A

APPENDIX A

Public Participation Materials

Big Twin Lake Association, Inc.

Big Twin Lake Comprehensive Management Planning Project

Kick-off Meeting

July 14, 2012

Brenton Butterfield

Onterra LLC

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

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 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!"

Elements of an Effective Lake Management Planning Project

- Data and Information Gathering
  - Environmental & Sociological
- Planning Process
  - Brings it all together

Data and Information Gathering

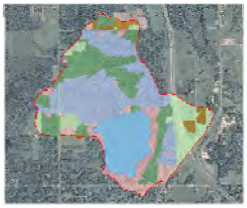
- Study Components
  - Water Quality Analysis
  - Watershed Assessment
  - Shoreline Assessment
  - Aquatic Plant Surveys
  - Fisheries Data Integration
  - Stakeholder Survey

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

Watershed Assessment

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



Shoreline Assessment

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

Urbanized

Range

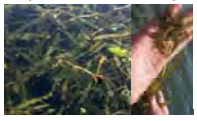
Natural

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

Non-native Aquatic Plants

- Curly-leaf pondweed (*Potamogeton crispus*)
- Early-season AIS Survey



Not Located in 2012

- Eurasian water milfoil (*Myriophyllum spicatum*)

First documented in 2005

Point-intercept Survey

- To be conducted by WDNR in 2012

Big Twin Lake
30-meter resolution
287 total points

Aquatic Plant Community Mapping

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

Stakeholder Survey

- Standard surveys used as base
  - Planning committee potentially develops additional questions and options
  - Must not lead respondent to specific answer through a "loaded" question
- Survey must be approved by WDNR

Planning Process

Planning Committee Meetings

Study Results (including stakeholder survey)

Conclusions & Initial Recommendations

Management Goals

Management Actions

Timeframe

Facilitator(s)

Implementation Plan

Big Twin Lake Management Planning Project

November 2012 Update

Submitted by: Brenton Butterfield, Onterra, LLC

With the help of a Lake Management Planning Grant totaling over $15,000 through the Wisconsin Department of Natural Resources (WDNR), a project is underway to create a lake management plan for Big Twin Lake. The lake management 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 Big Twin Lake during 2012. 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 Big Twin Lake Association, Inc. (BTLA) up-to-speed on the scientific studies that have occurred, provide some initial observations on the ecology of Big Twin Lake, and provide a rough timeline for the remaining actions that will be taken as a part of this planning project.

In March of 2012, Onterra staff had their first glimpse of Big Twin Lake with a water quality sampling visit. The lake is sampled during the spring and fall to analyze water chemistry during the lake's mixing, or *turnover* events. When a lake turns over, many physical and chemical constituents (temperature, dissolved oxygen, nutrients, etc.) are evenly mixed within the water column. This gives ecologists an idea of what the nutrient balance is within the lake, and supports modeling of the lake's watershed. During the summer months, water quality samples were collected by BTLA volunteers through the Citizen Lake Monitoring Network (CLMN). These results help ecologists understand how the physical and chemical constituents behave when the lake *stratifies*. Stratification is when a lake develops two separate layers of water – a warmer, upper layer and a cold, lower layer of water. Water samples targeting the larval stage of the invasive zebra mussel were also taken by Onterra staff and sent to the WDNR for analysis as part of efforts to monitor the lake for this invasive species. The zebra mussel results will be available in the spring.

All aquatic plant surveys were conducted as scheduled, first by visiting the lake on May 31, 2012 to complete an early-season AIS survey. This survey's primary purpose is to search the lake for curly-leaf pondweed (CLP), and is scheduled early in the summer to coincide with this species' 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. The whole-lake point-intercept survey was not conducted by Onterra ecologists in 2012 because it had recently been conducted by the WDNR in the summer of 2011. This is a grid-based survey designed to assess the aquatic plant community of Big Twin Lake at a lake-wide level. On August 29, 2012 one Onterra field crew conducted the aquatic plant community mapping survey and Eurasian water milfoil (EWM) peak-biomass survey. The purpose of the aquatic plant community mapping survey is to map the floating-leaf and emergent species that grow within the lake and are typically under-represented in the point-intercept survey. Like the early-season AIS survey, the EWM peak-biomass survey is a meander-based survey in which the field crew surveys the entire lake for EWM when it is at or near its peak growth in late summer. During this survey, EWM locations are mapped and assigned a density rating.

During the 2012 surveys, Eurasian water milfoil and purple loosestrife were the only non-native plants encountered. The 2011 WDNR point-intercept survey indicates that Big Twin Lake contains a relatively high number of native aquatic plant species. They recorded aquatic vegetation growing out to 25 feet, an indicator of the lake's high water clarity; the average Secchi disk depth for the summer of 2012 was 18.5 feet. The native species coontail, fern pondweed, and common waterweed were the three-most abundant plants within the lake in 2011, while EWM comprised a small portion (0.7%) of the lake's plant community (Figure 1).

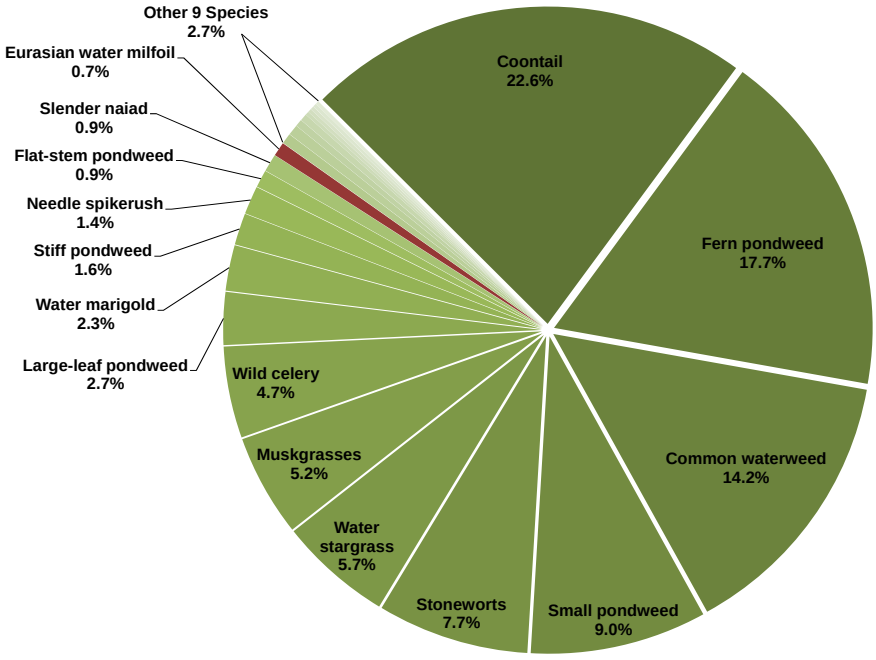


Figure 1. Big Twin Lake 2011 aquatic plant relative frequency of occurrence. Created using data from WDNR 2011 whole-lake point-intercept survey.

On October 8, 2012 a crew visited Big Twin Lake to conduct a shoreline assessment survey. During this survey, the lake's shoreline is examined and classified into one of five development categories based upon its level of human disturbance. The results of this survey may be used to prioritize areas for restoration if the BTLA wishes to pursue this. Course woody habitat around the lake's shoreline was also documented and categorized during this survey.

In addition to collecting ecological data from Big Twin Lake, sociological data was collected from the people who use and care for Big Twin Lake. This was approached in the form of a stakeholder survey, which was developed by Onterra staff and a planning committee comprised of BTLA volunteers. This survey was distributed in October 2012 to all riparian property owners, both association members and non-members.

In the coming months, Onterra will be sorting through the immense amount of water quality, aquatic plant, shoreline assessment and stakeholder survey data that has been collected. Additionally, 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. We will also be working with the WDNR to collect data and report upon the management of the fishery.

In summary, all project components are on schedule. Following data analysis and report creation, the Big Twin Lake Planning Committee and Onterra staff will meet to discuss the project results and begin creation of management goals and actions the BTLA will pursue to manage their lake in both a recreationally enjoyable and ecologically sound manner.

Presentation Outline

- Lake Management Planning Project Overview
- Study Results
  - Water Quality
  - Watershed
  - Shoreland
  - Aquatic Plants
  - Fishery

  Stakeholder Survey
- "Big Picture"

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Study and Plan Goals

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

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Wisconsin Ecoregions

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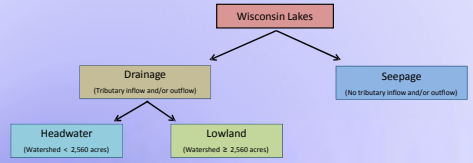
Wisconsin Lakes Classification



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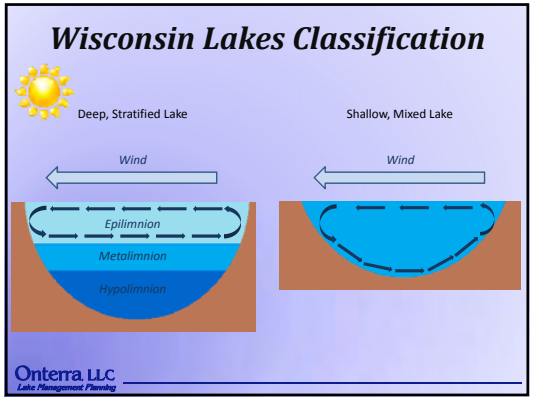
Wisconsin Lakes Classification
Deep, Stratified Lake
Shallow, Mixed Lake
Wind
Wind
Epilimnion
Metalimnion
Hypolimnion
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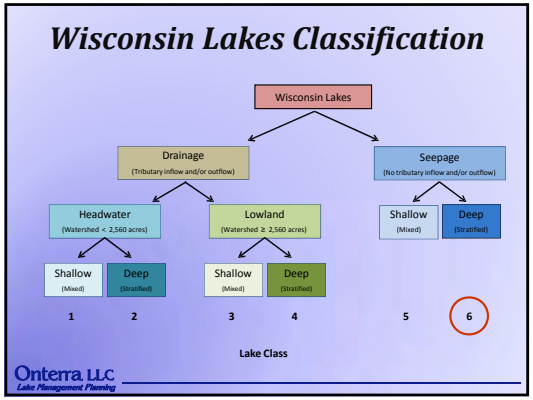
Wisconsin Lakes Classification
Wisconsin Lakes
Drainage
(Tributary inflow and/or outflow)
Seepage
(No tributary inflow and/or outflow)
Headwater
(Watershed < 2,560 acres)
Lowland
(Watershed ≥ 2,560 acres)
Shallow
(Mixed)
Deep
(Stratified)
Shallow
(Mixed)
Deep
(Stratified)
Shallow
(Mixed)
Deep
(Stratified)
1
2
3
4
5
6
Lake Class
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Water Quality
Phosphorus (Limiting Plant Nutrient)
Nitrogen:Phosphorus = 41:1
Chlorophyll-a (Algal Abundance)
Low abundance
Water Clarity (Secchi Disk)
High water clarity
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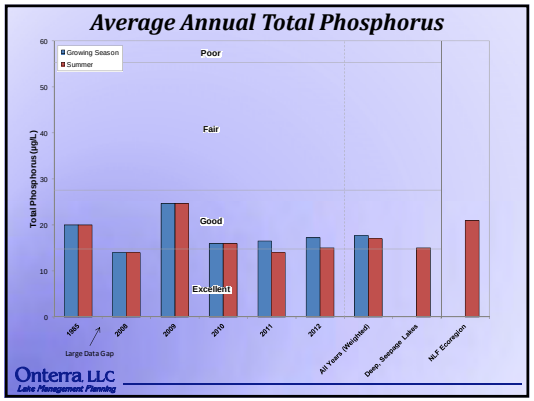
Lake Management Planning


Average Annual Total Phosphorus
Growing Season
Summer
Poor
Fair
Good
Excellent
Total Phosphorus (µg/L)
1985
2008
2009
2010
2011
2012
All Years (Weighted)
Deep, Seepage Lakes
NLF Ecoregion
Large Data Gap
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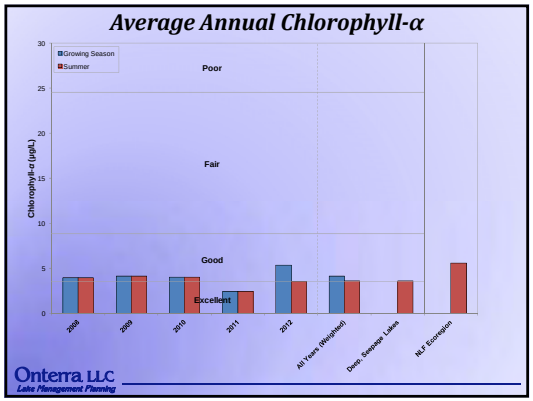
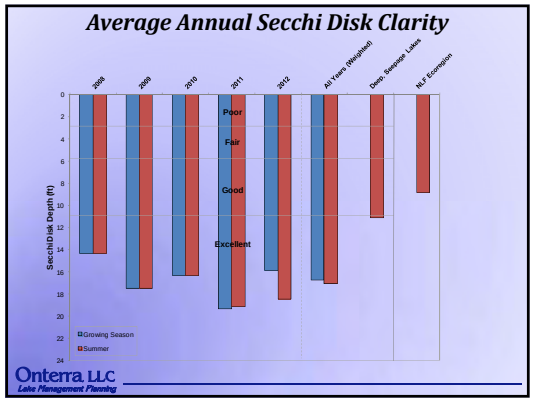
Lake Management Planning


Average Annual Chlorophyll-α
Growing Season
Summer
Poor
Fair
Good
Excellent
Chlorophyll-a (µg/L)
2008
2009
2010
2011
2012
All Years (Weighted)
Deep, Seepage Lakes
NLF Ecoregion
Onterra LLC
Lake Management Planning


Average Annual Secchi Disk Clarity
2008
2009
2010
2011
2012
All Years (Weighted)
Deep, Seepage Lakes
NLF Ecoregion
Poor
Fair
Good
Excellent
Secchi Disk Depth (ft)
Growing Season
Summer
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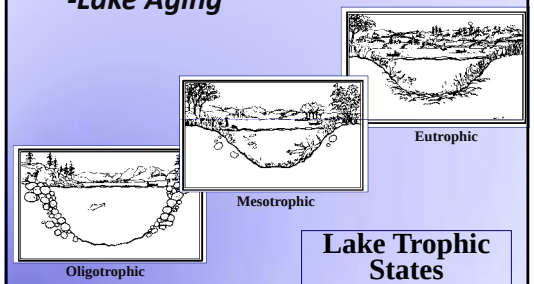
Eutrophication
-Lake Aging



Lake Trophic States

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Trophic State Index

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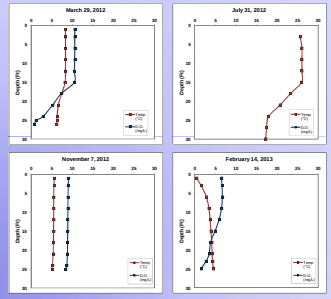
Dissolved Oxygen / Temperature



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Other Water Quality Results

- Alkalinity = 70.6 mg/L as $CaCO_3$ – indicates very little sensitivity to acid rain
- Moderate calcium concentrations (15.5 mg/L)
  - Borderline suitable for zebra mussel establishment

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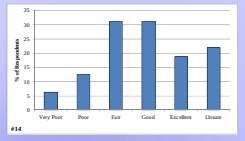
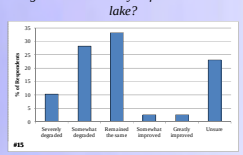
Stakeholder Survey – Water Quality

How would you describe the current water quality of Big Twin Lake?



How has the water quality changed in Big Twin Lake since you first visited the lake?



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Watershed Assessment Procedure

Determine Watershed Area and Boundaries

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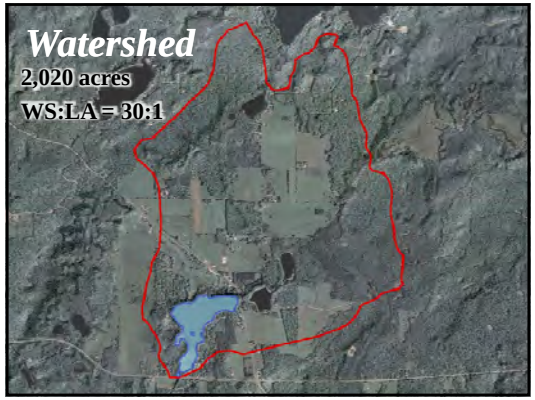
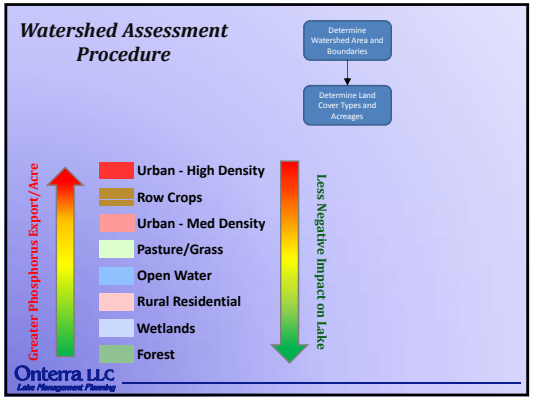

Watershed
2,020 acres
WS:LA = 30:1


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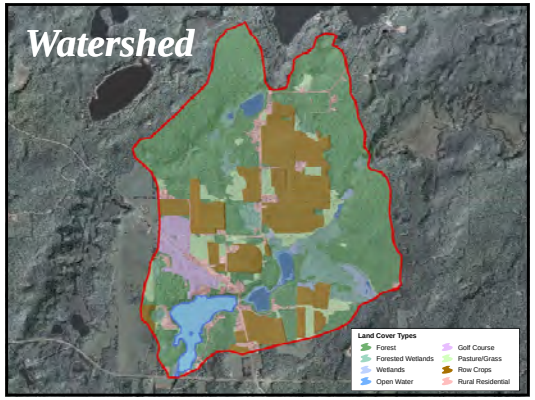
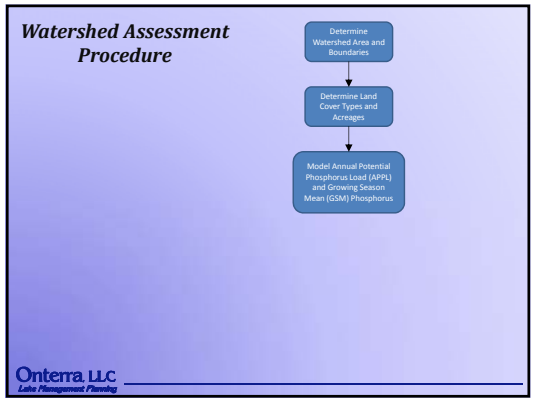

Watershed
Land Cover Types
Forest
Forested Wetlands
Wetlands
Open Water
Golf Course
Pasture/Grass
Row Crops
Rural Residential


Watershed Assessment Procedure
Determine Watershed Area and Boundaries
Determine Land Cover Types and Acreages
Model Annual Potential Phosphorus Load (APPL) and Growing Season Mean (GSM) Phosphorus
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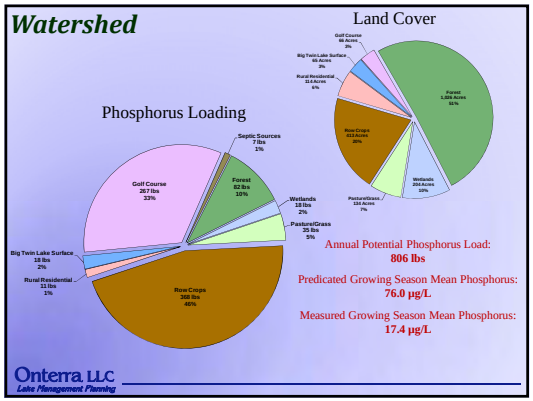
Watershed
Land Cover
Phosphorus Loading
Golf Course 267 lbs 33%
Septic Sources 7 lbs 1%
Forest 82 lbs 10%
Wetlands 18 lbs 2%
Pasture/Grass 35 lbs 5%
Row Crops 368 lbs 46%
Big Twin Lake Surface 18 lbs 2%
Rural Residential 11 lbs 1%
Annual Potential Phosphorus Load: 806 lbs
Predicated Growing Season Mean Phosphorus: 76.0 µg/L
Measured Growing Season Mean Phosphorus: 17.4 µg/L
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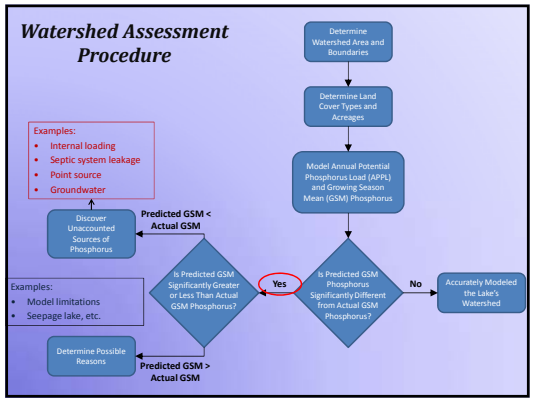
Watershed Assessment Procedure
Determine Watershed Area and Boundaries
Determine Land Cover Types and Acreages
Model Annual Potential Phosphorus Load (APPL) and Growing Season Mean (GSM) Phosphorus
Examples:
Internal loading
Septic system leakage
Point source
Groundwater
Discover Unaccounted Sources of Phosphorus
Predicted GSM < Actual GSM
Is Predicted GSM Significantly Greater or Less Than Actual GSM Phosphorus?
Yes
Is Predicted GSM Phosphorus Significantly Different from Actual GSM Phosphorus?
No
Accurately Modeled the Lake's Watershed
Examples:
Model limitations
Seepage lake, etc.
Determine Possible Reasons
Predicted GSM > Actual GSM

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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Shoreline Assessment Category Descriptions

More Natural Habitat

Greater Need for Restoration

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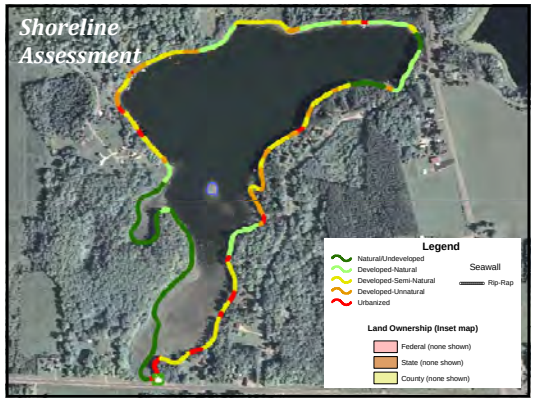

Coarse Woody Habitat

- 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 Big Twin Lake

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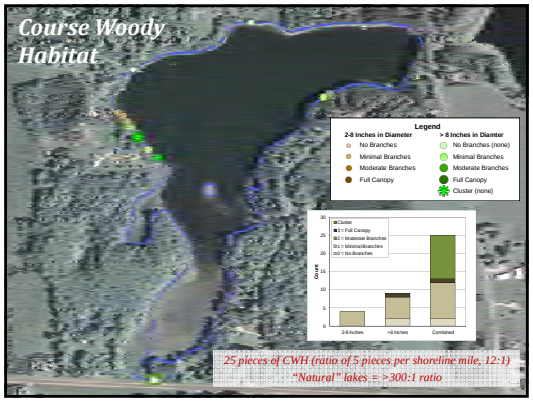
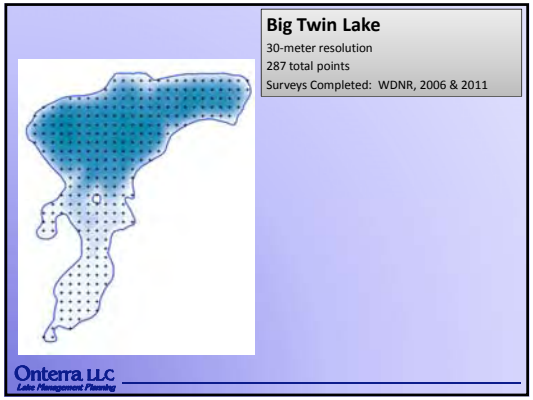
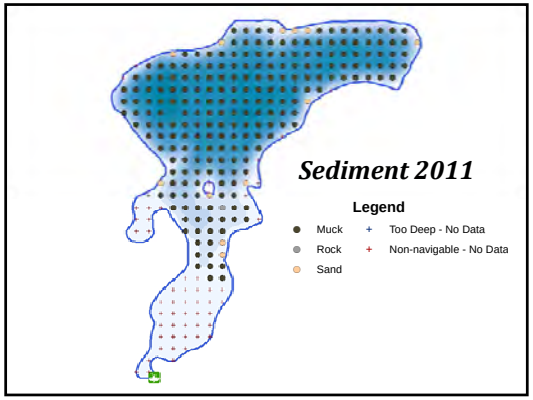
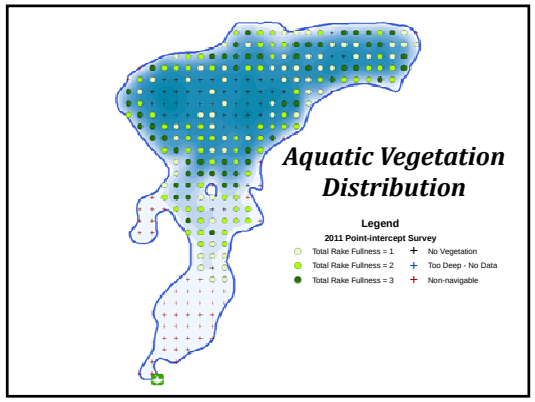
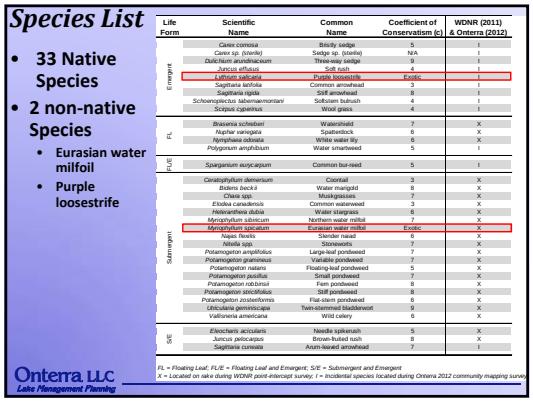




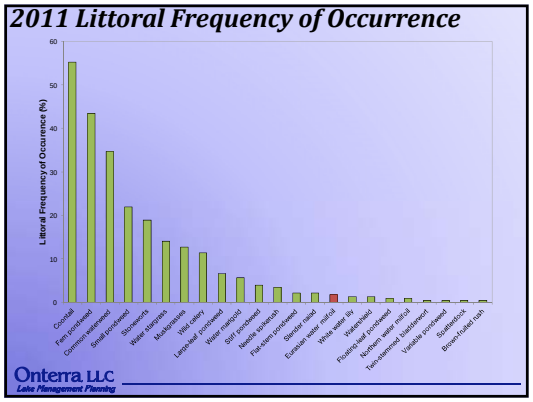


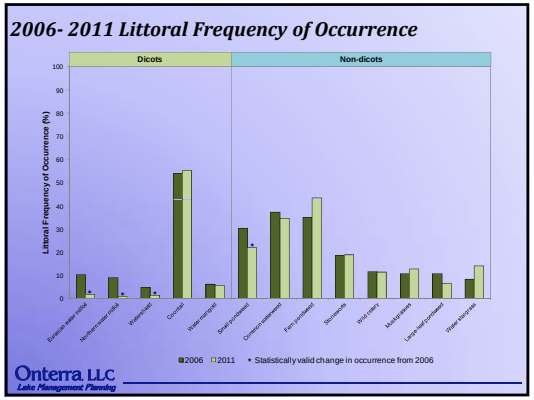




Life Form	Scientific Name	Common Name	Coefficient of Conservatism (c)	WDNR (2011) & Onterra (2012)
Emergent	*Carex comosa*	Bristly sedge	5	I
	Carex sp. (sterile)	Sedge sp. (sterile)	NA	I
	Dulichium arundinaceum	Three-way sedge	9	I
	Juncus effusus	Soft rush	4	I
	Lythrum salicaria	Purple loosestrife	Exotic	I
	Sagittaria latifolia	Common arrowhead	3	I
	Sagittaria rigida	Stiff arrowhead	8	I
	Schoenoplectus tabernaemontani	Softstem bulrush	4	I
	Scirpus cyperinus	Wool grass	4	I
FL	*Brasenia schreberi*	Watershield	7	X
	Nuphar variegata	Spatterdock	6	X
	Nymphaea odorata	White water lily	6	X
	Polygonum amphibium	Water smartweed	5	I
FL/E	*Sparganium eurycarpum*	Common bur-reed	5	I
Submergent	*Ceratophyllum demersum*	Coontail	3	X
	Bidens beckii	Water marigold	8	X
	Chara spp.	Muskgrasses	7	X
	Elodea canadensis	Common waterweed	3	X
	Heteranthera dubia	Water stargrass	6	X
	Myriophyllum sibiricum	Northern water milfoil	7	X
	Myriophyllum spicatum	Eurasian water milfoil	Exotic	X
	Najas flexilis	Slender naiad	6	X
	Nitella spp.	Stoneworts	7	X
	Potamogeton amplifolius	Large-leaf pondweed	7	X
	Potamogeton gramineus	Variable pondweed	7	X
	Potamogeton natans	Floating-leaf pondweed	5	X
	Potamogeton pusillus	Small pondweed	7	X
	Potamogeton robbinsii	Fern pondweed	8	X
	Potamogeton strictifolius	Stiff pondweed	8	X
	Potamogeton zosteriformis	Flat-stem pondweed	6	X
	Utricularia geminiscapa	Twin-stemmed bladderwort	9	X
	Vallisneria americana	Wild celery	6	X
S/E	*Eleocharis acicularis*	Needle spikerush	5	X
	Juncus pelocarpus	Brown-fruited rush	8	X
	Sagittaria cuneata	Arum-leaved arrowhead	7	I

FL = Floating Leaf; FL/E = Floating Leaf and Emergent; S/E = Submergent and Emergent
X = Located on lake during WDNR point-intercept survey; I = Incidental species located during Onterra 2012 community mapping survey




2006- 2011 Littoral Frequency of Occurrence
Dicots
Non-dicots
Littoral Frequency of Occurrence (%)
2006
2011
* Statistically valid change in occurence from 2006
Onterra LLC
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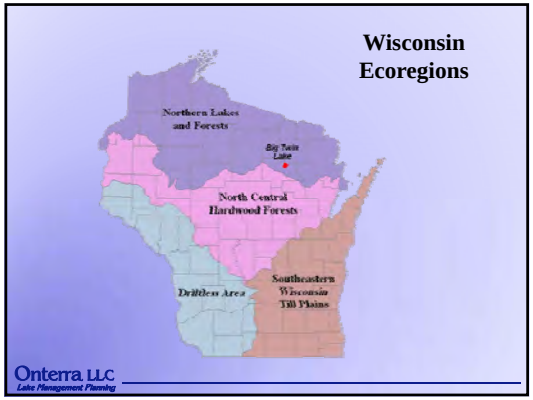
Wisconsin Ecoregions
Northern Lakes and Forests
Big Twin Lake
North Central Hardwood Forests
Driftless Area
Southeastern Wisconsin Till Plains
Onterra LLC
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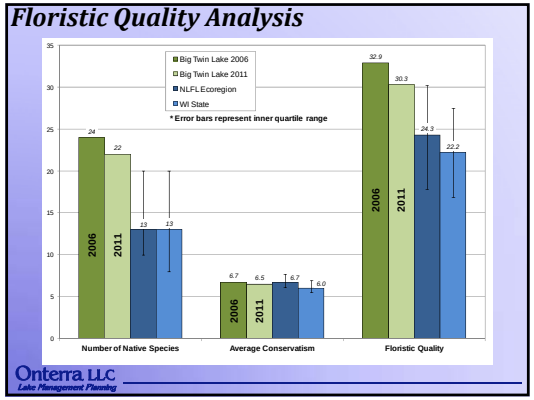
Floristic Quality Analysis
Big Twin Lake 2006
Big Twin Lake 2011
NLFL Ecoregion
WI State
* Error bars represent inner quartile range
Number of Native Species
Average Conservatism
Floristic Quality
Onterra LLC
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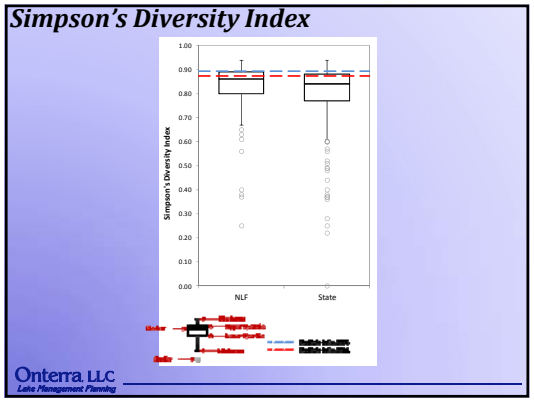
Simpson's Diversity Index
Simpson's Diversity Index
NLF
State
Onterra LLC
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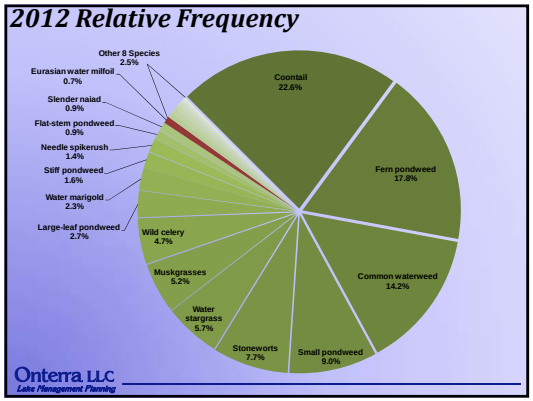
2012 Relative Frequency
Other 8 Species 2.5%
Eurasian water milfoil 0.7%
Slender naiad 0.9%
Flat-stem pondweed 0.9%
Needle spikerush 1.4%
Stiff pondweed 1.6%
Water marigold 2.3%
Large-leaf pondweed 2.7%
Wild celery 4.7%
Muskgrasses 5.2%
Water stargrass 5.7%
Stoneworts 7.7%
Small pondweed 9.0%
Common waterweed 14.2%
Fern pondweed 17.8%
Coontail 22.6%
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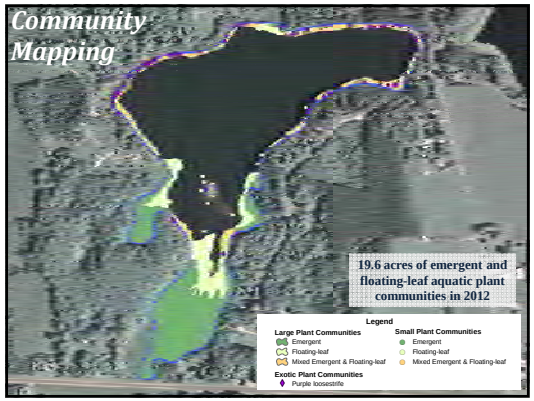
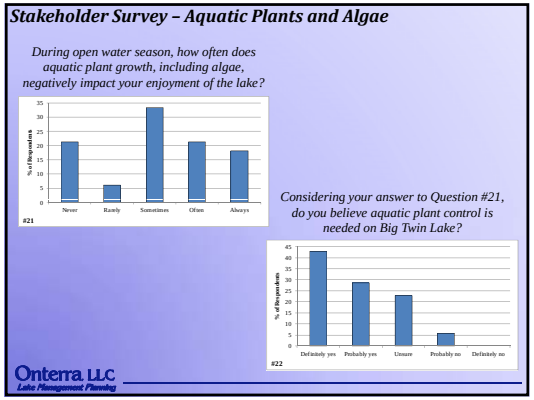

Community Mapping
19.6 acres of emergent and floating-leaf aquatic plant communities in 2012
Legend
Large Plant Communities
Emergent
Floating-leaf
Mixed Emergent & Floating-leaf
Small Plant Communities
Emergent
Floating-leaf
Mixed Emergent & Floating-leaf
Exotic Plant Communities
Purple loosestrife


Stakeholder Survey – Aquatic Plants and Algae
During open water season, how often does aquatic plant growth, including algae, negatively impact your enjoyment of the lake?
% of Respondents
Never
Rarely
Sometimes
Often
Always
#21
Considering your answer to Question #21, do you believe aquatic plant control is needed on Big Twin Lake?
% of Respondents
Definitely yes
Probably yes
Unsure
Probably no
Definitely no
#22
Onterra LLC
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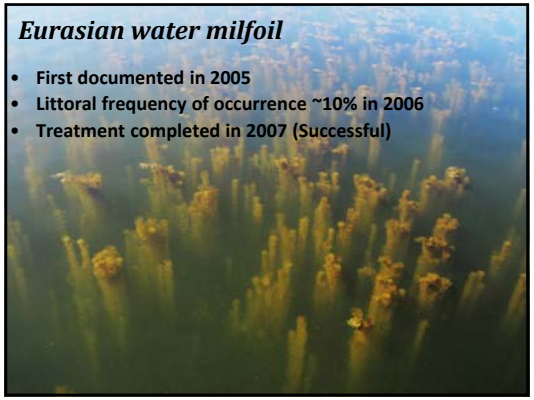
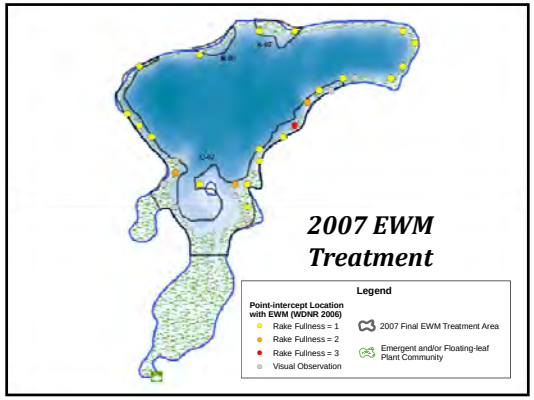
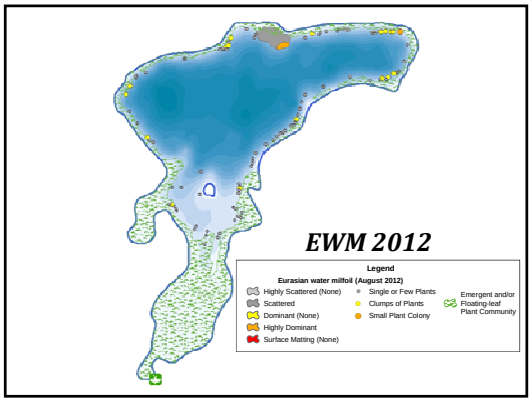
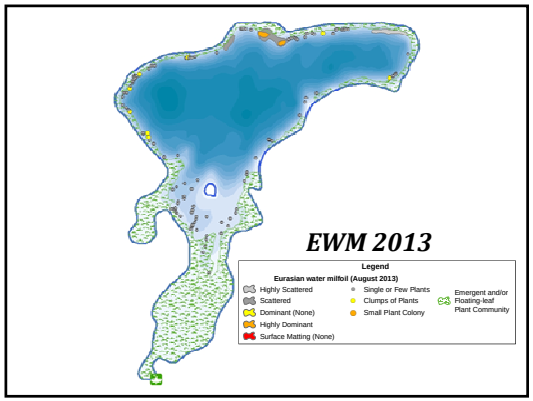

Eurasian water milfoil
First documented in 2005
Littoral frequency of occurrence ~10% in 2006
Treatment completed in 2007 (Successful)


2007 EWM Treatment
Legend
Point-intercept Location with EWM (WDNR 2006)
Rake Fullness = 1
Rake Fullness = 2
Rake Fullness = 3
Visual Observation
2007 Final EWM Treatment Area
Emergent and/or Floating-leaf Plant Community

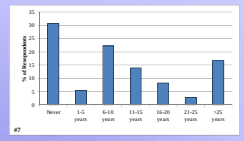

EWM 2012
Legend
Eurasian water milfoil (August 2012)
Highly Scattered (None)
Scattered
Dominant (None)
Highly Dominant
Surface Matting (None)
Single or Few Plants
Clumps of Plants
Small Plant Colony
Emergent and/or Floating-leaf Plant Community


EWM 2013
Legend
Eurasian water milfoil (August 2013)
Highly Scattered
Scattered
Dominant (None)
Highly Dominant
Surface Matting (None)
Single or Few Plants
Clumps of Plants
Small Plant Colony
Emergent and/or Floating-leaf Plant Community

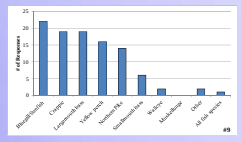

Fisheries

Stakeholder Survey – Big Twin Lake Fishery

For how many years have you fished Big Twin Lake?



What species of fish do you like to catch in Little Bearskin Lake?



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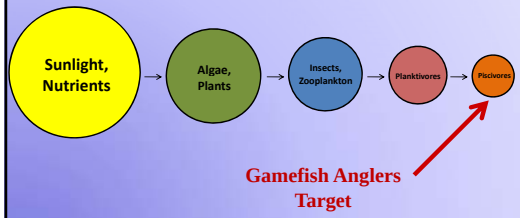
Big Twin Lake Fishery



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Native American Spear Harvest

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Conclusions

- Water quality for deep, seepage lake is good to excellent.
  - Minimal historical data – no apparent trends.
  - Relatively low phosphorus, low algal abundance, high water clarity
- Majority of watershed is forested; 20% comprised of row crop agriculture; adjacent golf course
  - Modeling predicted more phosphorus than measured
  - Limited ability of modeling software
  - Seepage lake; little overland water flow

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Conclusions continued

- Aquatic plant community
  - Based upon standard analysis, native plant community is of high quality.
    - High species diversity
    - Sensitive species present
    - High species richness
  - Abundance of organic substrate creates abundant aquatic plant growth.
  - Statistically valid decline in EWM occurrence from 2006-2011
  - Fisheries
  - Productive lake leads to robust fishery
  - Spearing has not occurred on the lake
  - Minimal coarse woody habitat

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Thank You

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

Wisconsin Lakes Partnership

UW Extension

Onterra LLC

Develop Control Strategy & Monitoring Plan

Control Strategy

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

Monitoring Plan

- Collection of Pretreatment & Post Treatment Data

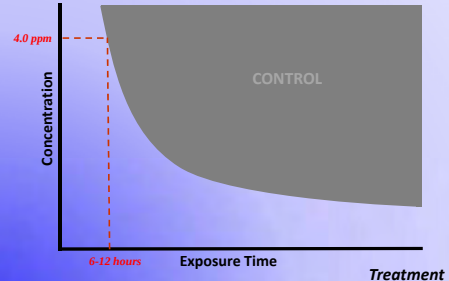
AIS Control Project Strategy

- **Hand removal**
- **Herbicide treatment**
- **Winter drawdown**
- **Mechanical harvesting**
- **Do Nothing (monitor)**

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

Herbicide Use Patterns

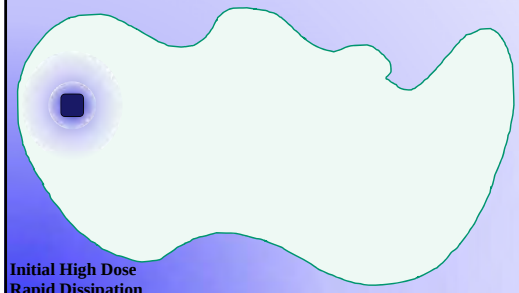


Treatment Type

Spot

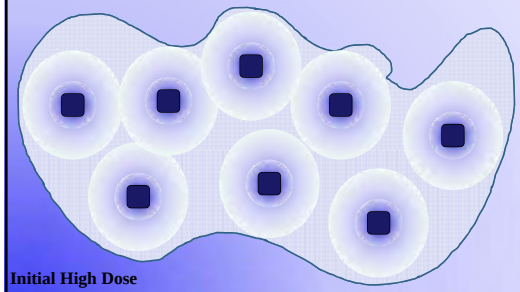
High Dose ► Short Exposure Time

Spot Treatment Use Pattern



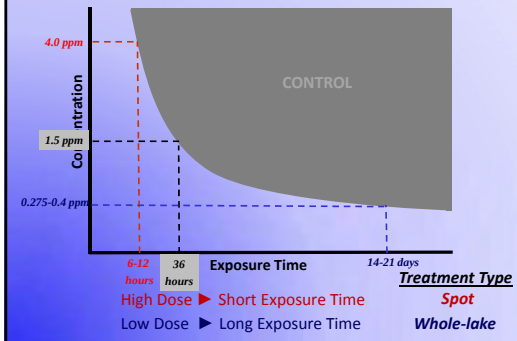
Initial High Dose
Rapid Dissipation
Herbicide concentrations too low outside of Treatment Area to cause impact

Whole-lake Use Pattern



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

Herbicide Use Patterns



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.

Large to whole-lake scale treatment expectations

- Approved APM plan following APM Guide
- A recent (year prior to implementation) baseline aquatic plant survey using the Point-intercept (PI) method
- A map documenting the proposed treatment areas
- Monitoring and evaluation plan
- Technical review by statewide team (esp. for first – time, whole-lake, or experimental projects)
- Meets NR107 and NR150 requirements

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

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.”

B

APPENDIX B

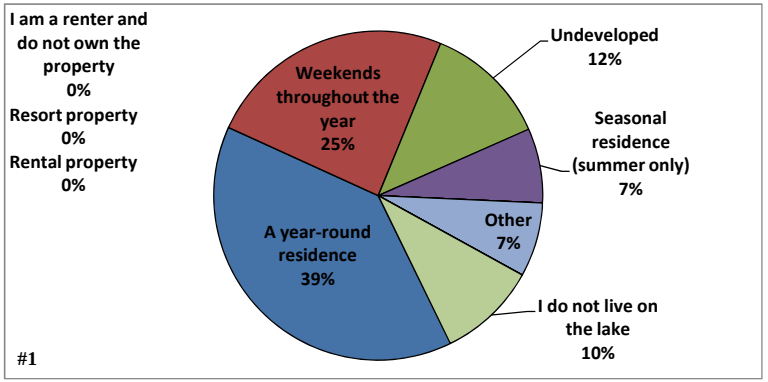
Stakeholder Survey Response Charts and Comments

Returned Surveys	42
Sent Surveys	77
Response Rate (%)	54.5

BIG TWIN LAKE PROPERTY

#1 How is your property on Big Twin Lake utilized?

	Total	%
A year-round residence	16	*39.0*
Weekends throughout the year	10	*24.4*
Undeveloped	5	*12.2*
Seasonal residence (summer only)	3	*7.3*
Resort property	0	*0.0*
Rental property	0	*0.0*
Other	3	*7.3*
I am a renter and do not own the property	0	*0.0*
I do not live on the lake	4	*9.8*
	41	100.0

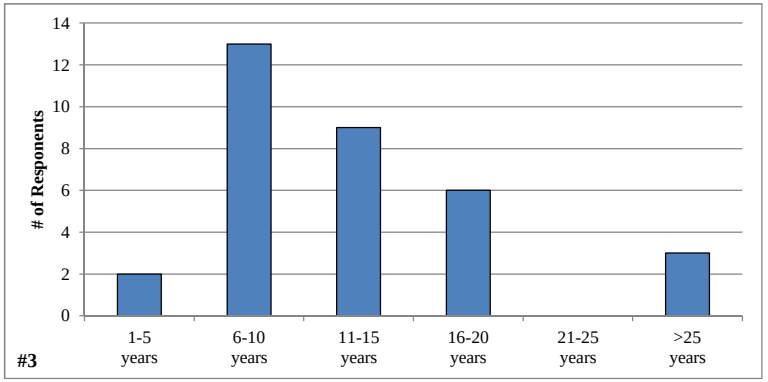


#2 How many days each year is your property used by you or others?

Answered Question	33
Average	146.1
Standard deviation	151.5

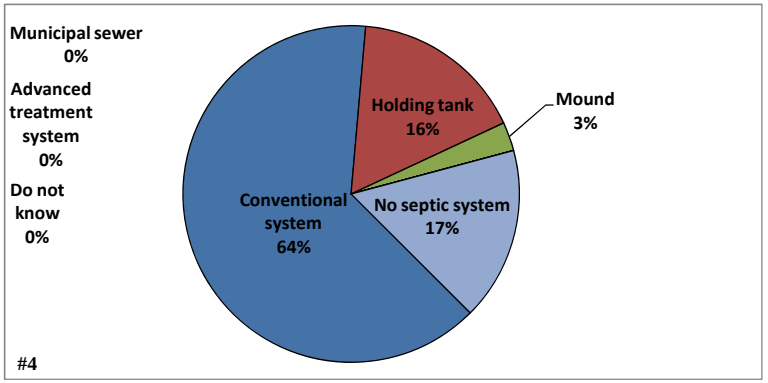
#3 How long have you owned or rented your property on Big Twin Lake?

	Total	%
1-5 years	2	*6.1*
6-10 years	13	*39.4*
11-15 years	9	*27.3*
16-20 years	6	*18.2*
21-25 years	0	*0.0*
>25 years	3	*9.1*
	33	*100.0*



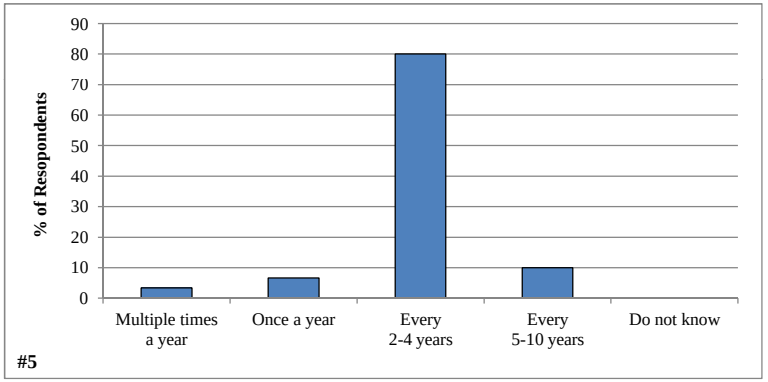
#4 What type of septic system does your property utilize?

	Total	%
Conventional system	23	*63.9*
Holding tank	6	*16.7*
Mound	1	*2.8*
Advanced treatment system	0	*0.0*
Municipal sewer	0	*0.0*
Do not know	0	*0.0*
No septic system	6	*16.7*
	36	*100.0*



#5 How often is the septic tank on your property pumped?

	Total	%
Multiple times a year	1	*3.3*
Once a year	2	*6.7*
Every 2-4 years	24	*80.0*
Every 5-10 years	3	*10.0*
Do not know	0	*0.0*
	30	*100.0*



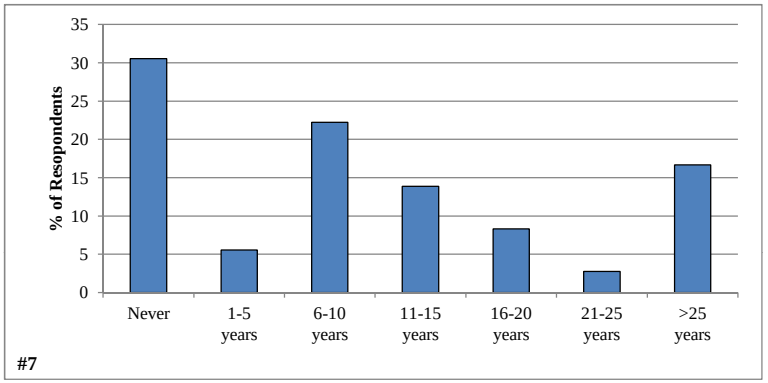
RECREATIONAL ACTIVITY ON BIG TWIN LAKE

#6 How many years ago did you first visit Big Twin Lake?

Answered Question	38
Average	22.7
Standard deviation	21.9

#7 For how many years have you fished Big Twin Lake?

	Total	%
Never	11	*30.6*
1-5 years	2	*5.6*
6-10 years	8	*22.2*
11-15 years	5	*13.9*
16-20 years	3	*8.3*
21-25 years	1	*2.8*
>25 years	6	*16.7*
	36	*100.0*



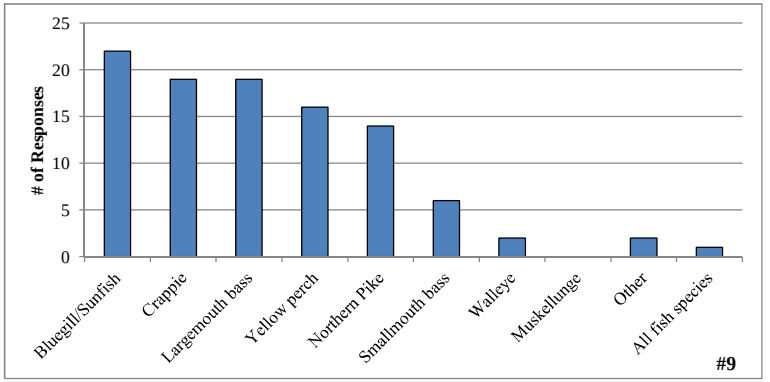
#7

#8 Have you personally fished on Big Twin Lake in the past three years?

	Total	%
Yes	24	*96.0*
No	1	*4.0*
	25	*100.0*

#9 What species of fish do you like to catch on Big Twin Lake?

	Total
Bluegill/Sunfish	22
Crappie	19
Largemouth bass	19
Yellow perch	16
Northern Pike	14
Smallmouth bass	6
Walleye	2
Muskellunge	0
Other	2
All fish species	1

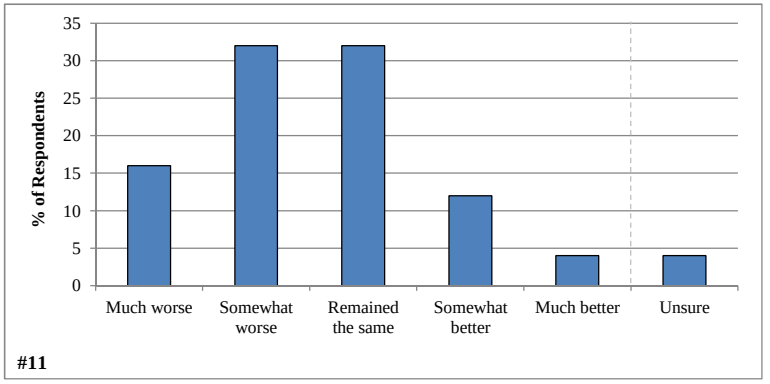


#10 How would you describe the current quality of fishing on Big Twin Lake?

	Total	%
Very Poor	0	*0.0*
Poor	6	*24.0*
Fair	9	*36.0*
Good	7	*28.0*
Excellent	1	*4.0*
Unsure	2	*8.0*
	25	*100.0*

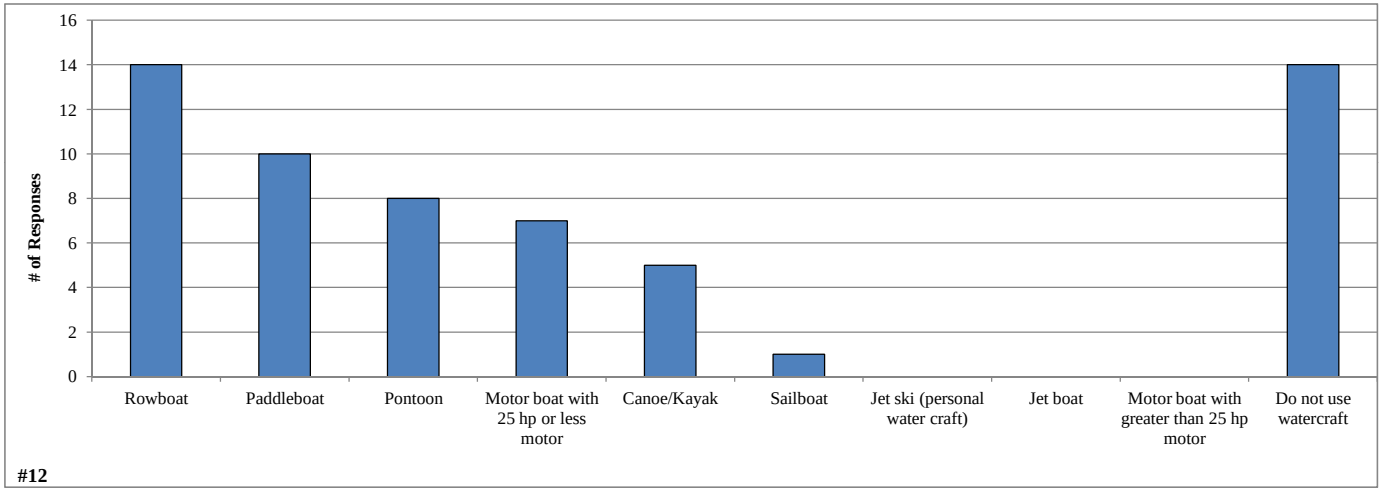
#11 How has the quality of fishing changed since you started fishing on the lake?

	Total	%
Much worse	4	*16.0*
Somewhat worse	8	*32.0*
Remained the Same	8	*32.0*
Somewhat better	3	*12.0*
Much better	1	*4.0*
Unsure	1	*4.0*
	25	*100.0*



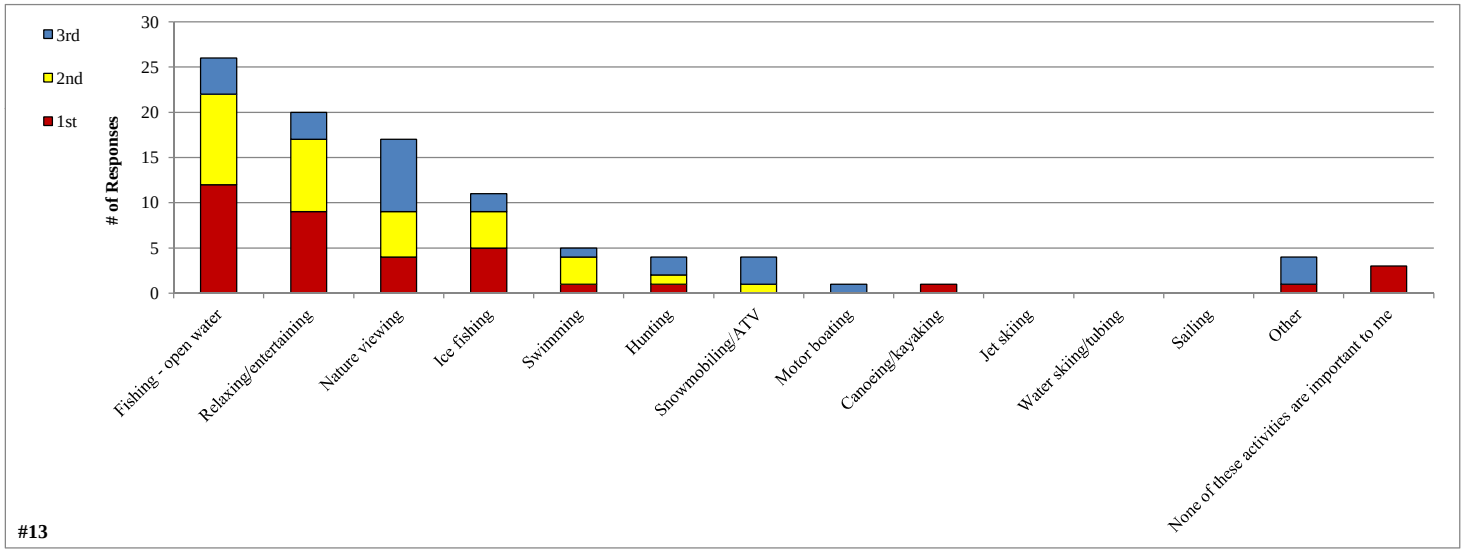
#12 What types of watercraft do you currently use on the lake?

	Total
Rowboat	14
Paddleboat	10
Pontoon	8
Motor boat with 25 hp or less motor	7
Canoe/Kayak	5
Sailboat	1
Jet ski (personal water craft)	0
Jet boat	0
Motor boat with greater than 25 hp motor	0
Do not use watercraft	14



#13 Please rank up to three activities that are important reasons for owning your property on or near the lake.

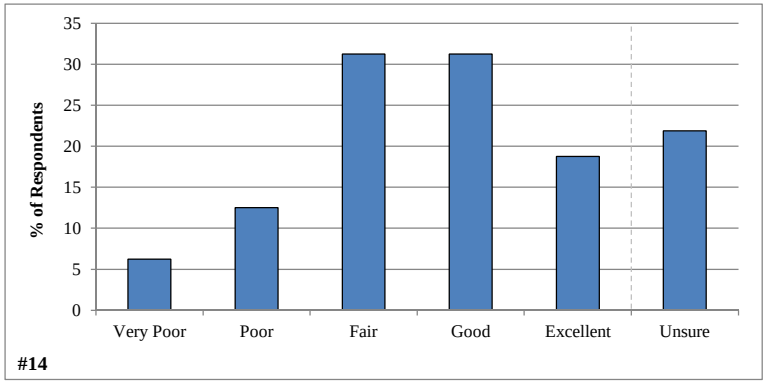
	1st	2nd	3rd	*% ranked*
Fishing - open water	12	10	4	*27.1*
Relaxing/entertaining	9	8	3	*20.8*
Nature viewing	4	5	8	*17.7*
Ice fishing	5	4	2	*11.5*
Swimming	1	3	1	*5.2*
Hunting	1	1	2	*4.2*
Snowmobiling/ATV	0	1	3	*4.2*
Motor boating	0	0	1	*1.0*
Canoeing/kayaking	1	0	0	*1.0*
Jet skiing	0	0	0	*0.0*
Water skiing/tubing	0	0	0	*0.0*
Sailing	0	0	0	*0.0*
Other	1	0	3	*4.2*
None of these activities are important to me	3	0	0	*3.1*
	37	32	27	*100.0*



BIG TWIN LAKE CURRENT AND HISTORIC CONDITION, HEALTH AND MANAGEMENT

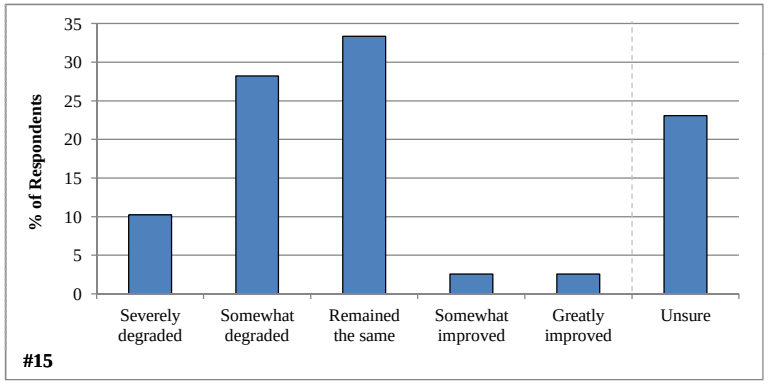
#14 How would you describe the current water quality of Big Twin Lake?

	Total	%
Very Poor	2	*6.3*
Poor	4	*12.5*
Fair	10	*31.3*
Good	10	*31.3*
Excellent	6	*18.8*
Unsure	7	*21.9*
	32	*100.0*



#15 How has the water quality changed in Big Twin Lake since you first visited the lake?

	Total	%
Severely degraded	4	*10.3*
Somewhat degraded	11	*28.2*
Remained the same	13	*33.3*
Somewhat improved	1	*2.6*
Greatly improved	1	*2.6*
Unsure	9	*23.1*
	39	*100.0*



#16 Have you ever heard of aquatic invasive species?

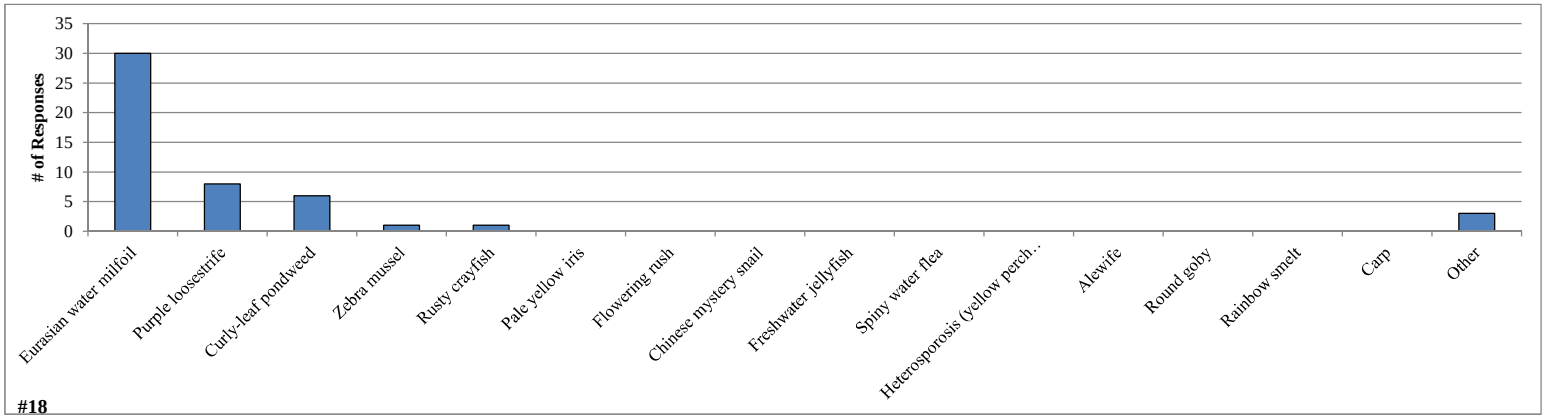
	Total	%
Yes	37	*97.4*
No	1	*2.6*
	38	*100.0*

#17 Are you aware of aquatic invasive species in the lake?

	Total	%
Yes	34	*97.1*
No	1	*2.9*
	35	*100.0*

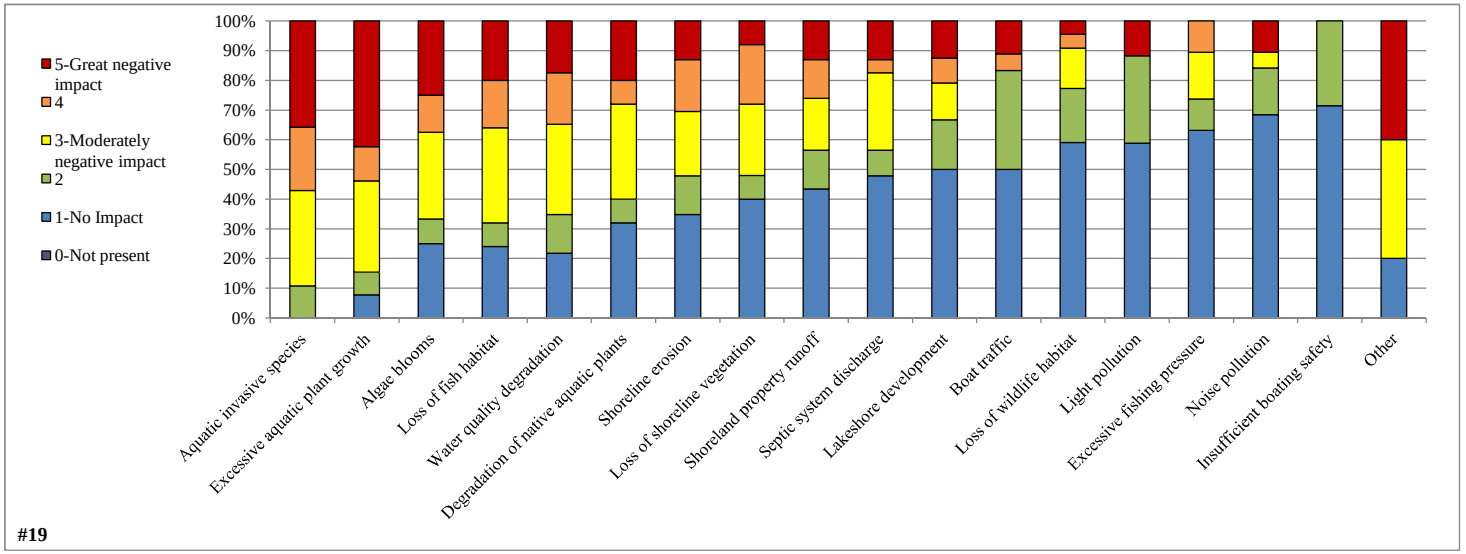
#18 Which aquatic invasive species are you aware of in the lake?

	Total
Eurasian water milfoil	30
Purple loosestrife	8
Curly-leaf pondweed	6
Zebra mussel	1
Rusty crayfish	1
Pale yellow iris	0
Flowering rush	0
Chinese mystery snail	0
Freshwater jellyfish	0
Spiny water flea	0
Heterosporosis (yellow perch parasite)	0
Alewife	0
Round goby	0
Rainbow smelt	0
Carp	0
Other	3



#19 To what level do you believe each of the following factors may be negatively impacting Big Twin Lake?

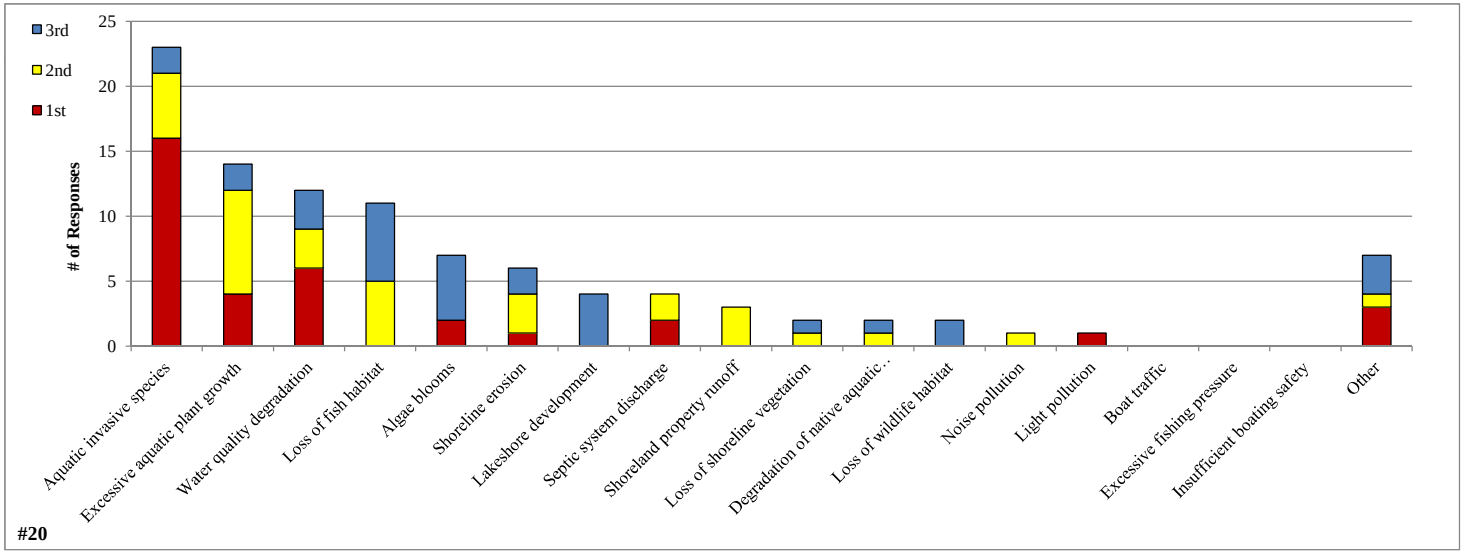
	0-Not present	1-No Impact	2	3-Moderately negative impact	4	5-Great negative impact	Unsure	*Total*	*Average*
Aquatic invasive species	0	0	3	9	6	10	7	*28*	*3.8*
Excessive aquatic plant growth	0	2	2	8	3	11	10	*26*	*3.7*
Algae blooms	0	6	2	7	3	6	10	*24*	*3.0*
Loss of fish habitat	0	6	2	8	4	5	6	*25*	*3.0*
Water quality degradation	0	5	3	7	4	4	9	*23*	*3.0*
Degradation of native aquatic plants	0	8	2	8	2	5	7	*25*	*2.8*
Shoreline erosion	0	8	3	5	4	3	9	*23*	*2.6*
Loss of shoreline vegetation	0	10	2	6	5	2	7	*25*	*2.5*
Shoreland property runoff	0	10	3	4	3	3	8	*23*	*2.4*
Septic system discharge	0	11	2	6	1	3	9	*23*	*2.3*
Lakeshore development	0	12	4	3	2	3	9	*24*	*2.2*
Boat traffic	0	9	6	0	1	2	9	*18*	*1.9*
Loss of wildlife habitat	0	13	4	3	1	1	9	*22*	*1.8*
Light pollution	0	10	5	0	0	2	8	*17*	*1.8*
Excessive fishing pressure	0	12	2	3	2	0	9	*19*	*1.7*
Noise pollution	0	13	3	1	0	2	8	*19*	*1.7*
Insufficient boating safety	0	10	4	0	0	0	11	*14*	*1.3*
Other	0	1	0	2	0	2	5	*5*	*3.4*



#19

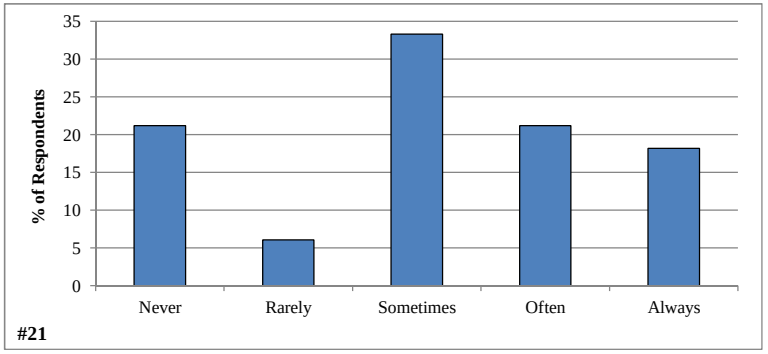
#20 From the list below, please rank your top three concerns regarding Big Twin Lake.

	1st	2nd	3rd	*% Ranked*
Aquatic invasive species	16	5	2	*23.2*
Excessive aquatic plant growth	4	8	2	*14.1*
Water quality degradation	6	3	3	*12.1*
Loss of fish habitat	0	5	6	*11.1*
Algae blooms	2	0	5	*7.1*
Shoreline erosion	1	3	2	*6.1*
Lakeshore development	0	0	4	*4.0*
Septic system discharge	2	2	0	*4.0*
Shoreland property runoff	0	3	0	*3.0*
Loss of shoreline vegetation	0	1	1	*2.0*
Degradation of native aquatic plants	0	1	1	*2.0*
Loss of wildlife habitat	0	0	2	*2.0*
Noise pollution	0	1	0	*1.0*
Light pollution	1	0	0	*1.0*
Boat traffic	0	0	0	*0.0*
Excessive fishing pressure	0	0	0	*0.0*
Insufficient boating safety	0	0	0	*0.0*
Other	3	1	3	*7.1*
	35	33	31	*100.0*



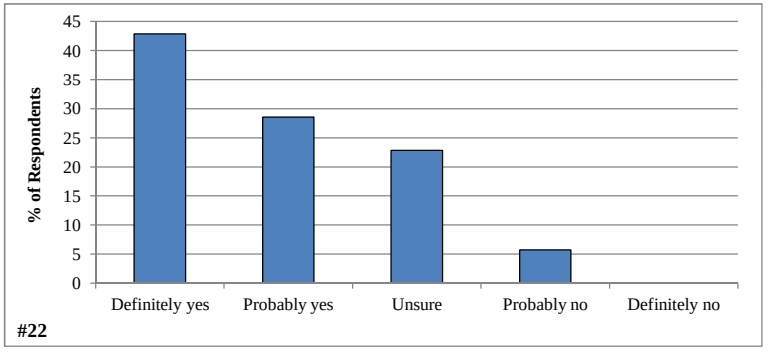
#21 During open water season how often does aquatic plant growth, including algae, negatively impact your enjoyment of Big Twin Lake?

	Total	%
Never	7	*21.2*
Rarely	2	*6.1*
Sometimes	11	*33.3*
Often	7	*21.2*
Always	6	*18.2*
	33	*100.0*



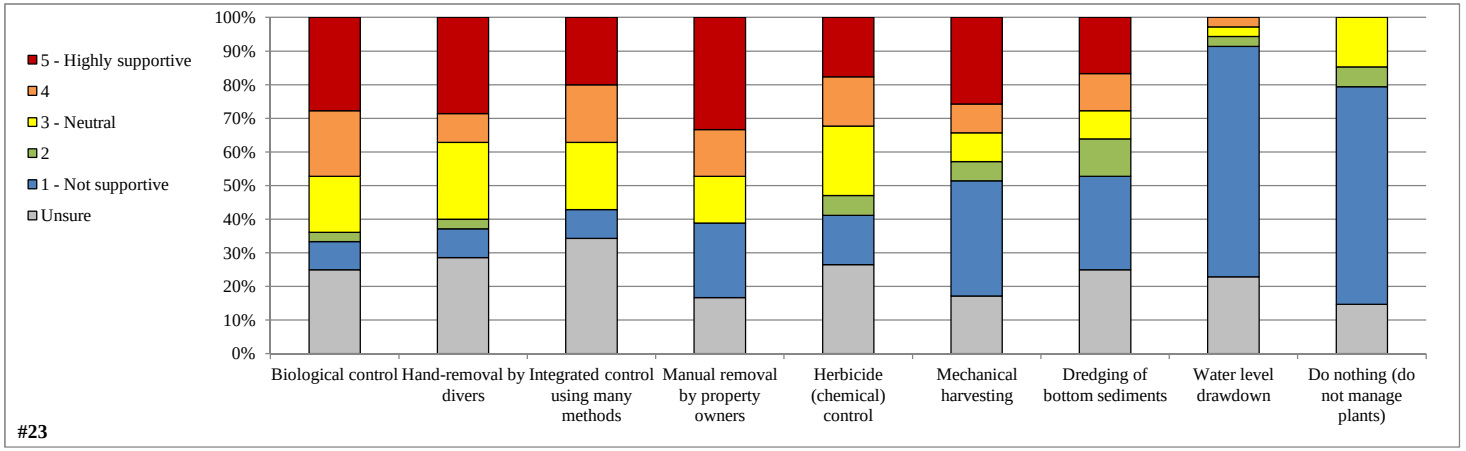
#22 Considering your answer to the question #21, do you believe aquatic plant control is needed on Big Twin Lake?

	Total	%
Definitely yes	15	*42.9*
Probably yes	10	*28.6*
Unsure	8	*22.9*
Probably no	2	*5.7*
Definitely no	0	*0.0*
	35	*100.0*



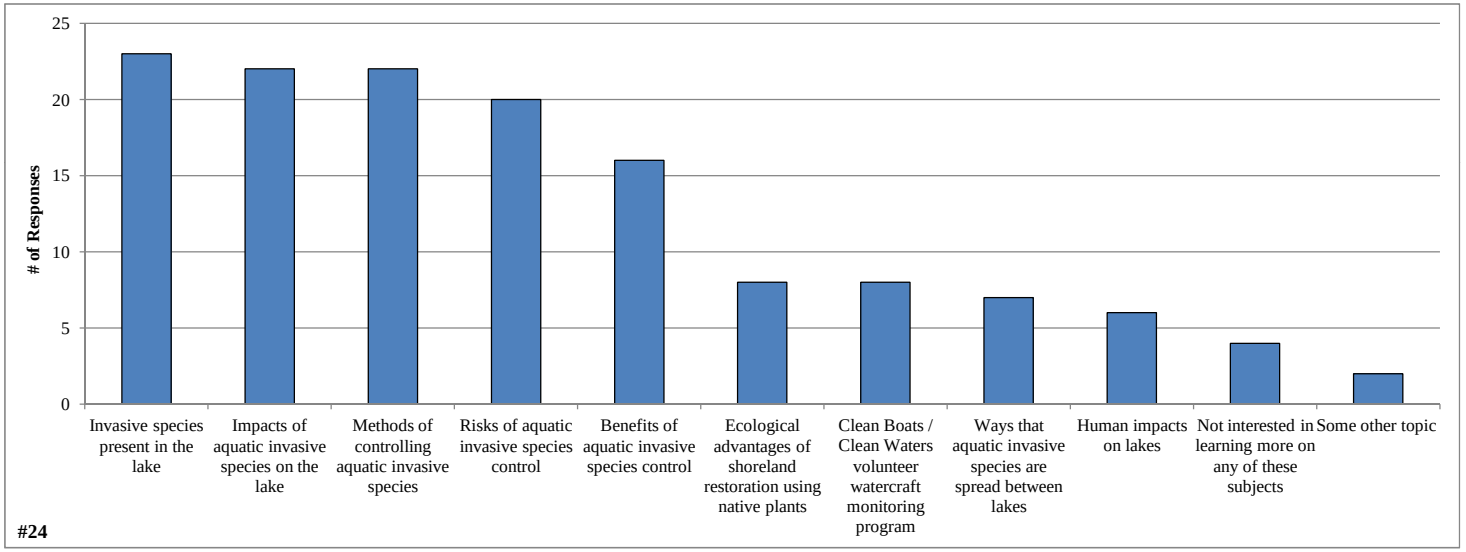
#23 Aquatic plants can be professionally managed using many techniques. What is your level of support for the responsible use of the following techniques on Big Twin Lake?

	1 - Not supportive	2	3 - Neutral	4	5 - Highly supportive	Unsure	Total	Average
Biological control	3	1	6	7	10	9	*27*	*3.7*
Hand-removal by divers	3	1	8	3	10	10	*25*	*3.6*
Integrated control using many methods	3	0	7	6	7	12	*23*	*3.6*
Manual removal by property owners	8	0	5	5	12	6	*30*	*3.4*
Herbicide (chemical) control	5	2	7	5	6	9	*25*	*3.2*
Mechanical harvesting	12	2	3	3	9	6	*29*	*2.8*
Dredging of bottom sediments	10	4	3	4	6	9	*27*	*2.7*
Water level drawdown	24	1	1	1	0	8	*27*	*1.2*
Do nothing (do not manage plants)	22	2	5	0	0	5	*29*	*1.4*



#24 Which of these subjects would you like to learn more about?

	Total
Invasive species present in the lake	23
Impacts of aquatic invasive species on the lake	22
Methods of controlling aquatic invasive species	22
Risks of aquatic invasive species control	20
Benefits of aquatic invasive species control	16
Ecological advantages of shoreland restoration using native plants	8
Clean Boats / Clean Waters volunteer watercraft monitoring program	8
Ways that aquatic invasive species are spread between lakes	7
Human impacts on lakes	6
Not interested in learning more on any of these subjects	4
Some other topic	2



BIG TWIN LAKE ASSOCIATION, INC.

#25 Before receiving this mailing, have you ever heard of the Big Twin Lake Lake Association?

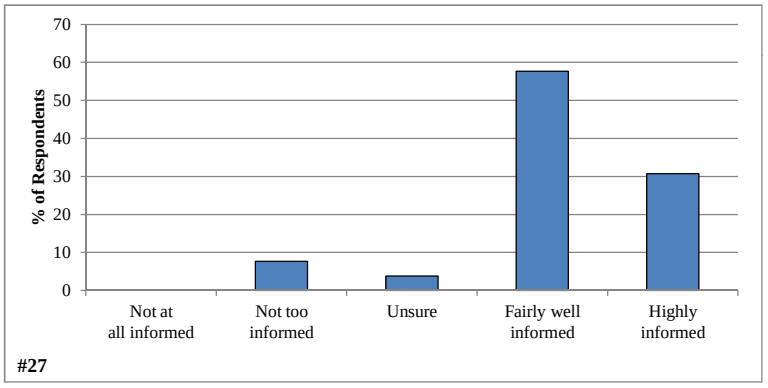
	Total	%
Yes	34	*94.4*
No	2	*5.6*
	36	*100.0*

#26 What is your membership status with the Big Twin Lake Lake Association?

	Total	%
Current member	24	*80.0*
Former member	3	*10.0*
Never been a member	3	*10.0*
	30	*100.0*

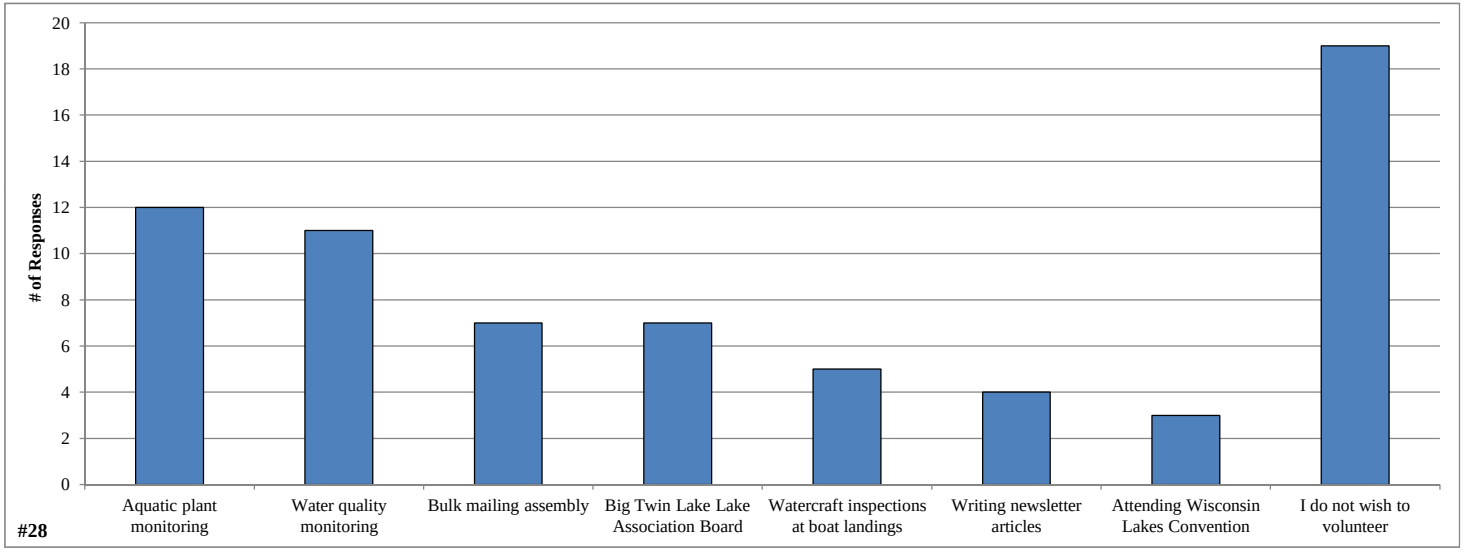
#27 How informed has the Big Twin Lake Lake Association kept you regarding issues with the lake and its management?

	Total	%
Not at all informed	0	*0.0*
Not too informed	2	*7.7*
Unsure	1	*3.8*
Fairly well informed	15	*57.7*
Highly informed	8	*30.8*
	26	*100.0*



#28 Please circle the activities you would be willing to participate in if the Big Twin Lake Lake Association requires additional assistance.

	Total
Aquatic plant monitoring	12
Water quality monitoring	11
Bulk mailing assembly	7
Big Twin Lake Lake Association Board	7
Watercraft inspections at boat landings	5
Writing newsletter articles	4
Attending Wisconsin Lakes Convention	3
I do not wish to volunteer	19



Survey Number	1g Comment	9i Comment	13m Comment	18p Comment	19r Comment	20r Comment	24k Comment	Other Comments (and Question 29)
1								I'm glad there are people willing to put forth the effort to conserve & protect the lake. Thank you for all you do (*Name removed*)
2								
3								
4								
5					low water levels	low water levels		
6								
7								
8				don't know names for sure				
9			speculating					With economy being what it is, I'm not willing to spend money to these lake study groups that will give you the same print out as every other lake in the area. It's a complete bullshit generic study that the University of Wisconsin Bontany Center will do for nothing. Wasted money and overpriced chemicals. Self proclaimed Eco System Experts.
10						we do not visit the lake or property so we don't know		
11								
12								
13								
14								
15	we have not used the property in the past 10 years and is for sale							
16	weekend and weekday use							
17								
18								
19								
20								
21					lake level	lake level		
22		bullhesd	snow shoeing				anything related to invasive species would be great. I'm also interested in shoreland restoration in and how it relates to big twins 100' setback	As you can see by our answers, invasive species are a problem and getting worse. Eurasian milfoil has really taken hold. I've been pulling around our shoreline, but can only do so much. BTW- I'm on the north shore hill …the floating EZ dock. As far as volunteering we're weekenders so I don't think I could do much "day to day. " But I certainly could be an "unofficial" volunteer for keeping an eye on the milfoil growth,water quality,etc. I'm also a fairly good writerso I could contibute an article to the newsletter from time to time. More from the humorous side - sort of" Big Twin Experiences" (*Name removed*)
23								water is low
24								
25		most perch are small			low water lake level			
26								Doug, We do not care about the lake. We absolutely refuse to spend another dime concerning undeveloped #54. We are not going to pay for trees being removed or anything . We own 3 properties and have enough! (*Name removed*)
27								
28								
29								
30								The survey is way to long!
31						receding lake level		Proactively the lake association should do everything possible to maintain the quality and beauty of Big Twin Lake. My family has lived and owned property on Big Twin Lake since the early 1900's, I am the third generation to have lived on this lake and my children and grandchildren all enjoy the lake. My main concern is the shallow end and bays of Big Twin Lake. The recent drought has left this area dry, but even before that, these areas have not been usable for the last 35 years. Even when the water level was higher, these shallow areas have become overgrown with aquatic weeds and marsh cattails, making it impossible to fish and enjoy the lake. These shallow areas always provided excellent spawning grounds for many of the lakes fish species. Also, why is Big Twin Lake so slow to recover its water level? Other lakes in the area seem to have recharged faster than Big Twin Lake. I know water used to flow in from the two small lakes to the north and east of Big Twin. Maybe lake water recharge can be part of the study. I believe now is the time to address these problems and return the lake to the beautiful resource I knew as a child growing up on Big Twin Lake. My family and I pledge our support on this project. Sincerely,
32	old house & buildings	bullheads	trapping			road oil and gas runoff from hwy 55	walleye restoration	
33								I do notuse the lake, so our only concern is maintaining or improving property values
34								We bought the lot quite awhile ago, don't have any intentions of building anytime soon, but don't plan on selling either
35								
36					excessive weeds & silt on south end of lake	excessive weeds & silt on south side of lake		
37				answer to #17 is based on probability, not personal experience				
38								
39				not shure				
40					golf course sucking out water of lake			
41			golf					
42								
43								
44								
45								

C

APPENDIX C

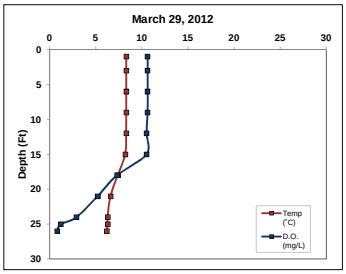
Water Quality Data

Big Twin Lake

Date: 3/29/2012
Time: 9:00
Weather: light breeze, 75% clouds, 38°F
Entry: TWH

Max Depth: 27.8
BTLS Depth (ft): 3.0
BTLB Depth (ft): 24.0
Secchi Depth (ft): 9.3

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	8.3	10.6	8.5	191.0
3	8.3	10.6	8.5	191.0
6	8.3	10.6	8.5	191.0
9	8.3	10.6	8.5	191.0
12	8.3	10.5	8.5	191.0
15	8.2	10.5	8.5	192.0
18	7.4	7.3	8.4	200.0
21	6.6	5.2	8.1	205.0
24	6.3	2.9	8.0	210.0
25	6.3	1.2	7.9	214.0
26	6.2	0.8	7.8	215.0



Parameter	BTLS	BTLB
Total P (µg/L)	20.00	40.00
Dissolved P (µg/L)	ND	0.00
Chl-a (µg/L)	12.50	NA
TKN (µg/L)	720.00	680.00
$NO_3 + NO_2$-N (µg/L)	120.00	170.00
NH_3-N (µg/L)	ND	70.00
Total N (µg/L)	840.00	850.00
Lab Cond. (µS/cm)	202.00	219.00
Lab pH	7.82	7.41
Alkalinity (mg/L $CaCO_3$)	70.60	76.60
Total Susp. Solids (mg/L)	ND	2.20
Calcium (mg/L)	15.50	NA
Magnesium (mg/L)	NA	NA
Hardness (mg/L)	NA	NA
Color (SU)	NA	NA
Turbidity (NTU)	NA	NA

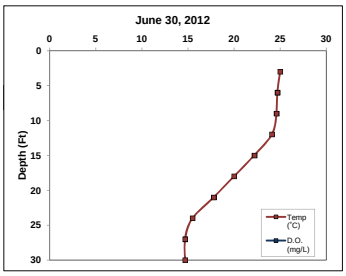
Data collected by TWH and EEC (Onterra)

Big Twin Lake

Date: 6/30/2012
Time:
Weather:
Entry: TWH

Max Depth:
BTLS Depth (ft): 6.0
BTLB Depth (ft):
Secchi Depth (ft): 19.0

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
3	25.0			
6	24.7			
9	24.6			
12	24.1			
15	22.2			
18	20.0			
21	17.8			
24	15.5			
27	14.7			
30	14.7			



Parameter	BTLS	BTLB
Total P (µg/L)	17.00	NA
Dissolved P (µg/L)	NA	NA
Chl-a (µg/L)	1.73	NA
TKN (µg/L)	NA	NA
$NO_3 + NO_2$-N (µg/L)	NA	NA
NH_3-N (µg/L)	NA	NA
Total N (µg/L)	NA	NA
Lab Cond. (µS/cm)	NA	NA
Lab pH	NA	NA
Alkalinity (mg/L $CaCO_3$)	NA	NA
Total Susp. Solids (mg/L)	NA	NA
Calcium (mg/L)	NA	NA
Magnesium (mg/L)	NA	NA
Hardness (mg/L)	NA	NA
Color (SU)	NA	NA
Turbidity (NTU)	NA	NA

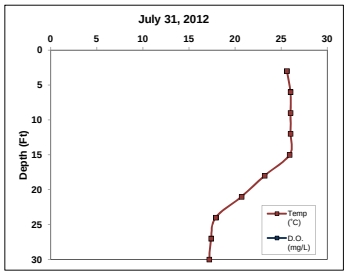
Data collected by Douglas N Tomany, John Eickholt (Citizen Lake Monitoring Network)

Big Twin Lake

Date: 7/31/2012
Time:
Weather:
Entry: TWH

Max Depth:
BTLS Depth (ft): 6.0
BTLB Depth (ft):
Secchi Depth (ft): 18.0

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
3	25.6			
6	26.0			
9	26.0			
12	26.0			
15	25.9			
18	23.2			
21	20.7			
24	17.9			
27	17.4			
30	17.2			



Parameter	BTLS	BTLB
Total P (µg/L)	14.00	NA
Dissolved P (µg/L)	NA	NA
Chl-a (µg/L)	3.74	NA
TKN (µg/L)	580.00	NA
$NO_3 + NO_2$-N (µg/L)	ND	NA
NH_3-N (µg/L)	ND	NA
Total N (µg/L)	580.00	NA
Lab Cond. (µS/cm)	NA	NA
Lab pH	NA	NA
Alkalinity (mg/L $CaCO_3$)	NA	NA
Total Susp. Solids (mg/L)	NA	NA
Calcium (mg/L)	NA	NA
Magnesium (mg/L)	NA	NA
Hardness (mg/L)	NA	NA
Color (SU)	NA	NA
Turbidity (NTU)	NA	NA

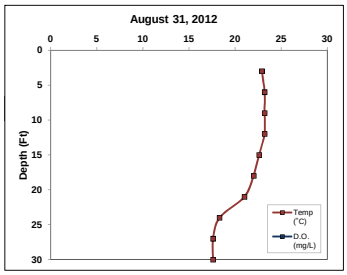
Data collected by Douglas Toumany (Citizen Lake Monitoring Network)

Big Twin Lake

Date: 8/31/2012
Time:
Weather:
Entry: TWH

Max Depth:
BTLS Depth (ft): 6
BTLB Depth (ft):
Secchi Depth (ft): 14.5

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
3	22.9			
6	23.2			
9	23.2			
12	23.2			
15	22.6			
18	22			
21	21			
24	18.3			
27	17.6			
30	17.6			



Parameter	BTLS	BTLB
Total P (µg/L)	14.00	NA
Dissolved P (µg/L)	NA	NA
Chl-a (µg/L)	5.28	NA
TKN (µg/L)	636.00	NA
$NO_3 + NO_2$-N (µg/L)	ND	NA
NH_3-N (µg/L)	43.00	NA
Total N (µg/L)	636.00	NA
Lab Cond. (µS/cm)	NA	NA
Lab pH	NA	NA
Alkalinity (mg/L $CaCO_3$)	NA	NA
Total Susp. Solids (mg/L)	NA	NA
Calcium (mg/L)	NA	NA
Magnesium (mg/L)	NA	NA
Hardness (mg/L)	NA	NA
Color (SU)	NA	NA
Turbidity (NTU)	NA	NA

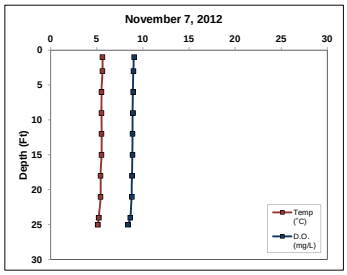
Data collected by Douglas N Tomany, John Eickholt (Citizen Lake Monitoring Network)

Big Twin Lake

Date: 11/7/2012
Time: 10:30
Weather: 37F, light breeze, 100% clouds
Entry: EEC

Max Depth: 27.1
BTLS Depth (ft): 3
BTLB Depth (ft): 25
Secchi Depth (ft): 18.6

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	5.6	9.04	6.5	
3	5.6	8.96	6.63	
6	5.5	8.94	6.76	
9	5.5	8.91	6.88	
12	5.5	8.87	6.92	
15	5.5	8.85	7.06	
18	5.4	8.81	7.06	
21	5.4	8.78	7.07	
24	5.2	8.63	7.11	
25	5.1	8.36	7.16	



Parameter	BTLS	BTLB
Total P (µg/L)	17.00	19.00
Dissolved P (µg/L)	NA	NA
Chl-a (µg/L)	3.62	NA
TKN (µg/L)	NA	NA
$NO_3 + NO_2$-N (µg/L)	NA	NA
NH_3-N (µg/L)	NA	NA
Total N (µg/L)	NA	NA
Lab Cond. (µS/cm)	NA	NA
Lab pH	NA	NA
Alkalinity (mg/L $CaCO_3$)	NA	NA
Total Susp. Solids (mg/L)	ND	ND
Calcium (mg/L)	NA	NA
Magnesium (mg/L)	NA	NA
Hardness (mg/L)	NA	NA
Color (SU)	NA	NA
Turbidity (NTU)	NA	NA

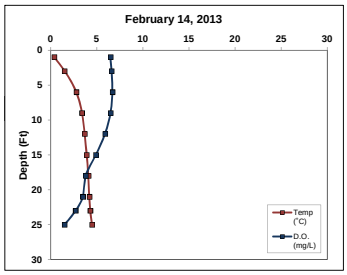
Data collected by EJG (Onterra)

Big Twin Lake

Date: 2/14/2013
Time: 14:13
Weather: 100% clouds, breezy, snowing, 30ºF
Entry: TWH

Max Depth: 26.4
BTLS Depth (ft): 3
BTLB Depth (ft): 23
Secchi Depth (ft): 12.2

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	0.4	6.5		
3	1.5	6.6		
6	2.8	6.7		
9	3.4	6.5		
12	3.7	5.9		
15	3.9	4.9		
18	4.1	3.8		
21	4.2	3.5		
23	4.3	2.7		
25	4.5	1.5		



Parameter	BTLS	BTLB
Total P (µg/L)	54.00	32.00
Dissolved P (µg/L)	6.00	12.00
Chl-a (µg/L)	NA	NA
TKN (µg/L)	830.00	780.00
$NO_3 + NO_2$-N (µg/L)	194.00	190.00
NH_3-N (µg/L)	110.00	183.00
Total N (µg/L)	NA	NA
Lab Cond. (µS/cm)	NA	NA
Lab pH	NA	NA
Alkalinity (mg/L $CaCO_3$)	NA	NA
Total Susp. Solids (mg/L)	NA	NA
Calcium (mg/L)	NA	NA
Magnesium (mg/L)	NA	NA
Hardness (mg/L)	NA	NA
Color (SU)	NA	NA
Turbidity (NTU)	NA	NA

Data collected by TWH and EJG (Onterra) Ice thickness: 1.3'

Water Quality Data

2012/2013	Surface		Bottom	
Parameter	Count	Mean	Count	Mean
Secchi Depth (feet)	6	15.3	NA	NA
Total P (µg/L)	6	22.7	3	30.3
Dissolved P (µg/L)	2	6.0	2	6.0
Chl a (µg/L)	5	5.4	0	NA
TKN (µg/L	4	691.5	2	730.0
NO3+NO2-N (µg/L)	4	157.0	2	180.0
NH3-N (µg/L)	4	76.5	2	126.5
Total N (µg/L)	3	685.3	1	850.0
Lab Cond. (µS/cm)	1	202.0	1	219.0
Lab pH	1	7.8	1	7.4
Alkal (mg/l CaCO3)	1	70.6	1	76.6
Total Susp. Solids (mg/l)	2	ND	2	2.2
Calcium (µg/L)	1	15.5	0	NA
Magnesium (mg/L)	0	NA	0	NA
Hardness (mg/L)	0	NA	0	NA
Color (SU)	0	NA	0	NA
Turbidity (NTU)	0	NA	0	NA

Morphological / Geographical Data

Parameter	Value
Acreage	
Volume (acre-feet)	
Perimeter (miles)	
Shoreland Developmetnt Factor	
Maximum Depth (feet)	
County	
WBIC	
Lillie Mason Region (1983)	NLF Ecoregion
Nichols Ecoregion (1999)	NLFL

Watershed Data

WiLMS Class	Acreage	kg/yr	lbs/yr
Forest			0.0
Open Water			0.0
Pasture/Grass			0.0
Row Crops			0.0
Urban - Rural Residential			0.0
Wetland			0.0
Watershed to Lake Area			

Trophic State Index (TSI)

Year	TP	Chl-a	Secchi
1985	47.3		
2008	42.2	44.0	38.8
2009	50.4	44.6	35.9
2010	44.1	44.3	36.9
2011	42.2	39.3	34.6
2012	43.2	43.1	35.1
All Years (Weighted)	45.0	43.2	36.2
Deep, Seepage Lakes	43.2	43.2	42.4
NLF Ecoregion	48.1	47.5	45.7

	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
1985									1	20.0	1.0	20.0
2008	3	14.3	3	14.3	3	3.9	3	3.9	3	14.0	3.0	14.0
2009	3	17.5	3	17.5	3	4.2	3	4.2	3	24.7	3.0	24.7
2010	3	16.3	3	16.3	3	4.0	3	4.0	3	16.0	3.0	16.0
2011	4	19.4	3	19.2	3	2.4	3	2.4	4	16.5	3.0	14.0
2012	5	15.9	2	18.5	5	5.4	3	3.6	5	17.2	3.0	15.0
All Years (Weighted)		16.7		17.1		4.2		3.6		17.7		16.9
Deep, Seepage Lakes				11.2				3.6				15.0
NLF Ecoregion				8.9				5.6				21.0

July 2012N: 580.0
July 2012 P: 14.0

Summer 2012 N:P 41 :1

D

APPENDIX D

Watershed Analysis WiLMS Results

Date: 7/11/2013 Scenario: Big Twin Lake Watershed Current

Lake Id: BigTwin_WS_Current

Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 1956.0 acre
Total Unit Runoff: 12 in.
Annual Runoff Volume: 1956.0 acre-ft
Lake Surface Area <As>: 65 acre
Lake Volume <V>: 770 acre-ft
Lake Mean Depth <z>: 11.8 ft
Precipitation - Evaporation: 5.3 in.
Hydraulic Loading: 1984.7 acre-ft/year
Areal Water Load <qs>: 30.5 ft/year
Lake Flushing Rate <p>: 2.58 1/year
Water Residence Time: 0.39 year
Observed spring overturn total phosphorus (SPO): 24.0 mg/m^3
Observed growing season mean phosphorus (GSM): 17.4 mg/m^3
% NPS Change: 0%
% PS Change: 0%

NON-POINT SOURCE DATA

Land Use	Acre	Low	Most Likely	High	Loading %	Low	Most Likely	High
	(ac)	Loading (kg/ha-year)				Loading (kg/year)		
Row Crop AG	413	0.50	1.00	3.00	66.1	84	167	501
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	199	0.10	0.30	0.50	9.6	8	24	40
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)	114	0.05	0.10	0.25	1.8	2	5	12
Wetlands	204	0.10	0.10	0.10	3.3	8	8	8
Forest	1026	0.05	0.09	0.18	14.8	21	37	75
Lake Surface	65.0	0.10	0.30	1.00	3.1	3	8	26

POINT SOURCE DATA

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

SEPTIC TANK DATA

Description		Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)		0.3	0.5	0.8	
# capita-years	67				
% Phosphorus Retained by Soil		98	90	80	
Septic Tank Loading (kg/year)		0.40	3.35	10.72	1.3

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	277.7	557.3	1484.2	100.0
Total Loading (kg)	126.0	252.8	673.2	100.0
Areal Loading (lb/ac-year)	4.27	8.57	22.83	0.0
Areal Loading (mg/m^2-year)	478.93	960.98	2559.43	0.0
Total PS Loading (lb)	0.0	0.0	0.0	0.0
Total PS Loading (kg)	0.0	0.0	0.0	0.0
Total NPS Loading (lb)	271.1	532.5	1402.6	98.7
Total NPS Loading (kg)	122.9	241.5	636.2	98.7

Phosphorus Prediction and Uncertainty Analysis Module

Date: 7/11/2013 Scenario: Big Twin Lake Watershed Current
Observed spring overturn total phosphorus (SPO): 24.0 mg/m^3
Observed growing season mean phosphorus (GSM): 17.4 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	23	46	122	29	167
Canfield-Bachmann, 1981 Natural Lake	32	57	121	40	230
Canfield-Bachmann, 1981 Artificial Lake	29	47	88	30	172
Rechow, 1979 General	21	42	112	25	144
Rechow, 1977 Anoxic	43	86	230	69	397
Rechow, 1977 water load<50m/year	31	61	163	44	253
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	34	67	179	43	179
Vollenweider, 1982 Combined OECD	26	47	104	26	126
Dillon-Rigler-Kirchner	17	35	93	11	46
Vollenweider, 1982 Shallow Lake/Res.	21	39	93	18	87
Larsen-Mercier, 1976	32	64	169	40	167
Nurnberg, 1984 Oxic	23	47	124	30	172

Lake Phosphorus Model	Confidence Lower Bound	Confidence Upper Bound	Parameter Fit?	Back Calculation (kg/year)	Model Type
Walker, 1987 Reservoir	27	95	FIT	0	GSM
Canfield-Bachmann, 1981 Natural Lake	18	164	FIT	1	GSM
Canfield-Bachmann, 1981 Artificial Lake	15	135	FIT	1	GSM
Rechow, 1979 General	24	88	FIT	0	GSM
Rechow, 1977 Anoxic	52	178	FIT	0	GSM
Rechow, 1977 water load<50m/year	35	128	P	0	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	34	146	FIT	0	SPO
Vollenweider, 1982 Combined OECD	23	94	FIT	0	ANN
Dillon-Rigler-Kirchner	21	72	P	0	SPO
Vollenweider, 1982 Shallow Lake/Res.	19	80	FIT	0	ANN
Larsen-Mercier, 1976	39	131	P Pin	0	SPO
Nurnberg, 1984 Oxic	24	100	FIT	0	ANN