A

APPENDIX A

Public Participation Materials

Presentation Outline

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

Onterra LLC
Lake Management Planning

Onterra, LLC

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

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Lake Management Planning

Why create a lake management plan?

- To create a better understanding of the lake's positive and negative attributes.
- To discover ways to minimize the negative attributes and maximize the positive attributes.
- To foster realistic expectations and dispel myths.
- To create a snapshot of the lake for future reference and planning.

A goal without a plan is just a wish!

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Elements of an Effective Lake Management Planning Project

Data and Information Gathering

Environmental & Sociological

Planning Process

Brings it all together

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Data and information gathering

- Study Components
  - Water Quality Analysis
  - Shoreland Condition Assessment
  - Course Woody Habitat Assessment
  - Watershed Review
  - Aquatic Plant Surveys
  - Fisheries Data Integration

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Water Quality Analysis

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

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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
  - Volunteer survey findings

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Non-native Aquatic Plants

Curly-leaf Pondweed

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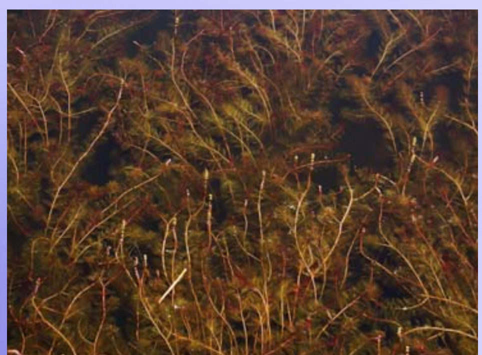
Lake Management Planning

Non-native Aquatic Plants

Eurasian Water Milfoil



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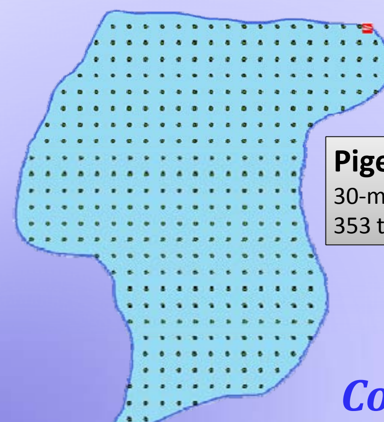
Lake Management Planning



Pigeon Lake
30-meter resolution
353 total points

Completed by WDNR in 2012

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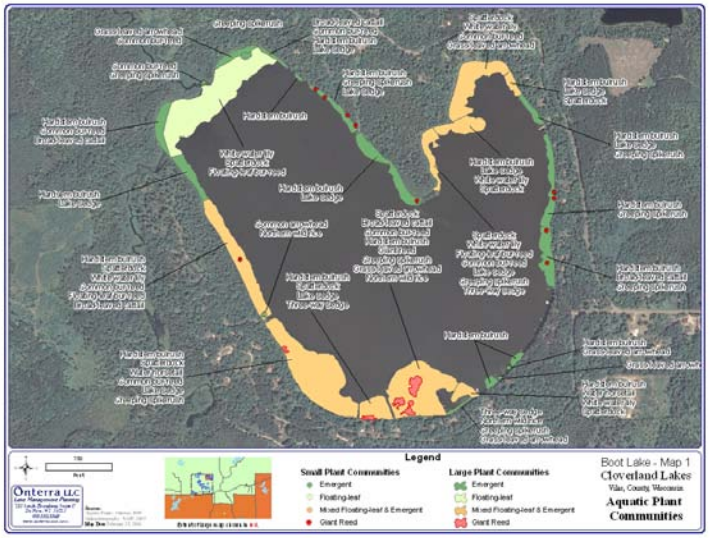
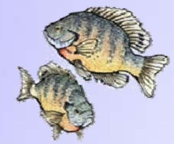


Fisheries Data Integration

- No fish sampling completed
- Assemble data from WDNR and other agencies
- Fish survey results summaries (if available)
- Use information in planning as applicable



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Shoreland Condition 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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Course Woody Habitat Assessment

- Course woody habitat is important for:
  - Shoreland stabilization
  - Insect and amphibian structure
  - Fish refuge and foraging
- Assessment includes all woody structure:
  - Extending 5’ into the lake
  - In 1’ or more water depth
  - 2” or greater in diameter

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Planning Process
Planning Committee Meeting
Study Results (including past studies)
Conclusions & Initial Recommendations
Management Goals
Management Actions
Timeframe
Facilitator(s)
Implementation Plan
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Thank You
Many of the graphics used in this presentation were supplied by:
Wisconsin
Lakes
Partnership
Extension
WISCONSIN
DEPT. OF NATURAL RESOURCES
Onterra, LLC
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Pigeon Lake Aquatic Plant Management Plan Update

November 2013 Update
Submitted by: Brenton Butterfield & Eddie Heath, Onterra, LLC

With the help of an Education, Planning, and Prevention Grant totaling nearly $10,000 through the Wisconsin Department of Natural Resources (WDNR), a project is underway to update the Aquatic Plant Management Plan for Pigeon Lake. This updated plan will contain historical and current data from the lake as well as provide guidance for its management by integrating stakeholder perceptions and goals with what is ecologically beneficial for the lake.

As described further below, numerous field studies were carried out on Pigeon Lake in 2013. Because of the wealth of data that was collected just within the past few months, much of the data analysis has yet to be completed. This update intends to bring the Pigeon Lake of Manitowoc County, Inc. (PLMC) up-to-speed on the scientific studies that have occurred, provide some initial observations on the ecology of Pigeon Lake, and provide a rough timeline for the remaining actions that will be taken as a part of this planning project.

On June 13, 2013, Onterra staff had their first visit to Pigeon Lake where they conducted an Early-Season Aquatic Invasive Species (ESAIS) Survey. The meander-based survey's purpose is to locate and map any potential aquatic invasive plant species, with a primary focus on location occurrences of curly-leaf pondweed (CLP) as this is when this plant is at or near its peak growth. This survey is also useful in finding incidences of Eurasian water milfoil (EWM) as it is further along in growth than most native plants in early summer. While not typically done at this time of year, areas of Eurasian water milfoil were mapped in detail to aid in the Eurasian water milfoil Peak-Biomass Survey conducted later in the summer. During the ESAIS Survey, Onterra ecologists were not able to locate any occurrences of CLP. Using a submersible camera, transects were conducted through areas where CLP had been located in a past survey (2005), though none was observed.

Onterra did not conduct a whole-lake point-intercept survey in 2013, as this survey was conducted by the WDNR in 2012. The aquatic plant community mapping survey, where areas of emergent and floating-leaf plant communities are delineated, was completed by Onterra on August 27, 2013. The Eurasian water milfoil peak-biomass survey was also conducted at this time. From this survey, just over 3 acres of colonized Eurasian water milfoil were mapped around the lake (see attached map).

The WDNR point-intercept survey indicates that Pigeon Lake contains 17 native aquatic plant species. Aquatic plants were found growing to a maximum depth of 20 feet, a testament to Pigeon Lake's high water clarity. The average Secchi disk depth for the summer of 2012 was 9.1 feet. Slender naiad, muskgrasses, and Illinois pondweed, all native species, were the most frequently encountered aquatic plants in the WDNR's 2012 survey, while EWM comprised a relative small portion (4%) of the lake's plant community (Figure 1).

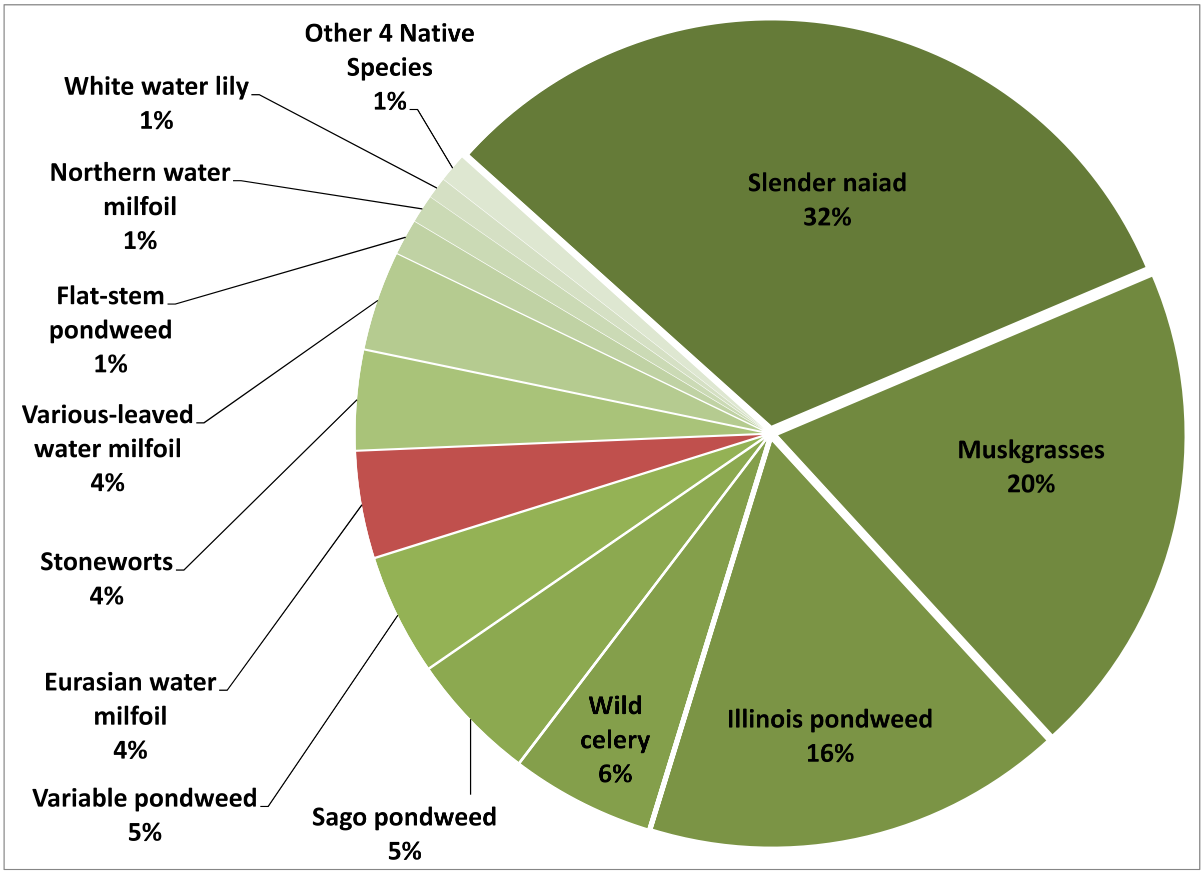

Figure 1. Pigeon Lake 2012 aquatic plant relative frequency of occurrence. Created using data from WDNR 2012 whole-lake point-intercept survey. Non-native species are indicated with red.

In the coming months, Onterra will be sorting through the water quality and aquatic plant data, and in addition, we will be looking at the watershed surrounding the lake and using a modeling program to estimate the amount of nutrients the lake receives on an annual basis.

In summary, all project components are on schedule. Following data analysis and report creation, the Pigeon Lake Planning Committee and Onterra staff will meet to discuss the project results and begin creation of management goals and actions the PLMC will pursue to manage their lake in both a recreationally enjoyable and ecologically sound manner. Likely one of the management goals will outline a management strategy for EWM. Onterra is in the process of investigating the applicability of various management strategies on Pigeon Lake, including but not limited to, coordinated hand-removal, herbicide treatments, and no-action but continued monitoring. This alternatives analysis will be presented in detail to the PLMC Planning Committee at the upcoming meetings for further discussion and consideration.


Pigeon Lake of Manitowoc County, Inc.
Pigeon Lake
Management Planning Project
Planning Meeting I
April 16, 2014
Tim Hoyman
Onterra LLC
Lake Management Planning


Presentation Outline
• Lake Management Planning Project Overview
• Study Results
– Water Quality
– Watershed
– Shoreland
– Aquatic Plants
– Fishery
– AIS (Eurasian water milfoil)
• "Big Picture"
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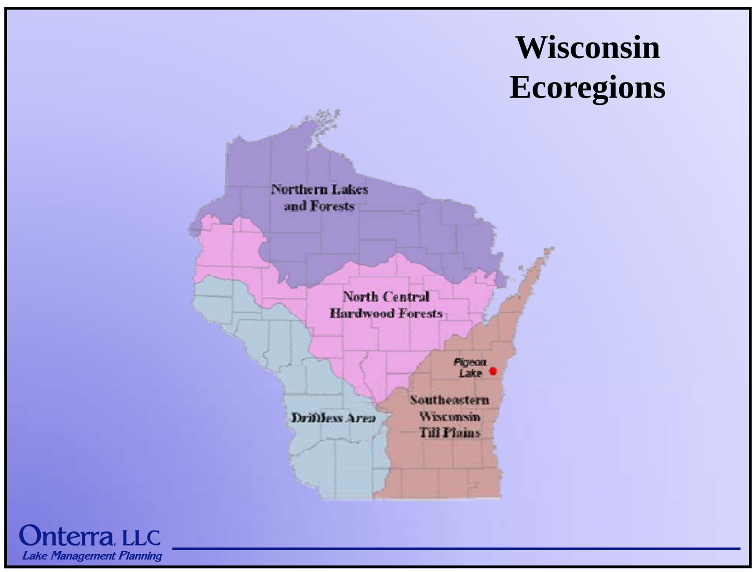
Wisconsin Ecoregions
Northern Lakes and Forests
North Central Hardwood Forests
Pigeon Lake
Southeastern Wisconsin Till Plains
Driftless Area
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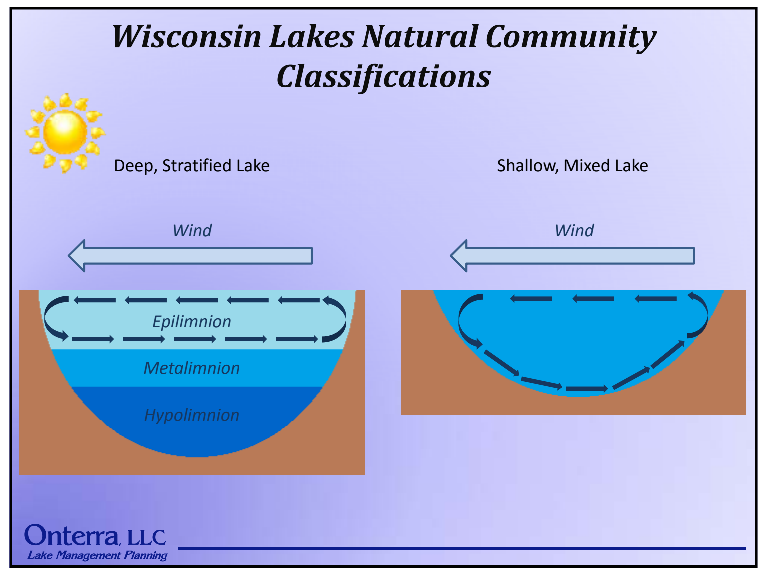
Wisconsin Lakes Natural Community Classifications
Deep, Stratified Lake
Shallow, Mixed Lake
Wind
Wind
Epilimnion
Metalimnion
Hypolimnion
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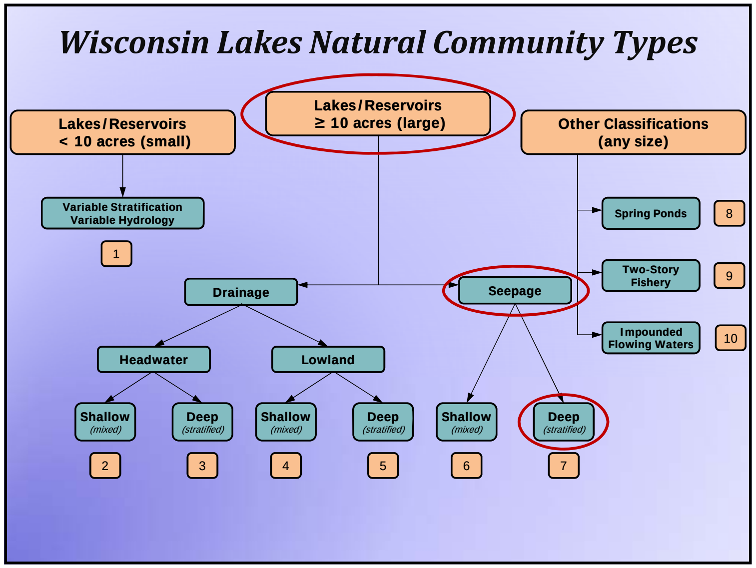
Lake Management Planning



Water Quality

Phosphorus (Limiting Plant Nutrient)

Lake is P limited (N:P)

Chlorophyll-*a* (Algal Abundance)

Low to moderate abundance

Water Clarity (Secchi Disk)

Moderate water clarity

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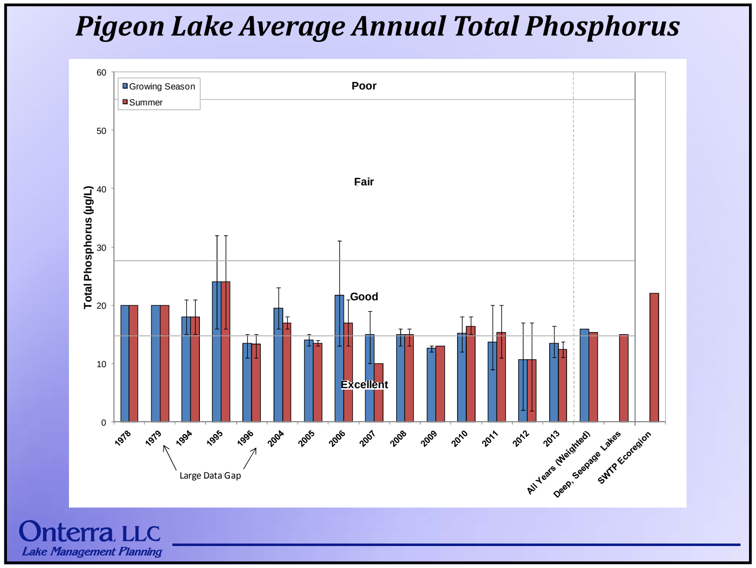
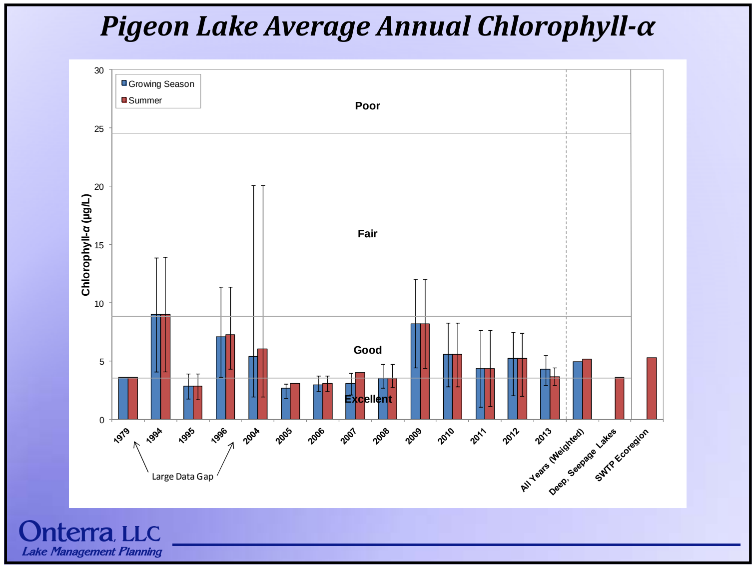
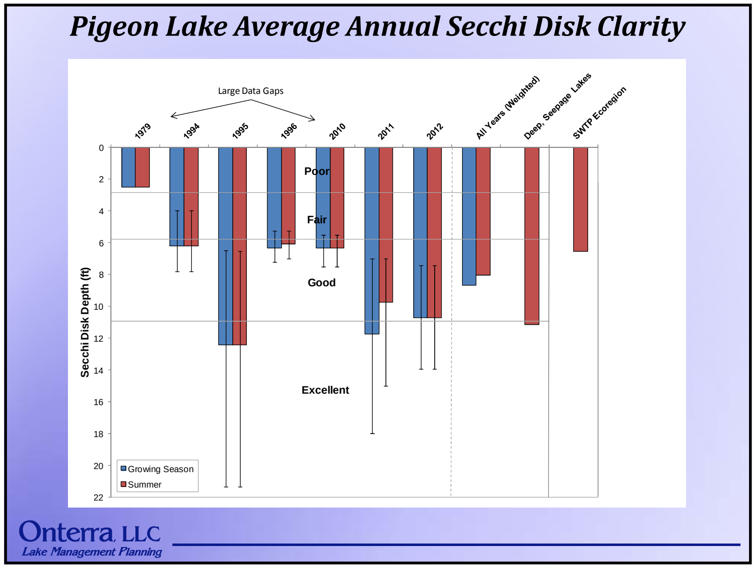
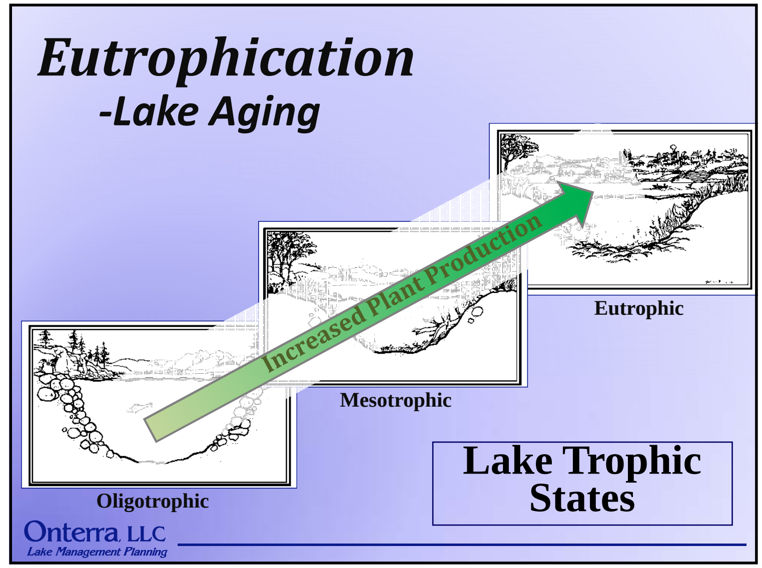





Pigeon Lake Average Annual Secchi Disk Clarity
Large Data Gaps
1979
1994
1995
1996
2010
2011
2012
All Years (Weighted)
Deep, Seepage Lakes
SWTP Ecoregion
Secchi Disk Depth (ft)
Poor
Fair
Good
Excellent
Growing Season
Summer
Onterra, LLC
Lake Management Planning


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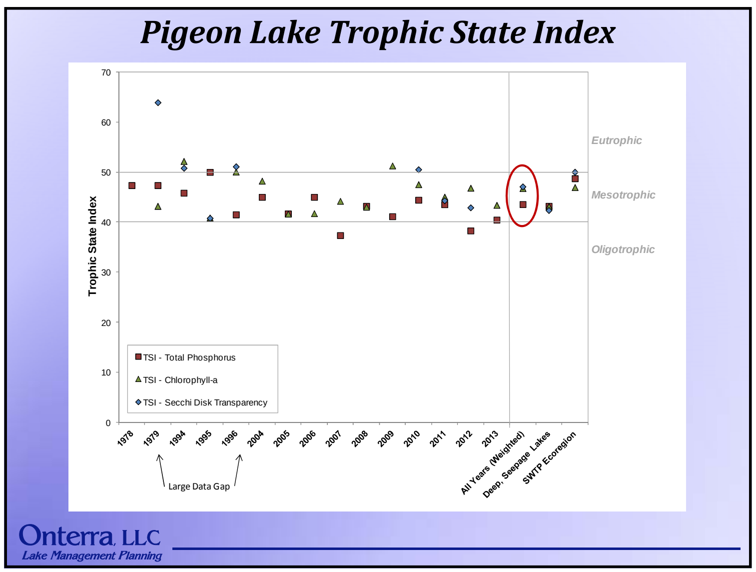
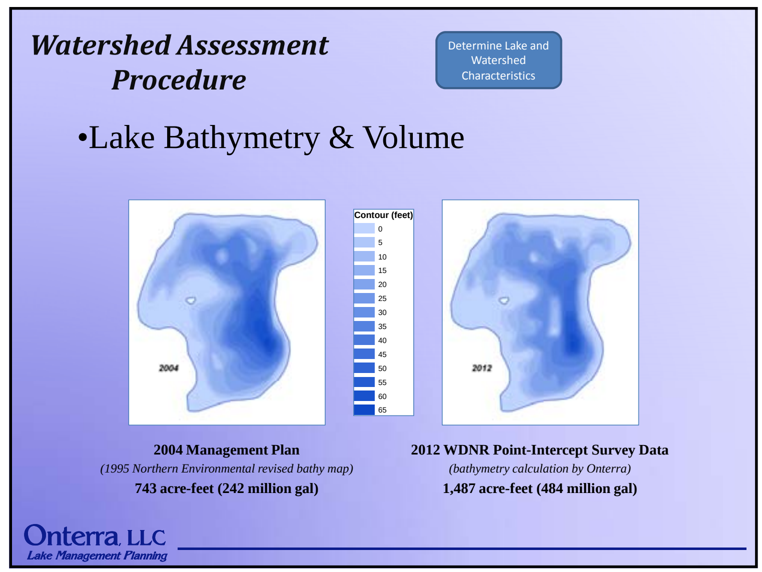
Lake Management Planning


Pigeon Lake Trophic State Index
Trophic State Index
Eutrophic
Mesotrophic
Oligotrophic
TSI - Total Phosphorus
TSI - Chlorophyll-a
TSI - Secchi Disk Transparency
1978
1979
1994
1995
1996
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
All Years (Weighted)
Deep, Seepage Lakes
SWTP Ecoregion
Large Data Gap
Onterra, LLC
Lake Management Planning


Watershed Assessment Procedure
Determine Lake and Watershed Characteristics
•Lake Bathymetry & Volume
2004
2012
Contour (feet)
2004 Management Plan
(1995 Northern Environmental revised bathy map)
743 acre-feet (242 million gal)
2012 WDNR Point-Intercept Survey Data
(bathymetry calculation by Onterra)
1,487 acre-feet (484 million gal)
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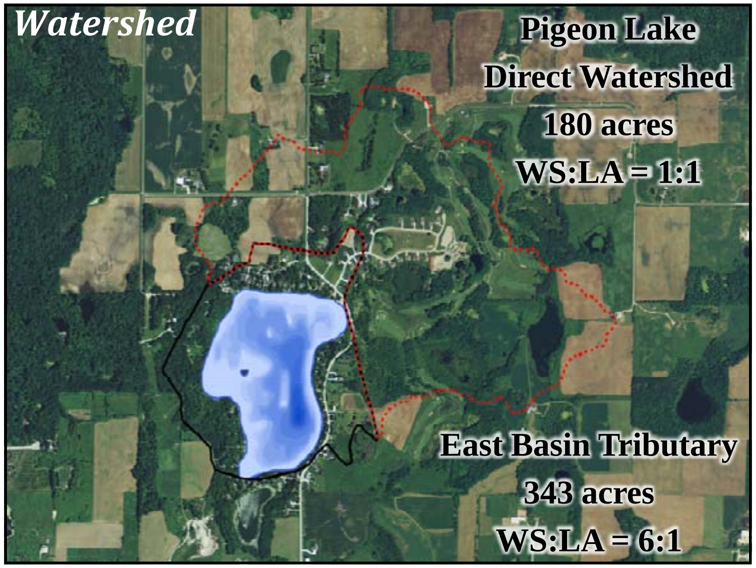
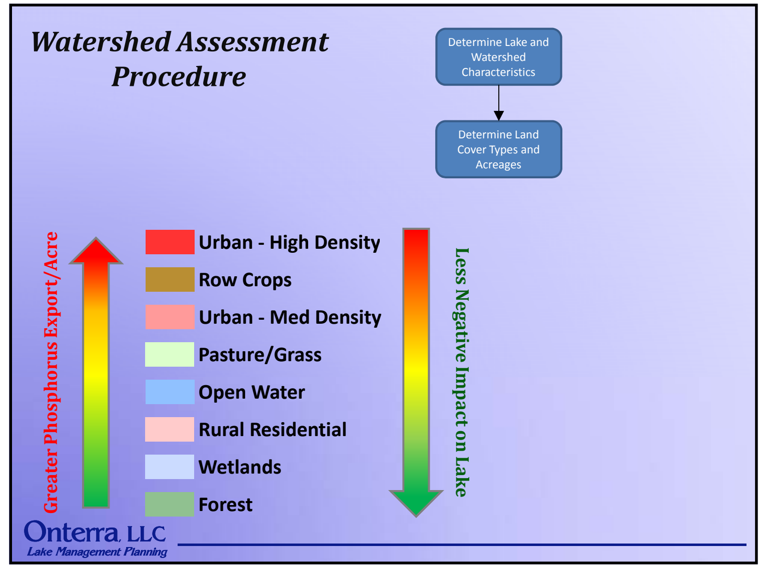

Watershed
Pigeon Lake
Direct Watershed
180 acres
WS:LA = 1:1
East Basin Tributary
343 acres
WS:LA = 6:1


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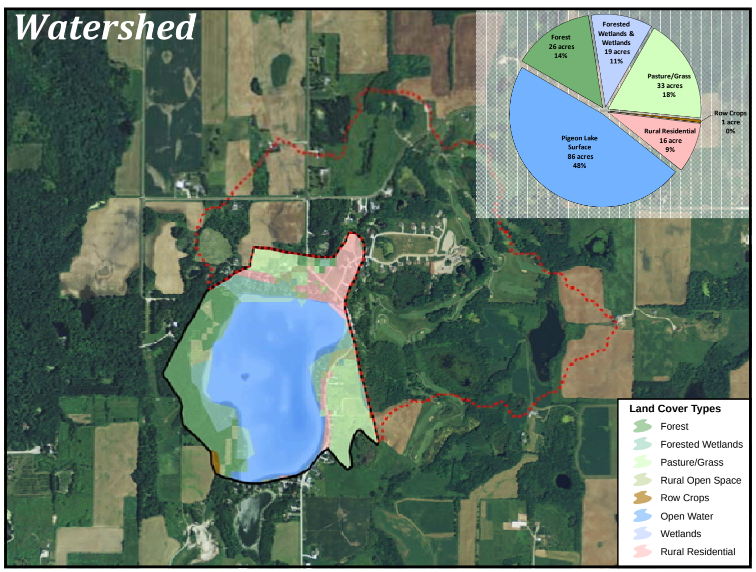
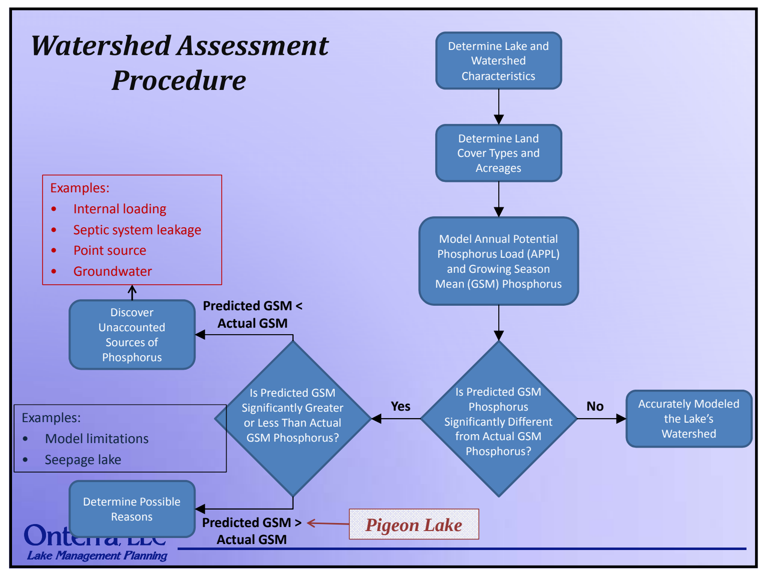
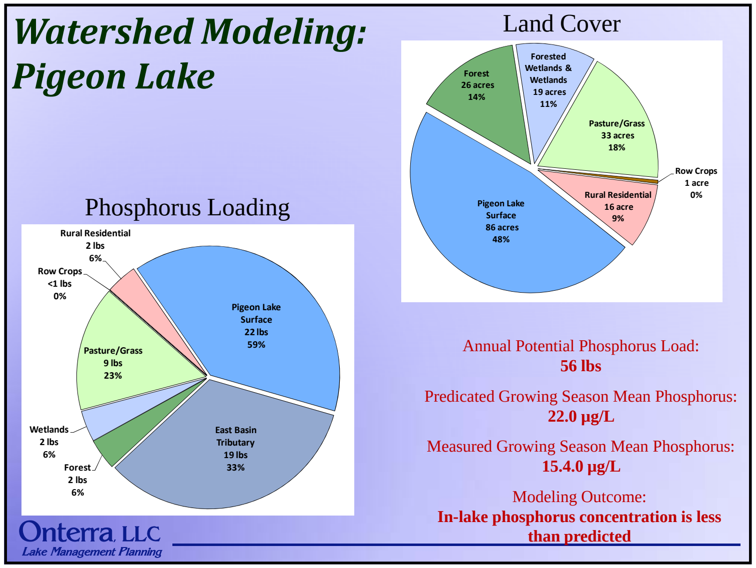

Watershed
Forest 26 acres 14%
Forested Wetlands & Wetlands 19 acres 11%
Pasture/Grass 33 acres 18%
Row Crops 1 acre 0%
Rural Residential 16 acre 9%
Pigeon Lake Surface 86 acres 48%
Land Cover Types
Forest
Forested Wetlands
Pasture/Grass
Rural Open Space
Row Crops
Open Water
Wetlands
Rural Residential


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


Watershed Modeling: Pigeon Lake
Land Cover
Forest 26 acres 14%
Forested Wetlands & Wetlands 19 acres 11%
Pasture/Grass 33 acres 18%
Row Crops 1 acre 0%
Rural Residential 16 acre 9%
Pigeon Lake Surface 86 acres 48%
Phosphorus Loading
Rural Residential 2 lbs 6%
Row Crops <1 lbs 0%
Pigeon Lake Surface 22 lbs 59%
Pasture/Grass 9 lbs 23%
Wetlands 2 lbs 6%
Forest 2 lbs 6%
East Basin Tributary 19 lbs 33%
Annual Potential Phosphorus Load:
56 lbs
Predicated Growing Season Mean Phosphorus:
22.0 µg/L
Measured Growing Season Mean Phosphorus:
15.4.0 µg/L
Modeling Outcome:
In-lake phosphorus concentration is less than predicted
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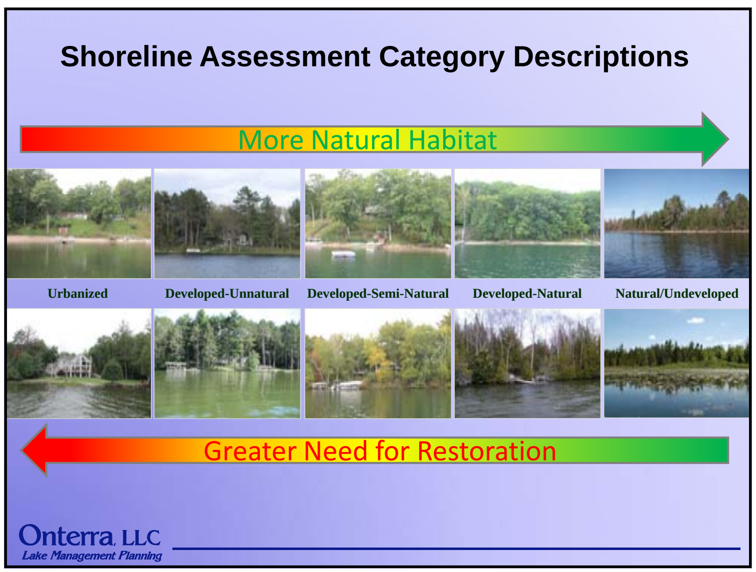
Lake Management Planning


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


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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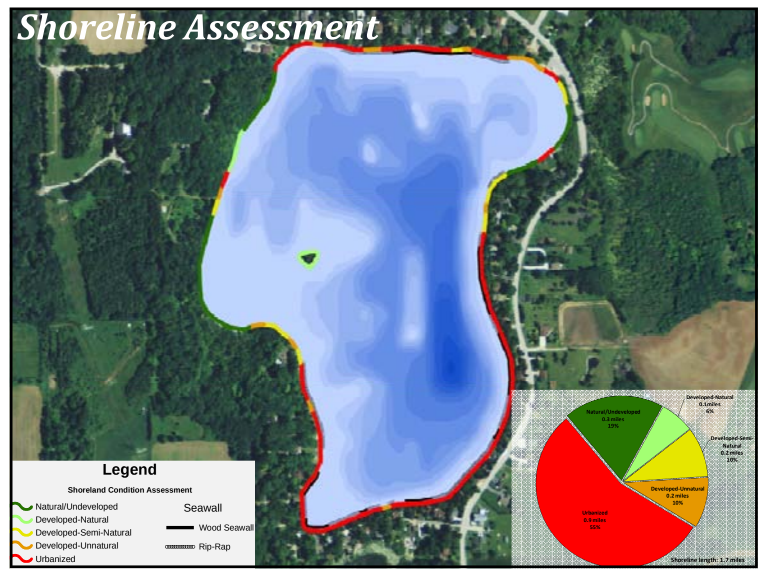
Shoreline Assessment
Legend
Shoreland Condition Assessment
Natural/Undeveloped
Developed-Natural
Developed-Semi-Natural
Developed-Unnatural
Urbanized
Seawall
Wood Seawall
Rip-Rap

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 Pigeon Lakes

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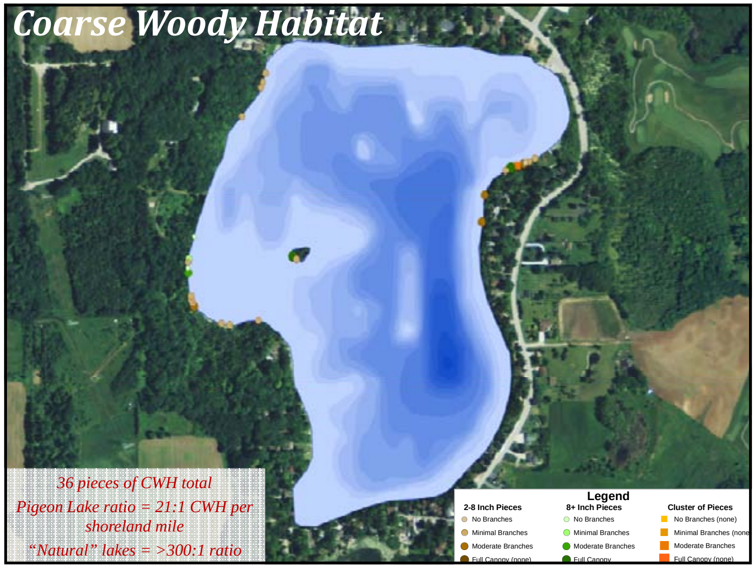
Coarse Woody Habitat

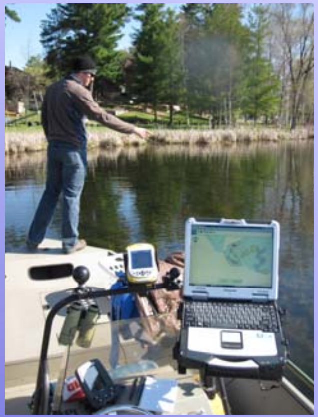


36 pieces of CWH total
Pigeon Lake ratio = 21:1 CWH per shoreland mile
"Natural" lakes = >300:1 ratio

Early Season AIS Survey

Meander based survey – find AIS if it is present.

Onterra completed: June 13, 2013



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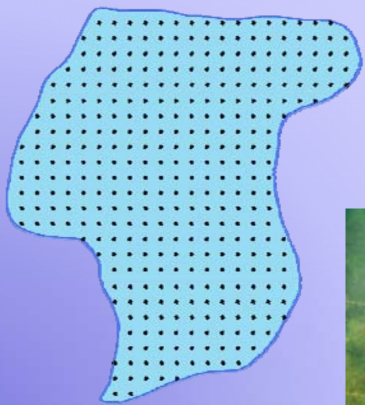
Point Intercept Survey

353 total points @ 30 meters

WDNR completed: Sept. 5, 2012



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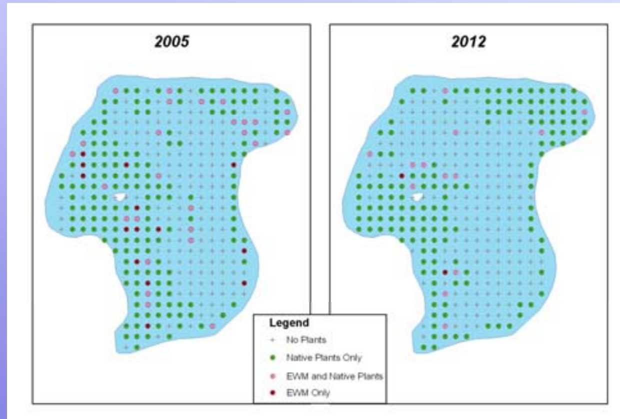
Aquatic Plant Distribution



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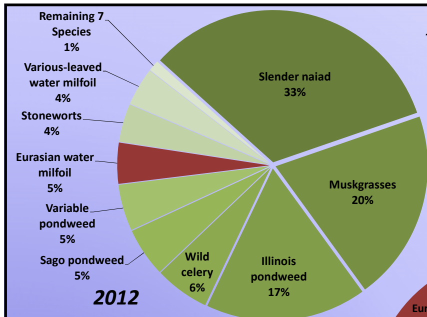
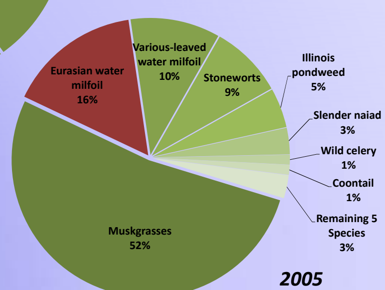
Aquatic Plant Summary

Pigeon Lake

- 19 native species
  - 15 on PI survey
  - 4 incidentally
- 3 non-native plant species
  - Eurasian water milfoil
  - Pale yellow iris
  - Purple loosestrife
- Maximum depth of plants = 21 feet

Relative Frequency





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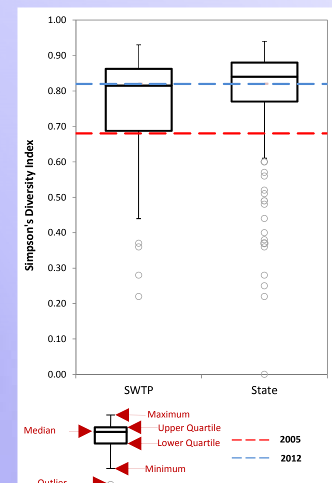
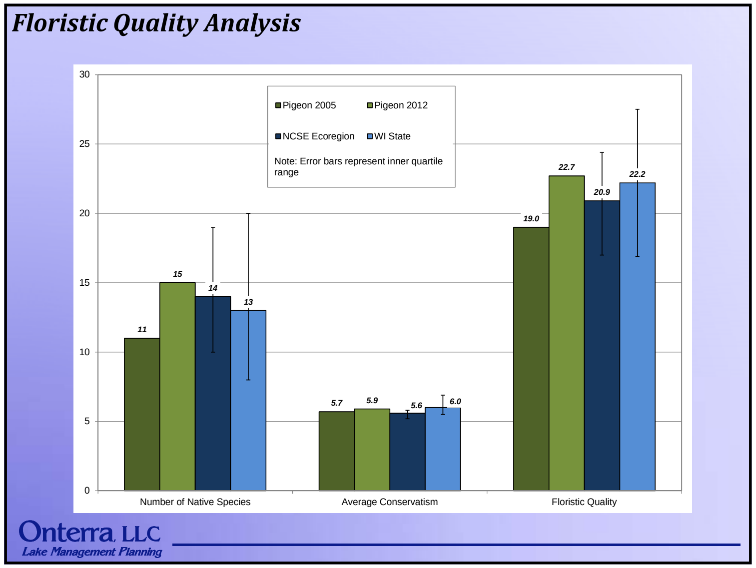
Simpson's Diversity

- Measures how "even" the distribution of plants are in a lake.
  - 2005 = 0.68
  - 2012 = 0.82



Onterra, LLC
Lake Management Planning


Floristic Quality Analysis
Pigeon 2005
Pigeon 2012
NCSE Ecoregion
WI State
Note: Error bars represent inner quartile range
30
25
20
15
10
5
0
11
15
14
13
5.7
5.9
5.6
6.0
19.0
22.7
20.9
22.2
Number of Native Species
Average Conservatism
Floristic Quality
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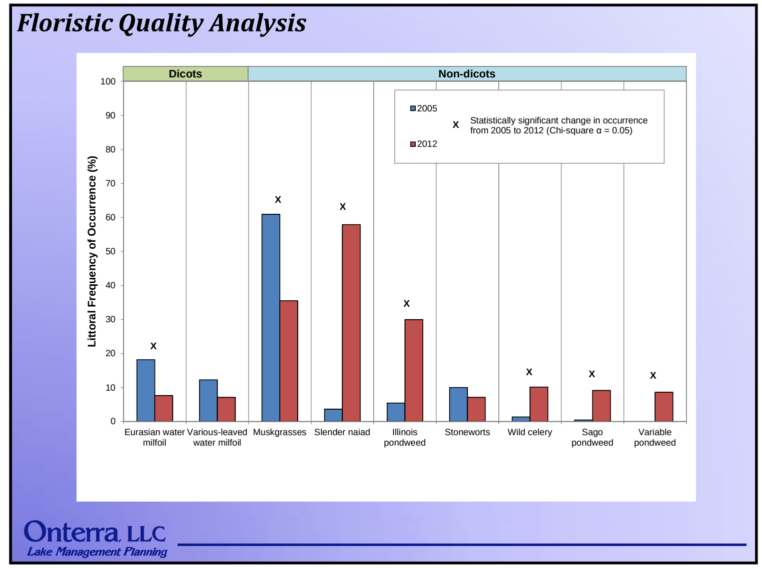
Floristic Quality Analysis
Dicots
Non-dicots
2005
2012
X Statistically significant change in occurrence from 2005 to 2012 (Chi-square α = 0.05)
Littoral Frequency of Occurrence (%)
100
90
80
70
60
50
40
30
20
10
0
Eurasian water milfoil
Various-leaved water milfoil
Muskgrasses
Slender naiad
Illinois pondweed
Stoneworts
Wild celery
Sago pondweed
Variable pondweed
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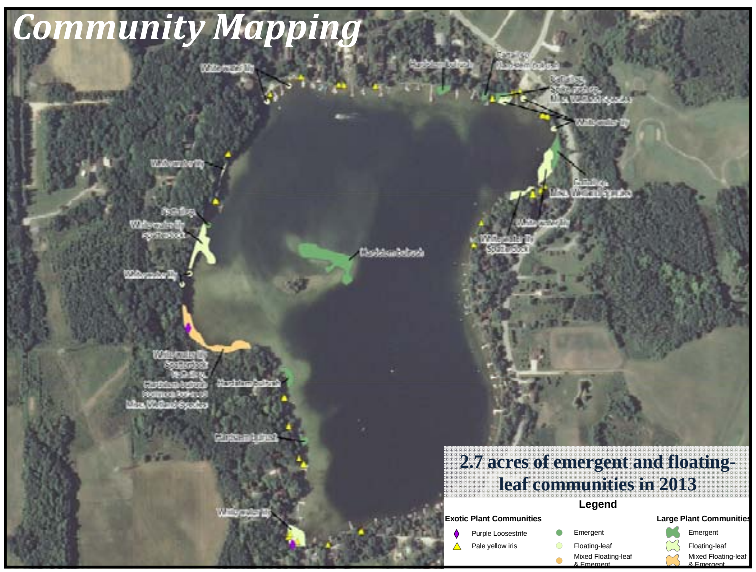
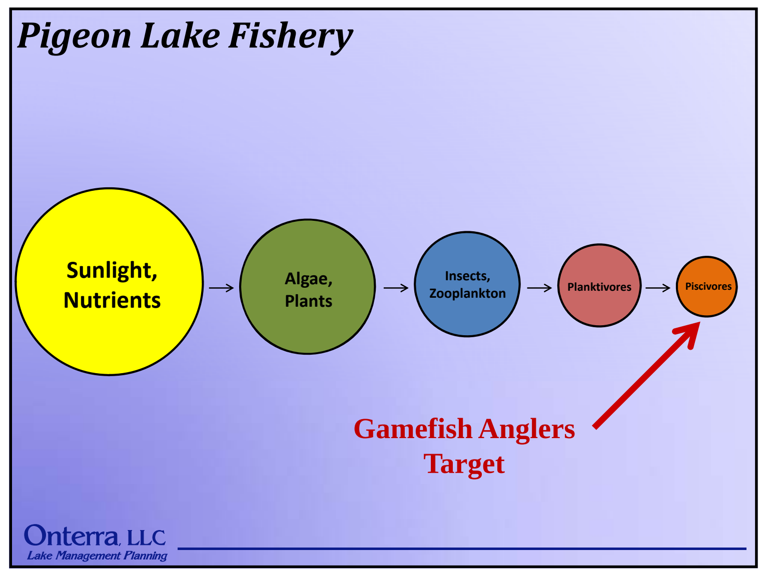
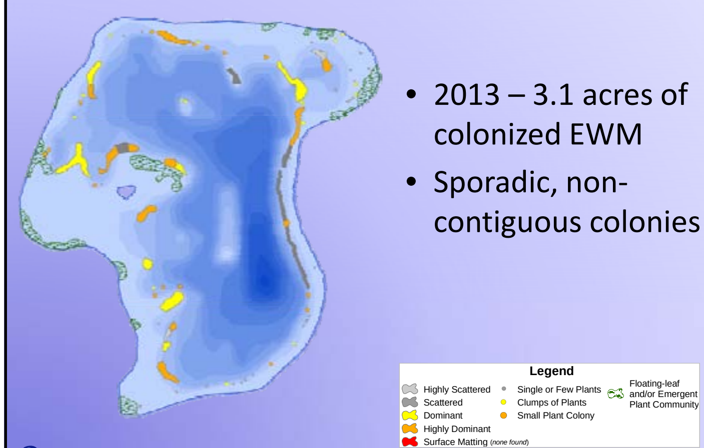

Community Mapping
2.7 acres of emergent and floating-leaf communities in 2013
Legend
Exotic Plant Communities
Purple Loosestrife
Pale yellow iris
Emergent
Floating-leaf
Mixed Floating-leaf & Emergent
Large Plant Communities
Emergent
Floating-leaf
Mixed Floating-leaf & Emergent


Pigeon Lake Fishery
Sunlight, Nutrients
Algae, Plants
Insects, Zooplankton
Planktivores
Piscivores
Gamefish Anglers Target
Onterra, LLC
Lake Management Planning

Pigeon Lake Fishery

- **Managed for walleye & largemouth bass**
  - Walleye
    - Little natural walleye spawning habitat
    - Stocking program implemented since 1970's
  - Bass
    - Small size compared to state averages
    - Growth rates greater than state averages
    - Substantial harvest may be occurring
    - 2000 fish kill impacts on population?
  - Concerns for fishery
    - Critical habitat loss to shoreland development & fast boating
    - Native submergent vegetation

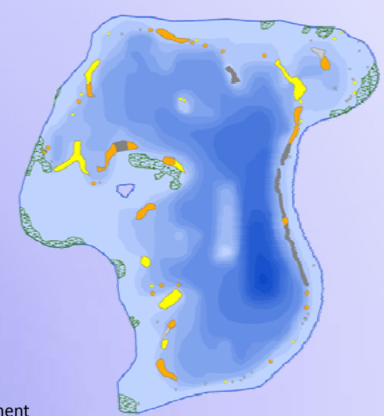
Pigeon Lake Eurasian Water Milfoil



- 2013 – 3.1 acres of colonized EWM
- Sporadic, non-contiguous colonies

AIS Control Strategies

- Do nothing (No AIS Management)
- Drawdown
  - Can be effective, not feasible
- Mechanical Harvesting
  - Not a long-term solution
  - May spread AIS to other areas of lake
  - Disrupts native vegetation
- Manual removal
  - Effective with small, localized colonies
  - Minimal/moderate cost (volunteers?)
- Bio-control
  - Not a proven technique for control
  - Not applicable for grant funding
- Herbicide Treatments
  - Moderate/high costs
  - Effective when properly planned
  - Spot Treatment vs. Whole Lake Treatment



Eurasian Water Milfoil Control Strategies: Herbicide Use

Spot Treatment

- Herbicide applied to a treatment area, with site-specific considerations.
- Effectiveness hard to reach due to dilution and dissipation.
  - Seasonal vs. long-term effectiveness

Whole Lake Treatment

- Herbicide is applied to treatment areas with whole-lake considerations.
- Dilution and dissipation accounted for in application strategy.

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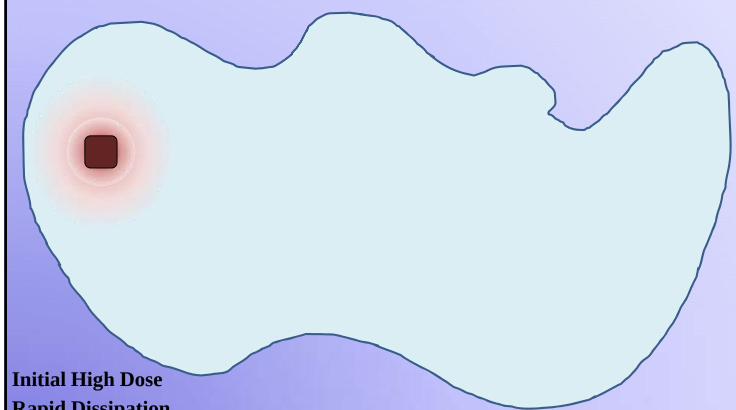
Spot Treatment Use Pattern



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

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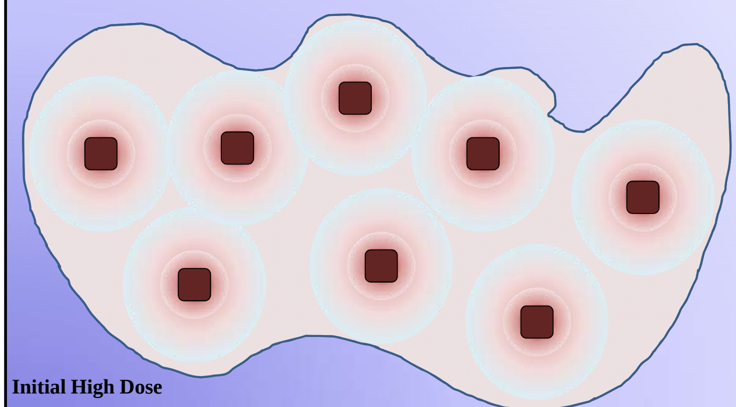
Whole-lake Use Pattern



Initial High Dose
Rapid Dissipation
Low-dose lake-wide concentration significant to cause control

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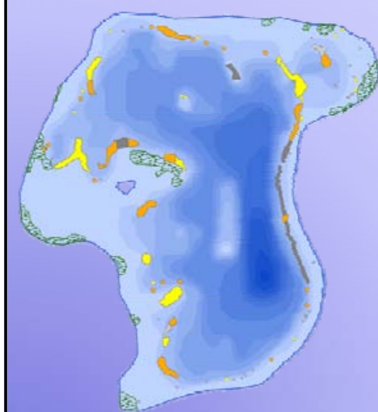
Pigeon Lake Eurasian Water Milfoil



Whole Lake Potential Treatment

- Application of liquid 2,4-D @ 3.25 ppm a.e.
- Anticipate herbicide mixing within upper 15-18 ft. of water column, lake-wide.
- Whole-lake concentration estimate = 0.35 ppm a.e.
- Application fees and permit = $10,000

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The Big Picture

Conclusions

- Water quality is “Good”
  - Moderate historical data – no trends detected
  - WQ may fluctuate from year to year
- Watershed is in good condition.
  - Direct watershed contains much “natural” land cover
  - Role of tributary stream uncertain.
  - Shoreland zone is highly developed and likely the biggest threat to lake’s well-being in the long-term.

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Conclusions continued

- Aquatic plant community
  - Based upon standard analysis, native plant community is of average quality
    - Moderate diverse
    - Species present are of moderate quality
  - Aquatic plant community has experienced significant changes 2005-2012
  - Aquatic plant community is of higher quality now vs. 2005
  - Concerns over AIS exist
- Fisheries
  - Habitat and human disturbance of concern

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Thank You

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Pigeon Lake of Manitowoc County, Inc.

Pigeon Lake

Management Planning Project

Wrap-Up Meeting

June 18, 2014

Tim Hoyman

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Study and Plan Goals

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

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Conclusions

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Conclusions continued

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  - Habitat and human disturbance of concern

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Water Quality

↑ **Phosphorus (Limiting Plant Nutrient)**

Lake is P limited (N:P)

↑ **Chlorophyll-*a* (Algal Abundance)**

Low to moderate abundance

↓ **Water Clarity (Secchi Disk)**

Good to moderate water clarity

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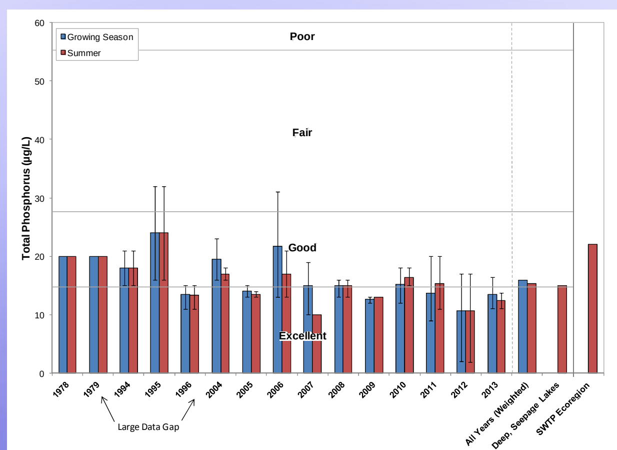
Pigeon Lake Average Annual Total Phosphorus



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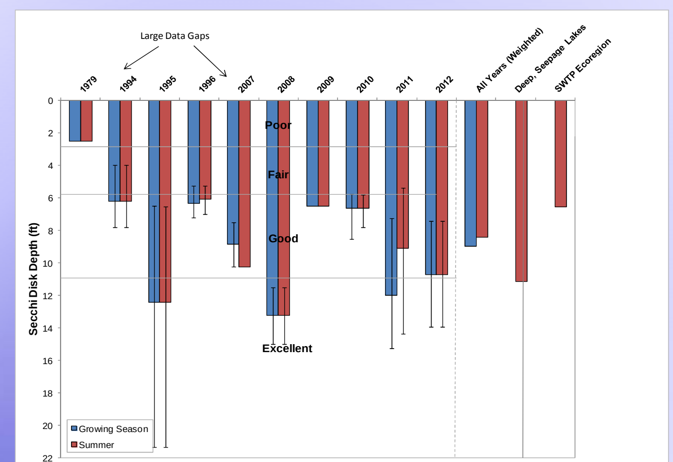
Pigeon Lake Average Annual Secchi Disk Clarity



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Conclusions

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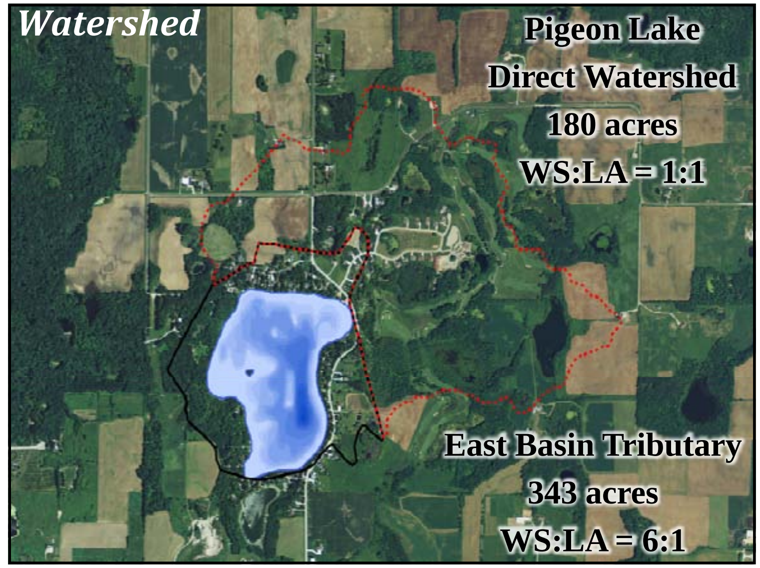
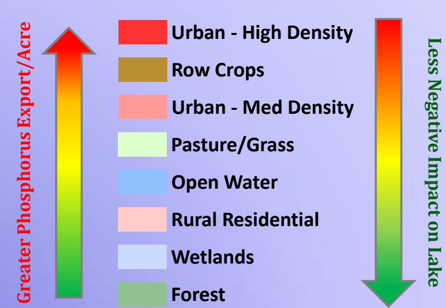


Watershed Land Cover Types



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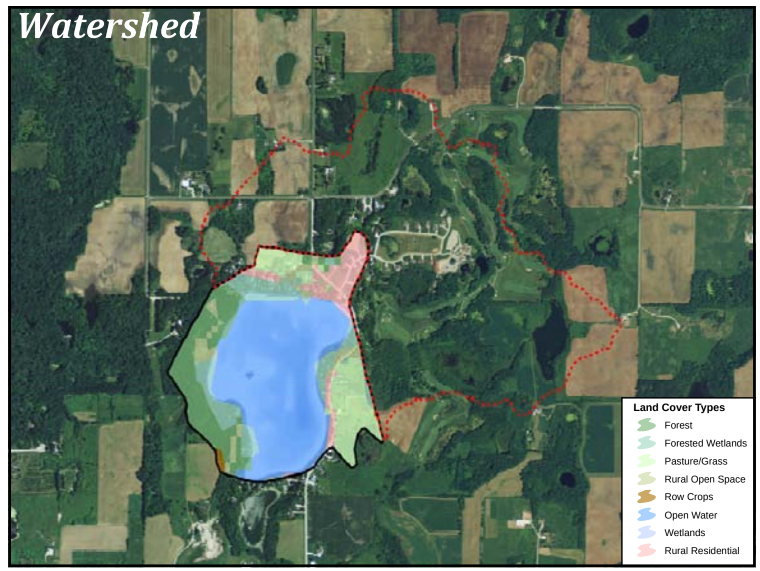
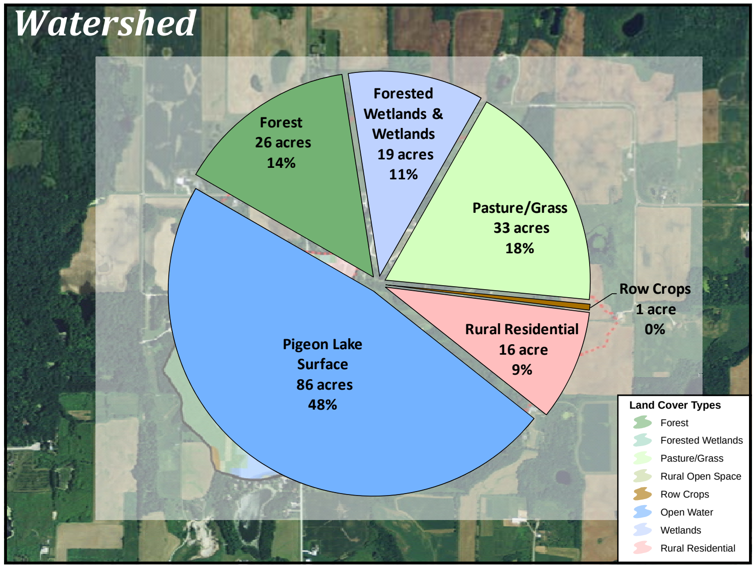
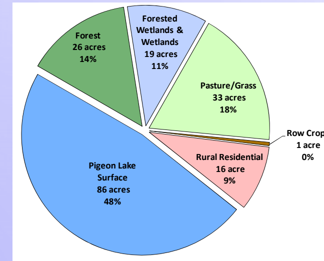


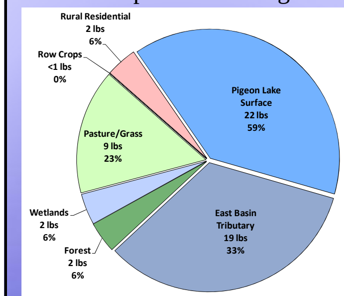


Watershed Modeling: Pigeon Lake

Land Cover



Phosphorus Loading



Annual Potential Phosphorus Load:
56 lbs

Predicated Growing Season Mean Phosphorus:
22.0 µg/L

Measured Growing Season Mean Phosphorus:
15.4.0 µg/L

Modeling Outcome:
In-lake phosphorus concentration is less than predicted

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Management Goal:
Maintain Current Lake Health

Management Actions

1. **Continue monitoring of water quality through WDNR Citizens Lake Monitoring Network.**
   Continuation of current effort
2. **Update Management Plan in five years (2019).**
   Initiate in 2018

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Conclusions

- Water quality is "Good"
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- Fisheries
  - Habitat and human disturbance of concern

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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
Natural
Range
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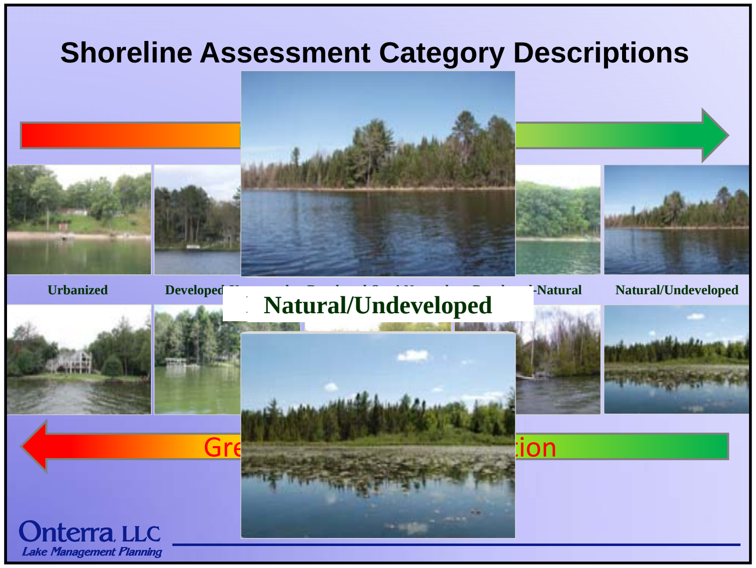
Shoreline Assessment Category Descriptions
Urbanized
Developed
Natural/Undeveloped
Natural/Undeveloped
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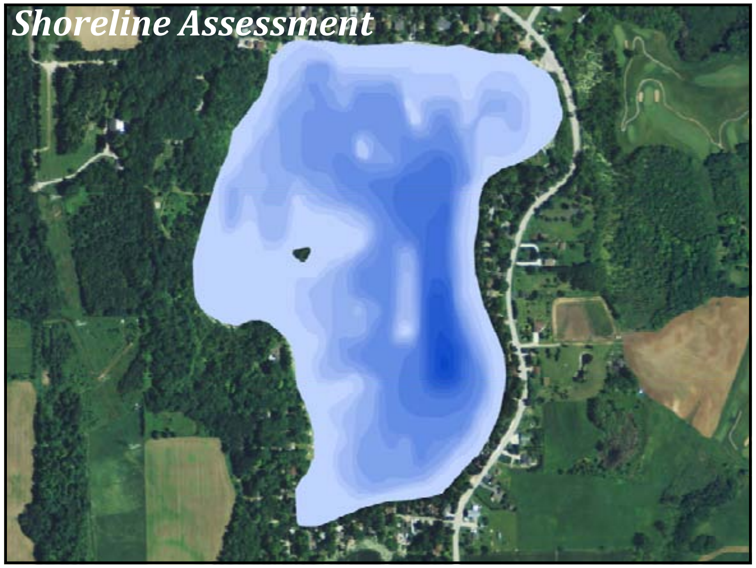
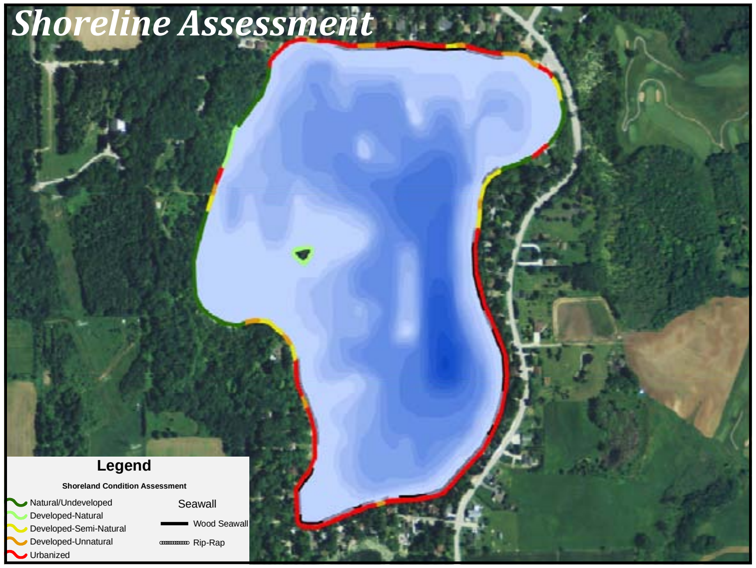
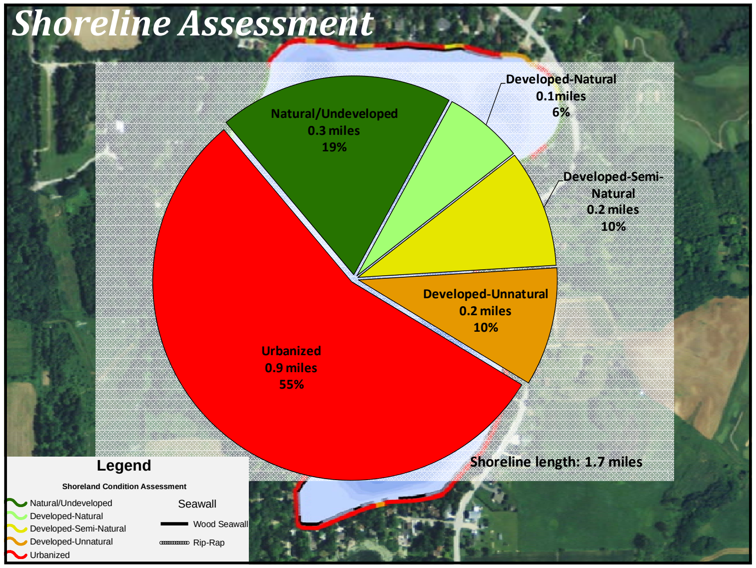

Shoreline Assessment


Shoreline Assessment
Legend
Shoreland Condition Assessment
Natural/Undeveloped
Developed-Natural
Developed-Semi-Natural
Developed-Unnatural
Urbanized
Seawall
Wood Seawall
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 Pigeon Lake

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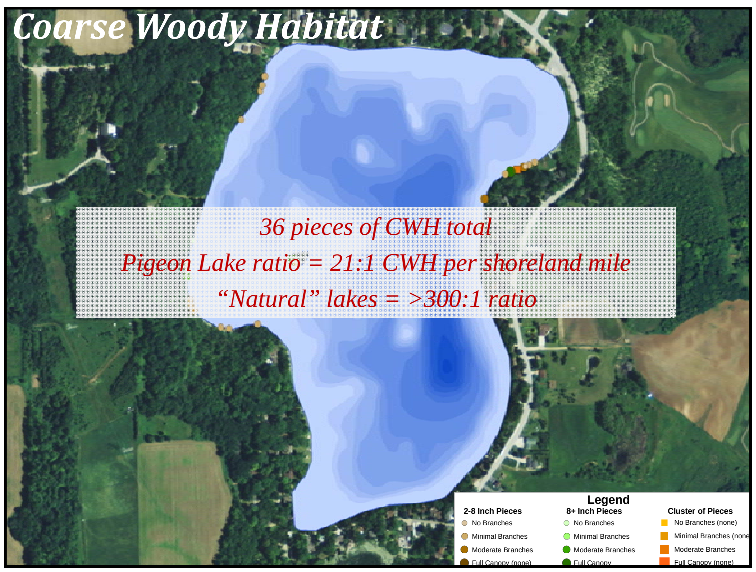

Management Goal:
Protect and Enhance Fisheries of Pigeon Lake

Management Actions

1. **Work with WDNR fisheries biologist to implement coarse woody habitat project.**
   Initiate in 2015
2. **Work with fisheries managers to understand and enhance fishery while communicating aspects of fishery studies to PLMC members.**
   Continuation of current effort

Conclusions continued

- Aquatic plant community
  - Based upon standard analysis, native plant community is of average quality
    - Moderately diverse
    - Species present are of moderate quality
  - Concerns over AIS exist

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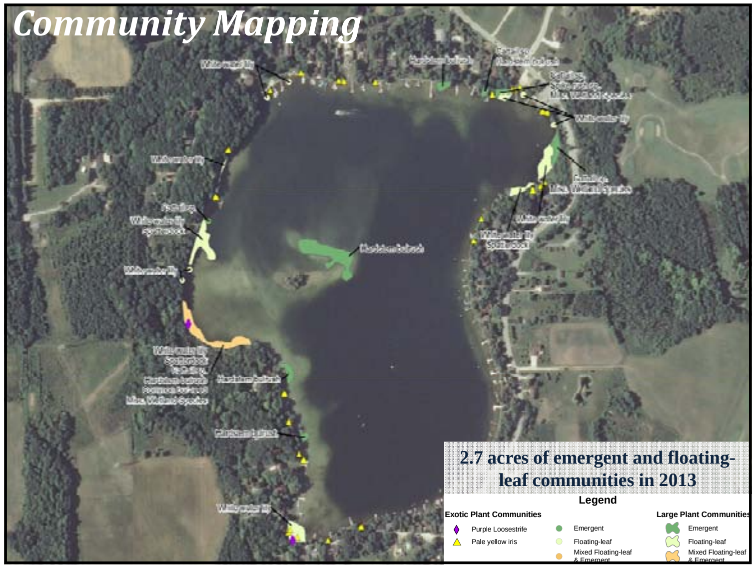
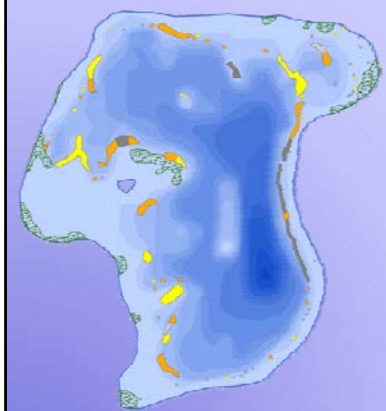
Aquatic Plant Summary

Pigeon Lake

- 19 native species
  - 15 on PI survey
  - 4 incidentally
- 3 non-native plant species
  - Eurasian water milfoil
  - Pale yellow iris
  - Purple loosestrife
- Maximum depth of plants = 21 feet



Pigeon Lake Eurasian Water Milfoil



- 2013 – 3.1 acres of colonized EWM
- Sporadic, non-contiguous colonies

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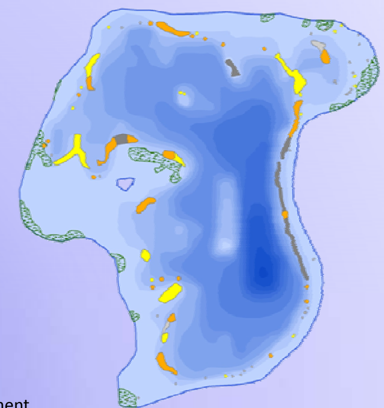
AIS Control Strategies

- Do nothing (No AIS Management)
- Drawdown
  - Can be effective, not feasible
- Mechanical Harvesting
  - Not a long-term solution
  - May spread AIS to other areas of lake
  - Disrupts native vegetation
- Manual removal
  - Effective with small, localized colonies
  - Minimal/moderate cost (volunteers?)
- Bio-control
  - Not a proven technique for control
  - Not applicable for grant funding
- Herbicide Treatments
  - Moderate/high costs
  - Effective when properly planned
  - Spot Treatment vs. Whole Lake Treatment



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Eurasian Water Milfoil Control Strategies: Herbicide Use

Spot Treatment

- Herbicide applied to a treatment area, with site-specific considerations.
- Effectiveness hard to reach due to dilution and dissipation.
  - Seasonal vs. long-term effectiveness

Whole Lake Treatment

- Herbicide is applied to treatment areas with whole-lake considerations.
- Dilution and dissipation accounted for in application strategy.

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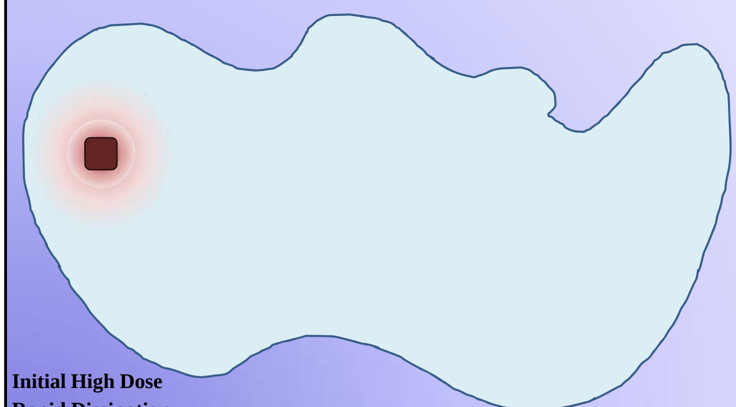
Spot Treatment Use Pattern



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

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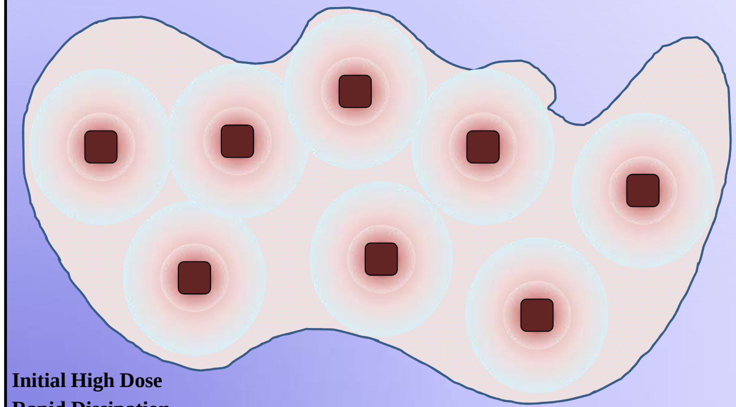
Whole-lake Use Pattern

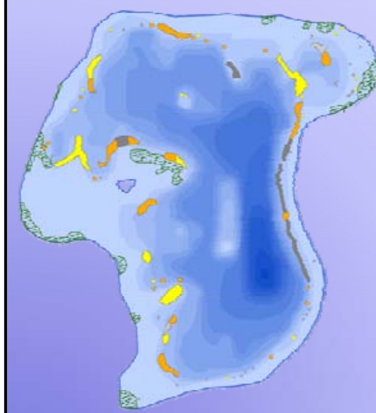


Initial High Dose

Rapid Dissipation

Low-dose lake-wide concentration significant to cause control

Pigeon Lake Eurasian Water Milfoil



Whole Lake Potential Treatment

- Application of liquid 2,4-D @ 3.25 ppm a.e.
- Anticipate herbicide mixing within upper 15-18 ft. of water column, lake-wide.
- Whole-lake concentration estimate = 0.35 ppm a.e.
- Application fees and permit = $10,000

Management Goal: Monitor and Control Aquatic Invasive Species within Pigeon Lake

Management Actions

1. **Continue Clean Boats Clean Waters watercraft inspections at the Pigeon Lake public access.**
   Continuation of current effort
2. **Reduce occurrence of purple loosestrife and pale yellow iris on Pigeon Lake shorelands.**
   Initiate 2014/2015

Management Goal: Monitor and Control Aquatic Invasive Species within Pigeon Lake

Management Actions (continued)

3. **Develop monitoring and control strategy for Eurasian water milfoil within Pigeon Lake.**
   In progress

Specific Action Steps

- ***Monitor EWM population each growing season (2013-2017)***
- ***Write grant to fund monitoring 2014-2017***
- ***If herbicide treatment is appropriate (expansion, greater density, impacting recreation and/or ecology), initiate additional, required studies during that same growing season***
- ***Complete treatment following spring and continue monitoring***

Management Goal:
Strengthen Association Relationships, Effectiveness, and Lake Managing Capacity

Management Actions

1. **Increase PLMCA membership and volunteerism.**
   Continuation of existing efforts
2. **Facilitate efficient dialogue with other management units.**
   Initiate 2014/2015

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Management Goal:
Increase PLMCA's Capacity to Educate and Communicate with Lake Stakeholders

Management Actions

1. **Support and Education and Communication Committee to promote lake health, public safety, and quality of life on Pigeon Lake.**
   Enhancement of existing efforts

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Thank You

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B

APPENDIX B

Water Quality Data

Pigeon Lake Water Quality Summary

Trophic State Index (TSI)

Year	TP	Chl-a	Secchi
1978	47.3		
1979	47.3	43.2	63.9
1994	45.8	52.2	50.8
1995	50.0	40.9	40.8
1996	41.5	50.1	51.1
2004	45.0	48.2	
2005	41.7	41.7	
2006	45.0	41.7	
2007	37.4	44.2	43.6
2008	43.2	43.0	39.9
2009	41.1	51.3	50.1
2010	44.4	47.5	49.9
2011	43.5	45.0	45.3
2012	38.3	46.8	42.9
2013	40.5	43.4	
All Years (Weighted)	43.6	46.8	46.4
Deep, Seepage Lakes	43.2	43.2	42.4
SWTP Ecoregion	48.7	47.0	50.0

	Secchi (feet)				Chlorophyll-*a* (µg/L)				Total Phosphorus (µg/L)			
	Growing Season		Summer		Growing Season		Summer		Growing Season		Summer	
Year	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean
1978									2	20.0	1.0	20.0
1979	1	2.5	1	2.5	1	3.6	1	3.6	1	20.0	1.0	20.0
1994	4	6.2	4	6.2	2	9.0	2	9.0	2	18.0	2.0	18.0
1995	3	12.4	3	12.4	2	2.8	2	2.8	2	24.0	2.0	24.0
1996	4	6.4	3	6.1	4	7.1	3	7.3	4	13.5	3.0	13.3
2004					8	5.4	6	6.0	4	19.5	2.0	17.0
2005					3	2.7	2	3.1	3	14.0	2.0	13.5
2006					3	3.0	2	3.1	4	21.8	2.0	17.0
2007	2	8.9	1	10.3	2	3.1	1	4.0	3	15.0	1.0	10.0
2008	2	13.3	2	13.3	3	3.5	3	3.5	3	15.0	3.0	15.0
2009	1	6.5	1	6.5	2	8.2	2	8.2	3	12.7	2.0	13.0
2010	4	6.6	4	6.6	3	5.6	3	5.6	4	15.3	3.0	16.3
2011	6	12.0	4	9.1	3	4.4	3	4.4	4	13.8	3.0	15.3
2012	2	10.8	2	10.8	3	5.2	3	5.2	3	10.7	3.0	10.7
2013					3	4.3	2	3.7	5	13.5	2.0	12.4
All Years (Weighted)		9.0		8.4		4.9		5.2		15.9		15.4
Deep, Seepage Lakes				11.2				3.6				15.0
SWTP Ecoregion				6.6				5.3				22.0

C

APPENDIX C

WiLMS Watershed Model Results

Date: 3/18/2014 Scenario: Direct WS with Tributary Input

Lake Id:
Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 95.0 acre
Total Unit Runoff: 7.60 in.
Annual Runoff Volume: 60.2 acre-ft
Lake Surface Area <As>: 85.7 acre
Lake Volume <V>: 1734 acre-ft
Lake Mean Depth <z>: 20.2 ft
Precipitation - Evaporation: 3.2 in.
Hydraulic Loading: 153.6 acre-ft/year
Areal Water Load <qs>: 1.8 ft/year
Lake Flushing Rate <p>: 0.09 1/year
Water Residence Time: 11.29 year
Observed spring overturn total phosphorus (SPO): 16.4 mg/m^3
Observed growing season mean phosphorus (GSM): 15.4 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre (ac)	Low	Most Likely	High	Loading %	Low	Most Likely	High
		|---- Loading (kg/ha-year) ----|				|----- Loading (kg/year) ----|		
Row Crop AG	1.0	0.50	1.00	3.00	1.6	0	0	1
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	33.0	0.10	0.30	0.50	15.5	1	4	7
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	0.0	0.30	0.50	0.80	0.0	0	0	0
Rural Res (>1 Ac)	16.0	0.05	0.10	0.25	2.5	0	1	2
Wetlands	19.0	0.10	0.10	0.10	3.0	1	1	1
Forest	26.0	0.05	0.09	0.18	3.7	1	1	2
Lake Surface	85.7	0.10	0.30	1.00	40.4	3	10	35

POINT SOURCE DATA

Point Sources	Water Load (m^3/year)	Low (kg/year)	Most Likely (kg/year)	High (kg/year)	Loading %
East Sub-Basin	87064.0	0.0	8.6	0.0	33.4

SEPTIC TANK DATA

Description		Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)		0.30	0.50	0.80	
# capita-years	0.0				
% Phosphorus Retained by Soil		98.0	90.0	80.0	
Septic Tank Loading (kg/year)		0.00	0.00	0.00	0.0

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	14.6	56.8	103.3	100.0
Total Loading (kg)	6.6	25.8	46.9	100.0
Areal Loading (lb/ac-year)	0.17	0.66	1.21	
Areal Loading (mg/m^2-year)	19.10	74.33	135.10	
Total PS Loading (lb)	0.0	19.0	0.0	33.4
Total PS Loading (kg)	0.0	8.6	0.0	33.4
Total NPS Loading (lb)	7.0	14.9	26.8	66.6
Total NPS Loading (kg)	3.2	6.8	12.2	66.6

Phosphorus Prediction and Uncertainty Analysis Module

Date: 8/4/2014   Scenario: 111
Observed spring overturn total phosphorus (SPO): 16.4 mg/m^3
Observed growing season mean phosphorus (GSM): 15.4 mg/m^3
Back calculation for SPO total phosphorus: 0.0 mg/m^3
Back calculation GSM phosphorus: 0.0 mg/m^3
% Confidence Range: 70%
Nurenberg Model Input - Est. Gross Int. Loading: 0 kg

Lake Phosphorus Model	Low Total P (mg/m^3)	Most Likely Total P (mg/m^3)	High Total P (mg/m^3)	Predicted -Observed (mg/m^3)	% Dif.
Walker, 1987 Reservoir	9	36	66	21	136
Canfield-Bachmann, 1981 Natural Lake	9	20	29	5	32
Canfield-Bachmann, 1981 Artificial Lake	10	21	28	6	39
Rechow, 1979 General	2	6	11	-9	-58
Rechow, 1977 Anoxic	11	45	81	30	195
Rechow, 1977 water load<50m/year	3	10	18	-5	-32
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	10	39	71	23	140
Vollenweider, 1982 Combined OECD	9	26	43	10	63
Dillon-Rigler-Kirchner	8	32	58	16	98
Vollenweider, 1982 Shallow Lake/Res.	6	21	36	5	31
Larsen-Mercier, 1976	8	31	57	15	91
Nurnberg, 1984 Oxic	7	26	47	11	71

Lake Phosphorus Model	Confidence Lower Bound	Confidence Upper Bound	Parameter Fit?	Back Calculation (kg/year)	Model Type
Walker, 1987 Reservoir	17	58	Tw	0	GSM
Canfield-Bachmann, 1981 Natural Lake	6	58	FIT	1	GSM
Canfield-Bachmann, 1981 Artificial Lake	7	60	FIT	1	GSM
Rechow, 1979 General	3	10	qs	0	GSM
Rechow, 1977 Anoxic	21	72	FIT	0	GSM
Rechow, 1977 water load<50m/year	5	16	FIT	0	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	16	69	FIT	0	SPO
Vollenweider, 1982 Combined OECD	11	46	FIT	0	ANN
Dillon-Rigler-Kirchner	15	51	P L qs p	0	SPO
Vollenweider, 1982 Shallow Lake/Res.	8	37	FIT	0	ANN
Larsen-Mercier, 1976	15	49	P Pin	0	SPO
Nurnberg, 1984 Oxic	11	45	FIT	0	ANN

Water and Nutrient Outflow Module

Date: 8/4/2014   Scenario: 99
Average Annual Surface Total Phosphorus: 15.9mg/m^3
Annual Discharge: 1.54E+002 AF => 1.89E+005 m^3
Annual Outflow Loading: 6.4 LB =>   2.9 kg

D

APPENDIX D

Aquatic Plant Survey Data (WDNR, 2012)

Sampling point	Latitiude	Longitude	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	Comments	Total Rake Fullness	Myriophyllum spicatum, Eurasian water-milfoil or Hybr	Ceratophyllum demersum, Coontail	Chara sp., Muskgrasses	Myriophyllum heterophyllum, Various-leaved water-mi	Myriophyllum sibiricum, Northern water-milfoil	Najas flexilis, Slender naiad	Nitella sp., Nitella	Nuphar variegata, Spatterdock	Nymphaea odorata, White water lily	Potamogeton amplifolius, Large-leaf pondweed	Potamogeton gramineus, Variable pondweed	Potamogeton illinoensis, Illinois pondweed	Potamogeton zosteriformis, Flat-stem pondweed	Schoenoplectus tabernaemontani, Softstem bulrush	Stuckenia pectinata, Sago pondweed	Vallisneria americana, Wild celery
1	43.98750682	-87.87762316	2.5	S	P		1				v		1			v	1		1				1
2	43.9872369	-87.87763278	2	S	P		1			1			1										
3	43.98696698	-87.8776424	2	S	P		1			1			1						v				
4	43.98669706	-87.87765202	2	S	P		1			1			1						v				
5	43.98642714	-87.87766164	2	S	P		1			1			1						v				
6	43.98615722	-87.87767127	1.5	S	P		1			1													
7	43.98803972	-87.87723006	9	S	P		3	1		1			1						1	1		1	3
8	43.9877698	-87.87723968	17																				
9	43.98749988	-87.87724931	15		R																		
10	43.98722996	-87.87725893	2.5	S	P		1						1					1				1	v
11	43.98696004	-87.87726855	1.5	S	P					v													
12	43.98669012	-87.87727818	2.5	S	P		1			1			1					1					
13	43.9864202	-87.8772878	2.5	S	P		1			1			1						1				
14	43.98615028	-87.87729742	1.5	S	P		2			2													
15	43.98857261	-87.87683695	4	S	P		2			1			1						v			2	
16	43.98830269	-87.87684658	10	S	P																		
17	43.98803277	-87.87685621	12	S	R		1				1								v				
18	43.98776285	-87.87686583	10	S	P														v				
19	43.98749293	-87.87687546	8	S	P		3						1						3				1
20	43.98722301	-87.87688508	3	S	P		1			1			1					1					
21	43.98695309	-87.87689471	3	S	P		1			1			1					v					
22	43.98668317	-87.87690433	3	S	P		1			1			1										
23	43.98641325	-87.87691396	2	S	P		2			1			2			v		v		v	v	v	v
24	43.98614333	-87.87692358	4	S	P		1			1			1										
25	43.98883558	-87.87645347	10	S	P		2				v		1						1	v			2
26	43.98856566	-87.8764631	11	S	P		3				v		3										
27	43.98829574	-87.87647273	18		R																		
28	43.98802582	-87.87648235	13		R		1						1										
29	43.9877559	-87.87649198	15		R																		
30	43.98748598	-87.87650161	13		P																		
31	43.98721606	-87.87651123	8	S	P		3												v			3	1
32	43.98694614	-87.87652086	5	S	P		1			1													
33	43.98667622	-87.87653049	3	S	P		2			1			2					1	v				
34	43.9864063	-87.87654011	3	S	P		1			1			1									v	
35	43.98613638	-87.87654974	2	S	P		1			1			1										
36	43.98936847	-87.87606035	6	S	P		1			1			1						1				
37	43.98909855	-87.87606998	19																				
38	43.98882863	-87.87607961	19																				
39	43.98855871	-87.87608924	20																				
40	43.98828879	-87.87609887	22																				
41	43.98801887	-87.8761085	19																				
42	43.98774895	-87.87611813	17		R																		
43	43.98747903	-87.87612776	11	S	P		1	1											v				
44	43.98720911	-87.87613739	9	S	P		3			3									2				
45	43.98693919	-87.87614702	4	S	P		2			1								2	1			v	
46	43.98666927	-87.87615664	5	S	P		1			1			1										
47	43.98639935	-87.87616627	4	S	P		1			1			1										
48	43.98612943	-87.8761759	3	S	P		1			1													

Sampling point	Latitiude	Longitude	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	Comments	Total Rake Fullness	Myriophyllum spicatum, Eurasian water-milfoil or Hybr	Ceratophyllum demersum, Coontail	Chara sp., Muskgrasses	Myriophyllum heterophyllum, Various-leaved water-mil	Myriophyllum sibiricum, Northern water-milfoil	Najas flexilis, Slender naiad	Nitella sp., Nitella	Nuphar variegata, Spatterdock	Nymphaea odorata, White water lily	Potamogeton amplifolius, Large-leaf pondweed	Potamogeton gramineus, Variable pondweed	Potamogeton illinoensis, Illinois pondweed	Potamogeton zosteriformis, Flat-stem pondweed	Schoenoplectus tabernaemontani, Softstem bulrush	Stuckenia pectinata, Sago pondweed	Vallisneria americana, Wild celery
49	43.98585951	-87.87618553	1	S	P		1			1													
50	43.98963143	-87.87567686	11	S	P		1												1			1	1
51	43.98936151	-87.87568649	19																				
52	43.98909159	-87.87569612	22																				
53	43.98882167	-87.87570575	23																				
54	43.98855175	-87.87571538	31																				
55	43.98828183	-87.87572502	30																				
56	43.98801191	-87.87573465	19																				
57	43.98774199	-87.87574428	4	S	P		3	1					3						1				
58	43.98747207	-87.87575391	4	S	P		3						3						1				
59	43.98720215	-87.87576354	5	S	P		1	1					1						1				v
60	43.98693223	-87.87577317	1	S	P								v										
61	43.98666231	-87.8757828	3	S	P		1			1			1										
62	43.98639239	-87.87579243	7	S	P		1			1			1						v				
63	43.98612247	-87.87580206	5	S	P		1			1			1						1				
64	43.98585255	-87.87581169	4	S	P		1			1			1										
65	43.98558263	-87.87582132	2	S	P																v		
66	43.98962448	-87.875303	13		R		1			1	1								v				
67	43.98935456	-87.87531263	26																				
68	43.98908464	-87.87532226	23																				
69	43.98881472	-87.8753319	24																				
70	43.9885448	-87.87534153	34																				
71	43.98827488	-87.87535116	34																				
72	43.98800496	-87.87536079	27																				
73	43.98773504	-87.87537043	10	S	P		3	1					1						3				1
74	43.98746512	-87.87538006	3	S	P		1												v		1		
75	43.9871952	-87.87538969	3	S	P		3			1			1						1			3	2
76	43.98692528	-87.87539932	1	S	P																		
77	43.98665536	-87.87540896	5	S	P		1			1			1										
78	43.98638544	-87.87541859	9	S	P		2						2						1				
79	43.98611552	-87.87542822	9	S	P		2			1			2						1				
80	43.9858456	-87.87543785	9	S	P		3						3						v				
81	43.98557568	-87.87544748	5	S	P		1			1			1										
82	43.98530576	-87.87545711	6	S	P		3						1						3				1
83	43.98503584	-87.87546674	3	S	P		1			1			1					1					
84	43.98476592	-87.87547637	3	S	P																		
85	43.98368624	-87.8755149	1	S	P																		
86	43.98341632	-87.87552453	1	S	P					v			v										
87	43.9831464	-87.87553416	1	S	P		1	v		1			1			v				1		1	
88	43.98961752	-87.87492913	23																				
89	43.9893476	-87.87493877	16		R																		
90	43.98907768	-87.8749484	32																				
91	43.98880776	-87.87495804	40																				
92	43.98853784	-87.87496767	39																				
93	43.98826792	-87.87497731	34																				
94	43.987998	-87.87498694	23																				
95	43.98772808	-87.87499658	13	S	R		1			1													
96	43.98745816	-87.87500621	5	S	P		3						2						2		v	2	

Sampling point	Latitiude	Longitude	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	Comments	Total Rake Fullness	Myriophyllum spicatum, Eurasian water-milfoil or Hybr	Ceratophyllum demersum, Coontail	Chara sp., Muskgrasses	Myriophyllum heterophyllum, Various-leaved water-mi	Myriophyllum sibiricum, Northern water-milfoil	Najas flexilis, Slender naiad	Nitella sp., Nitella	Nuphar variegata, Spatterdock	Nymphaea odorata, White water lily	Potamogeton amplifolius, Large-leaf pondweed	Potamogeton gramineus, Variable pondweed	Potamogeton illinoensis, Illinois pondweed	Potamogeton zosteriformis, Flat-stem pondweed	Schoenoplectus tabernaemontani, Softstem bulrush	Stuckenia pectinata, Sago pondweed	Vallisneria americana, Wild celery
97	43.98718824	-87.87501584	2	S	P		2						1						2			1	
98	43.98691832	-87.87502548	1.5	S	P					v								v					
99	43.9866484	-87.87503511	5	S	P		1			1			1					1					
100	43.98637848	-87.87504474	9	S	P		1				1		1										
101	43.98610856	-87.87505438	9	S	P		1												1				
102	43.98583864	-87.87506401	14	S	R		3			3									v				
103	43.98556872	-87.87507364	11	S	P		1					1											
104	43.9852988	-87.87508328	14	S	R		1				1												
105	43.98502888	-87.87509291	7	S	P		2						3						2				
106	43.98475897	-87.87510254	6	S	P		1			1			1						v				
107	43.98448905	-87.87511218	5	S	P		2						1						2				
108	43.98421913	-87.87512181	4	S	P		1			1			1										
109	43.98394921	-87.87513144	4	S	P		1			1								1					
110	43.98367929	-87.87514107	3	S	P		1			1			1					1	v				
111	43.98340937	-87.8751507	3	S	P		1			1			1						1				
112	43.98313945	-87.87516034	2	S	P		1			1			1					v	v				
113	43.98961056	-87.87455527	8	S	P		2	1				1							2			2	v
114	43.98934065	-87.87456491	14	S	R		1			1													
115	43.98907073	-87.87457454	30																				
116	43.98880081	-87.87458418	37																				
117	43.98853089	-87.87459382	38																				
118	43.98826097	-87.87460345	34																				
119	43.98799105	-87.87461309	31																				
120	43.98772113	-87.87462273	27																				
121	43.98745121	-87.87463236	10	S	P		1	1					1						v				
122	43.98718129	-87.874642	2	S	P		1			1								1					
123	43.98691137	-87.87465163	4	S	P		1			1			1						v			1	
124	43.98664145	-87.87466127	16		R		1							1									
125	43.98637153	-87.8746709	19		R		2							2									
126	43.98610161	-87.87468054	18		R		1			1				1									
127	43.98583169	-87.87469017	19		R		2							2									
128	43.98556177	-87.87469981	21		R																		
129	43.98529185	-87.87470944	21																				
130	43.98502193	-87.87471908	8	S	P		3	3											v				
131	43.98475201	-87.87472871	11	S	P																		
132	43.98448209	-87.87473834	8	S	P		2	1					1						2				
133	43.98421217	-87.87474798	18	S	R		1				1												
134	43.98394225	-87.87475761	11	S	P		1						1										
135	43.98367233	-87.87476725	11		P			1					1						v			v	v
136	43.98340241	-87.87477688	3	S	P		2			1			1					1	1				
137	43.98960361	-87.87418141	7	S	P		3						2						2				
138	43.98933369	-87.87419105	31																				
139	43.98906377	-87.87420069	36																				
140	43.98879385	-87.87421032	32																				
141	43.98852393	-87.87421996	13	S	P		1	1				1	1						v				
142	43.98825401	-87.8742296	27																				
143	43.98798409	-87.87423924	37																				
144	43.98771417	-87.87424887	33																				

Sampling point	Latitiude	Longitude	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	Comments	Total Rake Fullness	Myriophyllum spicatum, Eurasian water-milfoil or Hybr	Ceratophyllum demersum, Coontail	Chara sp., Muskgrasses	Myriophyllum heterophyllum, Various-leaved water-mil	Myriophyllum sibiricum, Northern water-milfoil	Najas flexilis, Slender naiad	Nitella sp., Nitella	Nuphar variegata, Spatterdock	Nymphaea odorata, White water lily	Potamogeton amplifolius, Large-leaf pondweed	Potamogeton gramineus, Variable pondweed	Potamogeton illinoensis, Illinois pondweed	Potamogeton zosteriformis, Flat-stem pondweed	Schoenoplectus tabernaemontani, Softstem bulrush	Stuckenia pectinata, Sago pondweed	Vallisneria americana, Wild celery
145	43.98744425	-87.87425851	13	S	P		1	1											1				
146	43.98717433	-87.87426815	4	S	P		1			1			1										
147	43.98690441	-87.87427779	20																				
148	43.98663449	-87.87428742	33																				
149	43.98636457	-87.87429706	24																				
150	43.98609465	-87.8743067	9		P		1				1												
151	43.98582473	-87.87431633	21																				
152	43.98555481	-87.87432597	29																				
153	43.98528489	-87.87433561	13		P		1							1									
154	43.98501497	-87.87434524	13		P		2	2						1					v			v	
155	43.98474505	-87.87435488	18		R		1							1									
156	43.98447513	-87.87436451	17		R																		
157	43.98420521	-87.87437415	21																				
158	43.98393529	-87.87438379	22																				
159	43.98366537	-87.87439342	13		P																		
160	43.98339545	-87.87440306	3	S	P		3			1								v	v			1	3
161	43.98959665	-87.87380755	7	S	P		3						3						v			1	
162	43.98932673	-87.87381719	28																				
163	43.98905681	-87.87382683	37																				
164	43.98878689	-87.87383647	35																				
165	43.98851697	-87.87384611	23																				
166	43.98824705	-87.87385575	22																				
167	43.98797713	-87.87386538	33																				
168	43.98770721	-87.87387502	40																				
169	43.98743729	-87.87388466	35																				
170	43.98716737	-87.8738943	11	S	P		1						1										
171	43.98689745	-87.87390394	27																				
172	43.98662753	-87.87391358	37																				
173	43.98635761	-87.87392322	37																				
174	43.98608769	-87.87393286	13		P																		
175	43.98581777	-87.87394249	33																				
176	43.98554785	-87.87395213	38																				
177	43.98527793	-87.87396177	33																				
178	43.98500801	-87.87397141	18		R		1							1									
179	43.98473809	-87.87398105	19		R		1			1				2									
180	43.98446817	-87.87399068	22																				
181	43.98419825	-87.87400032	23																				
182	43.98392833	-87.87400996	20																				
183	43.98365842	-87.8740196	24																				
184	43.9833885	-87.87402923	3	S	P		1			1			1						v				v
185	43.98958969	-87.87343368	4	S	P		2			1			1						1				
186	43.98931977	-87.87344333	24																				
187	43.98904985	-87.87345297	28																				
188	43.98877993	-87.87346261	24																				
189	43.98851001	-87.87347225	23																				
190	43.98824009	-87.87348189	26																				
191	43.98797017	-87.87349153	30																				
192	43.98770025	-87.87350117	43																				

Sampling point	Latitiude	Longitude	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	Comments	Total Rake Fullness	Myriophyllum spicatum, Eurasian water-milfoil or Hybr	Ceratophyllum demersum, Coontail	Chara sp., Muskgrasses	Myriophyllum heterophyllum, Various-leaved water-mi	Myriophyllum sibiricum, Northern water-milfoil	Najas flexilis, Slender naiad	Nitella sp., Nitella	Nuphar variegata, Spatterdock	Nymphaea odorata, White water lily	Potamogeton amplifolius, Large-leaf pondweed	Potamogeton gramineus, Variable pondweed	Potamogeton illinoensis, Illinois pondweed	Potamogeton zosteriformis, Flat-stem pondweed	Schoenoplectus tabernaemontani, Softstem bulrush	Stuckenia pectinata, Sago pondweed	Vallisneria americana, Wild celery
193	43.98743033	-87.87351081	43																				
194	43.98716041	-87.87352046	34																				
195	43.98689049	-87.8735301	43																				
196	43.98662057	-87.87353974	49																				
197	43.98635065	-87.87354938	49																				
198	43.98608073	-87.87355902	47																				
199	43.98581081	-87.87356866	51																				
200	43.98554089	-87.8735783	52																				
201	43.98527097	-87.87358794	37																				
202	43.98500105	-87.87359758	31																				
203	43.98473113	-87.87360721	34																				
204	43.98446122	-87.87361685	33																				
205	43.9841913	-87.87362649	21																				
206	43.98392138	-87.87363613	21																				
207	43.98365146	-87.87364577	18		R																		
208	43.98958273	-87.87305982	6	S	P		1						1						1				
209	43.98931281	-87.87306947	8	S	P		1						1						1			v	1
210	43.98904289	-87.87307911	10	S	P						3												
211	43.98877297	-87.87308875	12		P						1		1										
212	43.98850305	-87.8730984	20																				
213	43.98823313	-87.87310804	29																				
214	43.98796321	-87.87311768	35																				
215	43.98769329	-87.87312732	38																				
216	43.98742337	-87.87313697	44																				
217	43.98715345	-87.87314661	43																				
218	43.98688353	-87.87315625	44																				
219	43.98661361	-87.87316589	51																				
220	43.98634369	-87.87317553	53																				
221	43.98607377	-87.87318518	58																				
222	43.98580385	-87.87319482	56																				
223	43.98553393	-87.87320446	54																				
224	43.98526401	-87.8732141	51																				
225	43.98499409	-87.87322374	46																				
226	43.98472417	-87.87323338	41																				
227	43.98445425	-87.87324302	39																				
228	43.98418434	-87.87325267	34																				
229	43.98391442	-87.87326231	27																				
230	43.9836445	-87.87327195	18		R								1										
231	43.98957576	-87.87268596	4	S	P		1			1			1					1				1	
232	43.98930584	-87.87269561	6	S	P		1			1		1	1										
233	43.98903592	-87.87270525	7	S	P		2						2						1			1	1
234	43.988766	-87.8727149	17		R																		
235	43.98849608	-87.87272454	23																				
236	43.98822617	-87.87273418	41																				
237	43.98795625	-87.87274383	42																				
238	43.98768633	-87.87275347	39																				
239	43.98741641	-87.87276312	35																				
240	43.98714649	-87.87277276	42																				

Sampling point	Latitiude	Longitude	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	Comments	Total Rake Fullness	Myriophyllum spicatum, Eurasian water-milfoil or Hybr	Ceratophyllum demersum, Coontail	Chara sp., Muskgrasses	Myriophyllum heterophyllum, Various-leaved water-mi	Myriophyllum sibiricum, Northern water-milfoil	Najas flexilis, Slender naiad	Nitella sp., Nitella	Nuphar variegata, Spatterdock	Nymphaea odorata, White water lily	Potamogeton amplifolius, Large-leaf pondweed	Potamogeton gramineus, Variable pondweed	Potamogeton illinoensis, Illinois pondweed	Potamogeton zosteriformis, Flat-stem pondweed	Schoenoplectus tabernaemontani, Softstem bulrush	Stuckenia pectinata, Sago pondweed	Vallisneria americana, Wild celery
241	43.98687657	-87.87278241	53																				
242	43.98660665	-87.87279205	64																				
243	43.98633673	-87.87280169	64																				
244	43.98606681	-87.87281134	58																				
245	43.98579689	-87.87282098	58																				
246	43.98552697	-87.87283062	55																				
247	43.98525705	-87.87284027	48																				
248	43.98498713	-87.87284991	45																				
249	43.98471721	-87.87285955	40																				
250	43.98444729	-87.87286919	33																				
251	43.98417737	-87.87287884	32																				
252	43.98390745	-87.87288848	30																				
253	43.98363753	-87.87289812	15		R		1							1									
254	43.9895688	-87.8723121	4	S	P		2						1						2				
255	43.98929888	-87.87232175	8	S	P		2			2			1	1									
256	43.98902896	-87.87233139	15		R		1			1			1	1									
257	43.98875904	-87.87234104	22																				
258	43.98848912	-87.87235069	27																				
259	43.9882192	-87.87236033	35																				
260	43.98794928	-87.87236998	42																				
261	43.98767936	-87.87237962	44																				
262	43.98740944	-87.87238927	42																				
263	43.98713952	-87.87239892	34																				
264	43.9868696	-87.87240856	44																				
265	43.98659969	-87.87241821	59																				
266	43.98632977	-87.87242785	62																				
267	43.98605985	-87.8724375	59																				
268	43.98578993	-87.87244714	56																				
269	43.98552001	-87.87245679	53																				
270	43.98525009	-87.87246643	55																				
271	43.98498017	-87.87247608	64																				
272	43.98471025	-87.87248572	54																				
273	43.98444033	-87.87249537	40																				
274	43.98417041	-87.87250501	29																				
275	43.98390049	-87.87251465	23																				
276	43.98363057	-87.8725243	6	S	P		1			1			1						1				v
277	43.98956183	-87.87193824	3	S	P		1						1					v	1				
278	43.98929191	-87.87194789	5	S	P		1						1					2	1				
279	43.98902199	-87.87195753	21																				
280	43.98875208	-87.87196718	36																				
281	43.98848216	-87.87197683	41																				
282	43.98821224	-87.87198648	44																				
283	43.98794232	-87.87199613	43																				
284	43.9876724	-87.87200577	32																				
285	43.98740248	-87.87201542	24																				
286	43.98713256	-87.87202507	16																				
287	43.98686264	-87.87203472	26																				
288	43.98659272	-87.87204436	32																				

Sampling point	Latitiude	Longitude	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	Comments	Total Rake Fullness	Myriophyllum spicatum, Eurasian water-milfoil or Hybr	Ceratophyllum demersum, Coontail	Chara sp., Muskgrasses	Myriophyllum heterophyllum, Various-leaved water-mi	Myriophyllum sibiricum, Northern water-milfoil	Najas flexilis, Slender naiad	Nitella sp., Nitella	Nuphar variegata, Spatterdock	Nymphaea odorata, White water lily	Potamogeton amplifolius, Large-leaf pondweed	Potamogeton gramineus, Variable pondweed	Potamogeton illinoensis, Illinois pondweed	Potamogeton zosteriformis, Flat-stem pondweed	Schoenoplectus tabernaemontani, Softstem bulrush	Stuckenia pectinata, Sago pondweed	Vallisneria americana, Wild celery
289	43.9863228	-87.87205401	38																				
290	43.98605288	-87.87206366	42																				
291	43.98578296	-87.8720733	43																				
292	43.98551304	-87.87208295	50																				
293	43.98524312	-87.8720926	64																				
294	43.9849732	-87.87210224	67																				
295	43.98470329	-87.87211189	51																				
296	43.98443337	-87.87212154	39																				
297	43.98416345	-87.87213118	19		R		1							1									
298	43.98389353	-87.87214083	9	S	P		3						2						3				1
299	43.98955487	-87.87156438	3	S	P		1											1					
300	43.98928495	-87.87157403	5	S	P		2						1						2				
301	43.98901503	-87.87158368	7	S	P		3						1						2				2
302	43.98874511	-87.87159333	13		P		1				1												
303	43.98847519	-87.87160298	22																				
304	43.98820527	-87.87161263	30																				
305	43.98793535	-87.87162227	39																				
306	43.98766543	-87.87163192	6	S	P		2						2							1			
307	43.98739551	-87.87164157	5	S	P		1			1			1										
308	43.98712559	-87.87165122	3	S	P		1			1													
309	43.98685567	-87.87166087	2	S	P																		
310	43.98658575	-87.87167052	4	S	P		1			1			1						1				
311	43.98631584	-87.87168017	4	S	P		1			1			1										
312	43.98604592	-87.87168982	9	S	P		2						1						1				2
313	43.985776	-87.87169947	21																				
314	43.98550608	-87.87170911	35																				
315	43.98523616	-87.87171876	52																				
316	43.98496624	-87.87172841	52																				
317	43.98469632	-87.87173806	54																				
318	43.9844264	-87.87174771	36																				
319	43.98415648	-87.87175735	6	S	P		2			1			1						2				
320	43.9895479	-87.87119051	2	S	P		1						1						1				
321	43.98927798	-87.87120017	6	S	P		3				1		1						1			v	3
322	43.98900806	-87.87120982	16		R		1			1													
323	43.98873814	-87.87121947	8	S	P		2						2										
324	43.98846822	-87.87122912	8	S	P		1	1											v			2	
325	43.9881983	-87.87123877	6	S	P		2						1						2				
326	43.98792838	-87.87124842	4	S	P		1			1			1					1	v				
327	43.98576903	-87.87132563	3	S	P		1						1										
328	43.98549911	-87.87133528	6	S	P		2			1			2						1				
329	43.98522919	-87.87134493	21																				
330	43.98495927	-87.87135458	20		R		1							1									
331	43.98468935	-87.87136423	14		R																		
332	43.98441943	-87.87137388	6	S	P		3						1						2			1	2
333	43.98954093	-87.87081665	2	S	P		2						2					2	1				
334	43.98927101	-87.87082631	10		P		1						1						v				
335	43.98900109	-87.87083596	16		R		1				1		1										
336	43.98873117	-87.87084561	6	S	P		3						2						3				1

Sampling point	Latitiude	Longitude	Depth (ft)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	Comments	Total Rake Fullness	Myriophyllum spicatum, Eurasian water-milfoil or Hybr	Ceratophyllum demersum, Coontail	Chara sp., Muskgrasses	Myriophyllum heterophyllum, Various-leaved water-mil	Myriophyllum sibiricum, Northern water-milfoil	Najas flexilis, Slender naiad	Nitella sp., Nitella	Nuphar variegata, Spatterdock	Nymphaea odorata, White water lily	Potamogeton amplifolius, Large-leaf pondweed	Potamogeton gramineus, Variable pondweed	Potamogeton illinoensis, Illinois pondweed	Potamogeton zosteriformis, Flat-stem pondweed	Schoenoplectus tabernaemontani, Softstem bulrush	Stuckenia pectinata, Sago pondweed	Vallisneria americana, Wild celery
337	43.98846125	-87.87085527	7	S	P		3						3						3			1	
338	43.98819133	-87.87086492	4	S	P		3						2					1	2				v
339	43.98953396	-87.87044279	2	S	P		1				v		1			v				v			
340	43.98926404	-87.87045245	4	S	P		3						1						3				
341	43.98899412	-87.8704621	4	S	P		2						1						2				
342	43.9887242	-87.87047176	4	S	P		3						2						2				
343	43.98845428	-87.87048141	4	S	P		3						1						1			v	3
344	43.98818436	-87.87049107	2	S	P		1									1							v
345	43.98952699	-87.87006893	1	S	P		1						1										
346	43.98925707	-87.87007859	4	S	P		1						1						1				
347	43.98898715	-87.87008824	4	S	P		2						2						2				
348	43.98871723	-87.8700979	4	S	P		2						2										v
349	43.98844731	-87.87010756	3	S	P		3				1		3							1			
350	43.9892501	-87.86970473	2	S	P		1			1	1		1										
351	43.98898018	-87.86971439	2	S	P		1	1	v				1						1				1
352	43.98871026	-87.86972405	3	M	P		3				3				1	1				1			
353	43.98844034	-87.8697337	2	M	P		1		1						v	1							

E

APPENDIX E

Pigeon Lake Fisheries Memo (WDNR 2011)

CORRESPONDENCE/MEMORANDUM

State of Wisconsin

DATE: February 10, 2011 FILE REF: [Click **here** and type file ref.]

TO: Pigeon Lake File

FROM: Steve Hogler
Steve Surendonk

SUBJECT: Fall 2006 Fall Electrofishing Survey of Pigeon Lake

Background on Pigeon Lake:
Pigeon Lake is a seepage lake located in south-central Manitowoc County. It has a surface area of 77 acres, a maximum depth of 67 feet and the lake water is hard and clear. It experiences heavy recreational use with over sixty dwellings and a youth camp on its shores. Public access and parking is available in the northeast corner of the lake.

Fish Survey History:
A 1945 survey was the first to investigate the fish populations of the lake. During that survey, the fyke net catch was dominated by bluegill and rock bass. Largemouth bass were the most common gamefish, with few walleyes present in the catch. Fishing and other recreational uses of the lake were described as heavy. Beginning in 1956, a mixture of rainbow and brown trout were stocked into the lake to develop a two story fishery. A 1963 electroshocking survey captured some trout, but the catch was dominated by bluegill, rock bass, yellow perch and bullhead. Largemouth bass were the most common gamefish collected with several northern pike also captured. The management recommendation at that time was to discontinue rainbow stocking.

An intensive fisheries survey was conducted on Pigeon Lake in 1973. Bluegill, white sucker, yellow perch and walleye were the most common fish captured. The fish populations of the lake were characterized as generally slow growing. At that time, it was recommended to manage the lake as a warmwater fishery and to stock walleye.

The most recent comprehensive survey of Pigeon Lake occurred in 1984. A total of 3,312 fish representing twelve species were collected, with bluegill dominating the catch. Substantially lower numbers of rock bass, bullhead, walleye, largemouth bass, northern pike and alewife were captured during the survey. Walleye and largemouth bass were the dominant gamefish, with the walleye population sustained by private and DNR stocking. In general, the growth of gamefish species was slower than state averages. The panfish community was dominated by bluegill and rock bass. Growth of all panfish species were less than state averages. Few forage species were captured in this survey. The lack of forage may have contributed to the small size of panfish that were captured.

2006 Survey Results:

The entire 1.7 mile shoreline of Pigeon Lake was electroshocked on the night of October 9th using pulsed DC current. An attempt to net all fish was made and all captured fish were measured to the nearest mm. Scales for age analysis were collected from largemouth bass and bluegill at the rate of 10 per centimeter group.

During the 51 minutes of shocking, 146 individual fish representing nine species were captured that night (Table 1). Many bluntnose minnow were observed but not netted because of their small size. Bluegill and largemouth bass dominated the catch with substantially fewer individuals of other species captured. CPE for bluegill was 104.4/hr or 51.2/ mile shocked. Largemouth bass CPE was 66/hour or 32.4/mile shocked.

Table 1. Length frequency of captured fish caught during electroshocking on the night of October 9, 2006.

Length (mm)	Largemouth Bass	Northern Pike	Walleye	Bluegill	Rock Bass	Pumpkin-seed	Green sunfish	White Sucker	Brown Bullhead
70				3					
80				3					
90				9					
100				35					
110	4			8					
120	2			10		1			
130	1			8					
140	2			2			1		
150				4					
160									
170				1	1				
180	3			1					
190	10			2					
200	3								
210				1					
220	1								
230	2								
240	2								
250	2				1				
260	2								
270	2								
280	2								
290	2								
300	3								
310	2								1
320									
330	5								
340									
350	3								
360									
370									
380									
390	1		1						
400									
410									
420									
430		1							
440									
450	1								
460									
470									
480									
490									
500									
510									
520									
530									
540									
550								1	
560									
570									
580									
590									
600									
610		1							
Total	55	2	1	87	2	1	1	1	1
Ave. Length	233	520	390	112	210	120	140	550	310
S.D.	74.2	127.3	--	26	56.7	--	--	--	--

Gamefish

Largemouth bass were the dominant gamefish captured. The fifty-five bass ranged in length from 110 mm to 457 mm and had an average length of 233 mm. Only 3 bass (5.5%) were greater than the 14 inch (356 mm) minimum size limit. When scales were aged, age classes from young of year to age 6 were detected (Table 2).

Table 2. Age distribution of largemouth bass in Pigeon Lake caught during electroshocking on the night of October 9, 2006.

Length (mm)	Number	Age 0	1	2	3	4	5	6
70								
80								
90								
100								
110	4	4						
120	2	2						
130	1	1						
140	2	2						
150								
160								
170								
180	3		3					
190	10		10					
200	3		3					
210								
220	1			1				
230	2			2				
240	2			1	1			
250	2			1	1			
260	2			2				
270	2			2				
280	2				2			
290	2				1	1		
300	3				3			
310	2				1	1		
320								
330	5					5		
340								
350	3					1	2	
360								
370								
380								
390	1						1	
400								
410								
420								
430								
440								
450	1							1
Total	55	9	16	9	9	8	3	1
Ave. Length	233	121	190	248	283	325	363	450
S.D.	74.2	12.7	6.3	18.6	24.9	17.7	23.1	

Age 1 bass were the most common age bass captured, but other ages were also common. When compared to statewide length at age averages, bass in Pigeon Lake grew at average rates through age 5 and then grew at slightly less than average rates thereafter.

Northern pike and walleye were also captured, but in low number. The two captured northern pike averaged 520 mm in length and the single walleye was 392 mm in length. No age structures were collected from northern pike and walleye.

Panfish

Bluegill were the most common panfish captured during this survey. The eighty-seven bluegill ranged in length from 75 mm to 211 mm and had an average length of 112 mm (Table 1). Most bluegill were less than 120 mm in length and only one was greater than 200 mm in length.

When scales were aged, age classes 0 through 4 were detected in the sample (Table 3). Ages 0 and 1 were the most common age bluegill. Only one bluegill was older than age 3.

Table 3. Age distribution of bluegill captured on Pigeon Lake during fall 2006 electroshocking.

Length (mm)	Number	Age				
		0	1	2	3	4
70	3	3				
80	3	2	1			
90	9	8	1			
100	35	21	14			
110	8		6	2		
120	10		9	1		
130	8		5	3		
140	2		1	1		
150	4			4		
160						
170	1				1	
180	1				1	
190	2				2	
200						
210	1					1
220						
230						
240						
250						
Total	87	34	32	11	4	1
Ave. Length	112	94	111	134	184	210
S.D.	26	9.5	13.4	15.9	9.6	

When compared to statewide length at age averages, bluegill in Pigeon Lake were longer at each age than an average bluegill from other lakes in Wisconsin.

Other captured panfish included rock bass, pumpkinseed sunfish and green sunfish. The average lengths of these fish were 210 mm, 120 mm and 140 mm, respectively.

During this survey, we also captured white sucker and brown bullhead. Many bluntnose minnow were observed but because of their small size they passed through our dip nets.

Discussion and Conclusions:

The largemouth bass population in Pigeon Lake is fair when compared similar lakes in northeast Wisconsin. In the fall of 2006, the bass were small in size. Growth, however, is greater than state averages. The lack of large, old fish may indicate substantial harvest of large fish by anglers or could be the result of a fish kill that occurred in May 2000. That fish kill was caused by super-saturation of dissolved oxygen. Most of the 2006 captured fish were from spawning years that followed the fish kill.

Walleye and northern pike were captured in very low numbers during this survey. It is likely that spawning habitat loss caused by shoreline development and by fast boating has hurt the northern pike population by reducing critical habitat. The abundance of walleye in the lake is likely to be limited, because Pigeon Lake lacks suitable spawning substrate for walleye. Periodic stocking will be required to maintain a fishable walleye population in Pigeon Lake.

Abundance of panfish captured in 2006 was lower than measured in previous surveys. Low abundance of panfish is likely due to the 2000 fish kill, although population declines because of habitat loss should not be ignored. Angler harvest of larger bluegill may also impact the population.

Growth of bluegill captured in this survey was greater than in previous surveys and is likely due to lower competition for food resources because bluegill and other panfish were less abundant in 2006 than historic levels.

It should also be noted that during the 2006 survey, most fish were captured when aquatic vegetation was present. These plant beds were scarce and widely scattered along the shoreline. The abundance and distribution plants appeared to be much less than in previous years. An aquatic plant management permit was issued to the lake association for a chemical treatment of European water milfoil in 2006. Although there is no proof that the lack of vegetation and the herbicide treatment are linked, we are concerned about the lack of vegetation. The loss of plants when added to habitat loss caused by shoreline development and fast boating in shallow water may cause fish populations in Pigeon Lake to recover from the 2000 fish kill more slowly than usual. We recommend another electroshocking survey within five years to document the status of the fish population in Pigeon Lake. Barring any more fish kills, we hope the next survey will indicate a continued recovery of this fishery from the 2000 fish kill. The access site is adequate for this waterbody and no improvements are needed at this time.