pulled on Harris Lake in Winchester. Two interns and water program coordinator spent 3 hours (9 person-hours) pulling and surveying the area.

June 21, 2018
Early season AIS survey completed on Tamarack Lake in Winchester. No CLP found.

June 21, 2018
Early season AIS survey partially completed on Birch Lake in Winchester. No CLP found.

June 22, 2018
Curly-leaf pondweed hand pulled on Fawn Lake in Manitowish Waters. 3 interns spent 8 hours pulling (24 person-hours)

June 22, 2018
"Wonders of Wildlife: Shorebird" program about adaptation and migration of shorebirds in Wisconsin.

June 23, 2018
Float Your Boat Trivia Rally- an on-water scavenger hunt on the Manitowish Waters Chain of Lakes to test participants' knowledge on area history and ecology.

June 26, 2018
Water Program Coordinator and interns attended Aquatic Plant Identification Training Course offered by UW-Extension to be better able to identify aquatic plants during meander surveys.

June 29-July 4, 2018
Interns participated in WDNR's Landing Blitz during CBCW hours to promote the CBCW message to boaters during busy boating times. We handed out free towels with an AIS message to promote the "clean, drain, dry" message.

June 29, 2018
Steering committee meeting for Winchester Phase 3 (Turtle Chain) to discuss first steps in creating a management plan.

June 30, 2018
Provided AIS identification training for Turtle Chain in Winchester.

July 3, 2018
Purple loosestrife reported on Boulder Lake in Boulder Junction.

July 3, 2018
Clean Boats, Clean Waters training for Turtle Chain.

July 3, 2018
Water program coordinator and one intern interviewed for Newswatch 12 for a segment on AIS. Interview can be found at: http://www.wjfw.com/stories.html?SKU=20180703182447&textsize=large

July 4, 2018
AIS booth at the Manitowish Waters 4th of July celebration.

July 5, 2018
Discovery Center's Family Play Day, a free event for families, featuring several water topics such as AIS and fishing.

July 6, 2018
First round of purple loosestrife beetles matured and ready for release.

July 6, 2018
Early season AIS surveys completed on the Turtle Chain in Winchester

July 6, 2018
Clean Boats, Clean Waters and AIS identification training provided for Pardee Lake (Winchester Phase 4).

July 7, 2018
Purple loosestrife beetles released on Rice Creek in Boulder Junction and the Manitowish River running into Island Lake in Boulder Junction.

July 7, 2018
Attended Turtle Chain Lake Association to provide AIS and lake management planning updates

July 5, 2018
Family Play Day – An all-ages event for fun in the outdoors at the Discovery Center. Included topics relation to water such as frog catching, AIS identification, and macroinvertebrates.

July 6, 2018
Plunket Lake Canoe Trip – A relaxing canoe program to observe a wide variety of shoreline habitats and diverse aquatic life.

July 10, 2018
Purple loosestrife beetles released on Vance and Stepping Stone Lakes (Manitowish Waters). PL reported near Boulder Lake in Boulder Junction.

July 11, 2018
Purple loosestrife beetles released on Vance and Wild Rice Lakes in Manitowish Waters.

July 13, 2018
Mussel Workshop and Canoe Trip – WDNR Mussel Biologist joins us to discuss freshwater mussels of Wisconsin, threats to their habitats, and way to monitor and protect them.

July 15, 2018
AIS booth at the Lion's Chicken BBQ lunch in Winchester.

July 17, 2018
Released beetles into PL sites on the Manitowish River flowing into Island Lake. Clipped flower heads.

July 19, 2018
NLDC's annual meeting, which included an introduction and season update from interns.

July 21, 2018
Clipped PL flowers on Rice Creek in Boulder Junction.

July 24, 2018
Completed PL survey on Birch, Circle Lily, and Hiawatha Lakes in Winchester (no PL found).

July 25, 2018
Clipped PL flowers on Rice Creek in Boulder Junction.

July 26, 2018
Clipped PL flowers on Trout River and wetland on Wild Rice Lake in Boulder Junction.

July 27, 2018
Clipped PL flowers on the Manitowish River from the Rest Lake dam to the Highway 51 wayside.

July 28, 2018
Attended MWLA annual meeting to provide AIS and lake management planning updates.

July 31, 2018
Clipped PL flowers on the Manitowish River running into Island Lake (Boulder Junction), completed PL survey on Pardee Lake in Winchester (no PL found).

July 31, 2018
Clipped PL flowers at a wetland near Rest Lake in Manitowish Waters.

August 2, 2018
Clipped PL flowers on Rice Creek in Manitowish Waters.

August 3, 2018
Hosted Vilas County for a lakeshore erosion workshop.

August 3, 2018
Water Monitoring Interns attended Trout Lake Station's open house.

August 3, 2018
PL flowers clipped at wetland near Rest Lake.

August 6, September 7, 2018
Acoustic Bat Monitoring Pontoon Survey – An opportunity to learn about how your activities in and around the water affect our night-flying friends – bats.

August 7, 2018
Clipped PL flowers on Stepping Stone Lakes in Manitowish Waters.

August 8, 2018
Completed PL survey on Rainbow and Harris Lakes in Winchester. No PL found.

August 8, 2018
Attended workshop about how tribal government works in Lac du Flambeau.

August 9, 2018
Clipped PL flowers on Rice Creek in Manitowish Waters.

August 9, 2018
Allequash Lake State Natural Area Canoe – A relaxing paddle to learn about wild rice and birds.

August 10, 2018
Clipped PL flowers on Rice Creek in Manitowish Waters.

August 12, 2018
AIS booth at Boulder Junction's Musky Jamboree

August 14, 2018
"Eco-Discoverers (Ages 4-7) – Lake Rangers" program about Wisconsin's waters and the creepy crawlers that invade it.

August 15, 2018
"Eco-Explorers (Ages 7-10) – Aquatic Safari" program to catch critters in the lake, observe plankton, and meet live aquatic animals in the Nature Nook.

August 15, 2018
Appreciation Potluck for Volunteers, Interns, and Sponsors. An evening dinner to thank all who have helped us during the summer. Interns present on summer experiences and individual projects.

August 16, 2018
PL survey completed on Tamarack and wetland near Birch Lake in Winchester. PL hand removed in Winchester wetland.

August 16, 2018
PL survey and spiny water flea dredging completed on Rest Lake, Rest-Stone channel, Stone Lake, Fawn Lake, and Clear Lake. PL found on Rest and Stone Lakes.

August 17, 2018
PL survey and spiny water flea dredging completed on Spider Lake, Island Lake, Manitowish Lake, and Little Star Lake. PL found on Spider, Island, and the Spider-Island channel.

August 18, 2018
Palmer-Tenderfoot Nature Conservancy Area Canoe and Hike day trip along the Ontonagon River to the Tenderfoot Forest Reserve. A discussion of cultural history, old growth forests, and shoreline development are included.

August 18, 2018
Participated in Wisconsin's Snapshot Day.

August 18, 2018
AIS identification training for Boulder Lakes Alliance group.

August 21, 2018
PL survey and PL clipping on Manitowish River from Hwys H/K into Island Lake. PL infestation extensive in this area.

August 22, 2018
PL survey and spiny water flea dredging completed on Wild Rice Lake, the Trout River between Wild Rice and Alder, and Alder Lake. PL found on Wild Rice Lake.

August 23, 2018
PL survey completed on the Turtle Chain. No PL found.

September 7, 2018
Set up and manned an AIS booth for the Musky Classic.

September 8, October 20 2018
Bog Exploration and Hike – A discussion of unique bog landscapes and how humans affect them.

September 11, 2018
Provided advanced AIS training for Wisconsin Master Naturalists on Manitowish Chain of Lakes.

September 14, 2018
Rice Creek Canoe Trip – A peaceful paddle on Rice Creek to discuss the cultural significance of wild rice, and an opportunity to enjoy wildlife viewing.

September 22, 2018
Full Moon Canoe – A night time paddle on Plunkett Lake to enjoy the sounds and feel of the water at night.

September 25, 2018
Presented at Boulder Junction town meeting to provide a summer 2018 update and to request funding for 2019.

October 1, 2018
Presented at Winchester town meeting to provide a summer 2018 update and to request funding for 2019.

October 9, 2018
Presented at Manitowish Waters town meeting to provide a summer 2018 update and to request funding for 2019.

October 6, 2018
Set up and manned an AIS booth at Cranarama in Manitowish Waters.

October 22 and 23, 2018
Removed lake gauges for the winter for lake level monitoring project.

October 11, 2018
"The Food That Grows on Water" presentation by John Haack, long time wild rive harvester and processor to learn the unique biology of wild rice, its cultural significance, and its cultivation.

November 3, 2018
Hosted geologist Dave Ullman to speak on glaciers and how lakes were formed in this area.

November 13 and 14, 2018
Attended statewide AIS Coordinator meeting in Steven's Point to stay up-to-date on current research and findings.

Appendix II: Photographs of AIS monitoring, control, and education work

NLDC intern holding a cooler of invasive rusty crayfish removed from Presque Isle Lake, to be served at the annual volunteer appreciation lunch

NLDC intern conducting spiny water flea monitoring

NLDC intern participating in Wisconsin's Snapshot Day, monitoring for AIS at various boat landings

NLDC intern with over 10 bags of purple loosestrife cut from the Manitowish River

NLDC intern with a handful of freshly pulled curly leaf pondweed from Harris Lake

NLDC interns participating in the Clean Boats, Clean Waters program

NLDC intern interviewed by Newswatch 12 regarding invasive species and their prevention

All three NLDC interns at an AIS informational booth at the Manitowish Waters 4th of July celebration

NLDC intern with the controlled growing of purple loosestrife to rear cella beetles

NLDC intern during a beetle release on Rice Creek

NLDC interns pose with over 6 bags of purple loosestrife harvested from Rice Creek

Lake Level volunteers monitoring lake levels on Rainbow Lake

Participants of one of NLDC's free AIS trainings

NLDC intern teaches high school-aged students how to identify aquatic insects

High school students learn how to use a plankton net to monitor for spiny water flea

Wisconsin Master Naturalists learn how to identify AIS

Manitowish Waters Chain of Lakes
Management Planning Project

Update: December 2014

Submitted by: Dan Cibulka, Onterra, LLC

The North Lakeland Discovery Center (NLDC), Manitowish Waters Lake Association (MWLA) and Towns of Manitowish Waters and Boulder Junction are collectively involved in several projects that aim to protect and preserve the Manitowish Waters Chain of Lakes. This partnership has formed a working group called the Town Aquatic Invasive Species Partnership (TAISP) which aims to address AIS concerns in nearby waters through education, prevention and control. The TAISP is working closely with Onterra, LLC, a lake management planning firm out of De Pere, Wisconsin on these projects. These studies include both comprehensive lake management planning for the entire Manitowish Waters Chain of Lakes as well as aquatic invasive species (AIS) monitoring and education. Curly-leaf pondweed, an AIS of high concern, is being closely monitored on several chain lakes.

As the project sponsor, the NLDC has successfully obtained numerous grants through the Wisconsin Department of Natural Resources (WDNR) state-wide lake management grant program to partially fund these efforts. Hundreds of hours of in-kind, donated labor have been invested by the above named entities and town volunteers in these projects. Additionally, substantial cash contributions have been made from the Towns of Manitowish Waters and Boulder Junction as a sign of their support. To date, the grants obtained by the NLDC include:

- Lake Management Planning Grant
  - Designed to fund comprehensive lake management planning
  - 1 grant received (Aug 2011)
- AIS Education, Prevention and Planning Grants
  - Designed to fund comprehensive lake management planning in lakes with AIS
  - 5 grants received (Feb & Aug 2012, Feb & Aug 2013, Feb 2014)
- Clean Boats Clean Waters Grants
  - Designed to fund AIS education at boat landings
  - 1 grant received (Dec 2013)
- AIS Early Detection and Response Grants
  - Awarded to organized groups who are controlling/monitoring a new AIS infestation
  - 3 grants received (Feb 2012, 2013 and 2014)

This update intends to discuss activities involved with the comprehensive management planning projects (chain-wide and individual), the continued monitoring of CLP on the chain, and update the status of several WDNR grants the NLDC are working towards.

Management Planning Project

In 2011, the NLDC and MWLA began a lake management planning process with Onterra on Rest Lake and Papoose Bay. This project began in response to aquatic plant concerns on Papoose Bay in addition to concerns of curly-leaf pondweed, which had recently been discovered in upstream Island Lake / Rice Creek. Since then, the NLDC has continued to pursue comprehensive management plans and AIS monitoring on all 10 of the Manitowish Waters Chain of Lakes. The effort is being broken into five phases, with several lakes and river sections being studied during each phase. The

Manitowish Waters Chain of Lakes Management Plan will include a chain-wide plan as well as individual lake management plans for each lake in the chain. From 2011-2017, the water quality, watershed, aquatic plants, shoreland areas, fisheries management and stakeholder perspectives will be studied extensively in each lake in the chain.

In fall of 2013, Onterra ecologists visited with representatives from the Phase I lakes to discuss the ecology and management of their lakes, as well as chain-wide issues that were occurring. The meeting was met with very good discussion regarding the exceptional health of these lakes, and what could be done to preserve them. In August of 2014, a draft of the chain-wide and Phase I lakes (Rest, Island, Spider lakes and Rice Creek) management plan was approved by the NLDC and MWLA and sent to WDNR staff for review. During this time, data from the Phase II lakes (Clear Lake and Fawn Lake) was being compiled and analyzed from its collection in 2013. Additionally, field work was being conducted on the Phase III lakes (Wild Rice Lake, Alder Lake and the Trout River channels) during the summer of 2014. Data from the Phase II and III lakes will be compiled and included in later drafts of the management plan.

Overall, it was found that the Phase I lakes are of exceptional health. The water quality variables studied thus far indicate these lakes have moderate (healthy) nutrient content and average to good water clarity when compared to similar lakes across the state and within the northern region of Wisconsin. Similarly, the native aquatic plant variables studied in these lakes indicate the plant communities are of higher quality than similar lakes within the state and local region. Figure 1 displays the Floristic Quality of the Phase I and II lakes in the Manitowish Waters Chain of Lakes. The Floristic Quality Index is a measurement that examines species richness as well as composition (quality) and thus is a value that indicates the health of the lake's aquatic plant community as a whole. Altogether, a total of 87 aquatic plant species have been found in the Manitowish Waters Chain of Lakes – so far.

Additional studies on the Manitowish Waters Chain include an assessment of the shoreland habitat and development, watershed delineations and modeling, integration of fisheries data from WDNR and GLIFWC (Great Lakes Indian Fish and Wildlife Commission), and AIS monitoring and control.

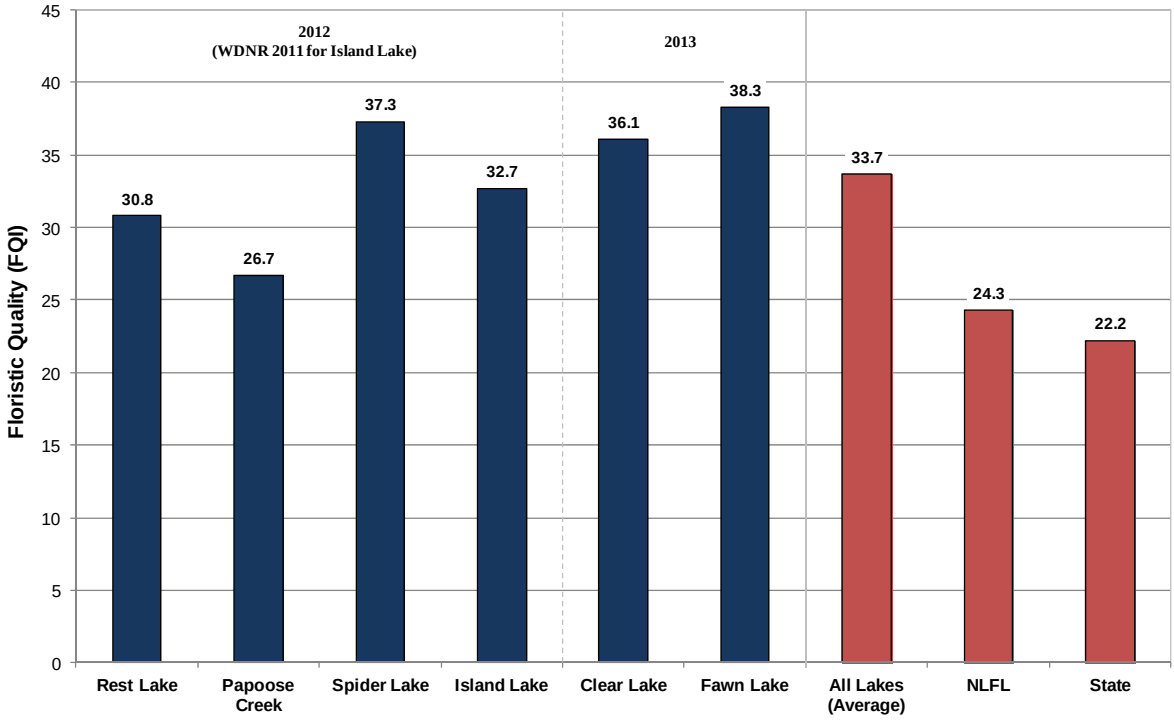

Figure 1. Manitowish Waters Chain of Lakes Floristic Quality Assessment. *Data from native aquatic plant species encountered on the rake during summer point-intercept surveys from 2012-2014. Analysis follows Nichols (1999). Note that NLFL means "Northern Lakes and Flowages"*

Aquatic Invasive Species Monitoring, Control and Education

During aquatic plant studies on the Manitowish Waters Chain of Lakes, several non-native species of plants have been observed. They include pale yellow iris (*Iris pseudacorus*), purple loosestrife (*Lythrum salicaria*), common forget-me-not (*Myosotis scorpioides*), reed canary grass (*Phalaris arundinacea*), giant reed (*Phragmites australis*) and curly-leaf pondweed (*Potamogeton crispus*). Five of the species are emergent wetland plants that may be found along the shoreline of a lake. The last plant mentioned, curly-leaf pondweed, is a submergent species that has been monitored heavily through the course of this project.

First discovered in Island Lake and Rice Creek in 2010, curly-leaf pondweed has since been found in Spider, Stone, Manitowish Lakes and the Manitowish River. Annual monitoring is conducted by the NLDC through their Lake Captain and Deckhands AIS program, as well as professional surveys by Onterra ecologists. Curly-leaf pondweed control actions have included aquatic herbicide applications in 2012, 2013 and 2014 to select areas in Island Lake and the Manitowish River. Additionally, both volunteer and professional hand-removal of curly-leaf pondweed has taken place in several locations where pioneering populations were observed. Overall, these control actions have been deemed to be largely successful. Curly-leaf pondweed management consists of annual herbicide treatments conducted in May/June with the goal of killing the plants before they are able to produce their asexual reproductive structures called turions. After multiple (generally 3-5 years) of treatment, the turion bank in the sediment is exhausted and the curly-leaf pondweed population decreases. The same theory may be applied to hand-removal of curly-leaf pondweed;

that is, remove the plant biomass before it is able to produce turions. So, it is anticipated that annual control actions will continue annually for the next few years in order to reduce curly-leaf pondweed colonies within the Manitowish Waters Chain of Lakes.

While most of the curly-leaf pondweed in the Manitowish Waters Chain is being targeted for control, several areas near wild rice communities are not being targeted at this time. Wild rice is an emergent aquatic grass that is of great cultural significance to Ojibewe Tribal Communities. In addition to it being an edible food item for humans, many wildlife species utilize it for food or nursery habitat as well. The curly-leaf pondweed is not being targeted for control in these areas due to concerns over impacts to the wild rice colonies that are growing nearby. However, monitoring of both species' populations and spatial density has occurred since 2012 and will continue in 2015 with the hopes that a solution to this puzzle may soon be met.

During the time in that Onterra has been conducting the above-mentioned studies, the NLDC has led Manitowish Waters Chain stakeholders in volunteer based AIS monitoring as well as a variety of educational activities and trainings. AIS monitoring consists of in-field surveys designed to identify early occurrences of AIS such as curly-leaf pondweed, purple loosestrife, giant reed, as well as other species of concern. This program has worked seamlessly with Onterra's monitoring activities, with each group sharing findings and results in a timely manner; and discussing the appropriate follow-up with agency partners such as the WDNR and Vilas County AIS Coordinator.

NLDC gives presentations to local chambers, libraries, lake associations, clubs and schools which range a wide variety of audiences and age groups. Additionally, educational outlets have included passive approaches such as newspaper articles, newsletters, radio, website and social media entries. These educational opportunities have reached out to countless people and provided the community with the most up-to-date information on AIS identification, monitoring, management, and the current situation facing the Manitowish Waters Chain of Lakes.

Manitowish Waters Chain of Lakes Grant Status and Upcoming Activities

The NLDC and partners have been successful in securing grants in a variety of categories, including Lake Management Planning, AIS Early Detection and AIS Education, Prevention and Planning. In February 2015, the NLDC intends to pursue grants in two new categories – Lake Management Protection and AIS Established Population Control. The grants would offer total project cost sharing of up to 75%, from the State of Wisconsin. The Lake Management Protection grant will capture two years worth of funding to continue the chain-wide management planning study for the Manitowish Waters Chain of Lakes (Phases IV and V) in addition to continuing AIS monitoring and education on the chain. The Established Population Control grant category is designed to fund AIS monitoring and control efforts.

With a successful grant application in these categories, the TAISP will be prepared to continue to effectively address AIS and other needs on the Manitowish Waters Chain for the next five years. It is also the hope of the TAISP that the continued education and close monitoring of AIS plant colonies will potentially reduce the money and time spent on controlling these non-native populations in the future. As these projects continue forward, Onterra staff will continue to meet with Manitowish Waters Chain stakeholders to keep them updated on the results of comprehensive studies as well as the AIS monitoring that is taking place on the Manitowish Waters Chain of Lakes.

Presentation Outline

- Phase II & III Lakes Study Results
  - Watershed (*Work conducted during Phase I*)
  - Shoreland Assessment
  - Coarse Woody Habitat
  - Water Quality
  - Aquatic Plants
  - Fisheries
- Chain-wide AIS Discussion
- Wild-rice Discussion
- Grant Discussion

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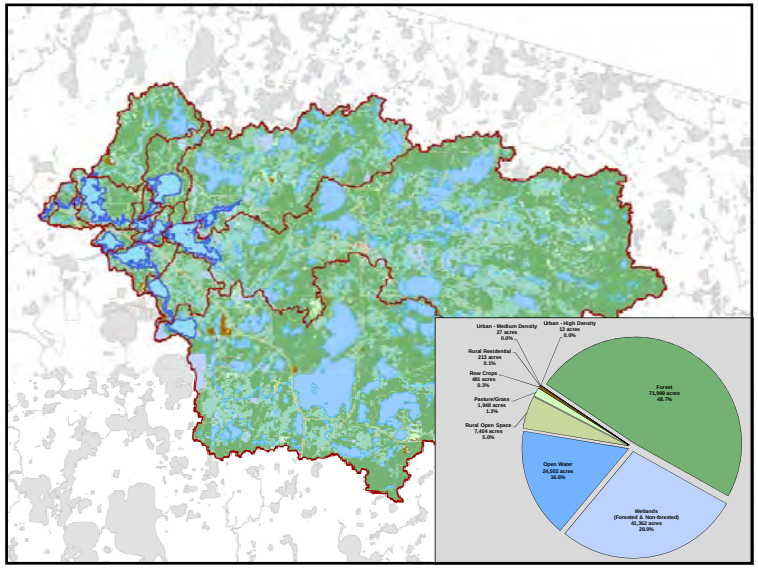

Shoreland Assessment

- 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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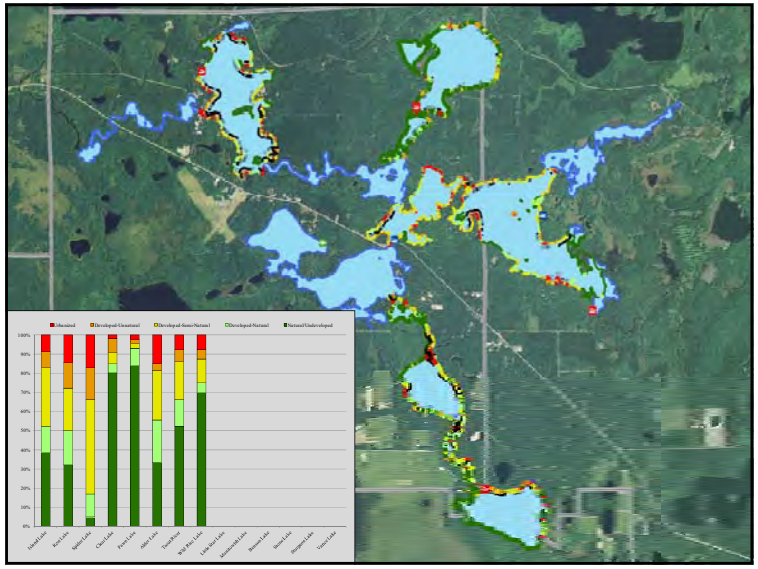

Coarse Woody Habitat

- 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 Manitowish Chain

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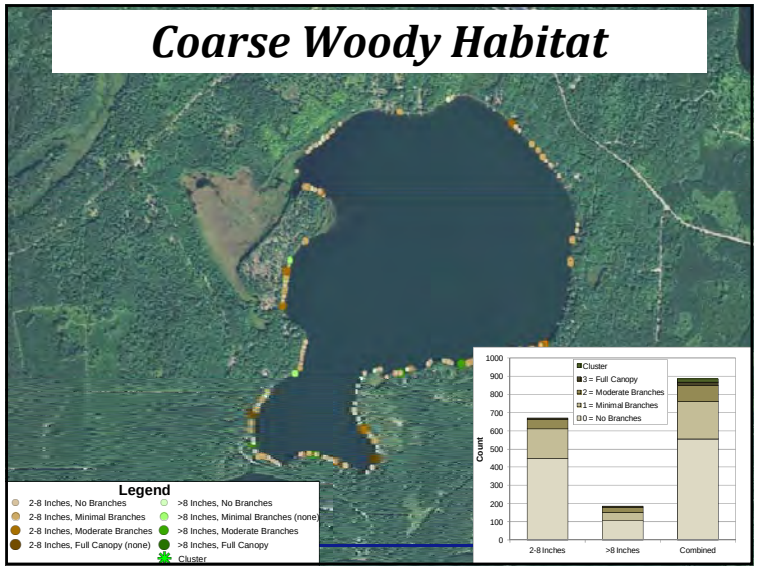

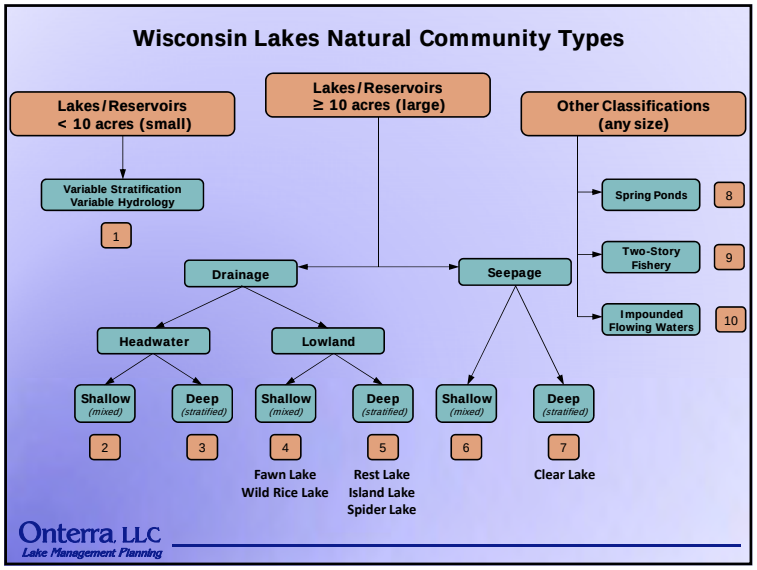

Water Quality

- Phosphorus (Limiting Plant Nutrient)
- Chlorophyll-*a* (Algal Abundance)
- Water Clarity (Secchi Disk)

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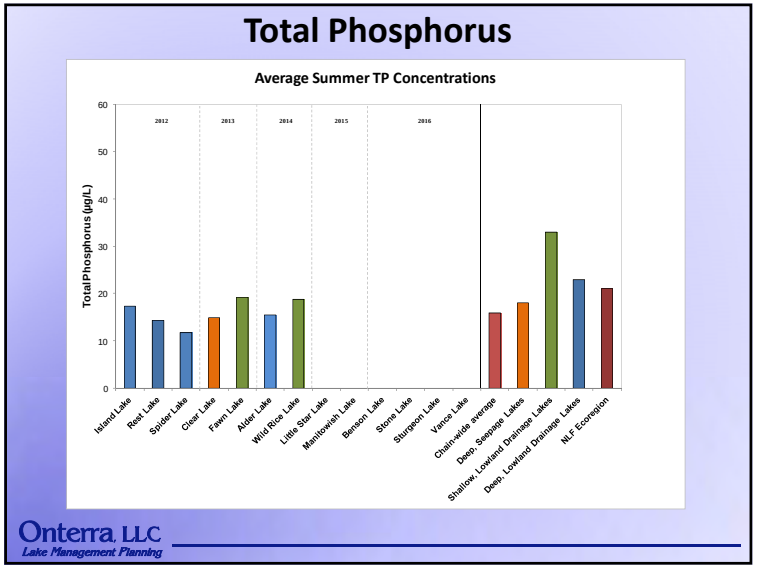
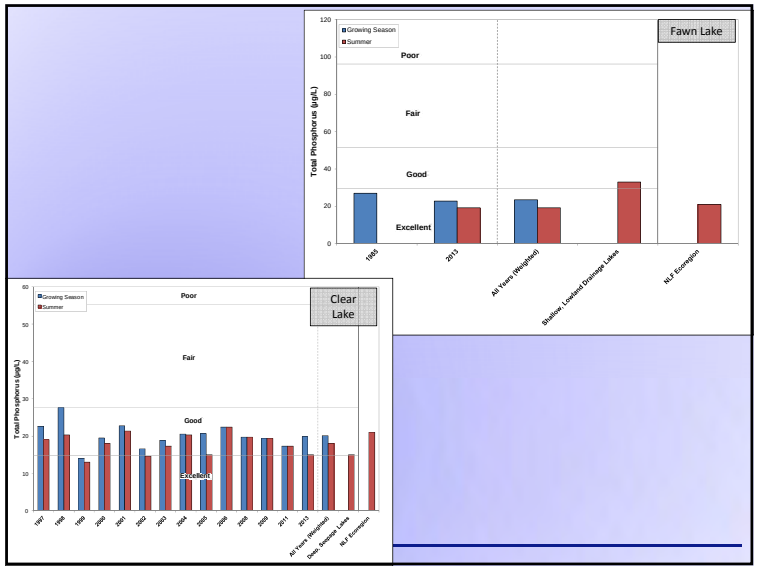
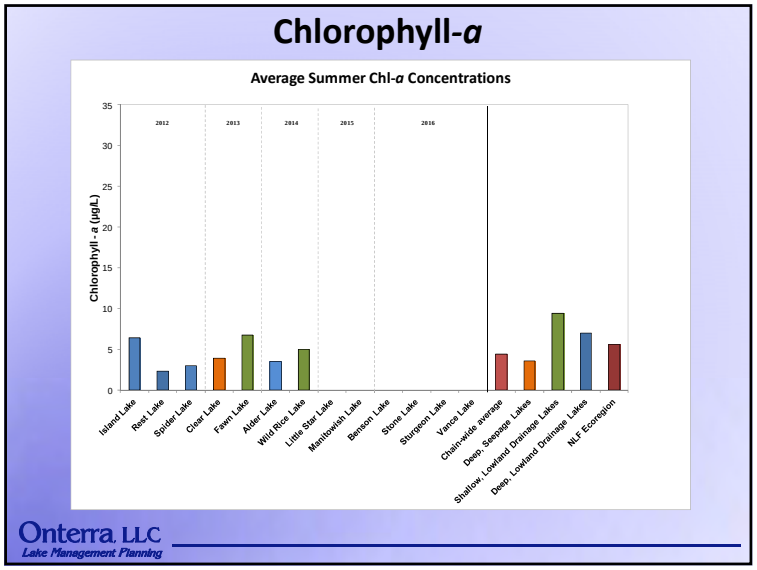



Fawn Lake
Growing Season
Summer
Poor
Fair
Good
Excellent
Total Phosphorus (µg/L)
1985
2013
All Years (Weighted)
Shallow, Lowland Drainage Lakes
NLF Ecoregion
Clear Lake


Chlorophyll-a
Average Summer Chl-a Concentrations
Chlorophyll - a (µg/L)
2012
2013
2014
2015
2016
Island Lake
Rest Lake
Spider Lake
Clear Lake
Fawn Lake
Alder Lake
Wild Rice Lake
Little Star Lake
Manitowish Lake
Benson Lake
Stone Lake
Sturgeon Lake
Vance Lake
Chain-wide average
Deep, Seepage Lakes
Shallow, Lowland Drainage Lakes
Deep, Lowland Drainage Lakes
NLF Ecoregion
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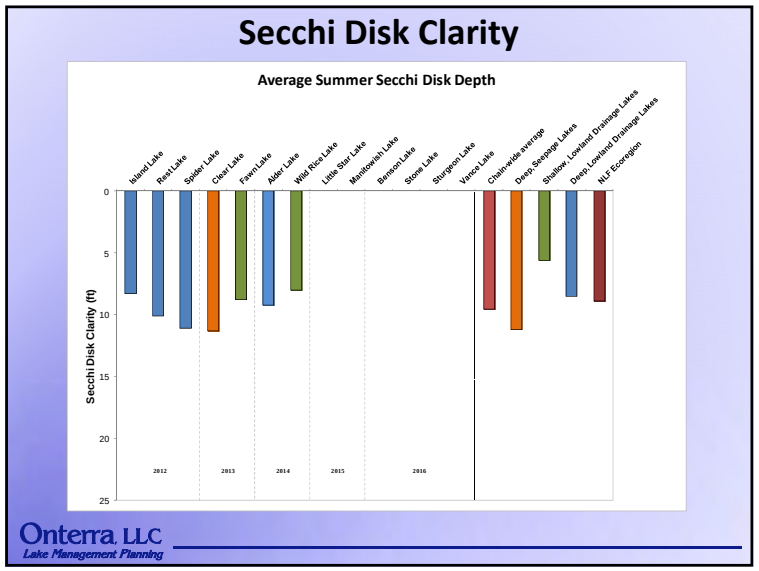
Secchi Disk Clarity
Average Summer Secchi Disk Depth
Secchi Disk Clarity (ft)
Island Lake
Rest Lake
Spider Lake
Clear Lake
Fawn Lake
Alder Lake
Wild Rice Lake
Little Star Lake
Manitowish Lake
Benson Lake
Stone Lake
Sturgeon Lake
Vance Lake
Chain-wide average
Deep Seepage Lakes
Shallow, Lowland Drainage Lakes
Deep Lowland Drainage Lakes
NLF Ecoregion
2012
2013
2014
2015
2016
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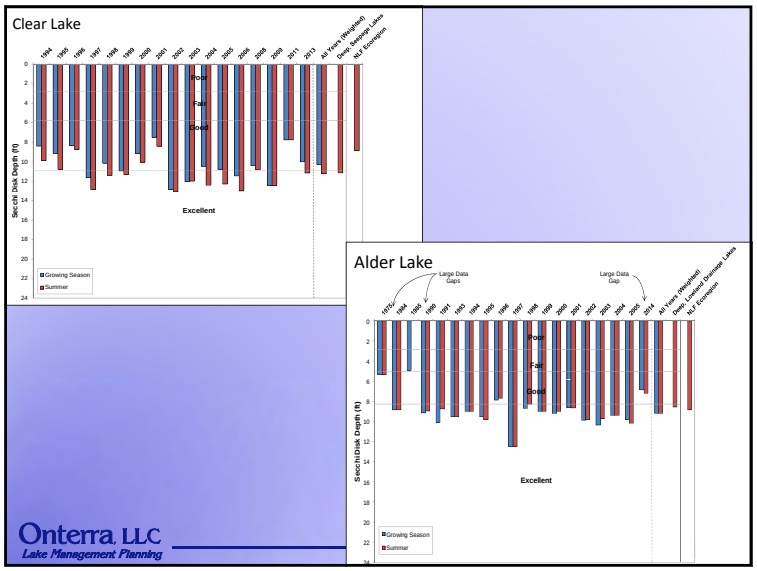
Clear Lake
Secchi Disk Depth (ft)
Poor
Fair
Good
Excellent
Growing Season
Summer
Alder Lake
Large Data Gaps
Large Data Gap
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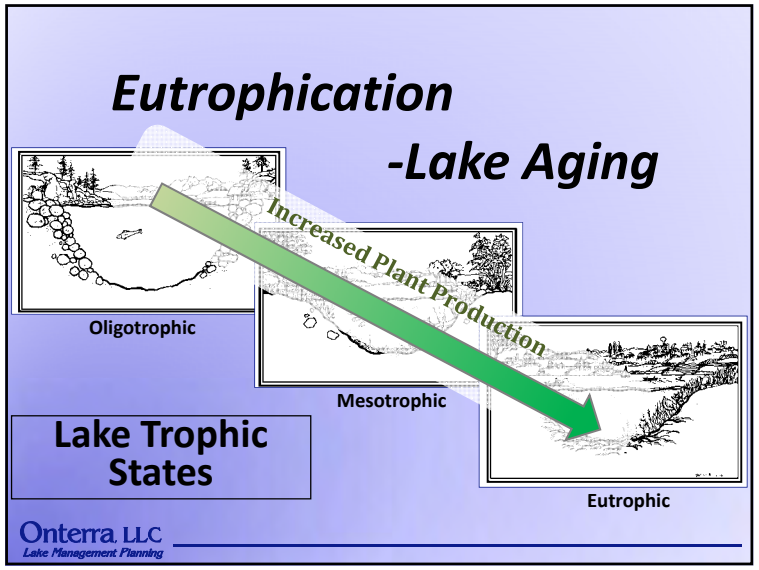
Eutrophication
-Lake Aging
Increased Plant Production
Oligotrophic
Mesotrophic
Eutrophic
Lake Trophic States
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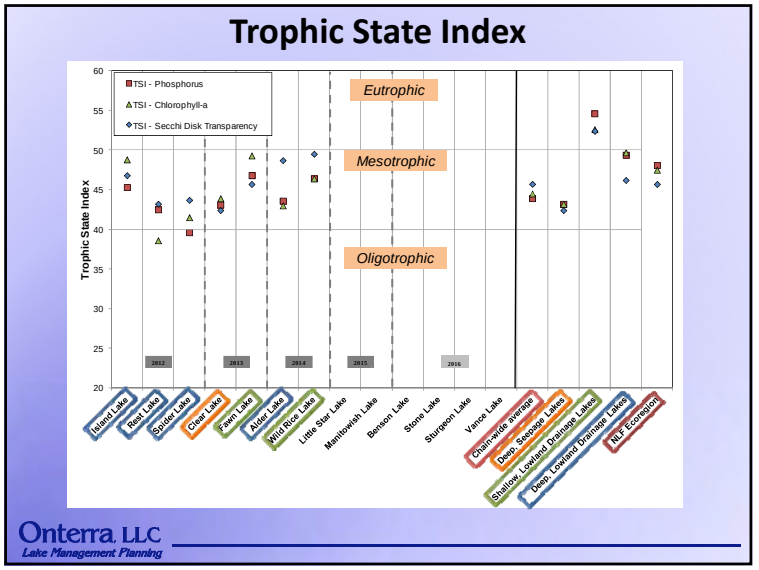
Trophic State Index
TSI - Phosphorus
TSI - Chlorophyll-a
TSI - Secchi Disk Transparency
Eutrophic
Mesotrophic
Oligotrophic
Trophic State Index
Island Lake
Rest Lake
Spider Lake
Clear Lake
Fawn Lake
Alder Lake
Wild Rice Lake
Little Star Lake
Manitowish Lake
Benson Lake
Stone Lake
Sturgeon Lake
Vance Lake
Chain-wide average
Deep, Seepage Lakes
Shallow, Lowland Drainage Lakes
Deep, Lowland Drainage Lakes
NLF Ecoregion
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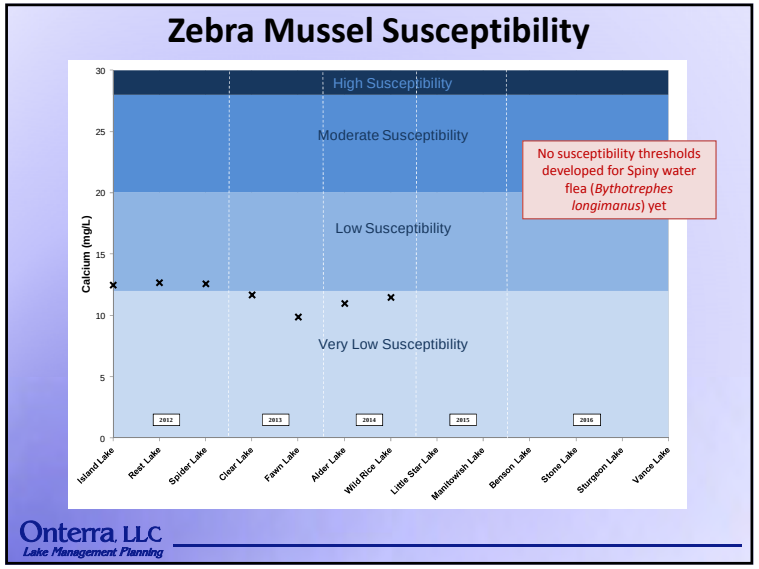
Zebra Mussel Susceptibility
High Susceptibility
Moderate Susceptibility
Low Susceptibility
Very Low Susceptibility
No susceptibility thresholds developed for Spiny water flea (Bythotrephes longimanus) yet
Calcium (mg/L)
Island Lake
Rest Lake
Spider Lake
Clear Lake
Fawn Lake
Alder Lake
Wild Rice Lake
Little Star Lake
Manitowish Lake
Benson Lake
Stone Lake
Sturgeon Lake
Vance Lake
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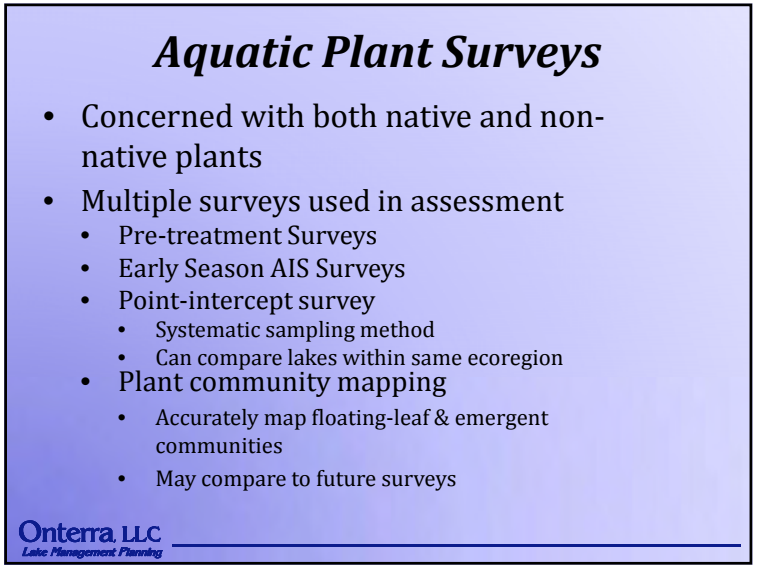
Lake Management Planning


Aquatic Plant Surveys
Concerned with both native and non-native plants
Multiple surveys used in assessment
Pre-treatment Surveys
Early Season AIS Surveys
Point-intercept survey
Systematic sampling method
Can compare lakes within same ecoregion
Plant community mapping
Accurately map floating-leaf & emergent communities
May compare to future surveys
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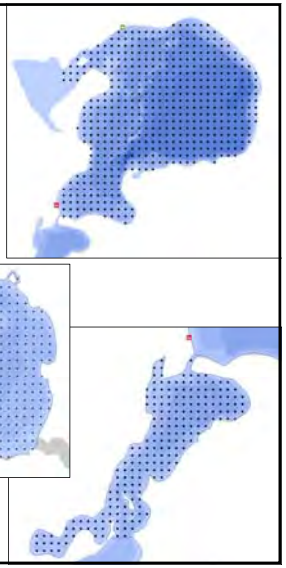
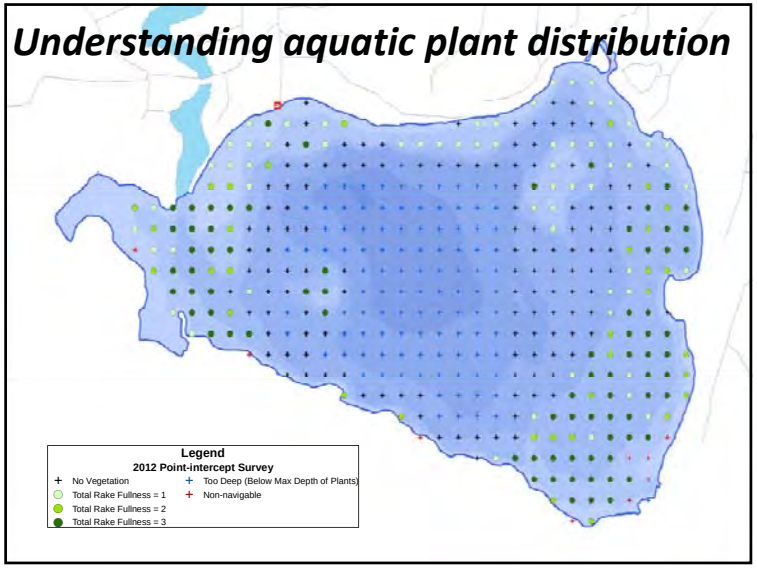
Point-intercept Surveys

Clear / Fawn Lakes: Onterra (2013)

Alder / Wild Rice Lakes: Onterra (2014)



Understanding aquatic plant distribution



Plant Data Overview

- 98 Native plants
  - 41 Submergent
  - 37 Emergent
  - 6 Floating-leaf
  - 7 Floating-leaf/Emergent
  - 5 Submergent/Emergent
  - 2 Free-floating
- 6 Non-native plant species
  - Curly-leaf pondweed
  - Giant reed
  - Purple loosestrife
  - Pale yellow iris
  - Common forget-me-not
  - Reed canary grass

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Aquatic Plants

Wisconsin Ecoregions

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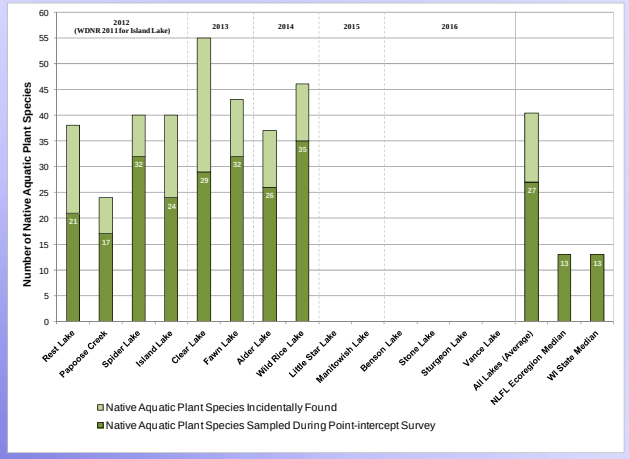
Species Richness



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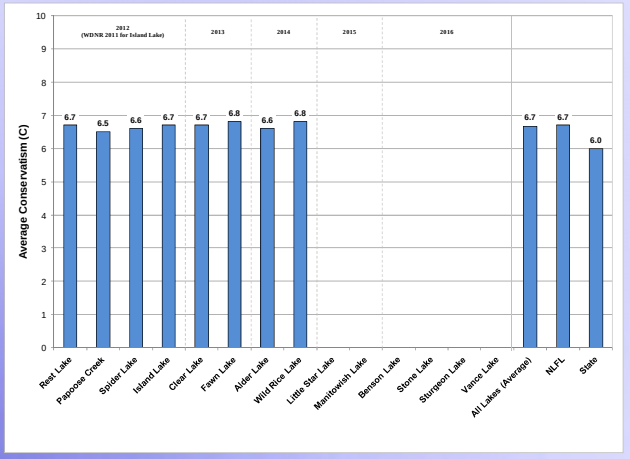
Average Conservatism



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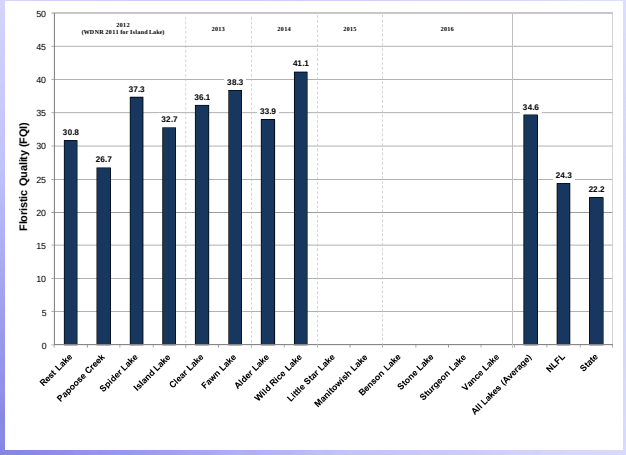
Floristic Quality



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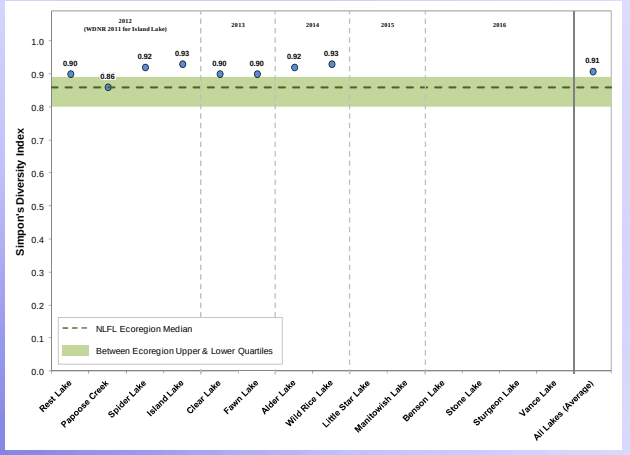
Simpson's Diversity



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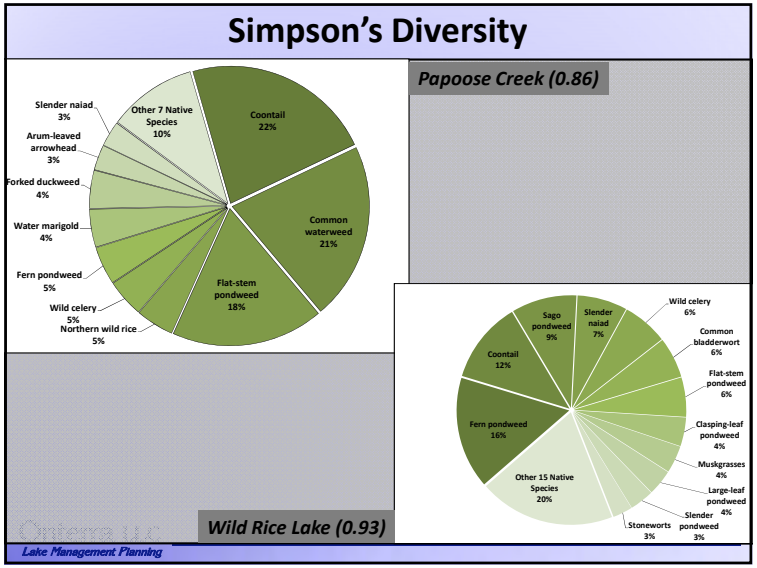
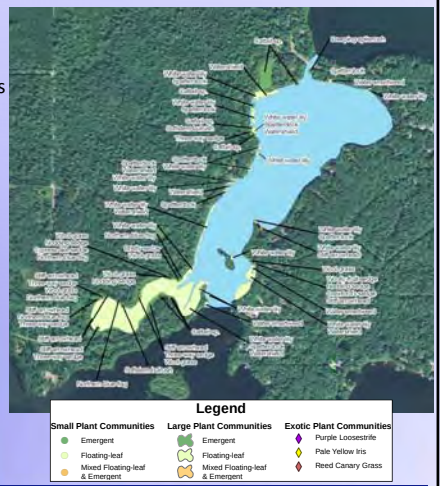
Simpson's Diversity



Community Mapping

Understand locations and types of emergent, floating-leaf species
- Spawning habitat
- Food source
- Shoreline stabilization

Useful in wild rice mapping, producing harvesting plans, etc.



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AIS Mapping Methodology

Point Mapping

- Single plants to colonies or areas <40 feet diameter
  - Single/few plants – Clump – Small Plant Colony

Polygon Mapping

- Larger, continuous colonies of plants >40-feet diameter
  - Highly Scattered – Scattered
  - Dominant – Highly Dominant – Surface Matted

Single or Few Plants
Clumps of Plants
Small Plant Colony

Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting

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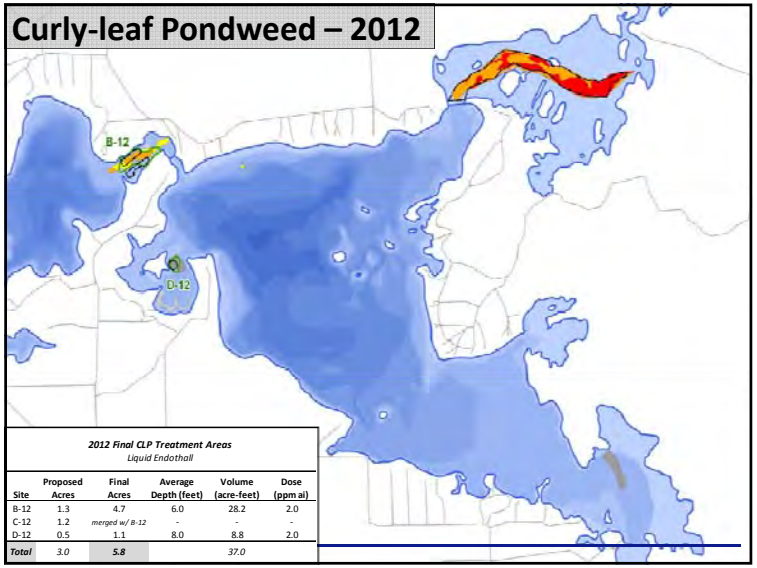
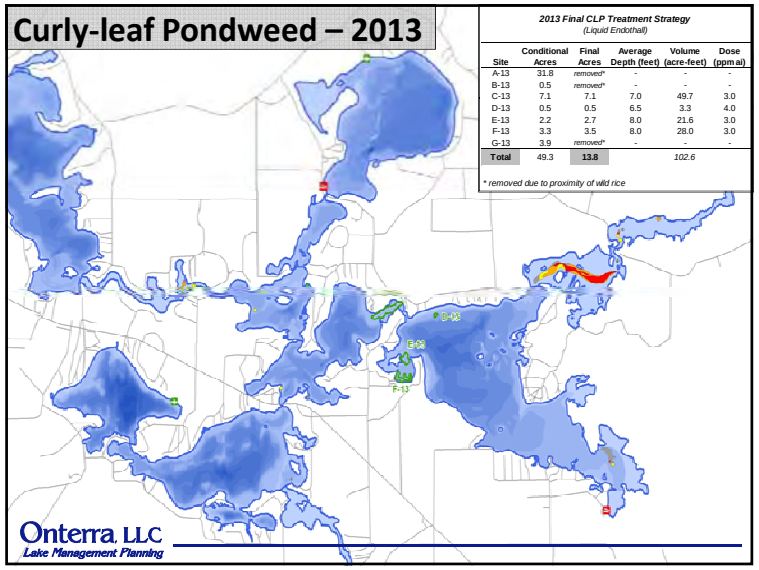
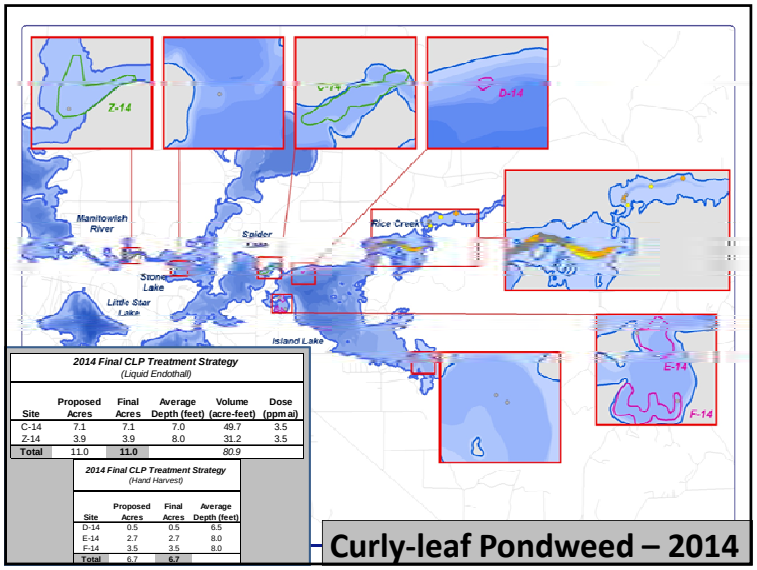
Curly-leaf Pondweed – 2012

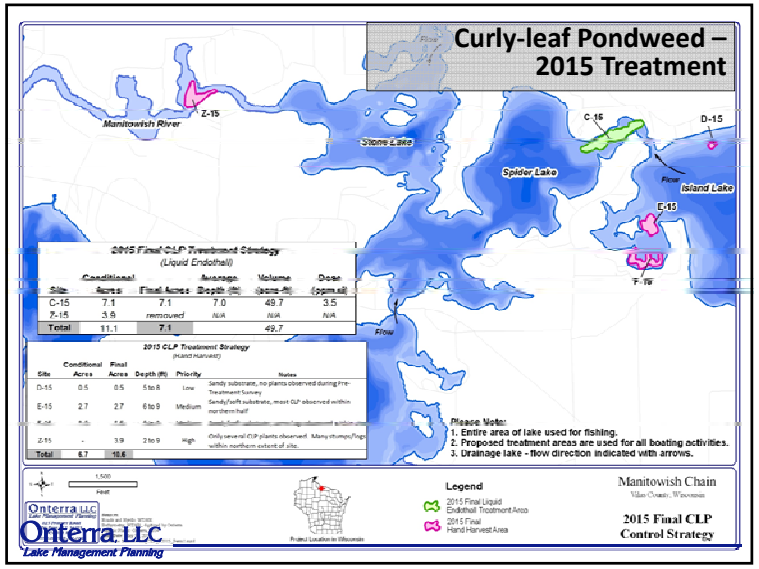


2012 Final CLP Treatment Areas
Liquid Endothall

Site	Proposed Acres	Final Acres	Average Depth (feet)	Volume (acre-feet)	Dose (ppm ai)
B-12	1.3	4.7	6.0	28.2	2.0
C-12	1.2	*merged w/ B-12*	-	-	-
D-12	0.5	1.1	8.0	8.8	2.0
Total	*3.0*	***5.8***		*37.0*	







CLP Treatment Effectiveness

Hand Harvesting

- Aquatic Plant Management, LLC

Site	# Divers	Diver Time (Minutes)	Diver Time (Hours)	Estimated EWM Removed (Gallons)
C-14	3	90	1.5	N/A
E-14	3	630	10.5	6
F-14	3	1275	21.25	15
West Stone Lake	3	480	8.0	2.5
Totals	-	2475.0	41.25	23.5

- Difficult to examine for efficiency
  - Scattered plants/colonies, different densities
- Greater communication and data transfer agreements for 2015

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CLP Treatment Effectiveness

Herbicide Treatments

- Quantitative assessment utilized
  - Sub Point Intercept Survey
  - Completed pre- and post-treatment, 2013 & 2014
  - Native plants examined between post treatment datasets
  - Non-native (CLP) examined between pre/post each year

Onterra LLC
Lake Management Planning

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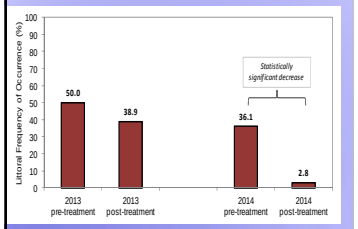

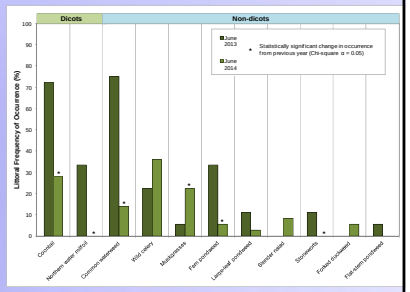

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Lake Management Planning

Giant Reed (*Phragmites australis*)

- Large, perennial grass species
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Photo courtesy of Anne Kretschmann, NLDC

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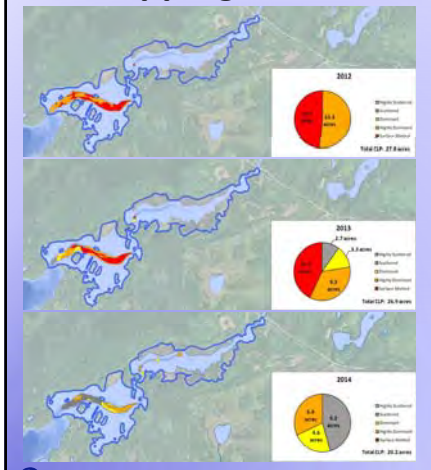
CLP Mapping



2012
27.8 Total Acres
Highly dense colonies

2013
26.9 Total Acres
Slight density decrease from 2012

2014
20.2 Total Acres
Large density decrease from 2012, 2013

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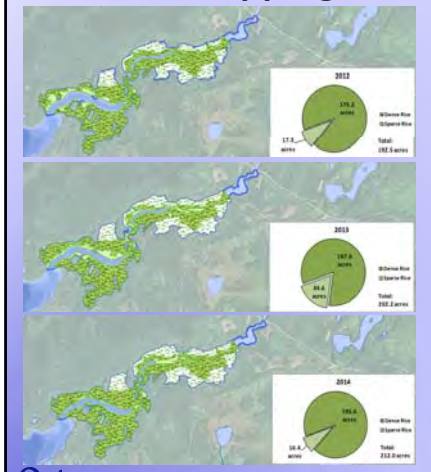
Wild Rice Mapping



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192.5 Total Acres
9.1 acre overlap with colonized CLP

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3.3 acre overlap with colonized CLP

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Lake Management Planning

CLP & Wild Rice Mapping

CLP mapping (known CLP lakes)

- Will continue in 2015
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Onterra LLC
Lake Management Planning

Grant Discussion

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AIS Established Population Control

- AIS Monitoring (surveys) & Control (herbicide, hand harvest)
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Lake Management Planning

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Next grant cycle…

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Lake Management Planning

Conclusions

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  - Based upon standard analysis, native community is of high quality
  - Interesting and special concern species present
  - AIS continuously monitored
    - CLP, phragmites pose threat to ecosystem

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Lake Management Planning

Next Steps…

1. **Review Phase I Implementation Plan**
   - New matters to discuss?
2. **Determine applicability to Phase II, Phase III lakes**
   - Review Management Goals for entire chain
   - Specify Imp Plan applicability to Phase II & III lakes
   - Specific lake issues to address?
3. **Develop and distribute stakeholder survey**
4. **Proceed with Phase III studies, examine options for continued grant funding**

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Thank You

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

Wisconsin Lakes Partnership

UW Extension

Wisconsin Dept. of Natural Resources

North Lakeland Discovery Center

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Management Goal 1

Strengthen Association Relationships, Effectiveness and Lake Management Capability

- Action: Enhance involvement with other entities that have a hand in managing Manitowish Waters Chain of Lakes
- Action: Increase the Manitowish Waters Chain's volunteer base

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Management Goal 2

Maintain Current Water Quality Conditions

- Action: Continue and expand monitoring of the Manitowish Waters Chain of Lakes' water quality through the WDNR Citizen Lake Monitoring Network
- Action: Educate property owners about the impacts of highly developed shoreland areas on the health of the Manitowish Waters Chain of Lakes and encourage shoreland restoration of these areas
- Action: Protect natural shoreland zones along the Manitowish Waters Chain of Lakes
- Action: Investigate algal blooms on the Manitowish Chain of Lakes

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Management Goal 3

Expand Awareness and Education of Lake Management and Stewardship Matters

- Action: Engage stakeholders on priority education items through efficient communication and outreach

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Management Goal 4

Control Existing and Prevent Further Aquatic Invasive Species Establishment within the Manitowish Waters Chain of Lakes

- Action: Continue control strategy for curly-leaf pondweed on the Manitowish Waters Chain of Lakes
- Action: Work with management partners to monitor curly-leaf pondweed and wild rice interactions within the Manitowish Waters Chain while assessing future management options
- Action: Reduce transport of curly-leaf pondweed from dense colony areas via watercraft

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Management Goal 4, continued

Control Existing and Prevent Further Aquatic Invasive Species Establishment within the Manitowish Waters Chain of Lakes

- Action: Continue control and monitoring efforts on other aquatic invasive species that pose a threat to the Manitowish Waters Chain of Lakes
- Action: Continue locally-based efforts including aquatic invasive species monitoring through the Lake Captain and Deckhand Program and watercraft inspections
- Action: Investigate feasibility of alternative aquatic invasive species control methodologies for applicability to the Manitowish Waters Chain of Lakes

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Management Goal 5

Enhance the Available Habitat and General Understanding of the Manitowish Waters Chain of Lakes Fishery

- Action: Work with WDNR fisheries managers and other stakeholders to enhance and understand the fishery

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Management Goal 6

Continue to Understand, Protect and Enhance the Ecology of the Manitowish Chain of Lakes Through Stakeholder Stewardship and Science-based Studies

- Action: Continue the development of comprehensive management plans for the Manitowish Chain waterbodies

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AIS Mapping Methodology

Point Mapping

- Single plants to colonies or areas <40 feet diameter
  - Single/few plants – Clump – Small Plant Colony

Polygon Mapping

- Larger, continuous colonies of plants >40-feet diameter
  - Highly Scattered – Scattered
  - Dominant – Highly Dominant – Surface Matted

Single or Few Plants
Clumps of Plants
Small Plant Colony

Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting

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Lake Management Planning

CLP Treatment Effectiveness

Hand Harvesting

- Aquatic Plant Management, LLC

Site	# Divers	Diver Time (Minutes)	Diver Time (Hours)	Estimated EWM Removed (Gallons)
C-14	3	90	1.5	N/A
E-14	3	630	10.5	6
F-14	3	1275	21.25	15
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Lake Management Planning

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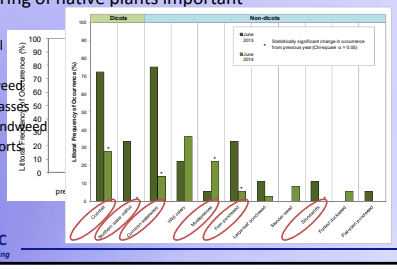
- ⇩ Coontail
- ⇩ N.W.M.
- ⇩ Waterweed
- ⇧ Muskgrasses
- ⇩ Fern pondweed
- ⇩ Stoneworts



Onterra, LLC
Lake Management Planning

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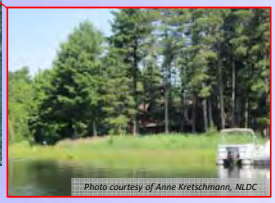

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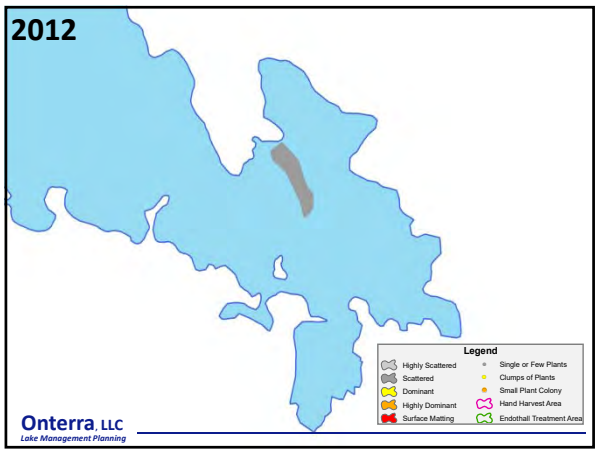
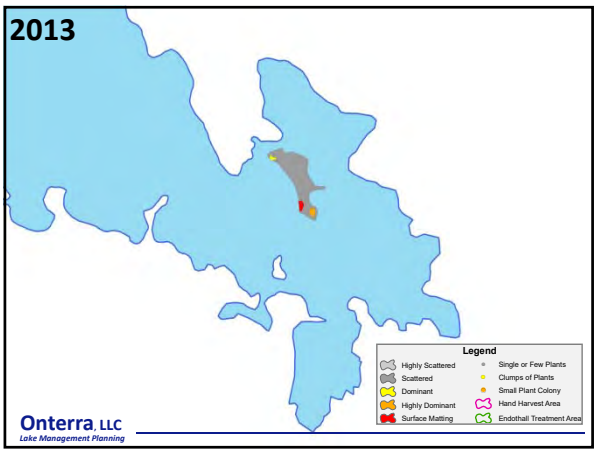

2012
Legend
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony
Hand Harvest Area
Endothall Treatment Area
Onterra, LLC
Lake Management Planning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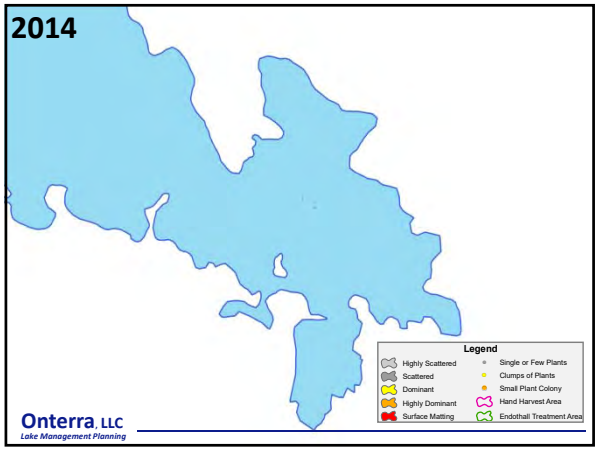
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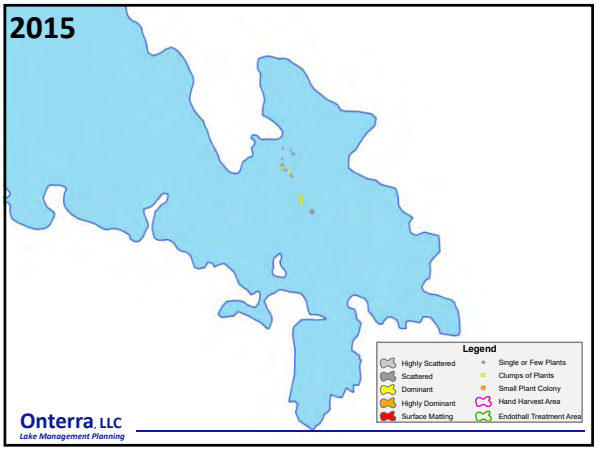
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Onterra, LLC
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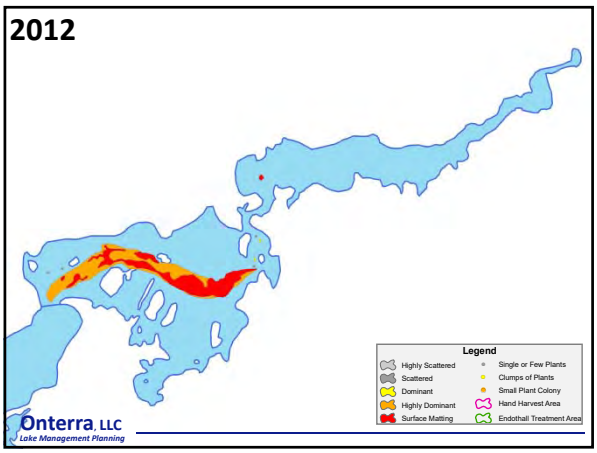
Rice Creek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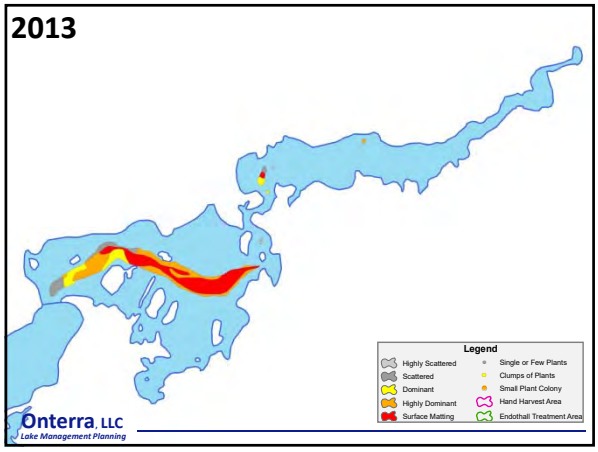
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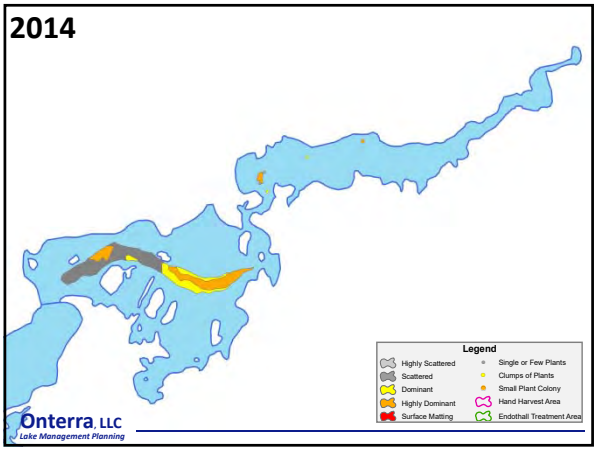
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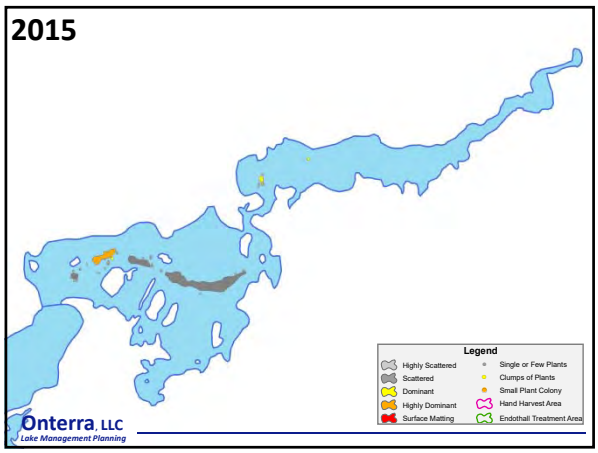
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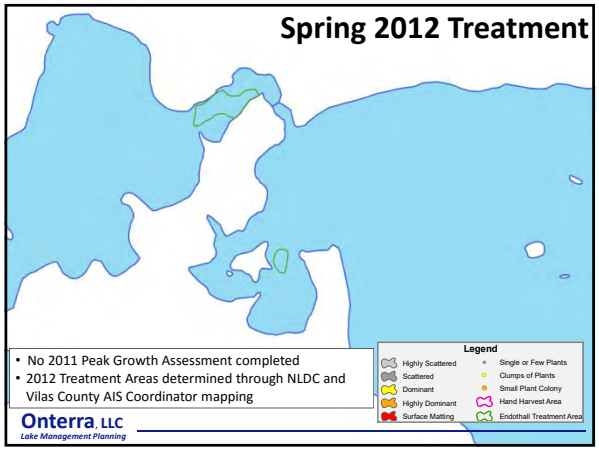
Onterra, LLC
Lake Management Planning


Spider/Island Channel &
West Island Lake


Spring 2012 Treatment
• No 2011 Peak Growth Assessment completed
• 2012 Treatment Areas determined through NLDC and Vilas County AIS Coordinator mapping
Legend
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony
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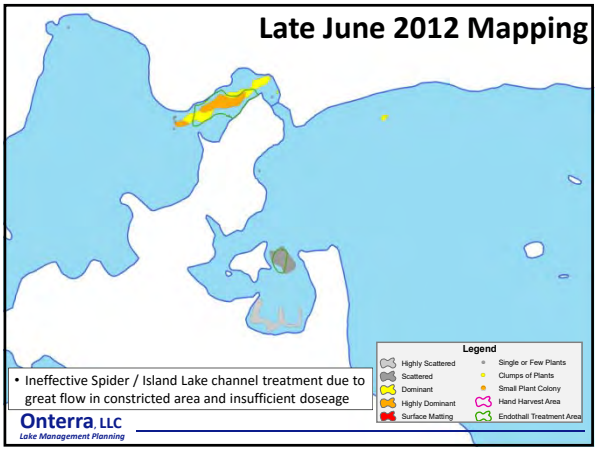
Late June 2012 Mapping
• Ineffective Spider / Island Lake channel treatment due to great flow in constricted area and insufficient doseage
Legend
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Dominant
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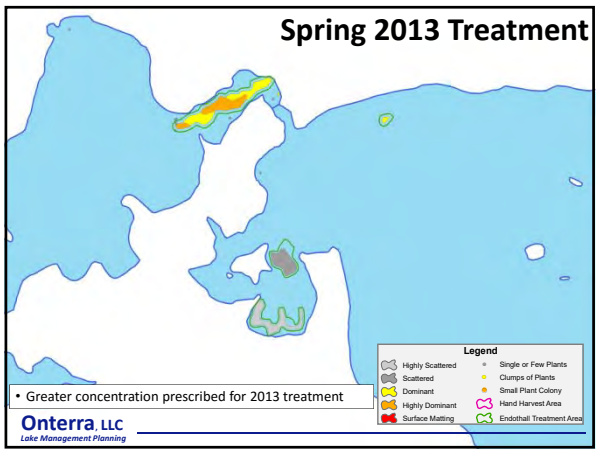
Spring 2013 Treatment
• Greater concentration prescribed for 2013 treatment
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Scattered
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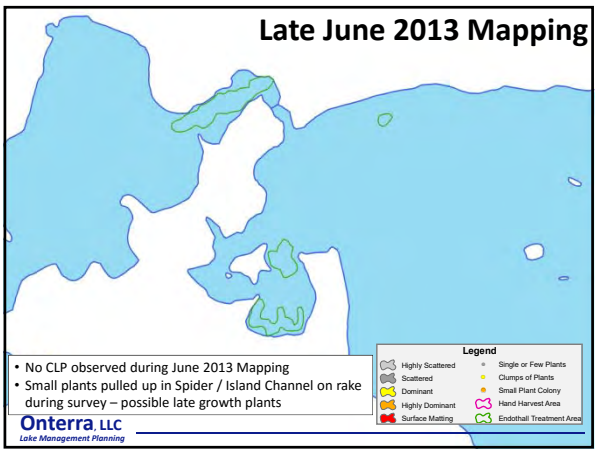
Late June 2013 Mapping
• No CLP observed during June 2013 Mapping
• Small plants pulled up in Spider / Island Channel on rake during survey – possible late growth plants
Legend
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony
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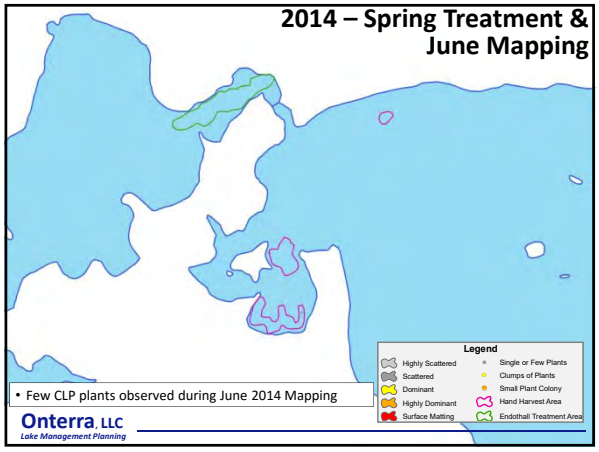
2014 – Spring Treatment & June Mapping
• Few CLP plants observed during June 2014 Mapping
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Scattered
Dominant
Highly Dominant
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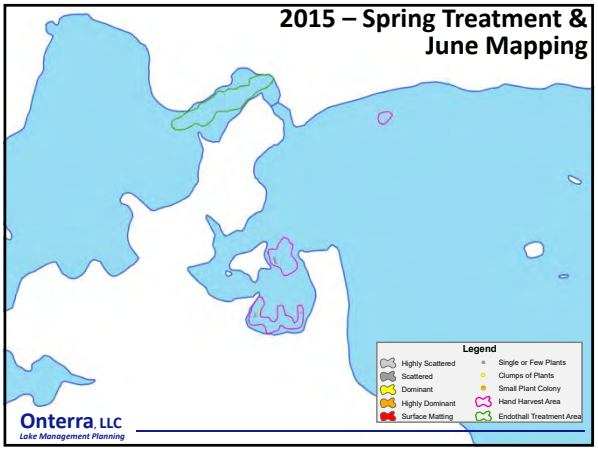
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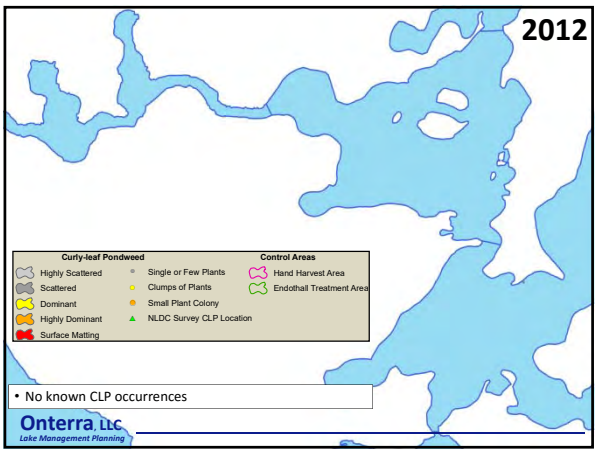
Lake Management Planning


Stone, West Spider Lake and Manitowish River


2012
Curly-leaf Pondweed
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Surface Matting
Single or Few Plants
Clumps of Plants
Small Plant Colony
NLDC Survey CLP Location
Control Areas
Hand Harvest Area
Endothall Treatment Area
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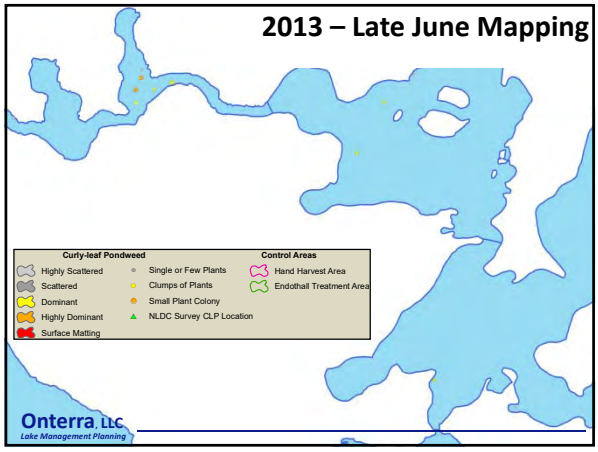
Onterra, LLC
Lake Management Planning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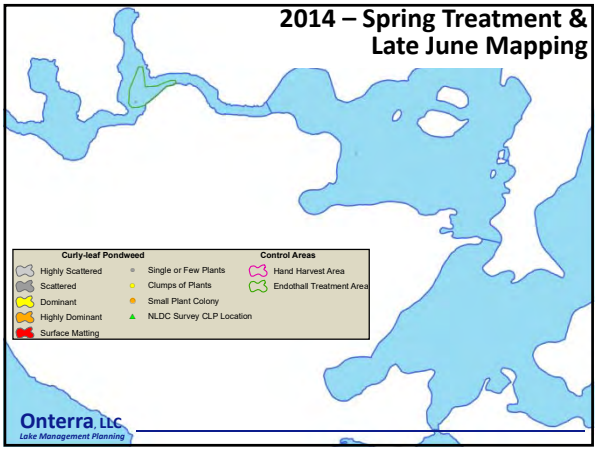
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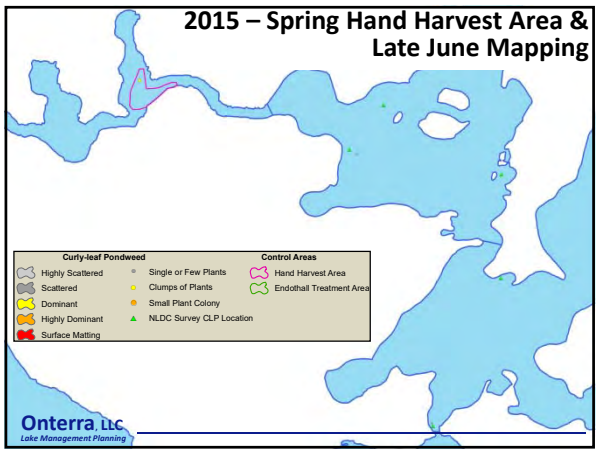
2015 – Spring Hand Harvest Area & Late June Mapping
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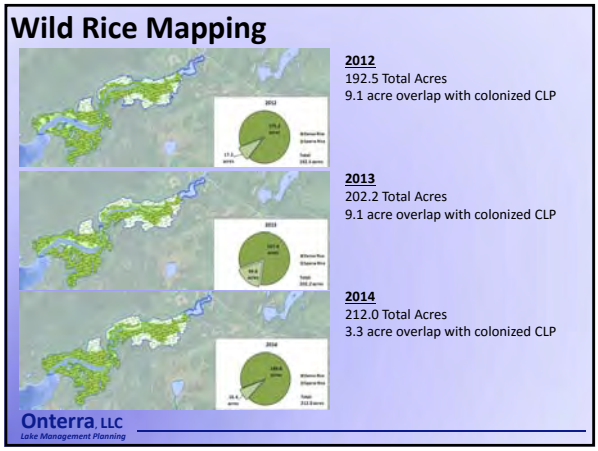
Rice Creek
Wild Rice Monitoring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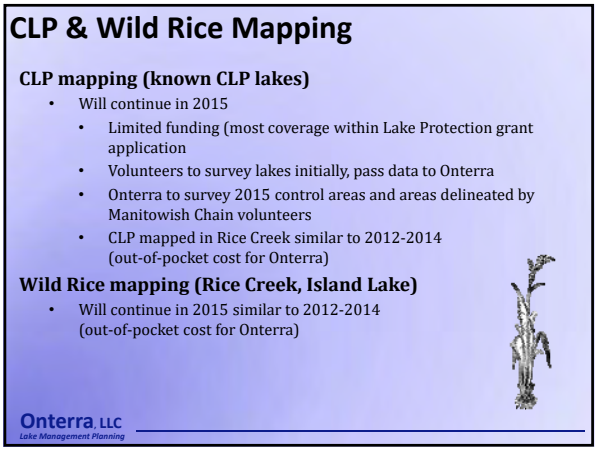
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Onterra, LLC Lake Management Planning

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   - Review Management Goals for entire chain
   - Specify Imp Plan applicability to Phase II & III lakes
   - Specific lake issues to address?
3. **Develop and distribute stakeholder survey**
4. **Proceed with Phase III studies, examine options for continued grant funding**

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Thank You

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

Wisconsin Lakes Partnership

UW Extension

Wisconsin Dept. of Natural Resources

North Lakeland Discovery Center

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Management Goal 1

Strengthen Association Relationships, Effectiveness and Lake Management Capability

- Action: Enhance involvement with other entities that have a hand in managing Manitowish Waters Chain of Lakes
- Action: Increase the Manitowish Waters Chain's volunteer base

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Management Goal 2

Maintain Current Water Quality Conditions

- Action: Continue and expand monitoring of the Manitowish Waters Chain of Lakes' water quality through the WDNR Citizen Lake Monitoring Network
- Action: Educate property owners about the impacts of highly developed shoreland areas on the health of the Manitowish Waters Chain of Lakes and encourage shoreland restoration of these areas
- Action: Protect natural shoreland zones along the Manitowish Waters Chain of Lakes
- Action: Investigate algal blooms on the Manitowish Chain of Lakes

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Management Goal 3

Expand Awareness and Education of Lake Management and Stewardship Matters

- Action: Engage stakeholders on priority education items through efficient communication and outreach

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Management Goal 4

Control Existing and Prevent Further Aquatic Invasive Species Establishment within the Manitowish Waters Chain of Lakes

- Action: Continue control strategy for curly-leaf pondweed on the Manitowish Waters Chain of Lakes
- Action: Work with management partners to monitor curly-leaf pondweed and wild rice interactions within the Manitowish Waters Chain while assessing future management options
- Action: Reduce transport of curly-leaf pondweed from dense colony areas via watercraft

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Management Goal 4, continued

Control Existing and Prevent Further Aquatic Invasive Species Establishment within the Manitowish Waters Chain of Lakes

- Action: Continue control and monitoring efforts on other aquatic invasive species that pose a threat to the Manitowish Waters Chain of Lakes
- Action: Continue locally-based efforts including aquatic invasive species monitoring through the Lake Captain and Deckhand Program and watercraft inspections
- Action: Investigate feasibility of alternative aquatic invasive species control methodologies for applicability to the Manitowish Waters Chain of Lakes

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Management Goal 5

Enhance the Available Habitat and General Understanding of the Manitowish Waters Chain of Lakes Fishery

- Action: Work with WDNR fisheries managers and other stakeholders to enhance and understand the fishery

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Management Goal 6

Continue to Understand, Protect and Enhance the Ecology of the Manitowish Chain of Lakes Through Stakeholder Stewardship and Science-based Studies

- Action: Continue the development of comprehensive management plans for the Manitowish Chain waterbodies

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Manitowish Waters
Lakes Association
Manitowish Waters Chain of Lakes
Management Planning – Phase IV
July 30, 2016
Tim Hoyman, CLM
Onterra LLC
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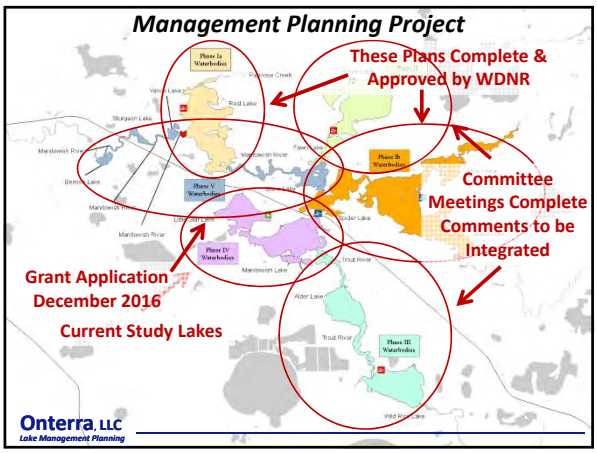
Management Planning Project
These Plans Complete &
Approved by WDNR
Committee
Meetings Complete
Comments to be
Integrated
Grant Application
December 2016
Current Study Lakes
Onterra LLC
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Curly-leaf Pondweed
Onterra LLC
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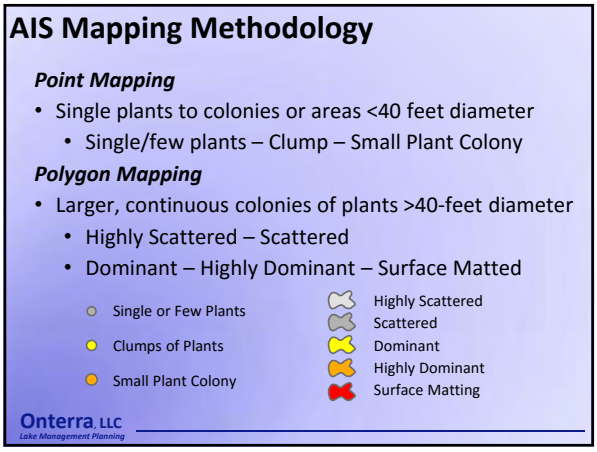
AIS Mapping Methodology
Point Mapping
• Single plants to colonies or areas <40 feet diameter
• Single/few plants – Clump – Small Plant Colony
Polygon Mapping
• Larger, continuous colonies of plants >40-feet diameter
• Highly Scattered – Scattered
• Dominant – Highly Dominant – Surface Matted
Single or Few Plants
Clumps of Plants
Small Plant Colony
Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting
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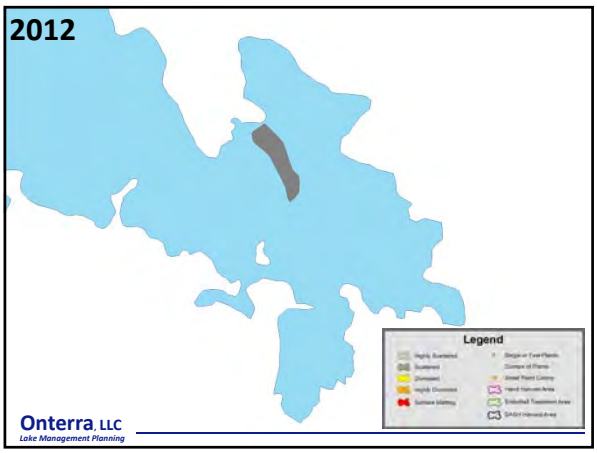
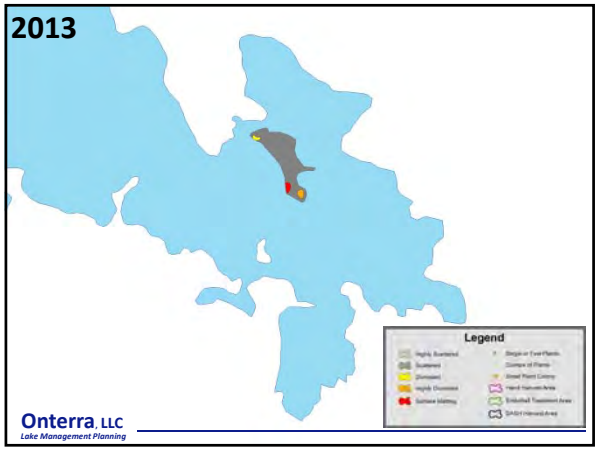
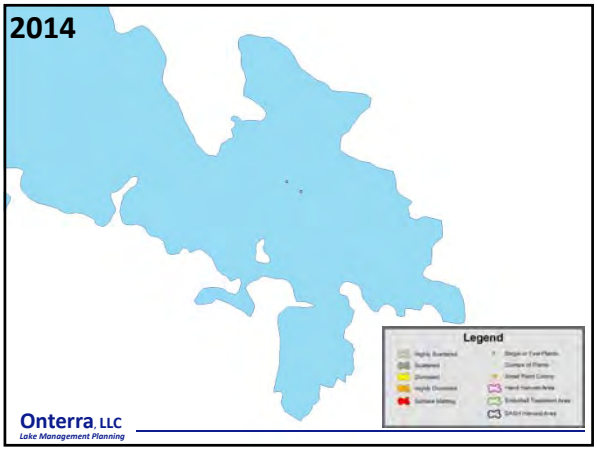
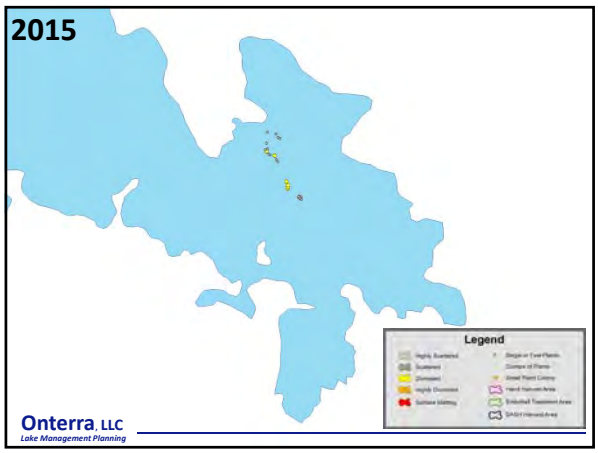
East Island Lake


2012
Legend
Onterra, LLC
Lake Management Planning


2013
Legend
Onterra, LLC
Lake Management Planning


2014
Legend
Onterra, LLC
Lake Management Planning


2015
Legend
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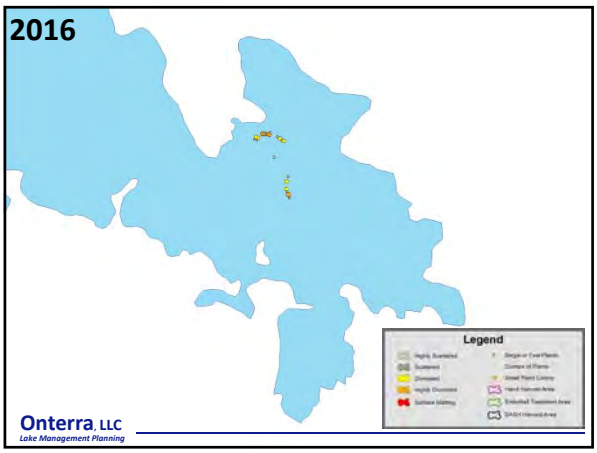
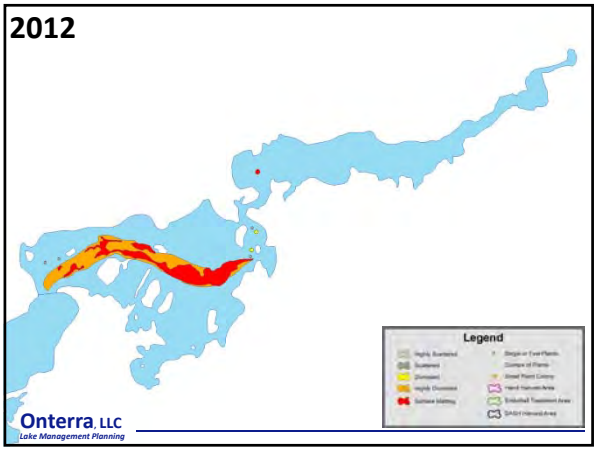
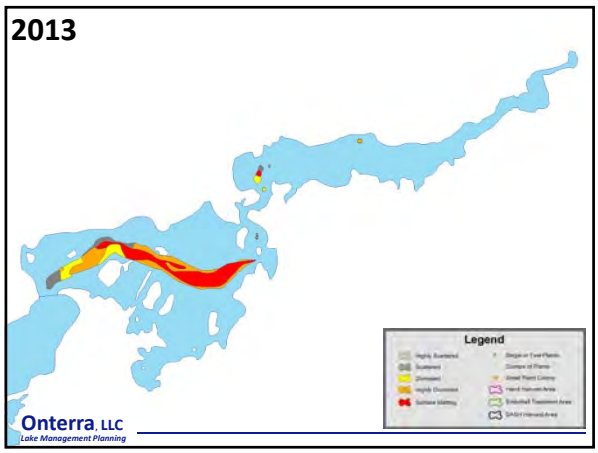
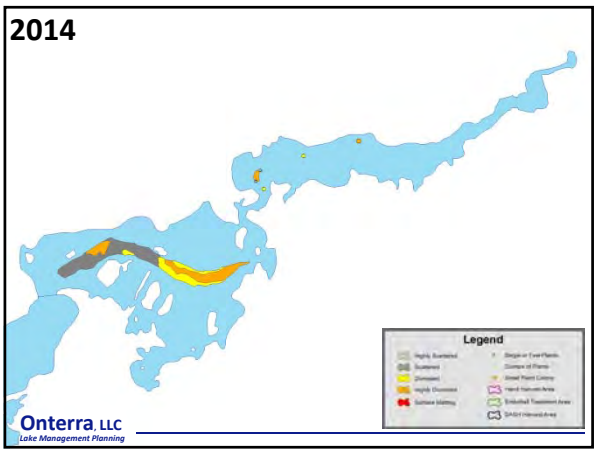
Lake Management Planning

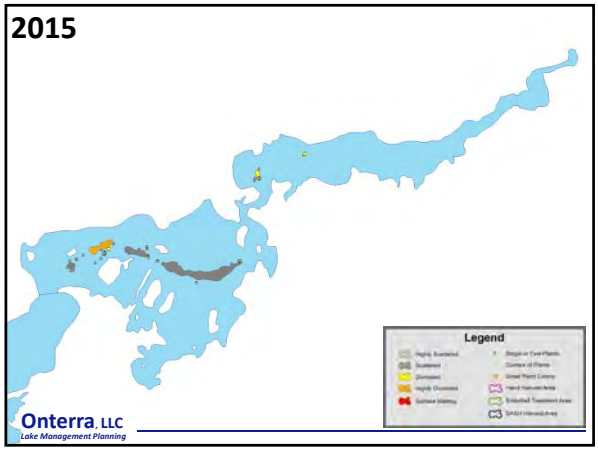

2016
Legend
Onterra, LLC
Lake Management Planning

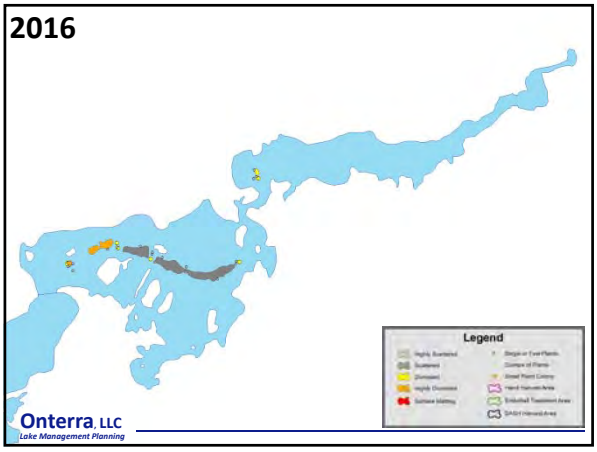

Rice Creek


2012
Legend
Onterra, LLC
Lake Management Planning

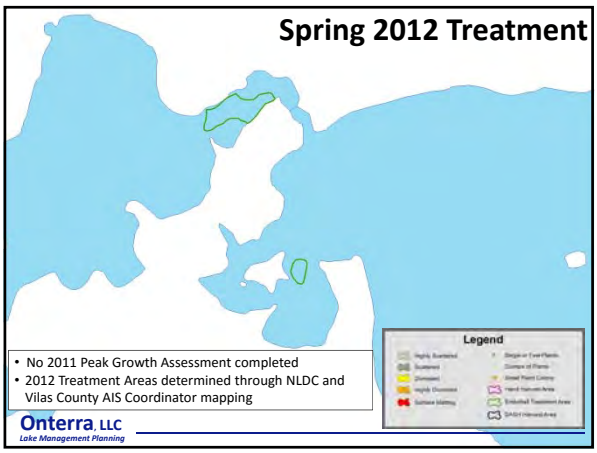

2013
Legend
Onterra, LLC
Lake Management Planning


2014
Legend
Onterra, LLC
Lake Management Planning


2015
Legend
Onterra, LLC
Lake Management Planning


2016
Legend
Onterra, LLC
Lake Management Planning


Spider/Island Channel &
West Island Lake


Spring 2012 Treatment
Legend
• No 2011 Peak Growth Assessment completed
• 2012 Treatment Areas determined through NLDC and Vilas County AIS Coordinator mapping
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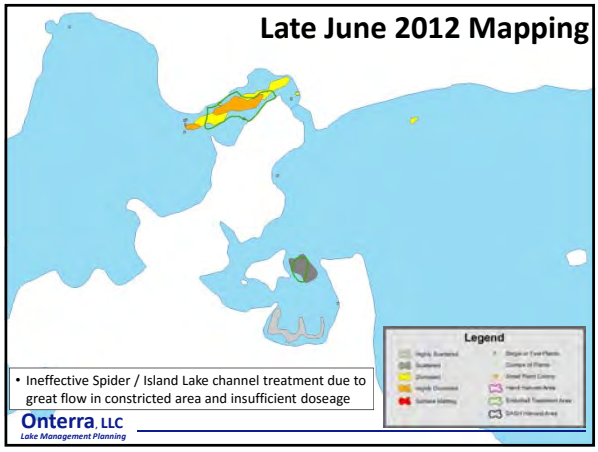
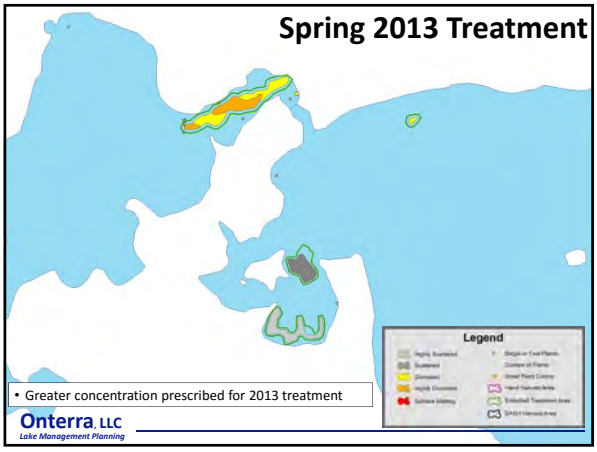
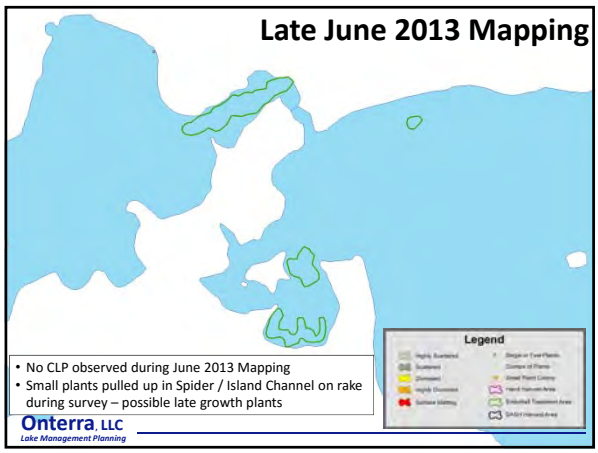
Lake Management Planning


Late June 2012 Mapping
Legend
• Ineffective Spider / Island Lake channel treatment due to great flow in constricted area and insufficient doseage
Onterra, LLC
Lake Management Planning


Spring 2013 Treatment
Legend
• Greater concentration prescribed for 2013 treatment
Onterra, LLC
Lake Management Planning


Late June 2013 Mapping
Legend
• No CLP observed during June 2013 Mapping
• Small plants pulled up in Spider / Island Channel on rake during survey – possible late growth plants
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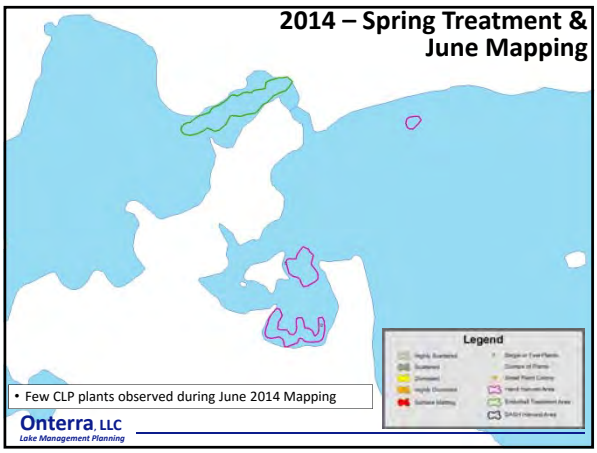
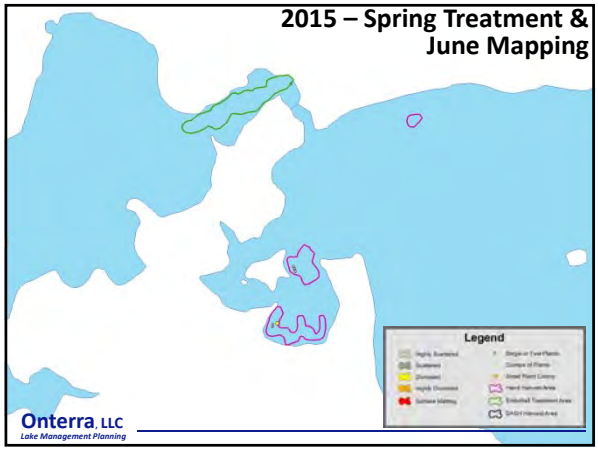
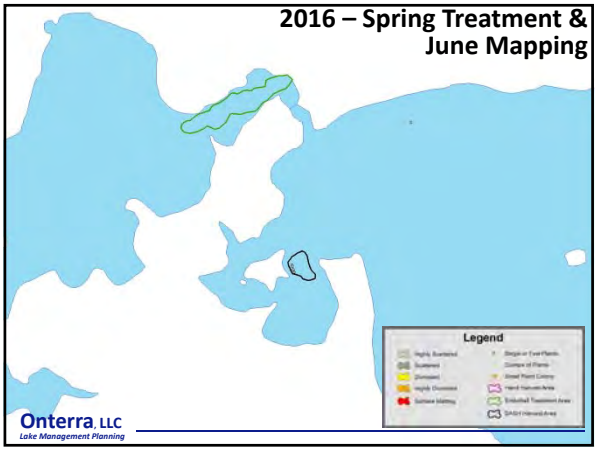

2014 – Spring Treatment & June Mapping
Legend
• Few CLP plants observed during June 2014 Mapping
Onterra, LLC
Lake Management Planning


2015 – Spring Treatment & June Mapping
Legend
Onterra, LLC
Lake Management Planning


2016 – Spring Treatment & June Mapping
Legend
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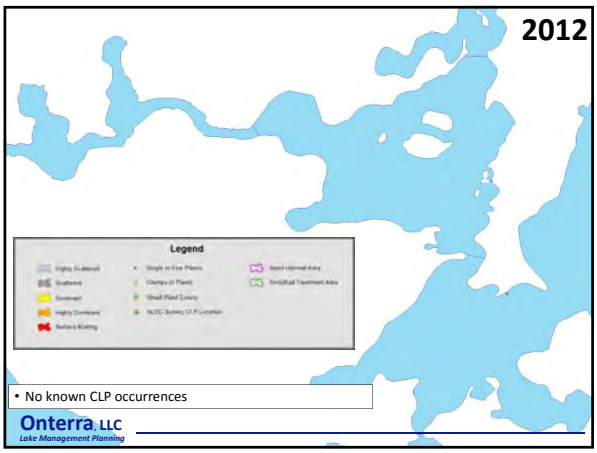
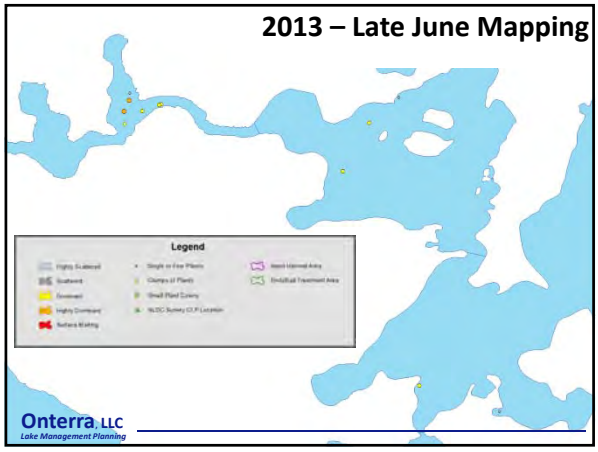
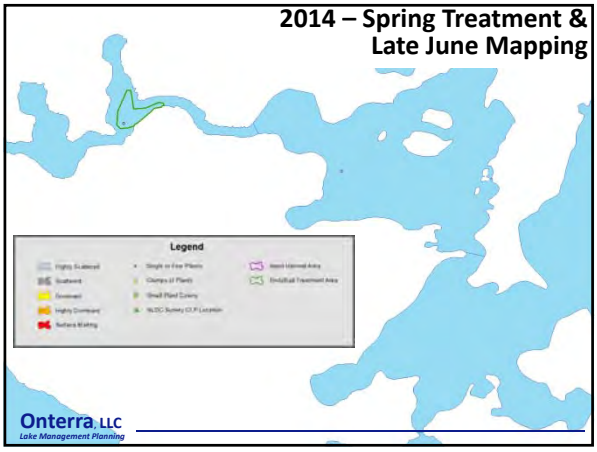
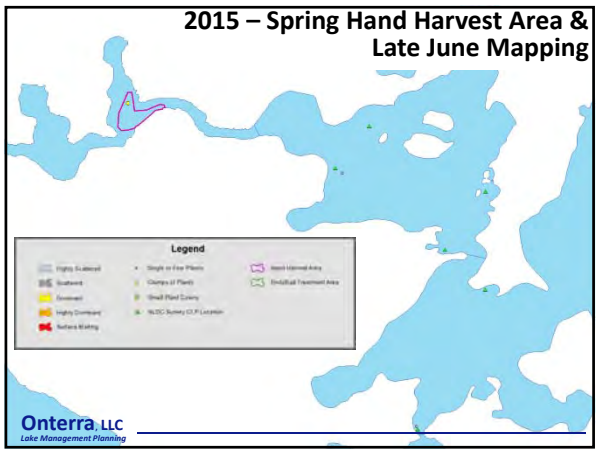
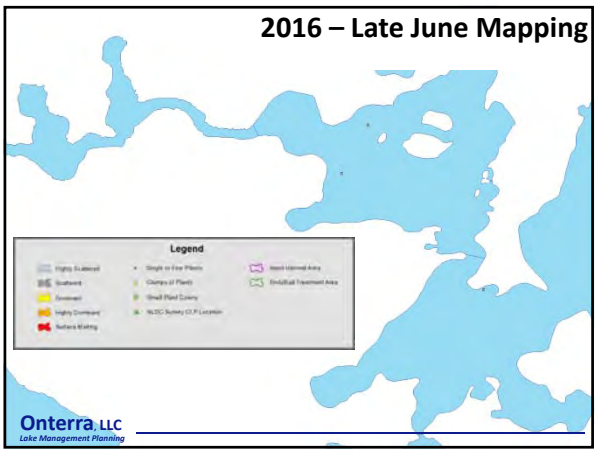
Stone, West Spider Lake and
Manitowish River


2012
Legend
• No known CLP occurrences
Onterra LLC
Lake Management Planning


2013 – Late June Mapping
Legend
Onterra LLC
Lake Management Planning


2014 – Spring Treatment &
Late June Mapping
Legend
Onterra LLC
Lake Management Planning


2015 – Spring Hand Harvest Area &
Late June Mapping
Legend
Onterra LLC
Lake Management Planning


2016 – Late June Mapping
Legend
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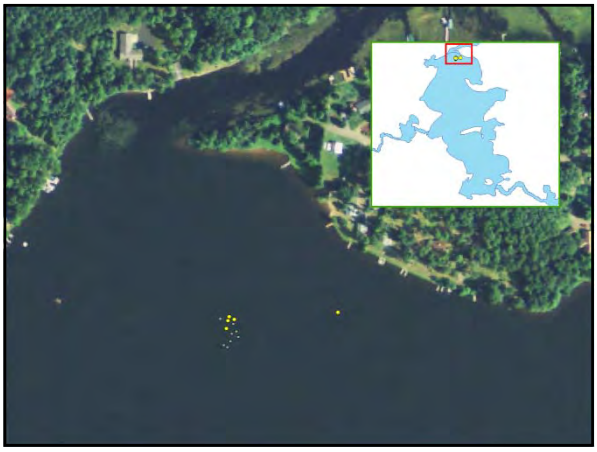
Rest Lake



Curly-leaf Pondweed

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Thank You

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UWEX Extension

Wisconsin Dept. of Natural Resources

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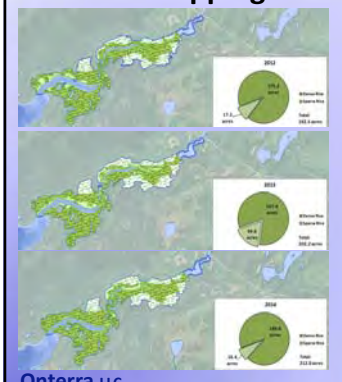
Rice Creek
Wild Rice Monitoring

Wild Rice Mapping



2012
192.5 Total Acres
9.1 acre overlap with colonized CLP

2013
202.2 Total Acres
9.1 acre overlap with colonized CLP

2014
212.0 Total Acres
3.3 acre overlap with colonized CLP

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CLP & Wild Rice Mapping

CLP mapping (known CLP lakes)

- Will continue in 2015
  - Limited funding (most coverage within Lake Protection grant application
  - Volunteers to survey lakes initially, pass data to Onterra
  - Onterra to survey 2015 control areas and areas delineated by Manitowish Chain volunteers
  - CLP mapped in Rice Creek similar to 2012-2014 (out-of-pocket cost for Onterra)

Wild Rice mapping (Rice Creek, Island Lake)

- Will continue in 2015 similar to 2012-2014 (out-of-pocket cost for Onterra)

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Grant Discussion

Applied for two February 1, 2015 grants

AIS Established Population Control

- AIS Monitoring (surveys) & Control (herbicide, hand harvest)
- Herbicide concentration monitoring
- Volunteer Monitoring, educational activities
- NLDC activities
- Awarded three year project, reduced NLDC scope

Lake Protection – Lake Plan Implementation

- Planning Project elements for Phase VI & V lakes
- Volunteer meeting attendance
- NLDC activities
- Application not successful in competitive pool

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Grant Discussion

Next grant cycle…

Need to reapply for Phase VI & V lakes funding

- Lake Protection – Lake Plan Implementation grant?
- Lake Management Planning Grants (2)
  - Conversations with WDNR during summer / fall will guide decision on which grant pool to pursue

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Conclusions

- Watershed is in great condition
  - Land cover is of high quality
  - Large, heavily forested watershed is responsible for stained waters
- Water quality is great
  - Overall, data indicate water quality is better than expected for lakes of this type, within this region
  - All lakes are considered in a mesotrophic state
- Aquatic plant community
  - Based upon standard analysis, native community is of high quality
  - Interesting and special concern species present
  - AIS continuously monitored
    - CLP, phragmites pose threat to ecosystem

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Next Steps…

1. **Review Phase I Implementation Plan**
   - New matters to discuss?
2. **Determine applicability to Phase II, Phase III lakes**
   - Review Management Goals for entire chain
   - Specify Imp Plan applicability to Phase II & III lakes
   - Specific lake issues to address?
3. **Develop and distribute stakeholder survey**
4. **Proceed with Phase III studies, examine options for continued grant funding**

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Lake Management Planning

Presentation Outline

- **Phased Lake Management Planning Project Overview**
- **Study Results**
  - Shoreland & CWH
  - Water Quality
  - Aquatic Plants
  - Curly-leaf Pondweed
- **Chainwide Implementation Plan**

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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

Greater Need for Restoration

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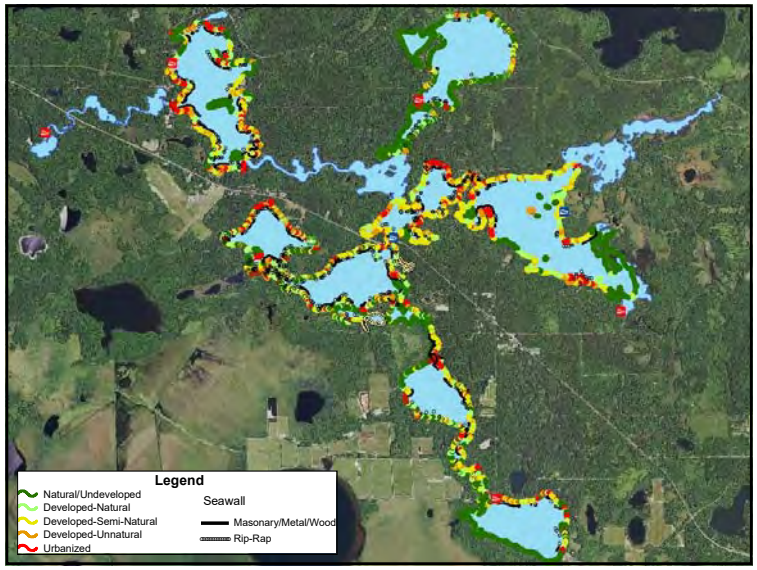

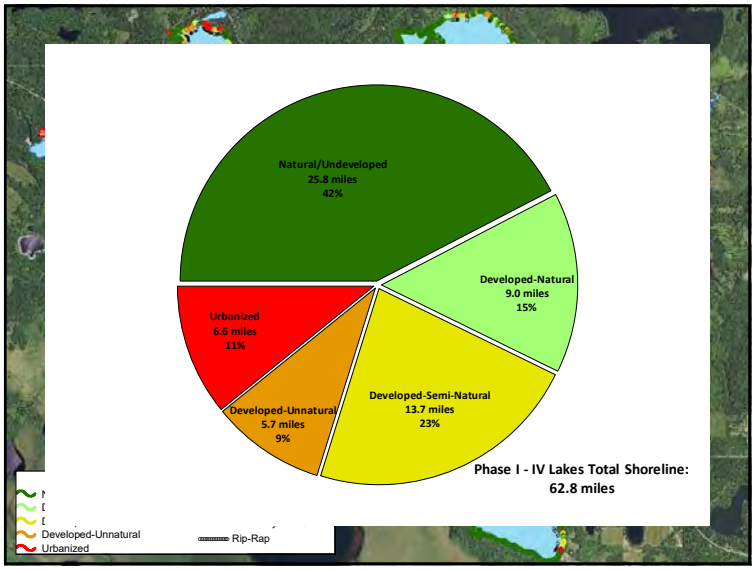

Coarse Woody Habitat

- 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 Manitowish Chain

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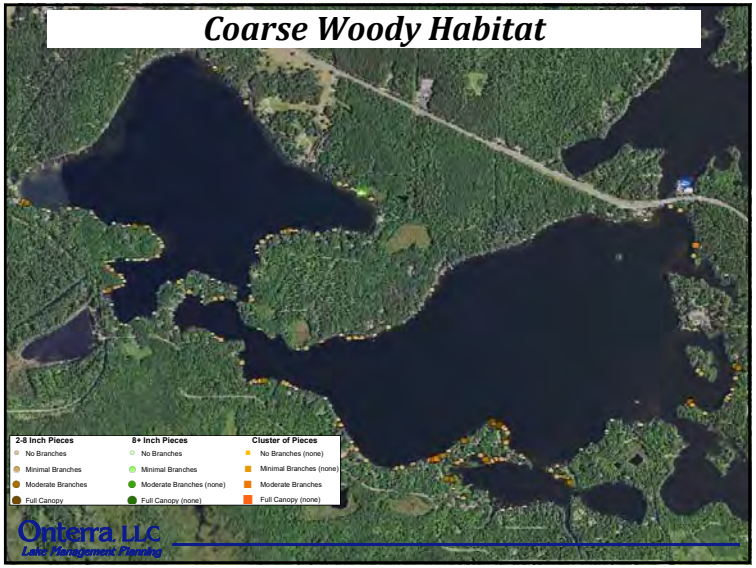
Coarse Woody Habitat



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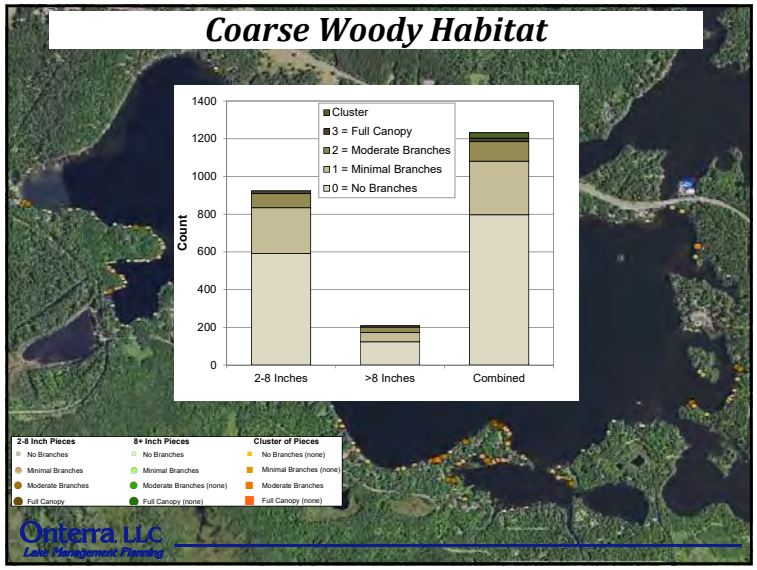
Coarse Woody Habitat
Cluster
3 = Full Canopy
2 = Moderate Branches
1 = Minimal Branches
0 = No Branches
Count
1400
1200
1000
800
600
400
200
0
2-8 Inches
>8 Inches
Combined
2-8 Inch Pieces
No Branches
Minimal Branches
Moderate Branches
Full Canopy
8+ Inch Pieces
No Branches
Minimal Branches
Moderate Branches (none)
Full Canopy (none)
Cluster of Pieces
No Branches (none)
Minimal Branches (none)
Moderate Branches
Full Canopy (none)
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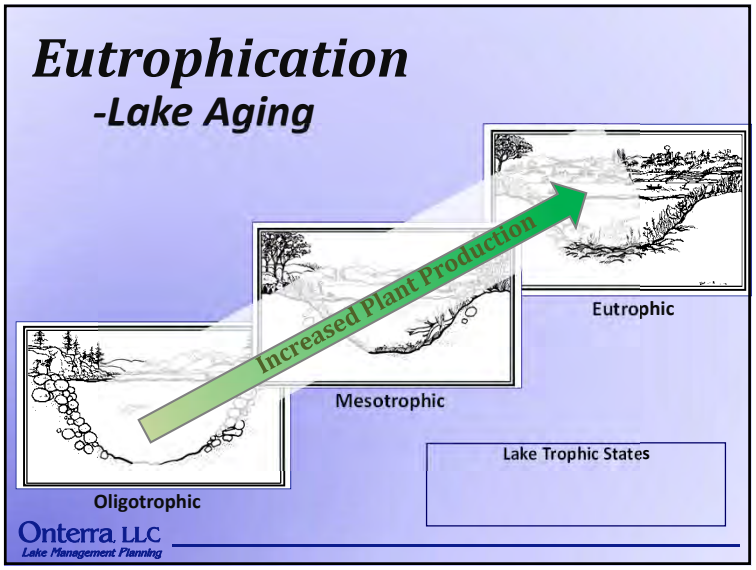
Eutrophication
-Lake Aging
Increased Plant Production
Eutrophic
Mesotrophic
Oligotrophic
Lake Trophic States
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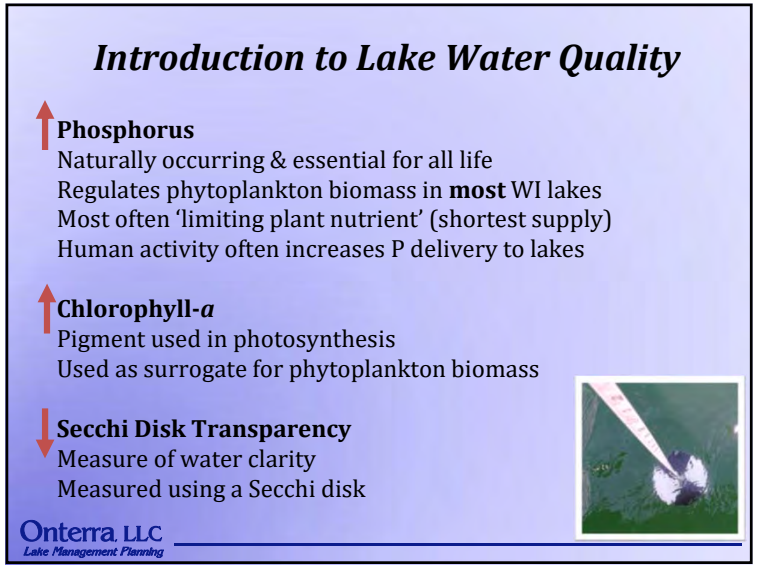
Introduction to Lake Water Quality
Phosphorus
Naturally occurring & essential for all life
Regulates phytoplankton biomass in most WI lakes
Most often 'limiting plant nutrient' (shortest supply)
Human activity often increases P delivery to lakes
Chlorophyll-a
Pigment used in photosynthesis
Used as surrogate for phytoplankton biomass
Secchi Disk Transparency
Measure of water clarity
Measured using a Secchi disk
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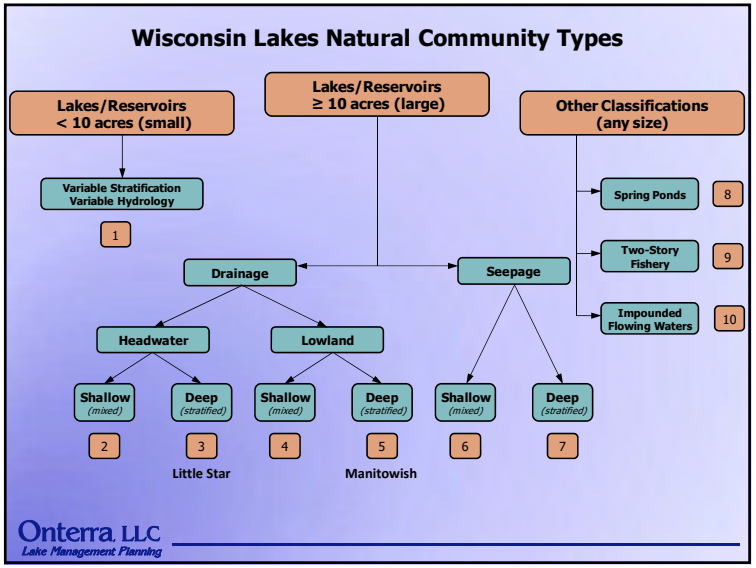
Wisconsin Lakes Natural Community Types
Lakes/Reservoirs < 10 acres (small)
Lakes/Reservoirs ≥ 10 acres (large)
Other Classifications (any size)
Variable Stratification Variable Hydrology
1
Drainage
Seepage
Spring Ponds
8
Two-Story Fishery
9
Impounded Flowing Waters
10
Headwater
Lowland
Shallow (mixed)
Deep (stratified)
Shallow (mixed)
Deep (stratified)
Shallow (mixed)
Deep (stratified)
2
3
4
5
6
7
Little Star
Manitowish
Onterra LLC
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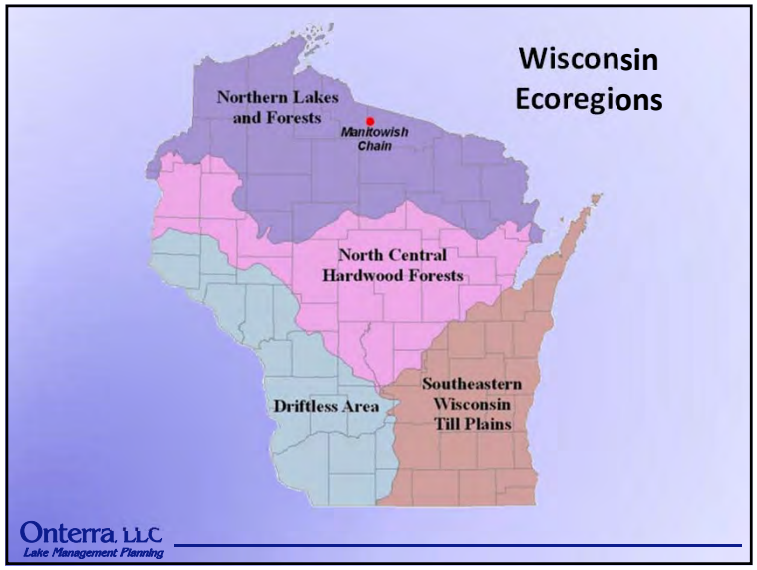
Wisconsin Ecoregions
Northern Lakes and Forests
Manitowish Chain
North Central Hardwood Forests
Driftless Area
Southeastern Wisconsin Till Plains
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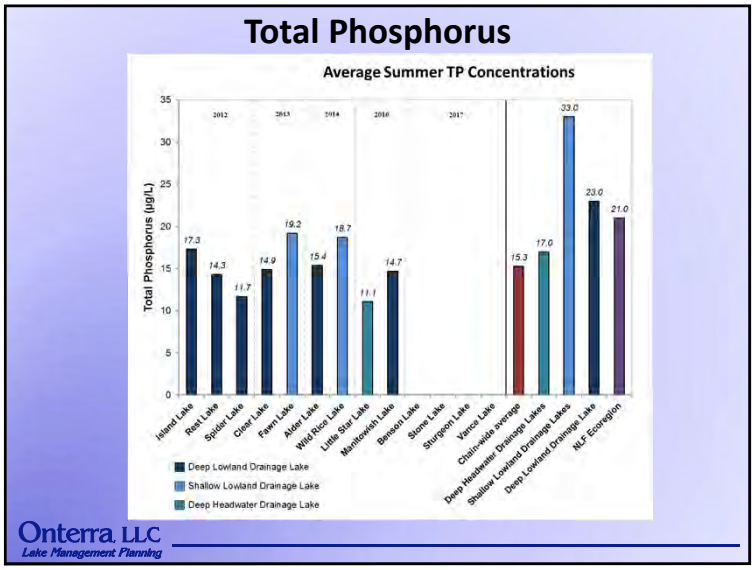
Total Phosphorus
Average Summer TP Concentrations
Total Phosphorus (µg/L)
Island Lake
Rest Lake
Spider Lake
Clear Lake
Fawn Lake
Alder Lake
Wild Rice Lake
Little Star Lake
Manitowish Lake
Benson Lake
Stone Lake
Sturgeon Lake
Vonca Lake
Chain-wide average
Deep Headwater Drainage Lakes
Shallow Lowland Drainage Lakes
Deep Lowland Drainage Lake
NLF Ecoregion
Deep Lowland Drainage Lake
Shallow Lowland Drainage Lake
Deep Headwater Drainage Lake
Onterra LLC
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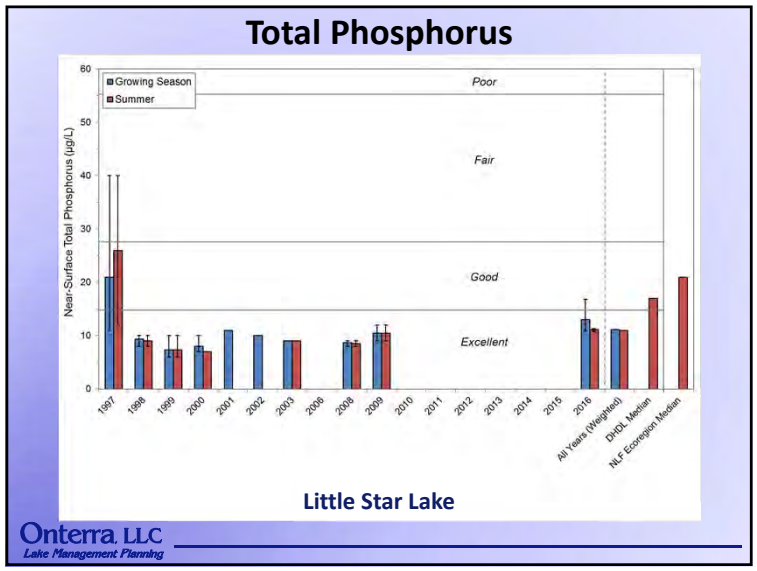
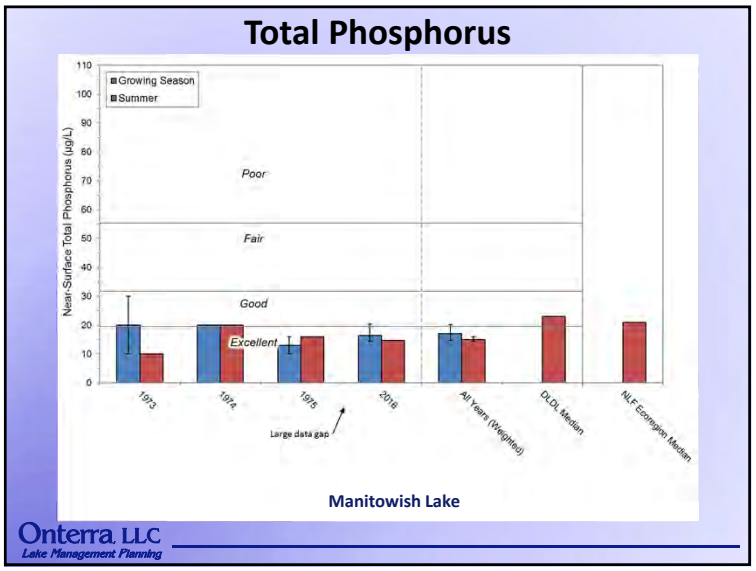

Total Phosphorus
Growing Season
Summer
Poor
Fair
Good
Excellent
Near-Surface Total Phosphorus (µg/L)
All Years (Weighted)
DHDL Median
NLF Ecoregion Median
Little Star Lake
Onterra LLC
Lake Management Planning


Total Phosphorus
Growing Season
Summer
Poor
Fair
Good
Excellent
Near-Surface Total Phosphorus (µg/L)
Large data gap
All Years (Weighted)
DLDL Median
NLF Ecoregion Median
Manitowish Lake
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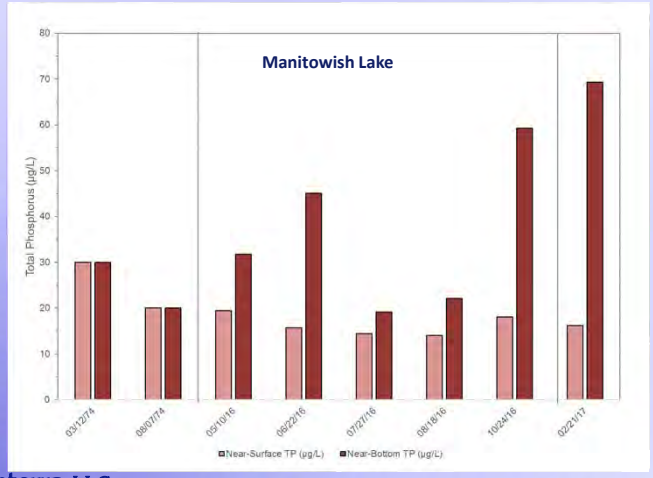
Total Phosphorus



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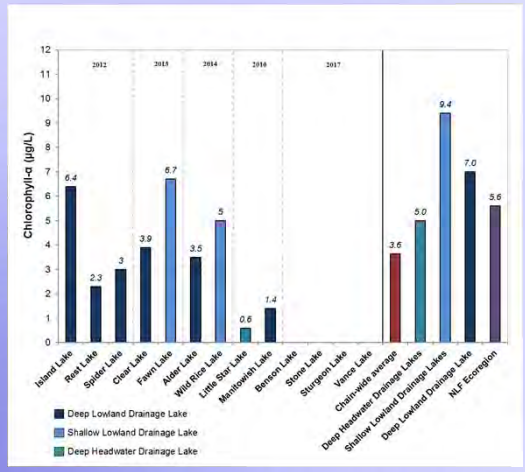
Chlorophyll-*a*



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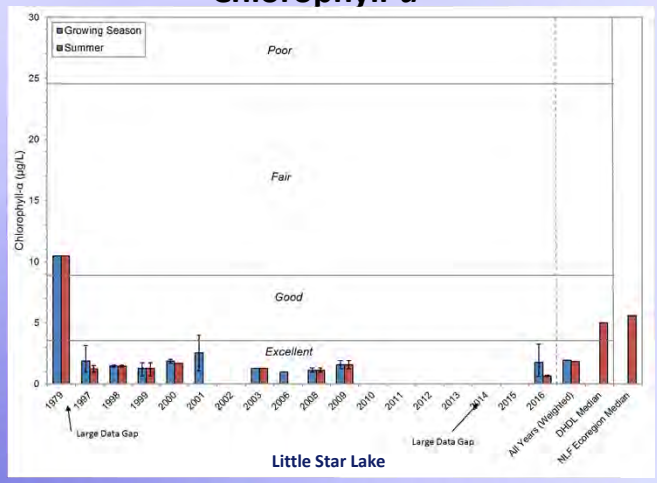
Chlorophyll-*a*



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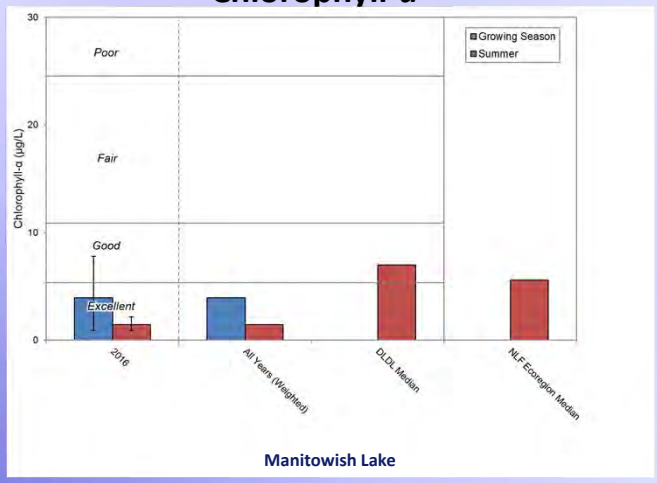
Lake Management Planning

Chlorophyll-*a*



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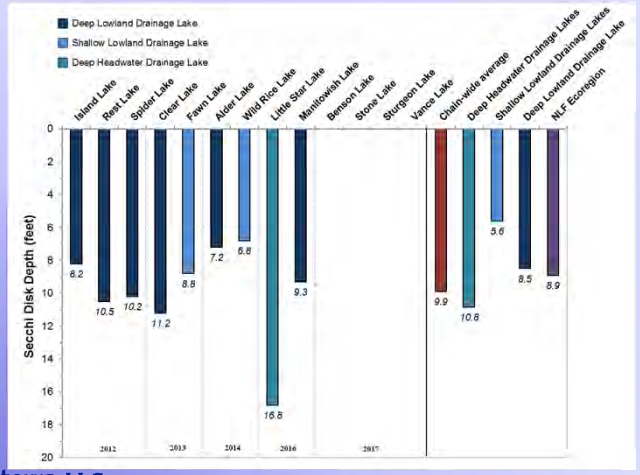
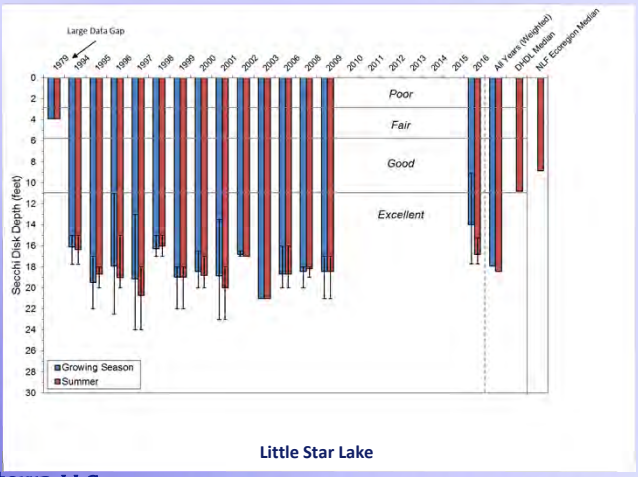
Lake Management Planning

Secchi Disk Clarity



Onterra LLC
Lake Management Planning

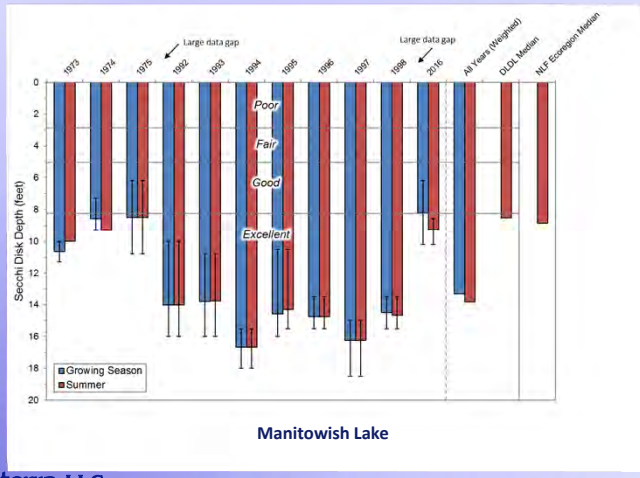
Secchi Disk Clarity



Little Star Lake

Onterra LLC
Lake Management Planning

Secchi Disk Clarity



Manitowish Lake

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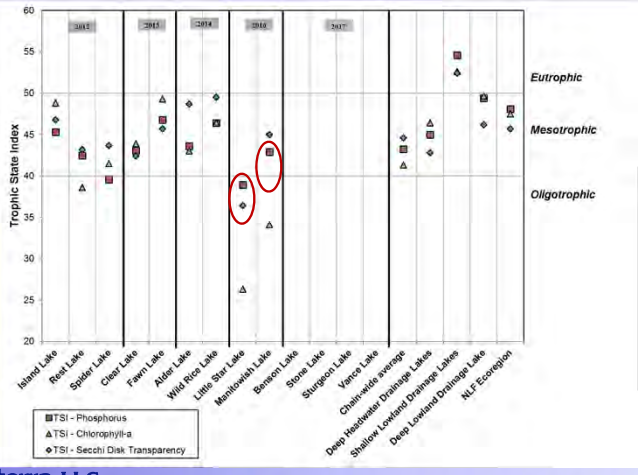
Trophic State Index



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Aquatic Plant Surveys

- Concerned with both native and non-native plants
- Multiple surveys used in assessment
  - Pre-treatment Surveys
  - Early Season AIS Surveys
  - Point-intercept survey
    - Systematic sampling method
    - Can compare lakes within same ecoregion
  - Plant community mapping
    - Accurately map floating-leaf & emergent communities
    - May compare to future surveys

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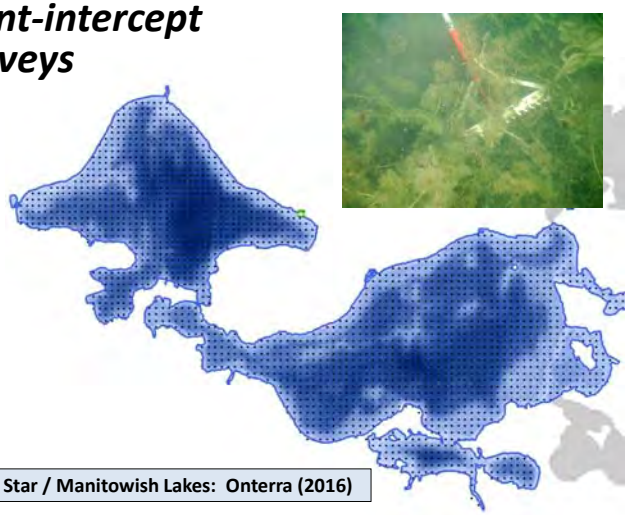
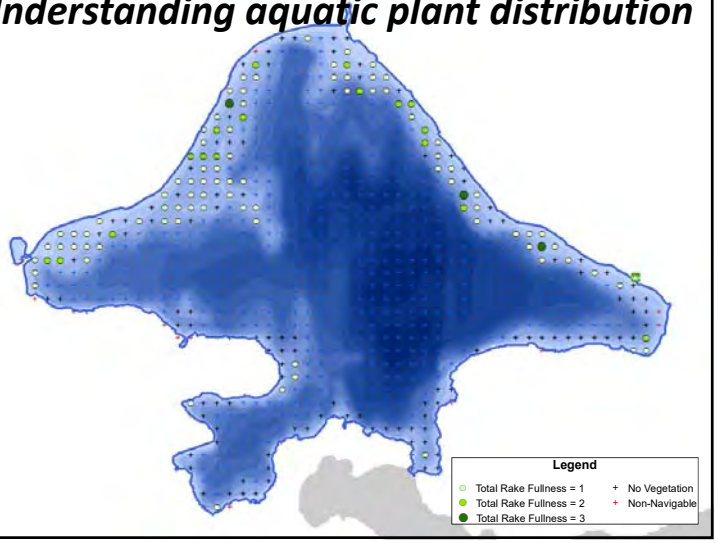
Point-intercept Surveys



Little Star / Manitowish Lakes: Onterra (2016)

Understanding aquatic plant distribution



Plant Data Overview

- 102 Native plants
  - 41 Submergent
  - 25 Emergent
  - 21 Floating-leaf
  - 7 Floating-leaf/Emergent
  - 5 Submergent/Emergent
  - 3 Free-floating

- 6 Non-native plant species
  - Curly-leaf pondweed
  - Giant reed
  - Purple loosestrife
  - Pale yellow iris
  - Common forget-me-not
  - Reed canary grass

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Aquatic Plants

Wisconsin Ecoregions

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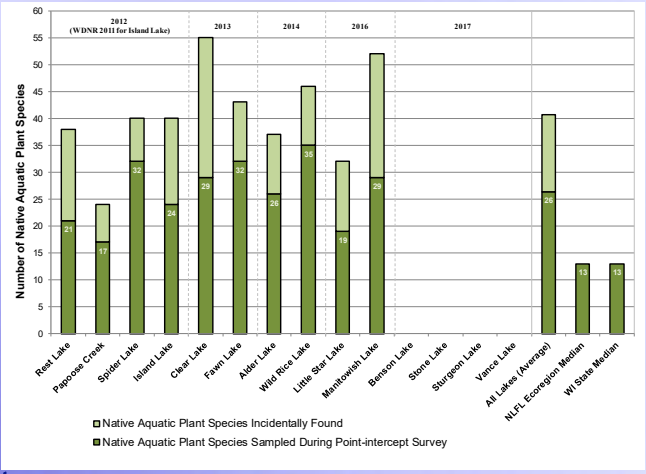
Species Richness



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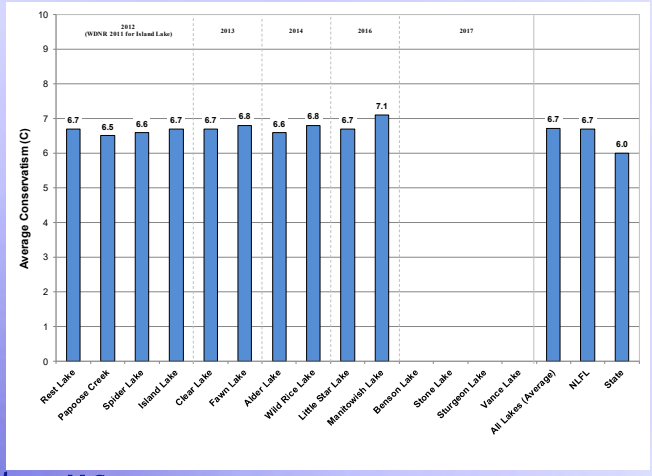
Average Conservatism



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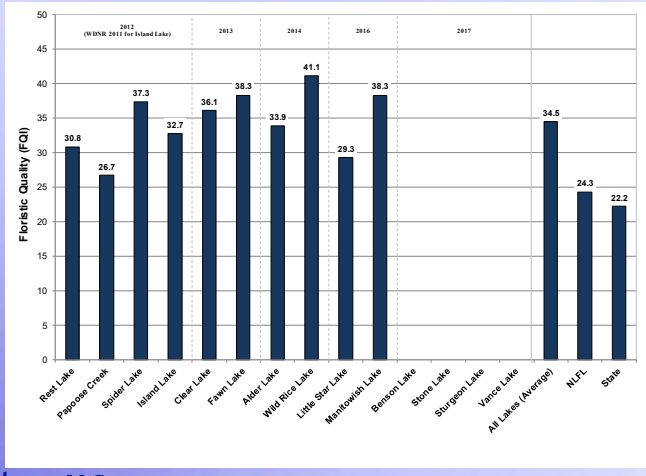
Floristic Quality



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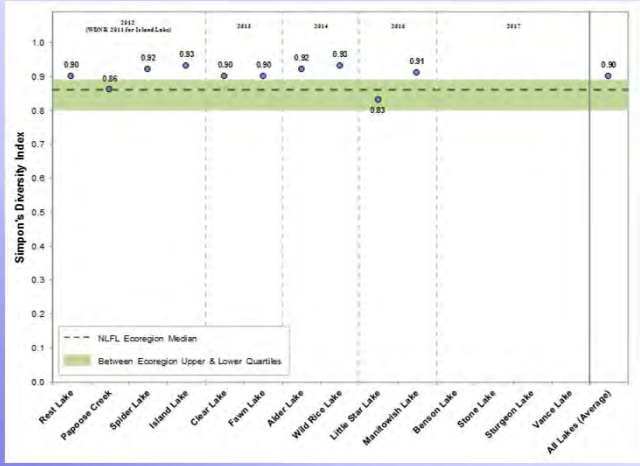
Simpson's Diversity



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Community Mapping

Understand locations and types of emergent, floating-leaf species
- Spawning habitat
- Food source
- Shoreline stabilization

Useful in wild rice mapping, producing harvesting plans, etc.

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AIS Mapping Methodology

Point Mapping
- Single plants to colonies or areas <40 feet diameter
  - Single/few plants – Clump – Small Plant Colony

Polygon Mapping
- Larger, continuous colonies of plants >40-feet diameter
  - Highly Scattered – Scattered
  - Dominant – Highly Dominant – Surface Matted

Single or Few Plants
Clumps of Plants
Small Plant Colony

Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting

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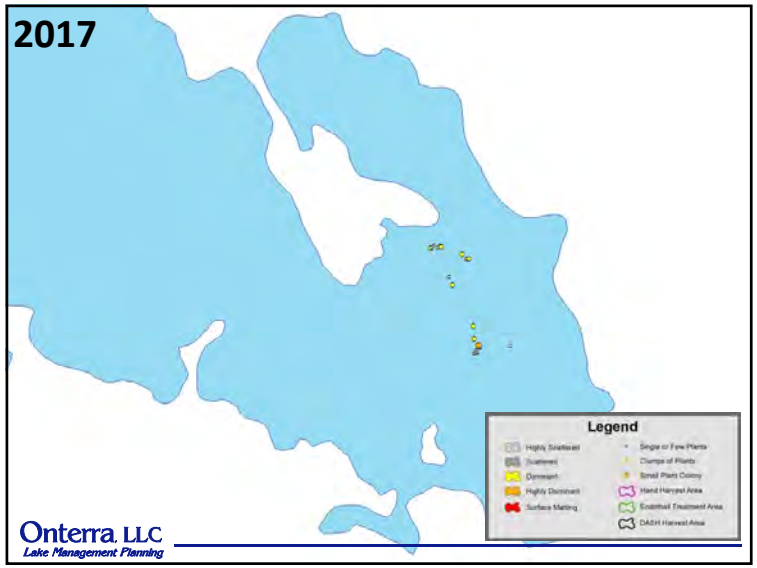
2017
Legend
Onterra LLC
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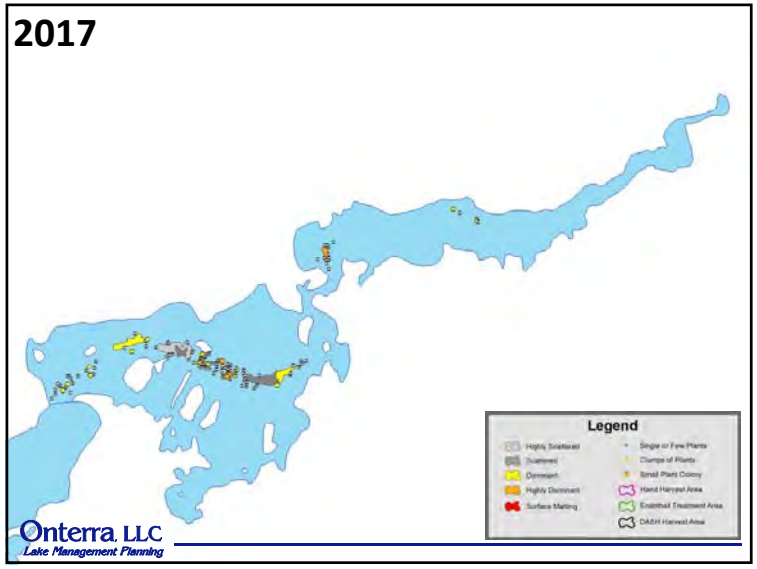
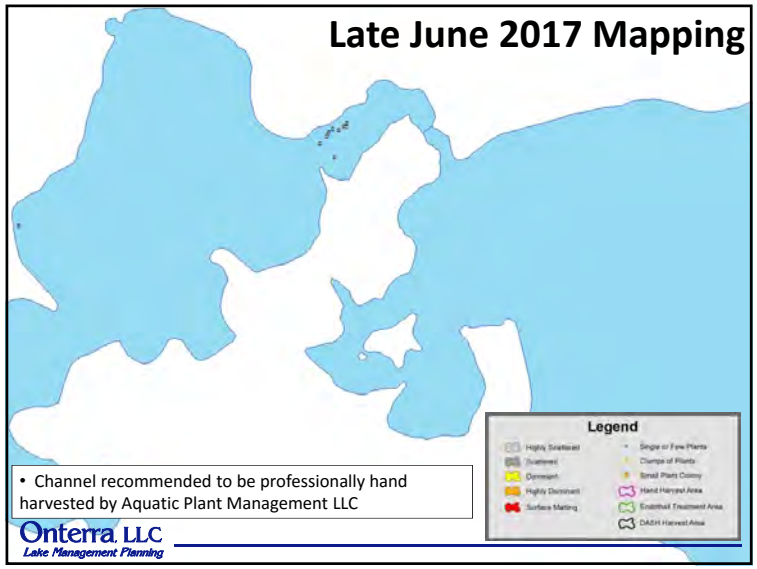
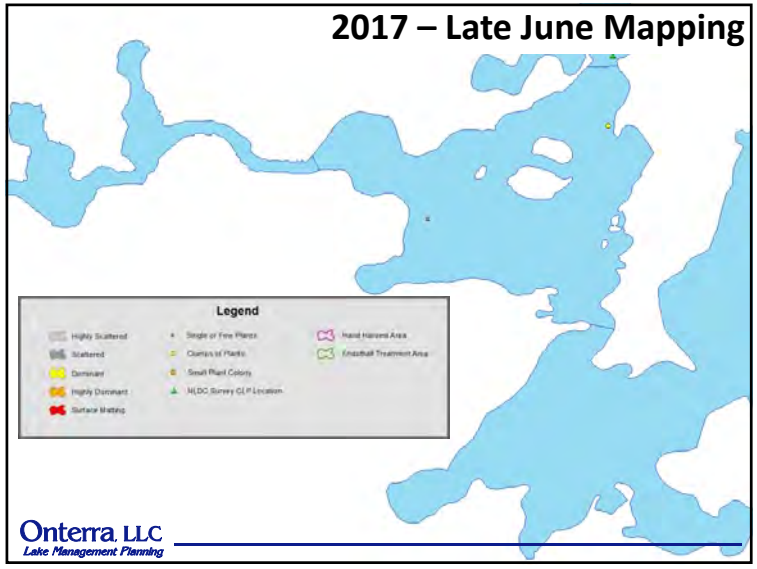
Rice Creek


2017
Legend
Onterra LLC
Lake Management Planning

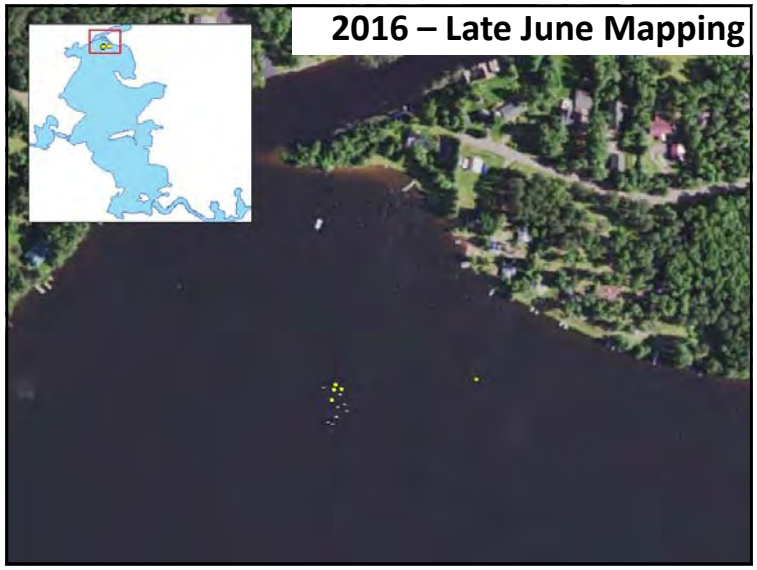

Spider/Island Channel &
West Island Lake

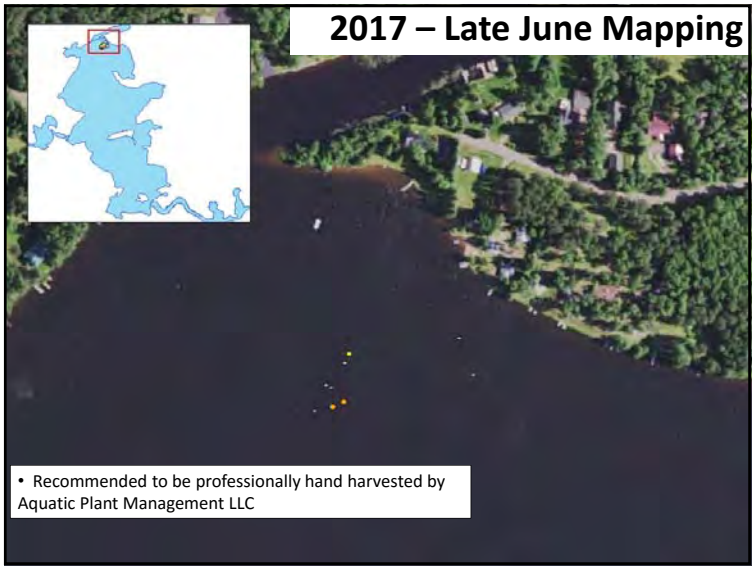

Late June 2017 Mapping
• Channel recommended to be professionally hand harvested by Aquatic Plant Management LLC
Legend
Onterra LLC
Lake Management Planning

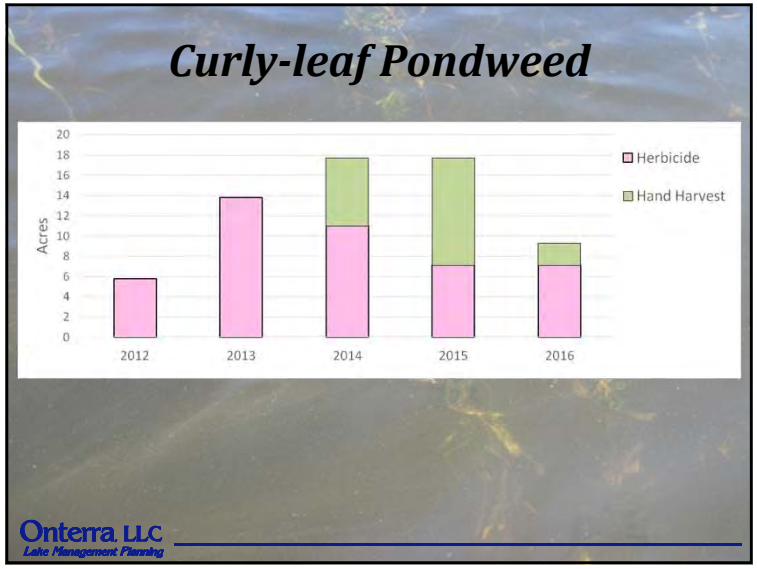

Stone, Fawn, West Spider Lake and Manitowish River


2017 – Late June Mapping
Legend
Onterra LLC
Lake Management Planning


Rest Lake







Planning Meeting I - Conclusions

- Watershed is in great condition
  - Land cover is of high quality
  - Areas of developed shoreline exist – best step to protect lakes
- Water quality is great
  - Overall, data indicate water quality is better than expected for lakes of this type, within this region
  - All lakes are considered in a mesotrophic or lower state
- Aquatic plant community
  - Based upon standard analysis, native community is of high quality
  - Interesting and special concern species present
  - AIS continuously monitored
    - CLP, Phragmites, etc. pose threat to ecosystem

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Management Goal 1

Strengthen Association Relationships, Effectiveness and Lake Management Capability

- Action: Enhance involvement with other entities that have a hand in managing Manitowish Waters Chain of Lakes
- Action: Increase the Manitowish Waters Chain's volunteer base

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Management Goal 2

Maintain Current Water Quality Conditions

- Action: Continue and expand monitoring of the Manitowish Waters Chain of Lakes' water quality through the WDNR Citizen Lake Monitoring Network
- Action: Educate property owners about the impacts of highly developed shoreland areas on the health of the Manitowish Waters Chain of Lakes and encourage shoreland restoration of these areas
- Action: Protect natural shoreland zones along the Manitowish Waters Chain of Lakes
- Action: Investigate algal blooms on the Manitowish Chain of Lakes

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Management Goal 3

Expand Awareness and Education of Lake Management and Stewardship Matters

- Action: Engage stakeholders on priority education items through efficient communication and outreach

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Management Goal 4

Control Existing and Prevent Further Aquatic Invasive Species Establishment within the Manitowish Waters Chain of Lakes

- Action: Continue control strategy for curly-leaf pondweed on the Manitowish Waters Chain of Lakes
- Action: Work with management partners to monitor curly-leaf pondweed and wild rice interactions within the Manitowish Waters Chain while assessing future management options
- Action: Reduce transport of curly-leaf pondweed from dense colony areas via watercraft

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Management Goal 4, continued

Control Existing and Prevent Further Aquatic Invasive Species Establishment within the Manitowish Waters Chain of Lakes

- Action: Continue control and monitoring efforts on other aquatic invasive species that pose a threat to the Manitowish Waters Chain of Lakes
- Action: Continue locally-based efforts including aquatic invasive species monitoring through the Lake Captain and Deckhand Program and watercraft inspections
- Action: Investigate feasibility of alternative aquatic invasive species control methodologies for applicability to the Manitowish Waters Chain of Lakes

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Management Goal 5

Enhance the Available Habitat and General Understanding of the Manitowish Waters Chain of Lakes Fishery

- Action: Work with WDNR fisheries managers and other stakeholders to enhance and understand the fishery

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Management Goal 6

Continue to Understand, Protect and Enhance the Ecology of the Manitowish Chain of Lakes Through Stakeholder Stewardship and Science-based Studies

- Action: Continue the development of comprehensive management plans for the Manitowish Chain waterbodies

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Presentation Outline

- **Phased Lake Management Planning Project Overview**
- **Study Results**
  - Watershed
  - Shoreland & CWH
  - Water Quality
  - Aquatic Plants
  - Curly-leaf Pondweed
- **Chainwide Implementation Plan**

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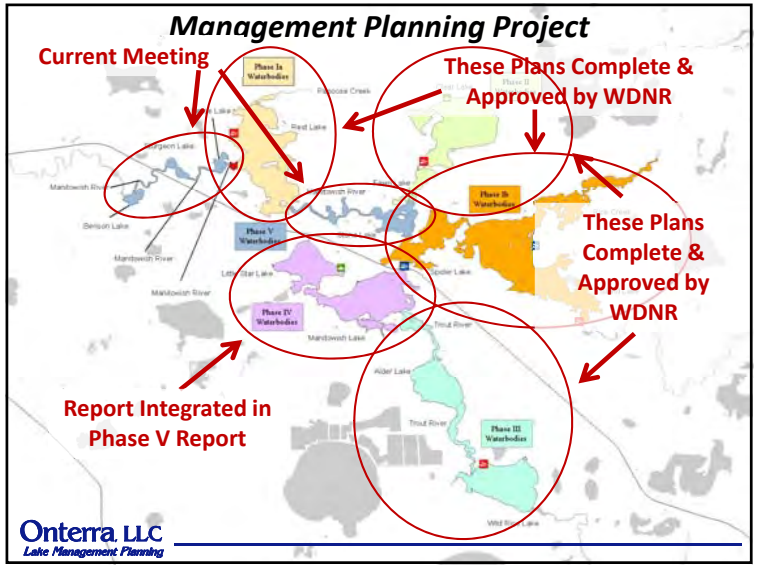
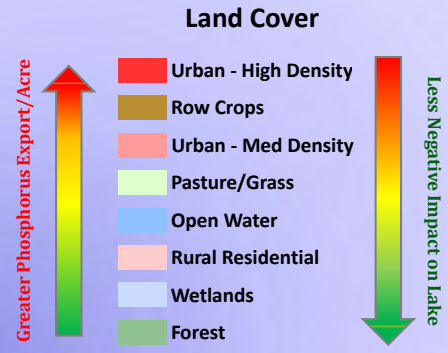


Watershed



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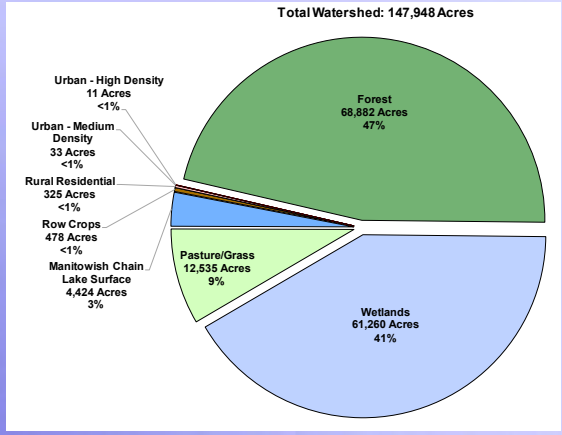
Watershed



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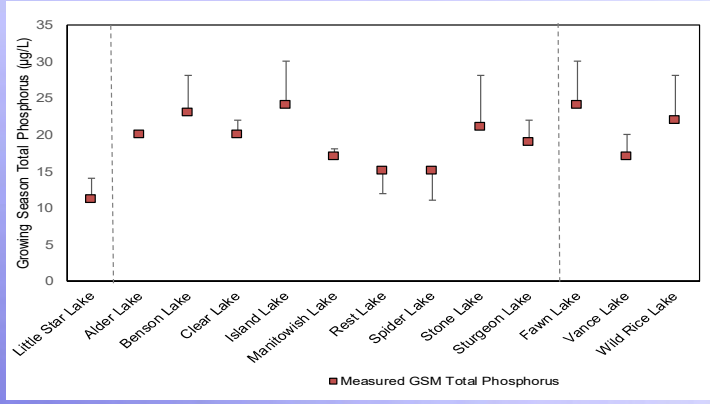
Watershed



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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

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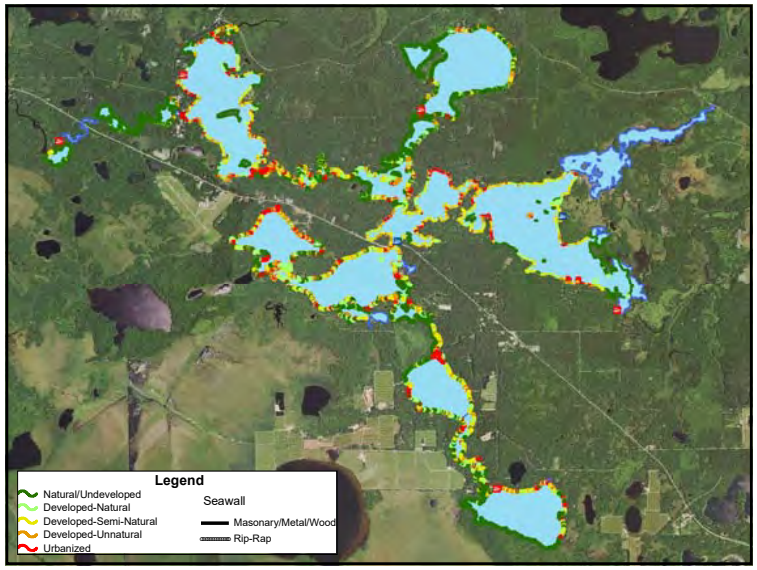
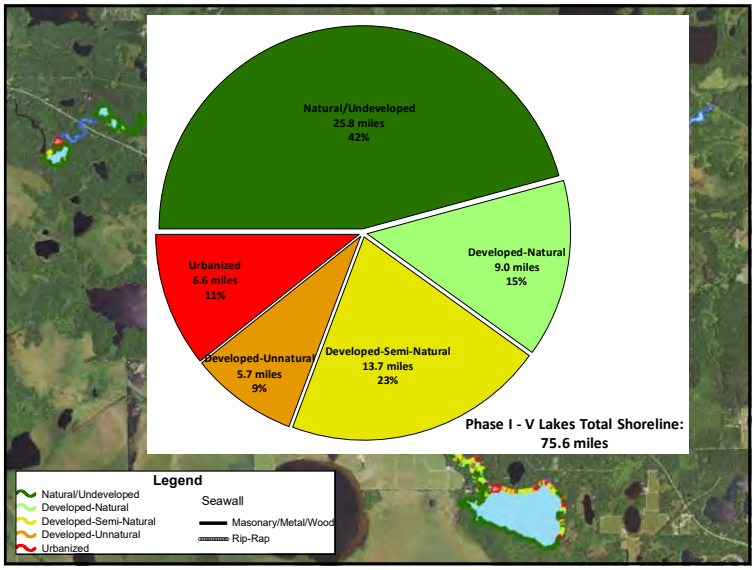
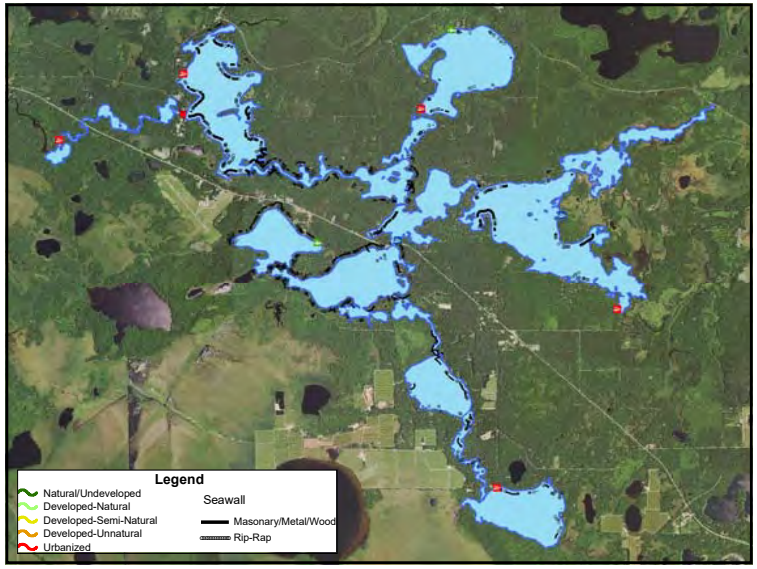

Legend
Natural/Undeveloped
Developed-Natural
Developed-Semi-Natural
Developed-Unnatural
Urbanized
Seawall
Masonary/Metal/Wood
Rip-Rap


Natural/Undeveloped
25.8 miles
42%
Developed-Natural
9.0 miles
15%
Developed-Semi-Natural
13.7 miles
23%
Developed-Unnatural
5.7 miles
9%
Urbanized
6.6 miles
11%
Phase I - V Lakes Total Shoreline:
75.6 miles
Legend
Natural/Undeveloped
Developed-Natural
Developed-Semi-Natural
Developed-Unnatural
Urbanized
Seawall
Masonary/Metal/Wood
Rip-Rap


Legend
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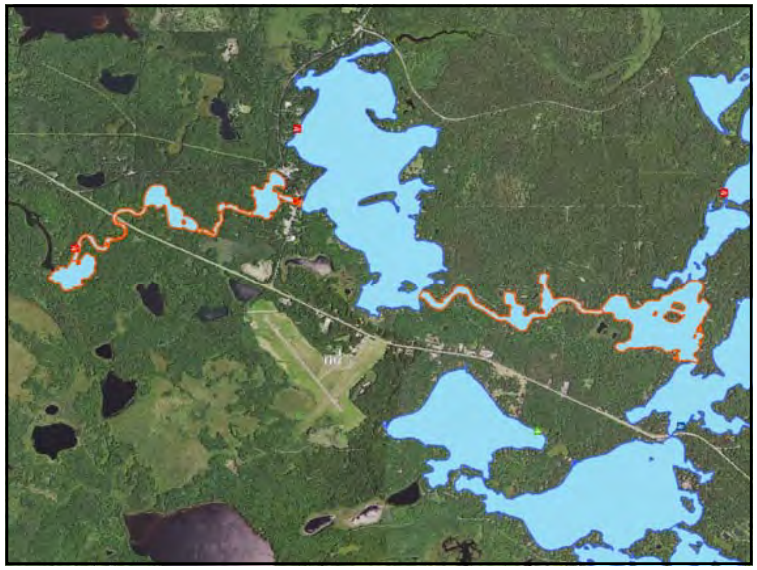
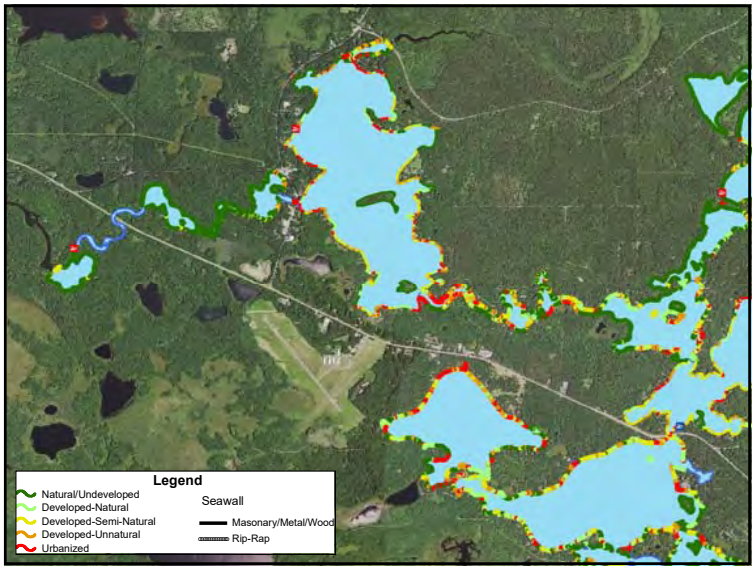
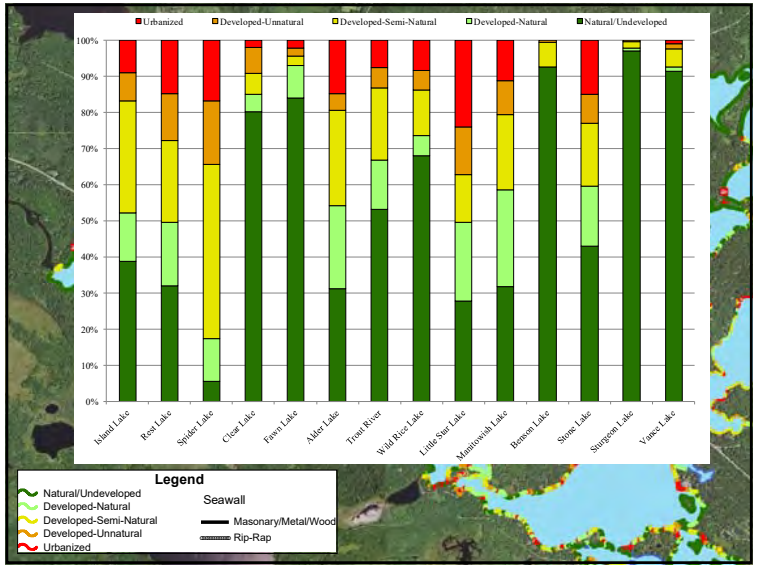
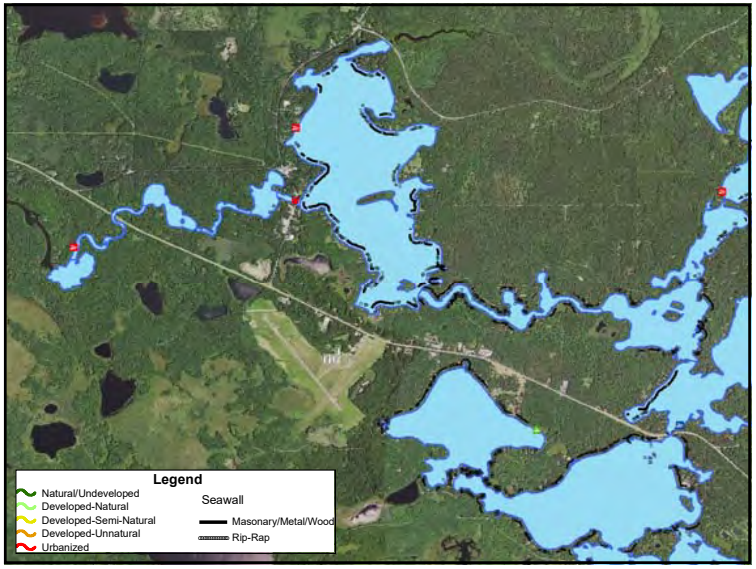



Legend
Natural/Undeveloped
Developed-Natural
Developed-Semi-Natural
Developed-Unnatural
Urbanized
Seawall
Masonary/Metal/Wood
Rip-Rap


Urbanized
Developed-Unnatural
Developed-Semi-Natural
Developed-Natural
Natural/Undeveloped
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Island Lake
Rest Lake
Spider Lake
Clear Lake
Fawn Lake
Alder Lake
Trout River
Wild Rice Lake
Little Star Lake
Manitowish Lake
Benson Lake
Stone Lake
Sturgeon Lake
Vance Lake
Legend
Natural/Undeveloped
Developed-Natural
Developed-Semi-Natural
Developed-Unnatural
Urbanized
Seawall
Masonary/Metal/Wood
Rip-Rap


Legend
Natural/Undeveloped
Developed-Natural
Developed-Semi-Natural
Developed-Unnatural
Urbanized
Seawall
Masonary/Metal/Wood
Rip-Rap

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 Manitowish Chain

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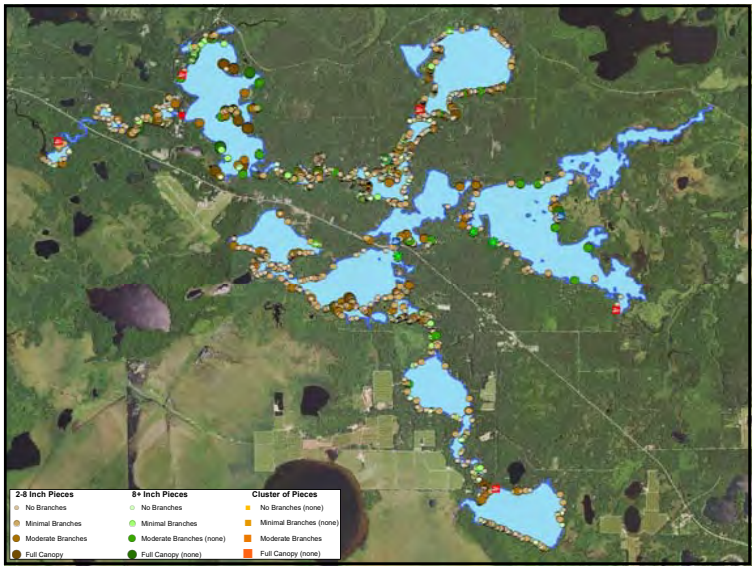
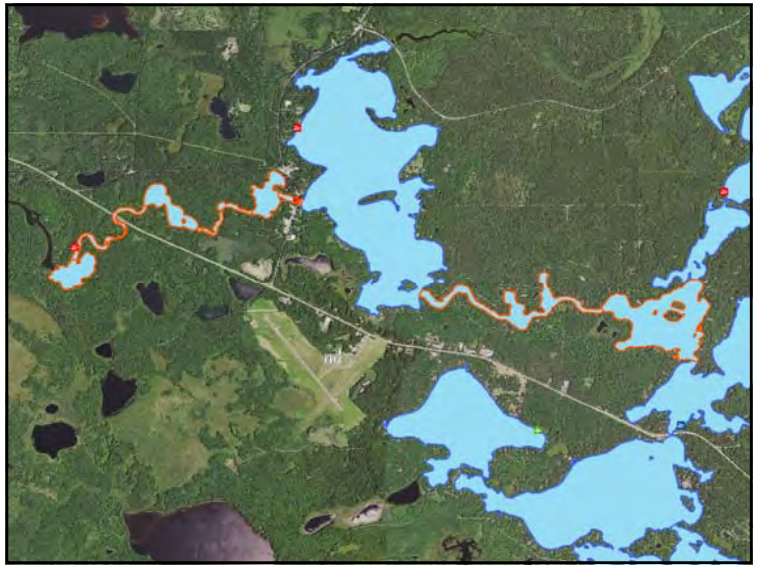
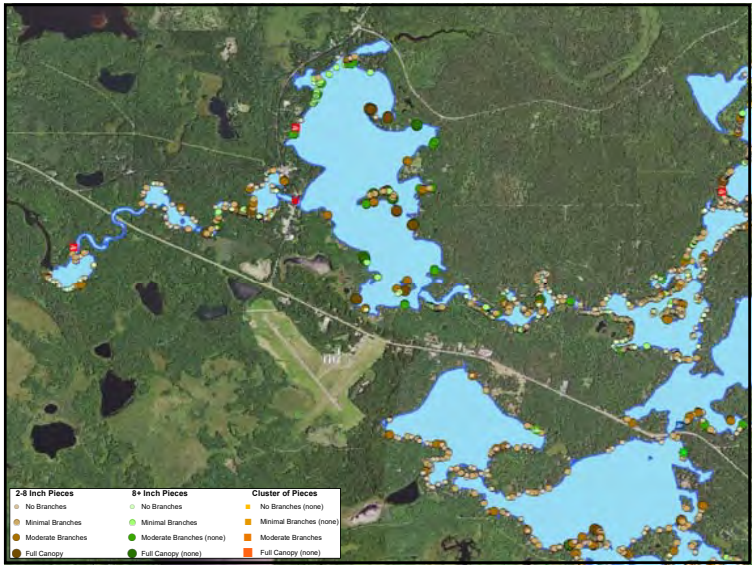
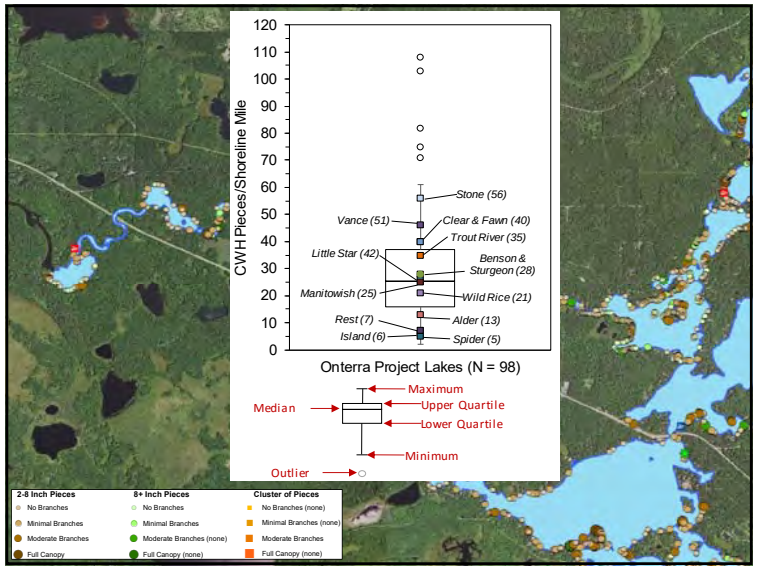
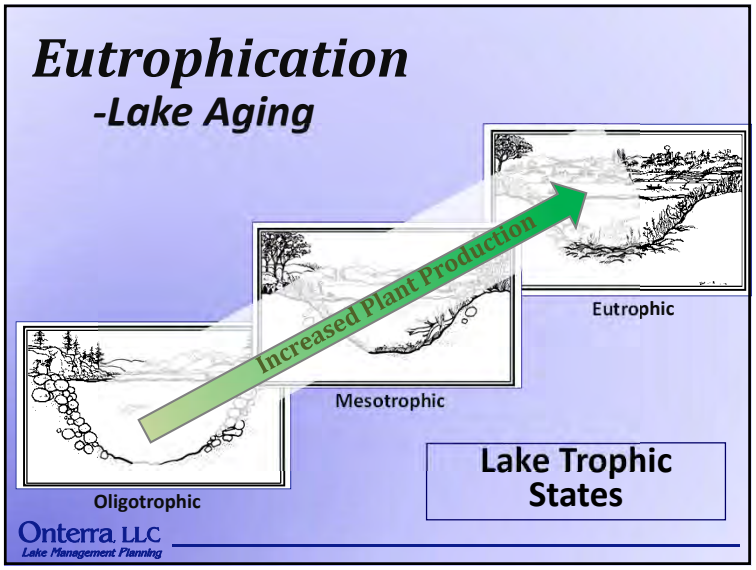








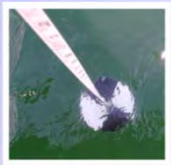


Introduction to Lake Water Quality

Phosphorus
Naturally occurring & essential for all life
Regulates phytoplankton biomass in **most** WI lakes
Most often 'limiting plant nutrient' (shortest supply)
Human activity 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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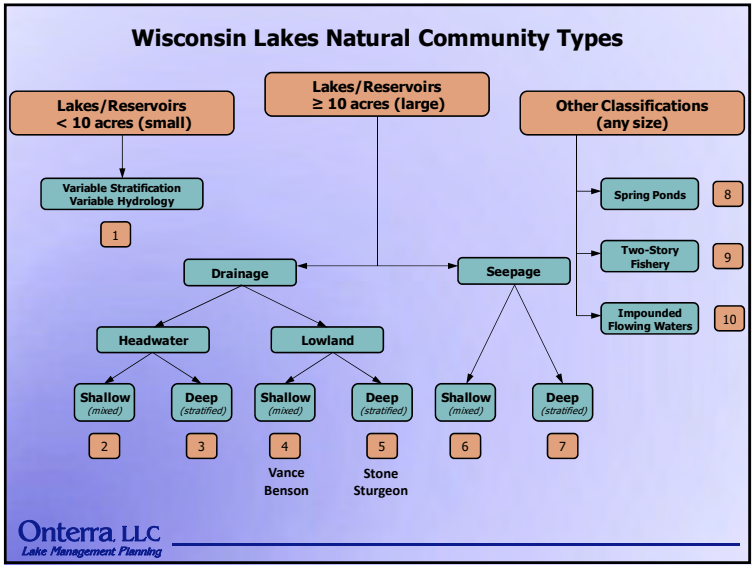

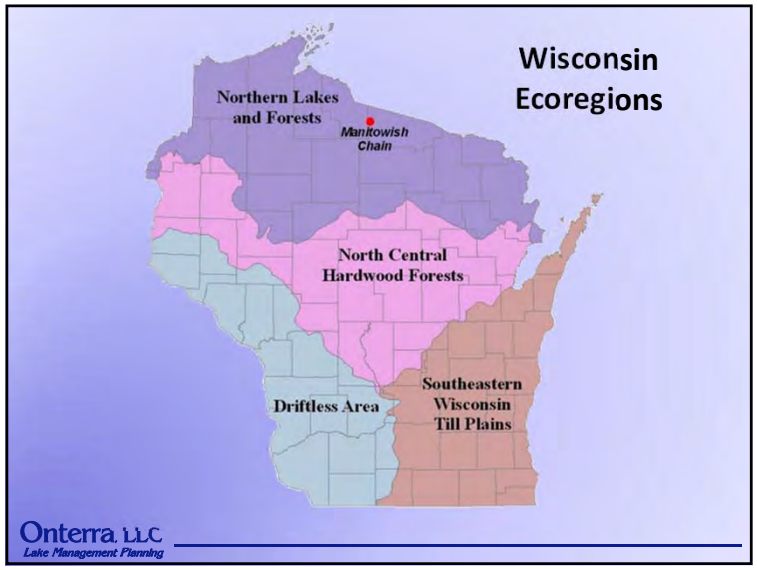
Wisconsin Ecoregions
Northern Lakes and Forests
Manitowish Chain
North Central Hardwood Forests
Driftless Area
Southeastern Wisconsin Till Plains
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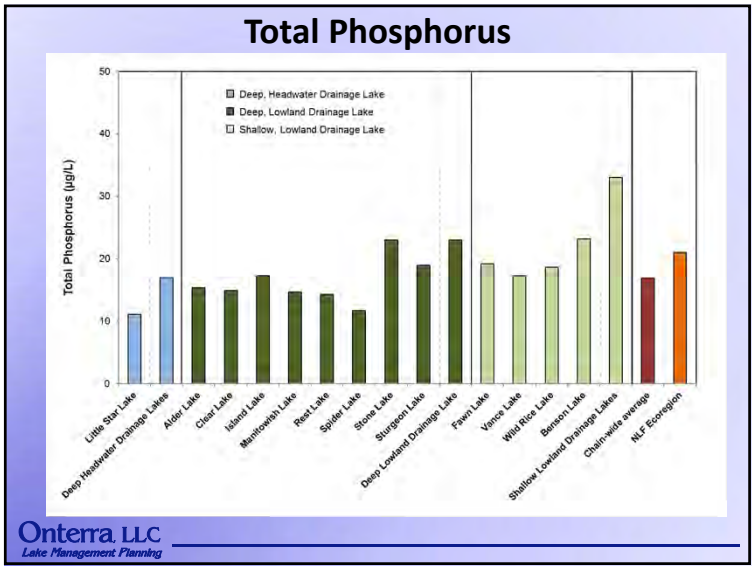
Total Phosphorus
Deep, Headwater Drainage Lake
Deep, Lowland Drainage Lake
Shallow, Lowland Drainage Lake
Total Phosphorus (µg/L)
0
10
20
30
40
50
Little Star Lake
Deep Headwater Drainage Lakes
Alder Lake
Clear Lake
Island Lake
Manitowish Lake
Rest Lake
Spider Lake
Stone Lake
Sturgeon Lake
Deep Lowland Drainage Lake
Fawn Lake
Vance Lake
Wild Rice Lake
Benson Lake
Shallow Lowland Drainage Lakes
Chain-wide average
NLF Ecoregion
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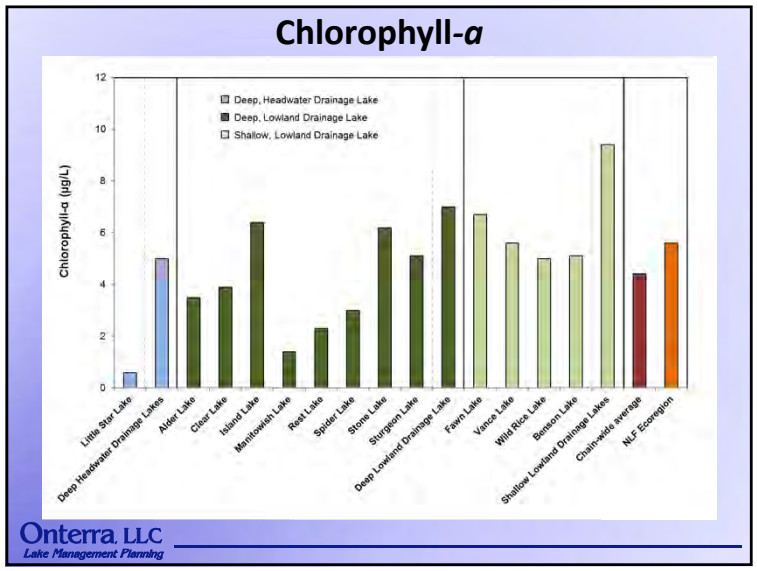
Chlorophyll-a
Deep, Headwater Drainage Lake
Deep, Lowland Drainage Lake
Shallow, Lowland Drainage Lake
Chlorophyll-a (µg/L)
0
2
4
6
8
10
12
Little Star Lake
Deep Headwater Drainage Lakes
Alder Lake
Clear Lake
Island Lake
Manitowish Lake
Rest Lake
Spider Lake
Stone Lake
Sturgeon Lake
Deep Lowland Drainage Lake
Fawn Lake
Vance Lake
Wild Rice Lake
Benson Lake
Shallow Lowland Drainage Lakes
Chain-wide average
NLF Ecoregion
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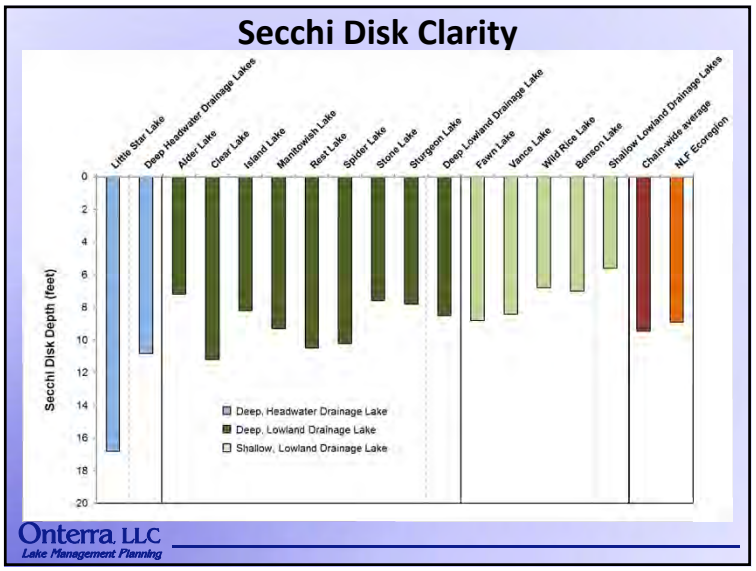
Secchi Disk Clarity
Secchi Disk Depth (feet)
0
2
4
6
8
10
12
14
16
18
20
Deep, Headwater Drainage Lake
Deep, Lowland Drainage Lake
Shallow, Lowland Drainage Lake
Little Star Lake
Deep Headwater Drainage Lakes
Alder Lake
Clear Lake
Island Lake
Manitowish Lake
Rest Lake
Spider Lake
Stone Lake
Sturgeon Lake
Deep Lowland Drainage Lake
Fawn Lake
Vance Lake
Wild Rice Lake
Benson Lake
Shallow Lowland Drainage Lakes
Chain-wide average
NLF Ecoregion
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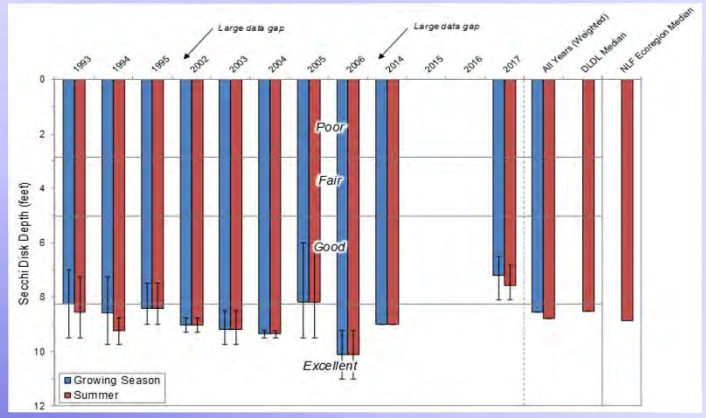
Stone Lake Secchi Disk Clarity



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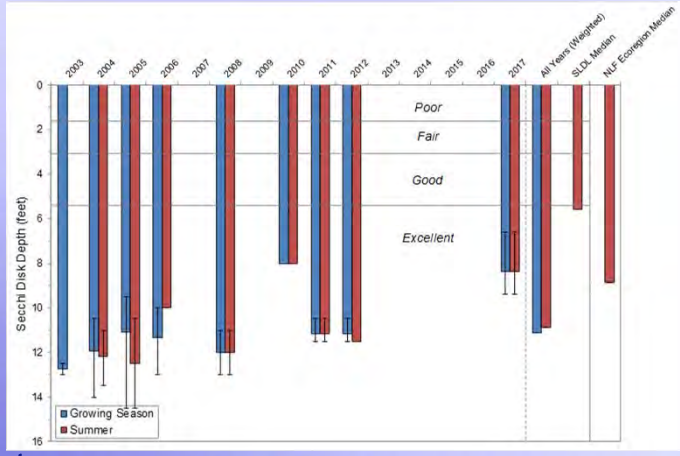
Vance Lake Secchi Disk Clarity



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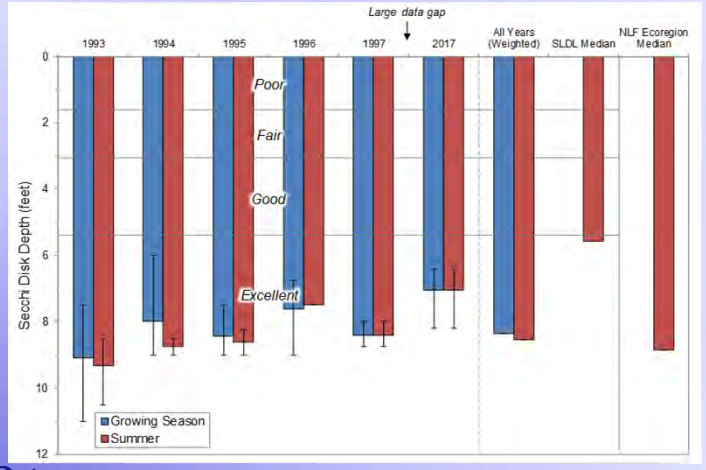
Benson Lake Secchi Disk Clarity



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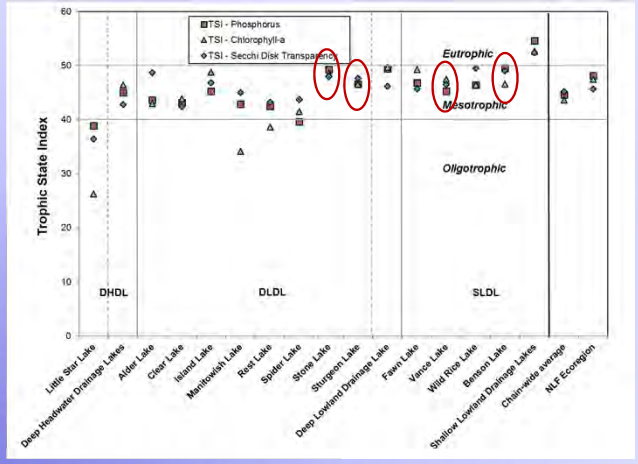
Trophic State Index



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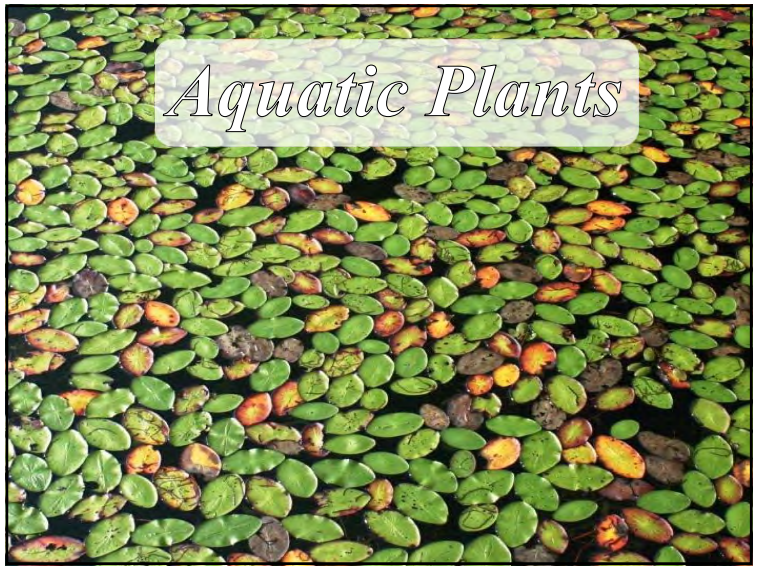

Aquatic Plant Surveys

- Concerned with both native and non-native plants
- Multiple surveys used in assessment
  - Pre-treatment Surveys
  - Early Season AIS Surveys
  - Point-intercept survey
    - Systematic sampling method
    - Can compare lakes within same ecoregion
  - Plant community mapping
    - Accurately map floating-leaf & emergent communities
    - May compare to future surveys

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Point-intercept Surveys

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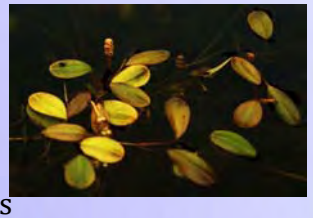
Plant Data Overview

- 109 Native plants
  - 46 Submergent
  - 44 Emergent
  - 9 Floating-leaf
  - 10 Mixed category



- 6 Non-native plant species
  - Curly-leaf pondweed
  - Giant reed
  - Purple loosestrife
  - Pale yellow iris
  - Common forget-me-not
  - Reed canary grass

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Aquatic Plants

Wisconsin Ecoregions

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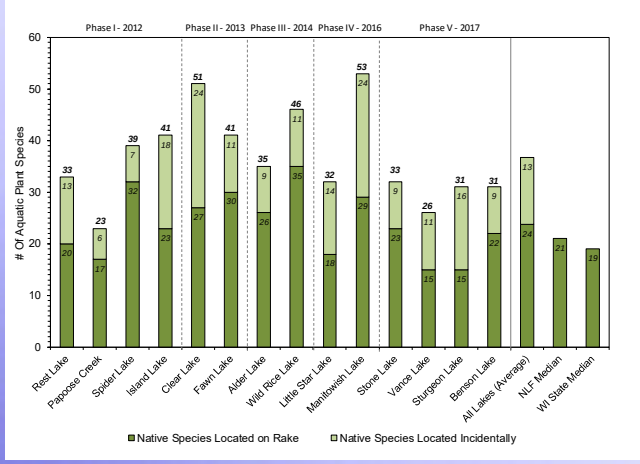
Species Richness



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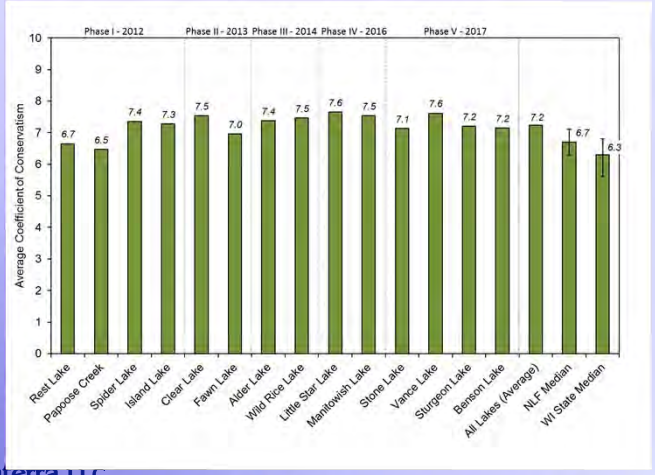
Average Conservatism



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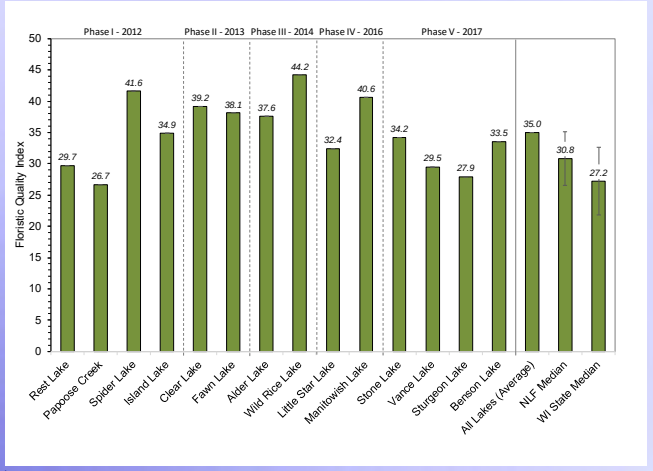
Floristic Quality



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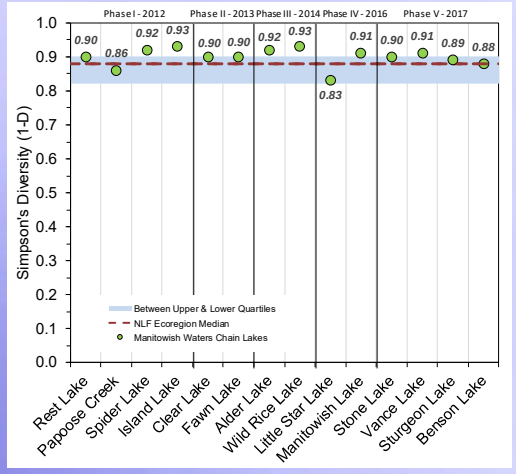
Simpson's Diversity



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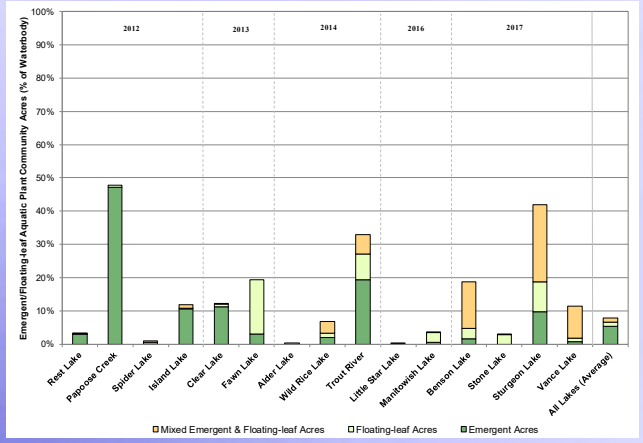
Community Mapping



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AIS Mapping Methodology

Point Mapping

- Single plants to colonies or areas <40 feet diameter
  - Single/few plants – Clump – Small Plant Colony

Polygon Mapping

- Larger, continuous colonies of plants >40-feet diameter
  - Highly Scattered – Scattered
  - Dominant – Highly Dominant – Surface Matted

Single or Few Plants
Clumps of Plants
Small Plant Colony

Highly Scattered
Scattered
Dominant
Highly Dominant
Surface Matting

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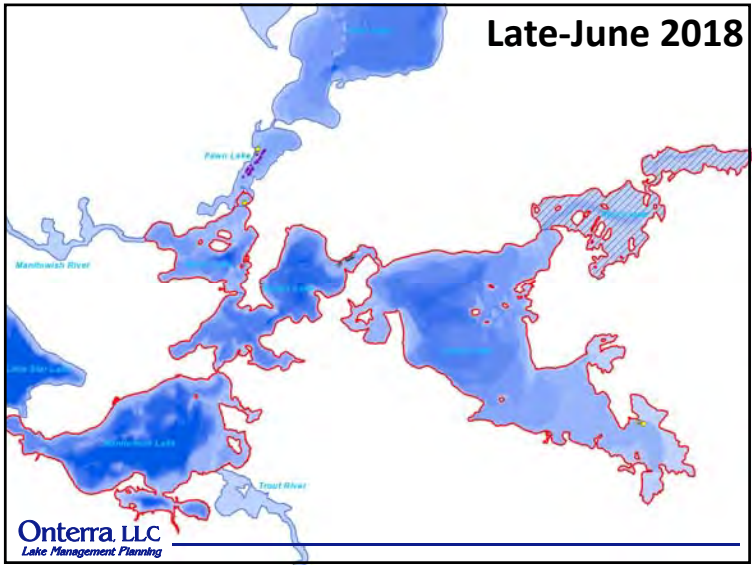
Late-June 2018



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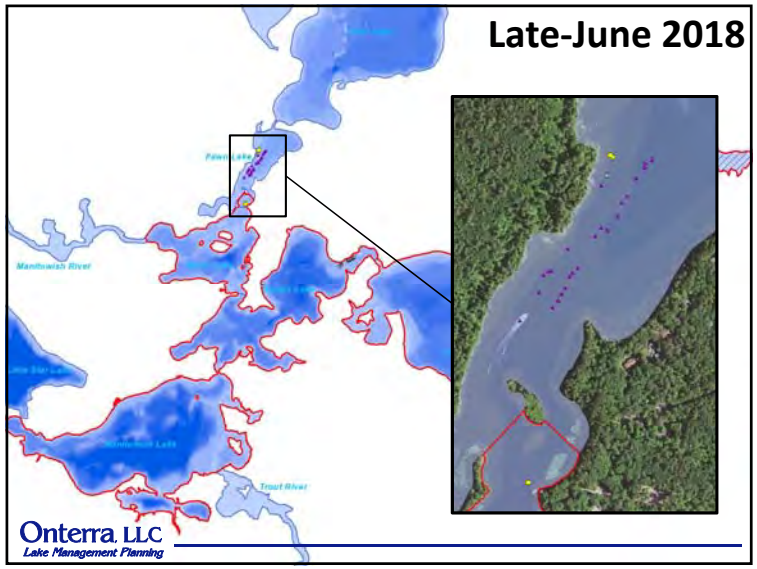
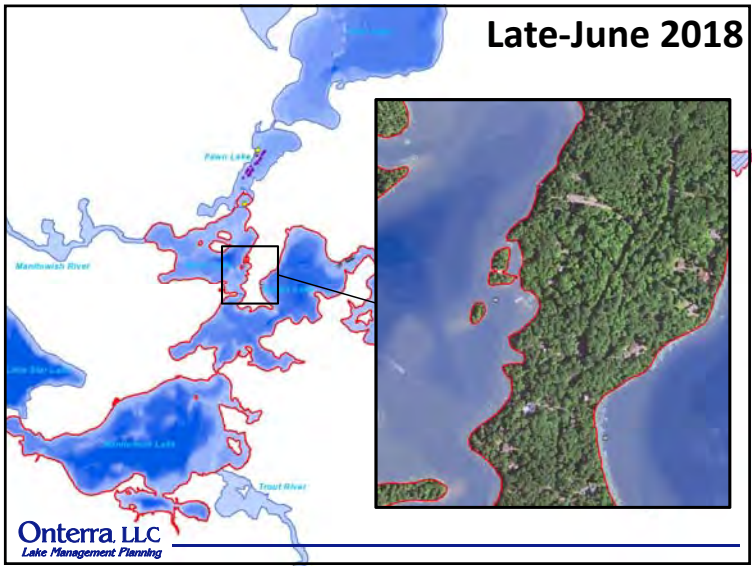

Late-June 2018
Onterra LLC
Lake Management Planning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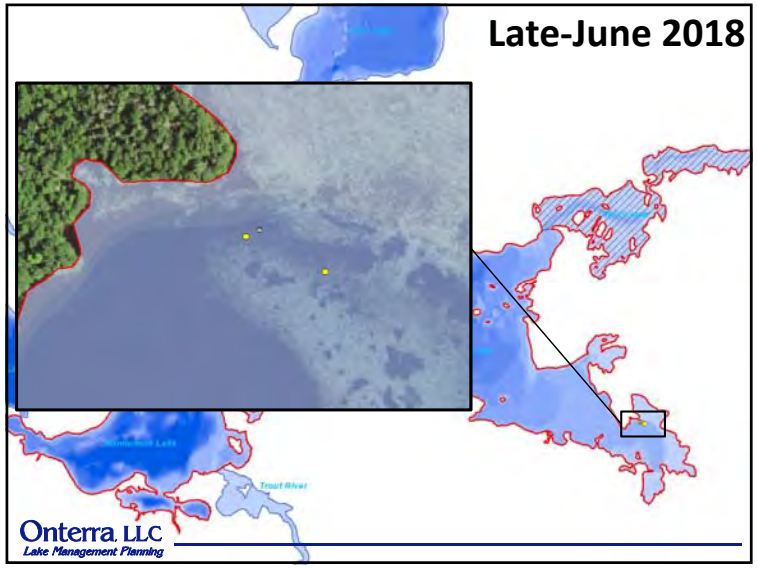
Onterra LLC
Lake Management Planning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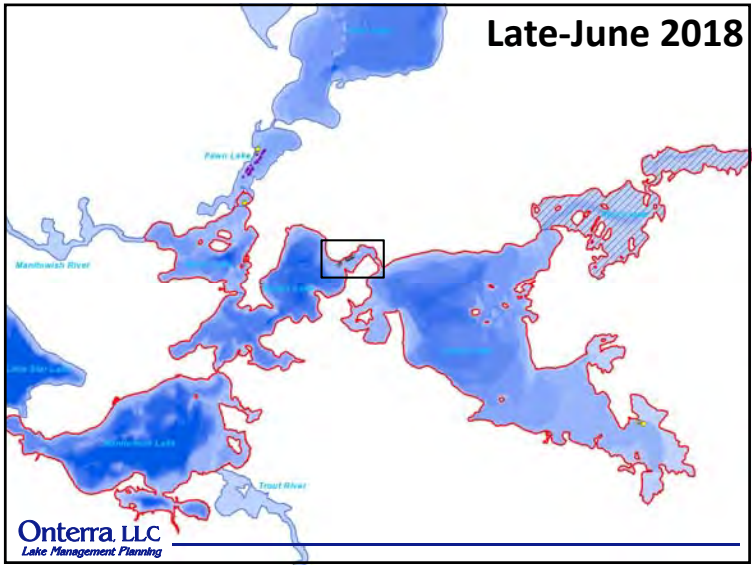
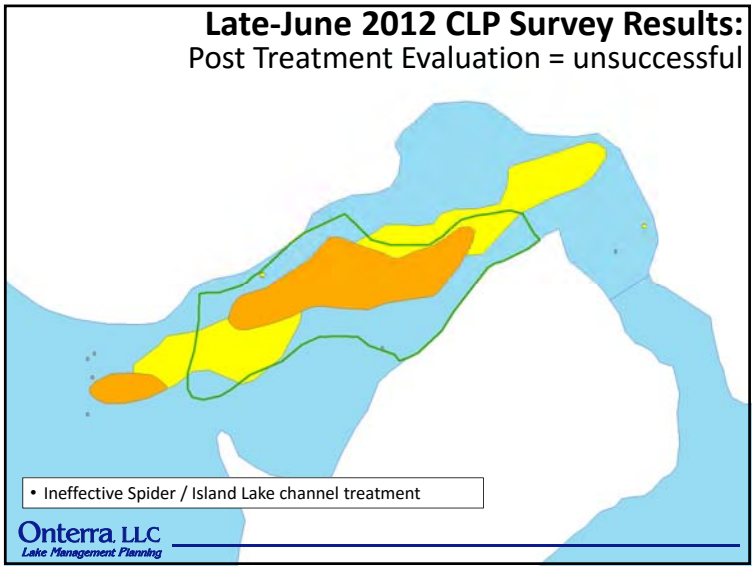
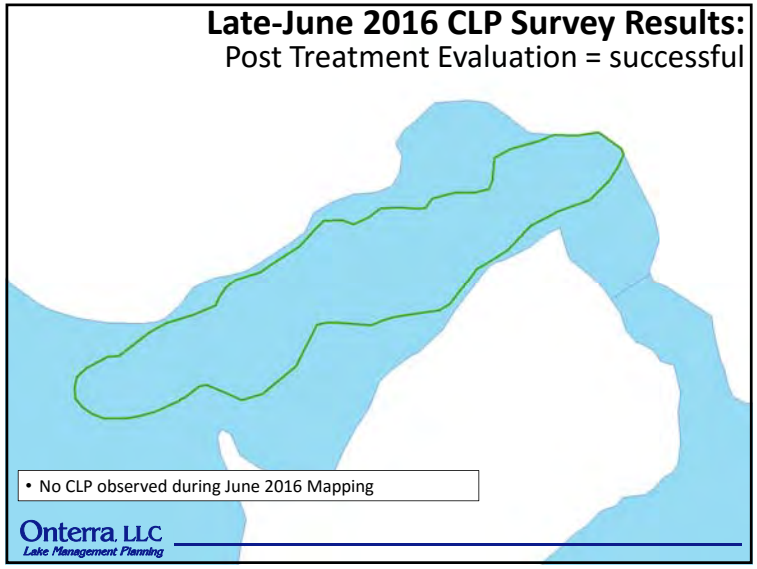
Lake Management Planning

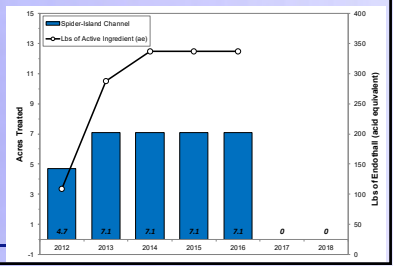

Late-June 2018
Onterra LLC
Lake Management Planning





2012-2016 CLP Strategy Overview

- After unsuccessful treatment in 2012, 4 consecutive years of successful control was achieved
  - CLP was controlled before turion production
  - Native plant impacts noted in this area
- Next phase of management recommended for 2017 and beyond – monitoring and hand-harvesting



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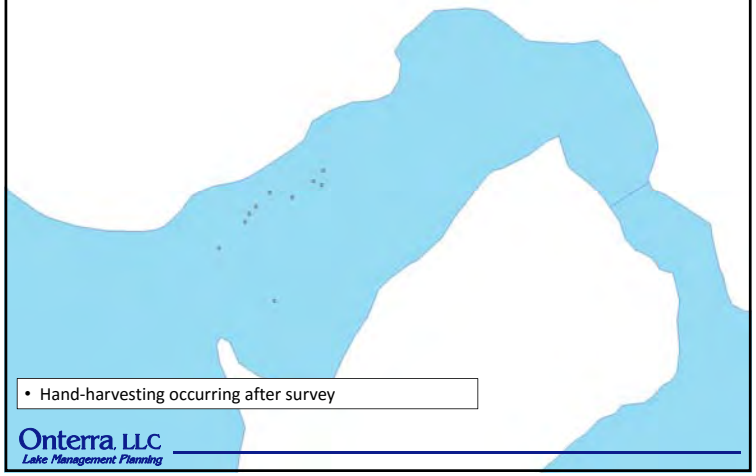
Late-June 2017 CLP Survey Results



- Hand-harvesting occurring after survey

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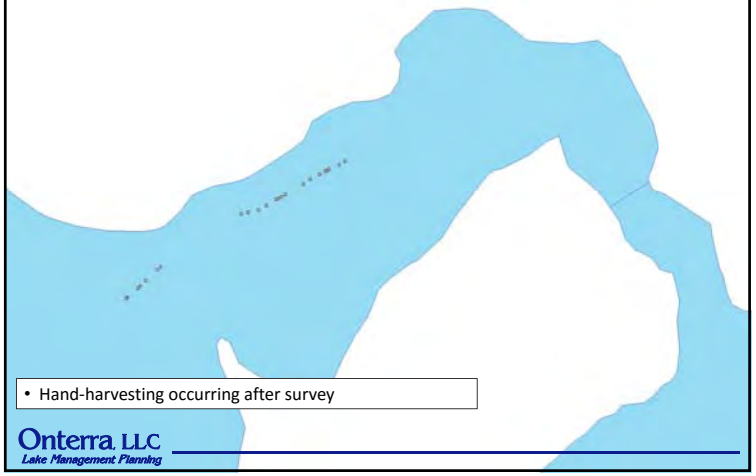
Late-June 2018 CLP Survey Results



- Hand-harvesting occurring after survey

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2017-2018 CLP Strategy Overview

- While difficult to define level of control, lack of rapid rebound of CLP population is promising
  - Turion base reductions from treatment program
  - Hand-harvesting able to keep population low, causing minimal turions being added to sediment
  - Continued monitoring of native plant population

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Phase V - Conclusions

- Watershed is in great condition
  - Land cover is of high quality
  - Areas of developed shoreline exist – restoration is best opportunity to protect lakes
- Water quality is great
  - Overall, data indicate water quality is better than expected for lakes of this type, within this region
  - All lakes are considered in a mesotrophic or lower state
- Aquatic plant community
  - Based upon standard analysis, native community is of high quality
  - Interesting and special concern species present
  - AIS continuously monitored
    - CLP, Phragmites, etc. pose controllable threat to ecosystem

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Management Goal 1

Strengthen Association Relationships, Effectiveness and Lake Management Capability

- Action: Enhance involvement with other entities that have a hand in managing Manitowish Waters Chain of Lakes
- Action: Increase the Manitowish Waters Chain's volunteer base

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Management Goal 2

Maintain Current Water Quality Conditions

- Action: Continue and expand monitoring of the Manitowish Waters Chain of Lakes' water quality through the WDNR Citizen Lake Monitoring Network
- Action: Educate property owners about the impacts of highly developed shoreland areas on the health of the Manitowish Waters Chain of Lakes and encourage shoreland restoration of these areas
- Action: Protect natural shoreland zones along the Manitowish Waters Chain of Lakes
- Action: Investigate algal blooms on the Manitowish Chain of Lakes

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Management Goal 3

Expand Awareness and Education of Lake Management and Stewardship Matters

- Action: Engage stakeholders on priority education items through efficient communication and outreach

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Management Goal 4

Control Existing and Prevent Further Aquatic Invasive Species Establishment within the Manitowish Waters Chain of Lakes

- Action: Continue control strategy for curly-leaf pondweed on the Manitowish Waters Chain of Lakes
  - Continue professional and local CLP monitoring efforts
- Action: Work with management partners to monitor curly-leaf pondweed and wild rice interactions within the Manitowish Waters Chain while assessing future management options
- Action: Reduce transport of curly-leaf pondweed from dense colony areas via watercraft

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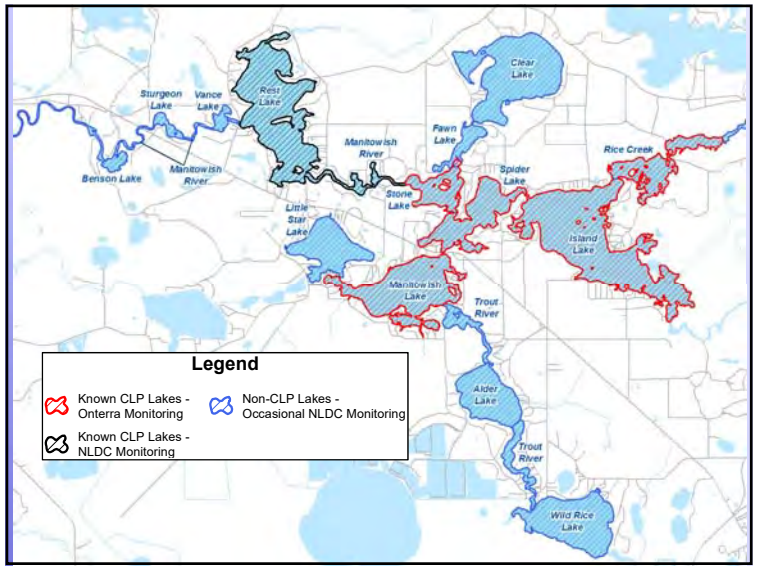

Management Goal 4, continued

Control Existing and Prevent Further Aquatic Invasive Species Establishment within the Manitowish Waters Chain of Lakes

- Action: Continue control and monitoring efforts on other aquatic invasive species that pose a threat to the Manitowish Waters Chain of Lakes
- Action: Continue locally-based efforts including aquatic invasive species monitoring through the Lake Captain and Deckhand Program and watercraft inspections
- Action: Investigate feasibility of alternative aquatic invasive species control methodologies for applicability to the Manitowish Waters Chain of Lakes

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Management Goal 5

Enhance the Available Habitat and General Understanding of the Manitowish Waters Chain of Lakes Fishery

- Action: Work with WDNR fisheries managers and other stakeholders to enhance and understand the fishery

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Management Goal 6

Continue to Understand, Protect and Enhance the Ecology of the Manitowish Chain of Lakes Through Stakeholder Stewardship and Science-based Studies

- Action: Continue the development of comprehensive management plans for the Manitowish Chain waterbodies

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