A

APPENDIX A

Public Participation Materials

Presentation Outline

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

  Stakeholder Survey
- "Big Picture"
- Next Steps

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Management Planning Project Overview

- Foster holistic understanding of Twin Lakes ecosystem
- Collect & analyze data
  - Technical & sociological
- Construct long-term & useable plan
  - Update management strategies for aquatic plants

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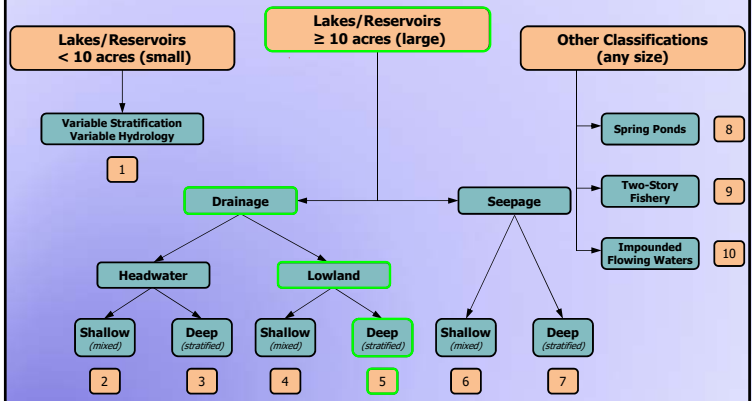
Wisconsin Lakes Natural Community Types



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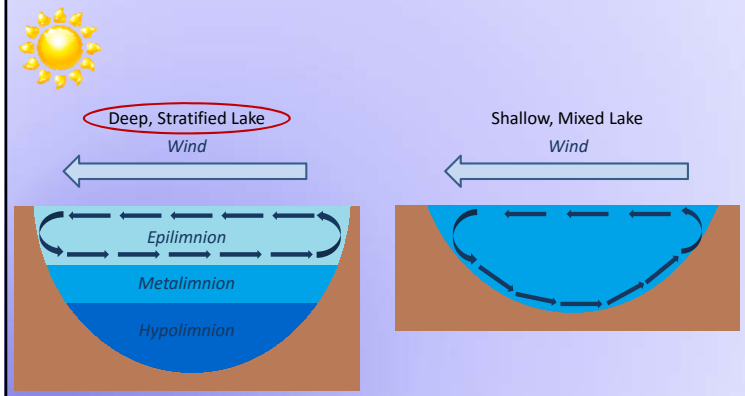
Wisconsin Lakes Classification



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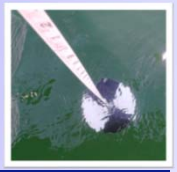
Introduction to Lake Water Quality

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

Chlorophyll-*a*
Pigment used in photosynthesis
Used as surrogate for phytoplankton biomass

Secchi Disk Transparency
Measure of water clarity
Measured using a Secchi disk



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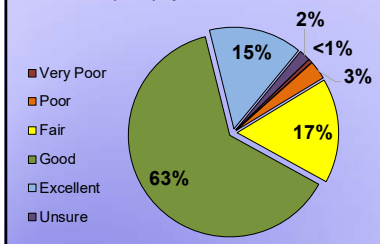
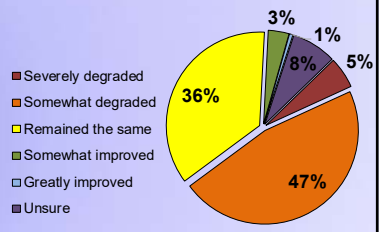
Twin Lakes' Stakeholder Perceptions of Water Quality

How would you describe the current water quality of the Twin Lakes?



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



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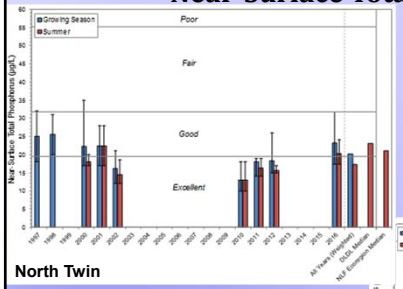
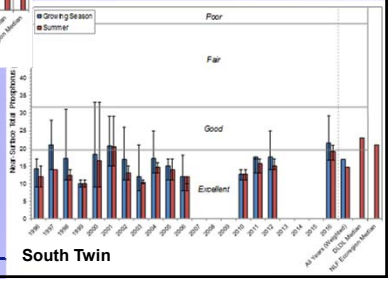
Long-Term Trends
Near-Surface Total Phosphorus



North Twin

North Twin ave summer = 17.2 µg/L
South Twin ave summer = 14.7 µg/L

- **Both *excellent* for DLDL**
- **Both lower than ecoregion & DLDL medians**
- **No trends observed**
- **South Twin is lower because some P settles out in North Twin**



South Twin

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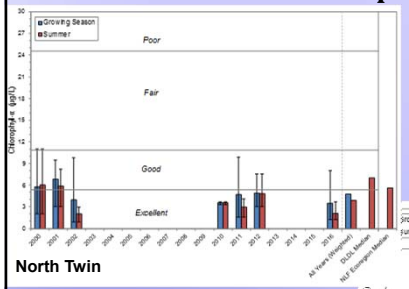
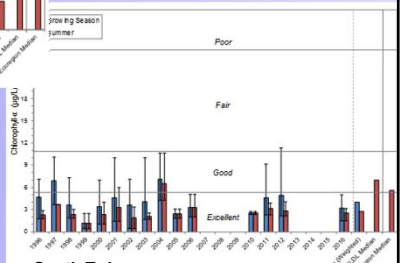
Long-Term Trends
Chlorophyll-*a*



North Twin

North Twin ave summer = 3.9 µg/L
South Twin ave summer = 2.8 µg/L

- Both *excellent* for DLDL
- Both lower than ecoregion & DLDL medians
- No trends observed



South Twin

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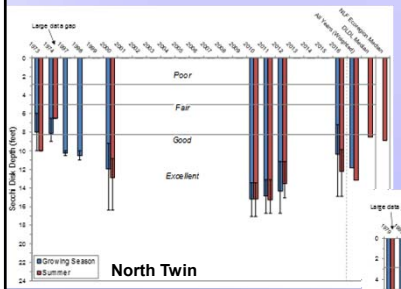
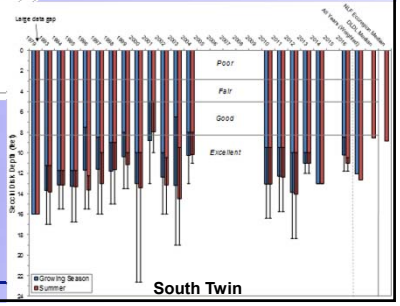
Long-Term Trends
Secchi Disk Transparency



North Twin

North Twin ave summer = 13.2 ft
South Twin ave summer = 1.27 ft

- Both *excellent* for DLDL
- Both higher than ecoregion & DLDL medians
- No trends observed (statistical trend analysis conducted)



South Twin

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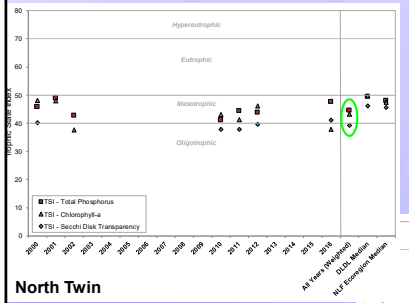
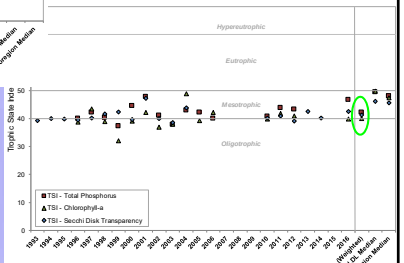
Trophic State Index



North Twin

North Twin = mesotrophic
South Twin = oligo-mesotrophic

- Productivity lower than ecoregion & DLDL medians



South Twin

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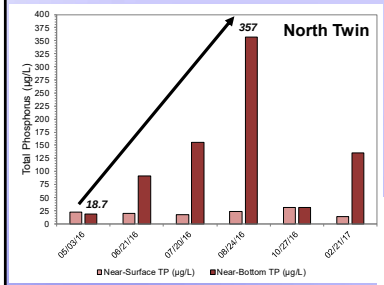
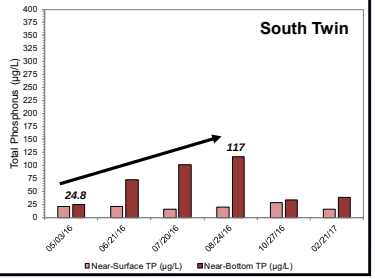
Internal Nutrient Loading



- Internal release of phosphorus to hypolimnion in both lakes as summer progresses
- Stratification keeps phosphorus sequestered in hypolimnion until turnover
- It is a natural process and impact is minimal (fall surface TP is a little higher than spring)



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Additional Water Quality Parameters

Alkalinity – capacity to resist fluctuations in pH

- NTwn=44; STwn= 43 as mg/$CaCO_3$ in 2016
  - Sufficiently high to resist fluctuations in pH

Calcium

- NTwn=11.6; STwn= 11.2 mg/L in 2016
  - Lakes below 12 mg/L are considered *low susceptibility* to zebra mussels
- Along with pH (8.1), Twin Lakes are considered *borderline suitable* for ZM
- Zebra mussel *veliger* samples were negative in 2016
- No adult zebra mussels observed

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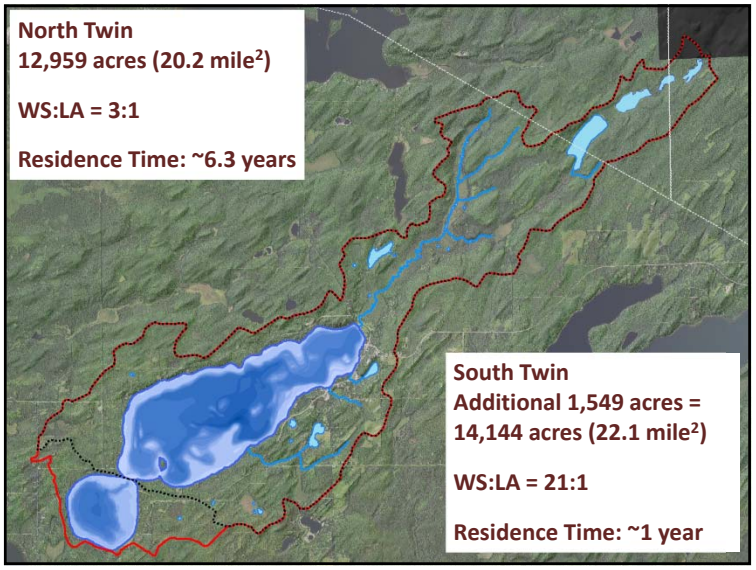

Watershed Assessment Procedure

Determine Watershed Area and Boundaries

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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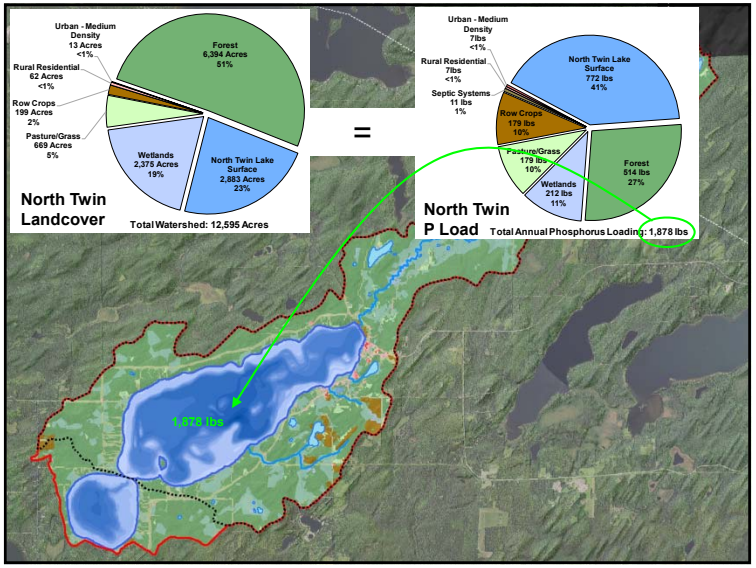

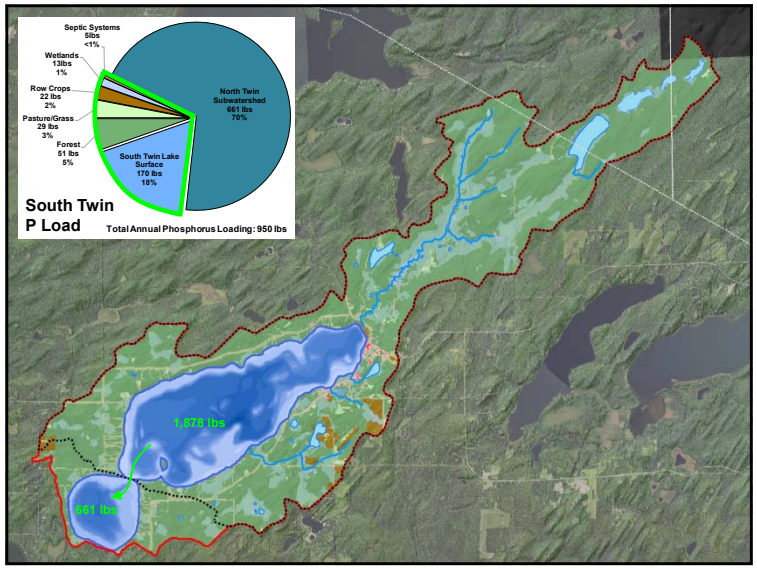

Watershed Phosphorus Modeling

North Twin	South Twin
Annual Potential Phosphorus Load From Watershed: **~1,878 lbs**	Annual Potential Phosphorus Load From Watershed: **~ 950 lbs (NTwn: 661 + Direct: 289)**
Predicted In-Lake Growing Season Mean Total Phosphorus Concentration: **15 µg/L**	Predicted In-Lake Growing Season Mean Total Phosphorus Concentration: **15 µg/L**
Actual In-Lake Growing Season Mean Total Phosphorus Concentration: **20 µg/L**	Actual In-Lake Growing Season Mean Total Phosphorus Concentration: **16.9 µg/L**
Indicates fairly accurate model of lake's watershed (high predicted in model was 26 µg/L)	Indicates fairly accurate model of lake's watershed

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Shoreland Assessment

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

Urbanized Range **Natural**

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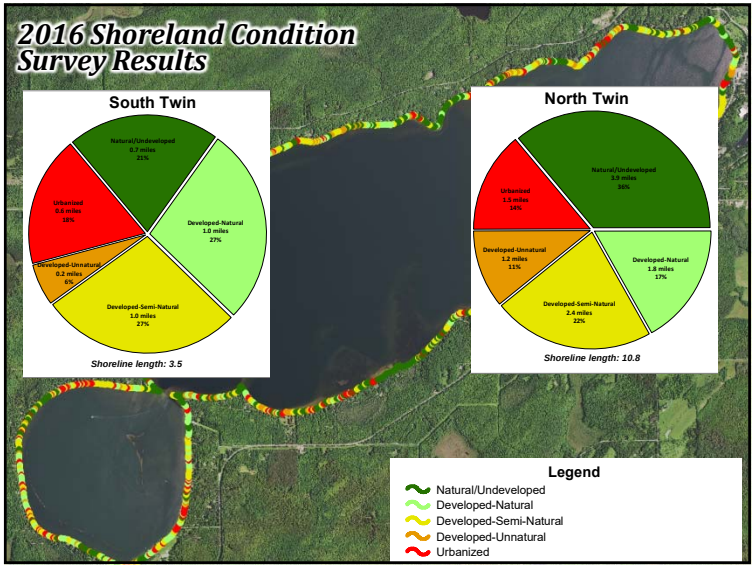
2016 Shoreland Condition Survey Results



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 Twin Lakes

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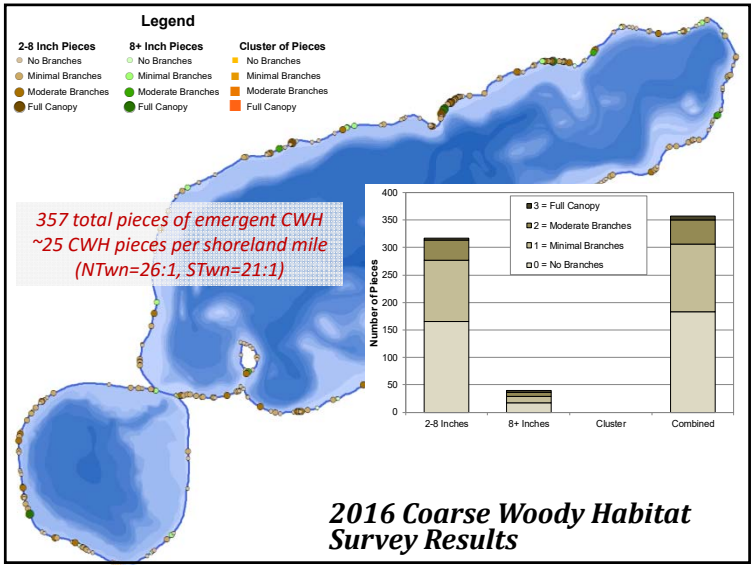

2016 Coarse Woody Habitat Survey Results

Aquatic Plant Surveys

- Determine changes in plant community from past surveys
- Assess both native and non-native populations
- Numerous surveys completed in 2016
  - Early-Season AIS Survey
  - Whole-Lake Point-Intercept Survey
  - Emergent/Floating-Leaf Community Mapping Survey
  - EWM Peak-Biomass Survey

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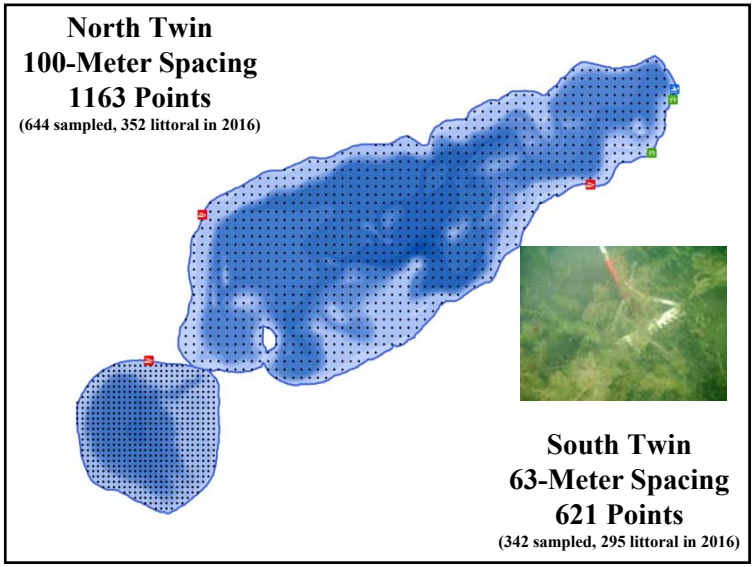
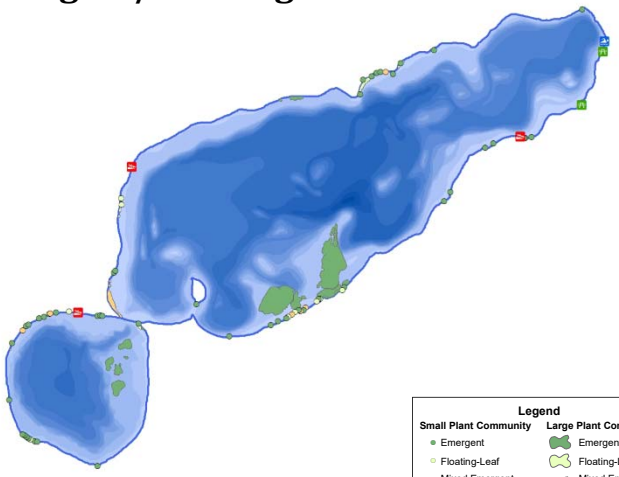
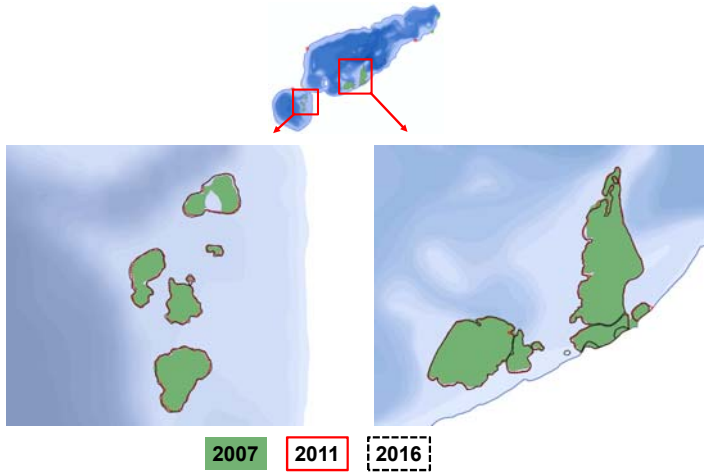


Emergent/Floating-Leaf Communities



Bulrush Communities



Aquatic Plant Species List

~40 Native Species
1 Non-Native Species
Eurasian water milfoil

Growth Form	Scientific Name	Common Name	Coefficient of Conservatism (C)	North Twin 2016 (Onterra)	South Twin 2016 (Onterra)
Emergent	*Carex lacustris*	Lake sedge	6		I
	Eleocharis palustris	Creeping spikerush	6	X	
	Phragmites australis subsp. americanus	Common reed	5	I	
	Sagittaria rigida	Stiff arrowhead	8	I	I
	Schoenoplectus acutus	Hardstem bulrush	5	X	X
	Schoenoplectus tabernaemontani	Softstem bulrush	4	X	
	Typha spp.	Cattail spp.	1	I	I
FL	*Nuphar variegata*	Spatterdock	6	I	
	Sparganium angustifolium	Narrow-leaf bur-reed	9	I	I
	Bidens beckii	Water marigold	8	X	X
	Ceratophyllum demersum	Coontail	3	X	X
	Chara spp.	Muskgrasses	7	X	X
	Elodea canadensis	Common waterweed	3	X	X
	Heteranthera dubia	Water stargrass	6	X	X
	Isoetes spp.	Quillwort spp.	8	X	X
	Myriophyllum alterniflorum	Alternate-flowered water milfoil	10	X	X
	Myriophyllum sibiricum	Northern water milfoil	7	X	X
	Myriophyllum spicatum	Eurasian water milfoil	Exotic	X	X
	Najas flexilis	Slender naiad	6	X	X
	Nitella spp.	Stoneworts	7	X	X
	Potamogeton amplifolius	Large-leaf pondweed	7	X	X
	Potamogeton berchtoldii	Slender pondweed	7	X	
	Potamogeton friesii	Fries' pondweed	8	X	
	Potamogeton gramineus	Variable-leaf pondweed	7	X	X
	Potamogeton illinoensis	Illinois pondweed	6		X
	Potamogeton praelongus	White-stem pondweed	8	X	X
	Potamogeton pusillus	Small pondweed	7		X
	Potamogeton richardsonii	Clasping-leaf pondweed	5	X	X
	Potamogeton robbinsii	Fern-leaf pondweed	8	X	X
	Potamogeton strictifolius	Stiff pondweed	8	X	X
	Potamogeton zosteriformis	Flat-stem pondweed	6	X	X
	Ranunculus aquatilis	White water crowfoot	8	X	
	Sagittaria sp. (rosette)	Arrowhead sp. (rosette)	N/A	X	
	Stuckenia pectinata	Sago pondweed	3	X	
	Utricularia vulgaris	Common bladderwort	7	X	
	Vallisneria americana	Wild celery	6	X	X
S/E	*Eleocharis acicularis*	Needle spikerush	5	X	X
	Juncus pelocarpus	Brown-fruited rush	8		X

FL = Floating Leaf; FL/E = Floating Leaf and Emergent; S/E = Submergent and Emergent; FF = Free Floating
X = Located on lake during point intercept survey; I = Incidental Species

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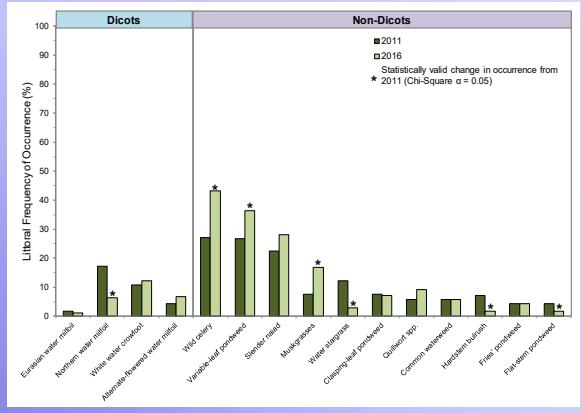
North Twin LFOO Compare (2011 & 2016)



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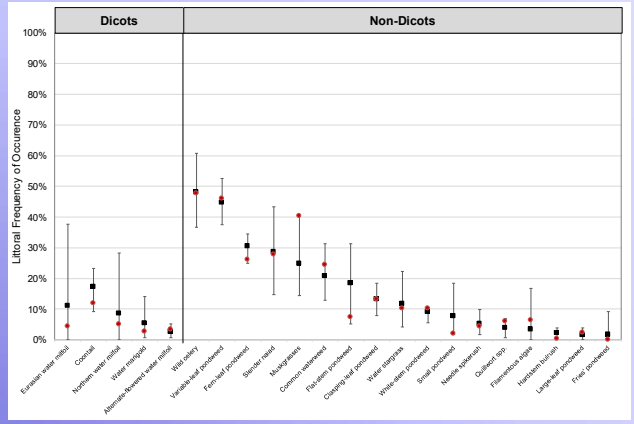
South Twin LFOO Compare (2008-2016)



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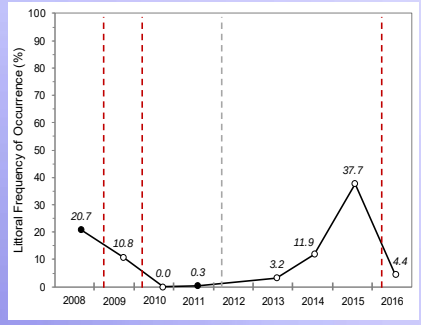
South Twin EWM Compare (2008-2016)



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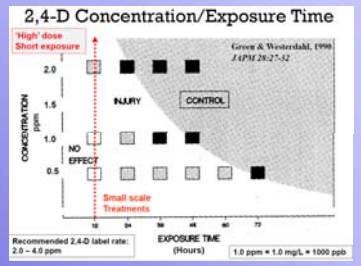
Herbicide Spot Treatment

- **Ecological Definition:** Herbicide applied at a scale where dissipation will not result in significant lake wide concentrations; impacts are anticipated to be localized to in/around application area.



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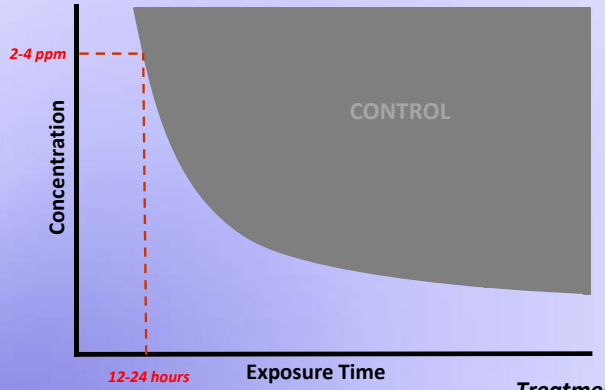
Herbicide Use Patterns



High Concentration ▶ Short Exposure Time

Treatment Type
Spot

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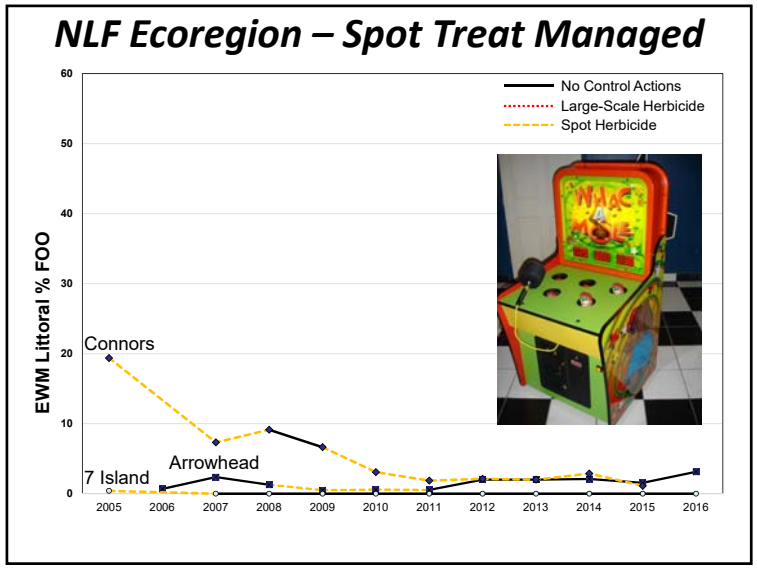
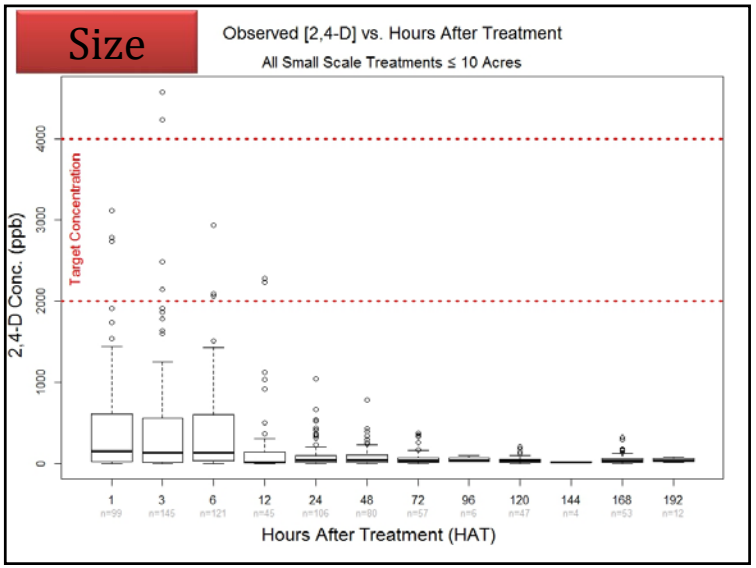
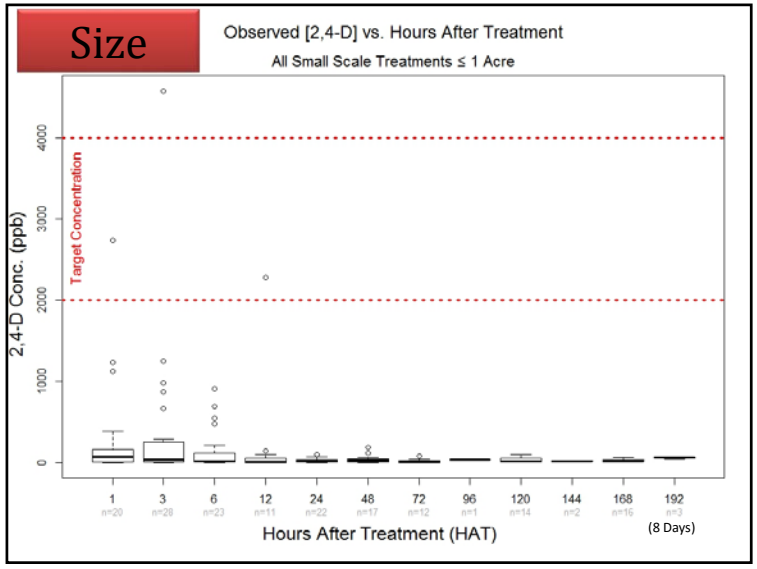
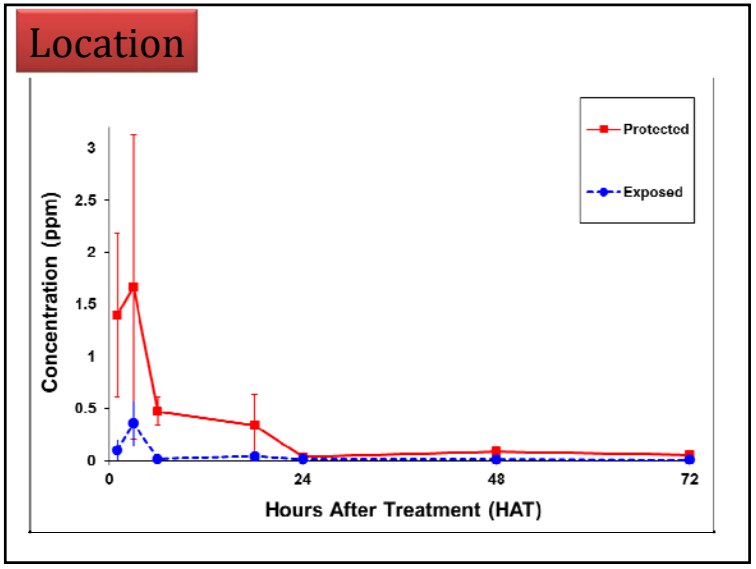
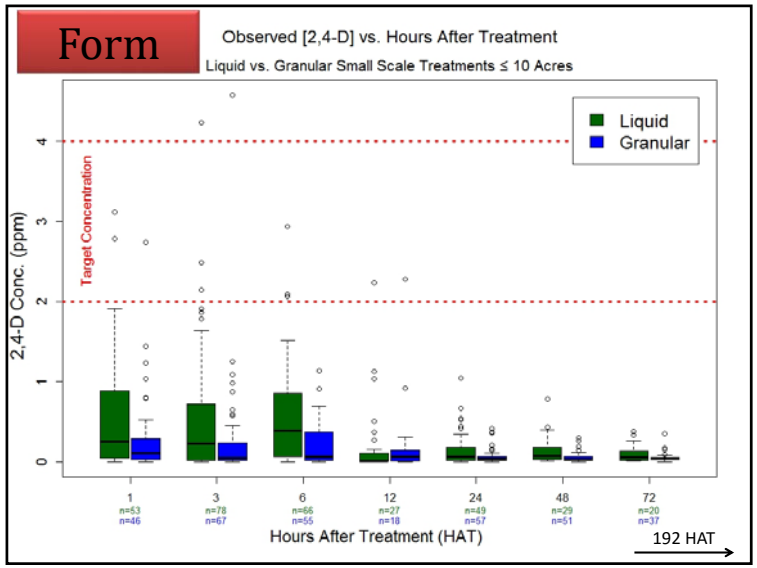

NLF Ecoregion – Spot Treat Managed
No Control Actions
Large-Scale Herbicide
Spot Herbicide
EWM Littoral % FOO
Connors
Arrowhead
7 Island
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016


Size
Observed [2,4-D] vs. Hours After Treatment
All Small Scale Treatments ≤ 10 Acres
Target Concentration
2,4-D Conc. (ppb)
Hours After Treatment (HAT)


Size
Observed [2,4-D] vs. Hours After Treatment
All Small Scale Treatments ≤ 1 Acre
Target Concentration
2,4-D Conc. (ppb)
Hours After Treatment (HAT)
(8 Days)


Location
Protected
Exposed
Concentration (ppm)
Hours After Treatment (HAT)



2015 Treatment on Loon Lake

- **Diquat (2 gallons per surface acre of application area)**
- ~24 acres of 305 acre lake (7.8%)
- Tracer Dye (Rhodamine WT) Survey
- Pre (spring) & post (late-summer) point-intercept sub-sampling

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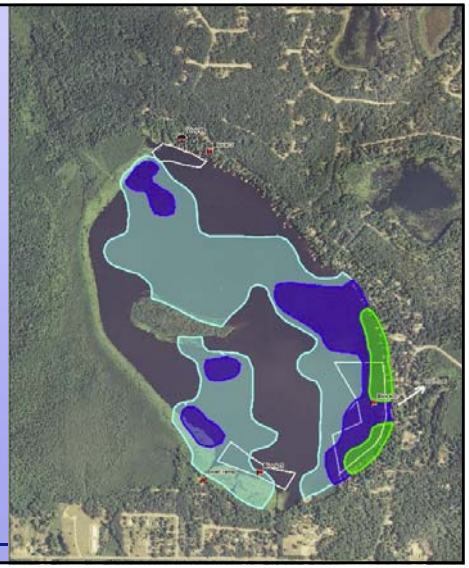
6 HAT

75-100%
50-75%
25-50%
10-25%
5-10%

If apply 2,4-D at 4.0 ppm, 5-10% would be 0.2 - 0.4 ppm



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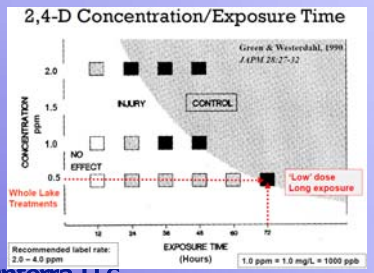
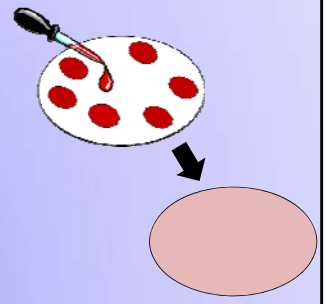
Large-Scale (Whole-lake) Treatment

- Ecological Definition: *Herbicide applied at a scale where dissipation will result in significant lake wide concentrations; impacts are anticipated to be on a lake wide scale*





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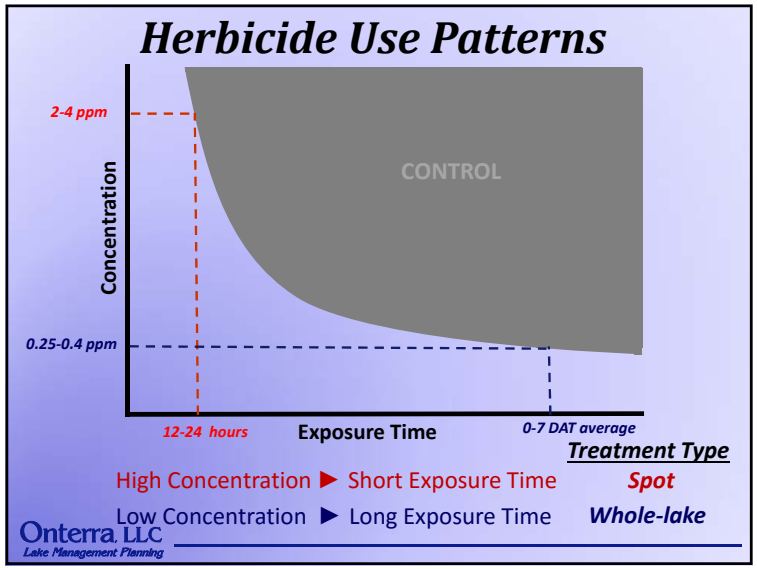
Herbicide Use Patterns
2-4 ppm
0.25-0.4 ppm
Concentration
CONTROL
12-24 hours
Exposure Time
0-7 DAT average
Treatment Type
High Concentration ▶ Short Exposure Time
Spot
Low Concentration ▶ Long Exposure Time
Whole-lake
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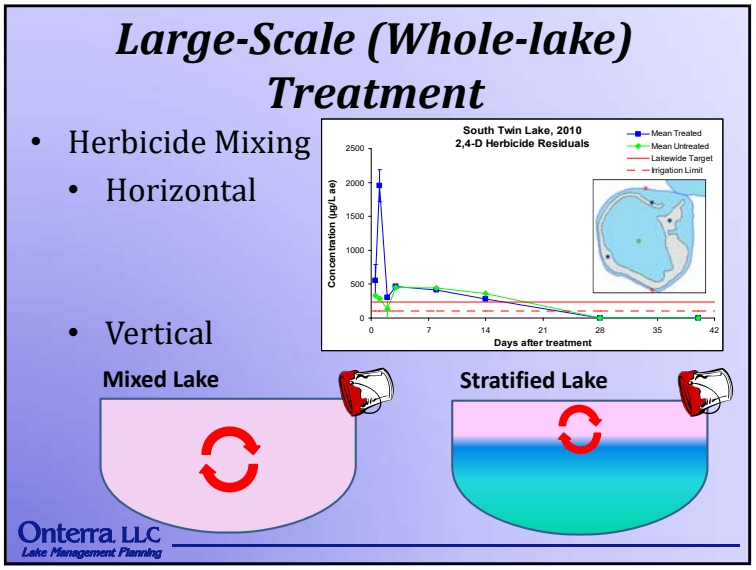
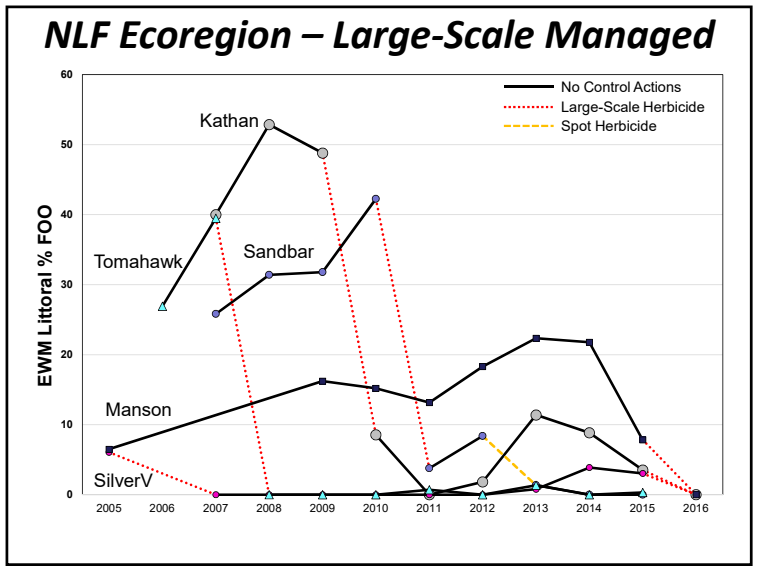
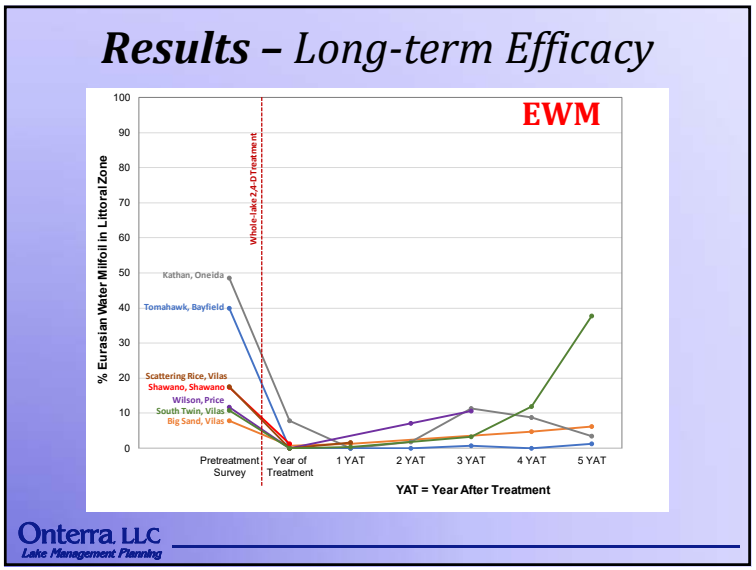

Large-Scale (Whole-lake) Treatment
Herbicide Mixing
Horizontal
Vertical
South Twin Lake, 2010
2,4-D Herbicide Residuals
Mean Treated
Mean Untreated
Lakewide Target
Irrigation Limit
Concentration (µg/L ae)
Days after treatment
Mixed Lake
Stratified Lake
Onterra LLC
Lake Management Planning


NLF Ecoregion – Large-Scale Managed
No Control Actions
Large-Scale Herbicide
Spot Herbicide
EWM Littoral % FOO
Kathan
Tomahawk
Sandbar
Manson
SilverV
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016


Results – Long-term Efficacy
EWM
% Eurasian Water Milfoil in Littoral Zone
Whole-lake 2,4-D Treatment
Kathan, Oneida
Tomahawk, Bayfield
Scattering Rice, Vilas
Shawano, Shawano
Wilson, Price
South Twin, Vilas
Big Sand, Vilas
Pretreatment Survey
Year of Treatment
1 YAT
2 YAT
3 YAT
4 YAT
5 YAT
YAT = Year After Treatment
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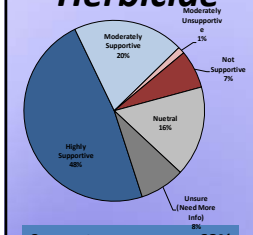
Stakeholder Survey

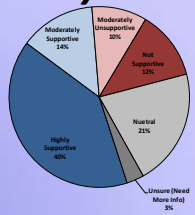
- What is your level of support for the responsible use of the following techniques on Twin Lakes?

Herbicide



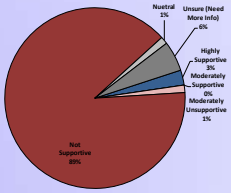
Support	68%
Not Support	8%
Unsure/Neutral	24%

HH by Divers



Support	54%
Not Support	22%
Unsure/Neutral	24%

Do Nothing



Support	3%
Not Support	90%
Unsure/Neutral	7%

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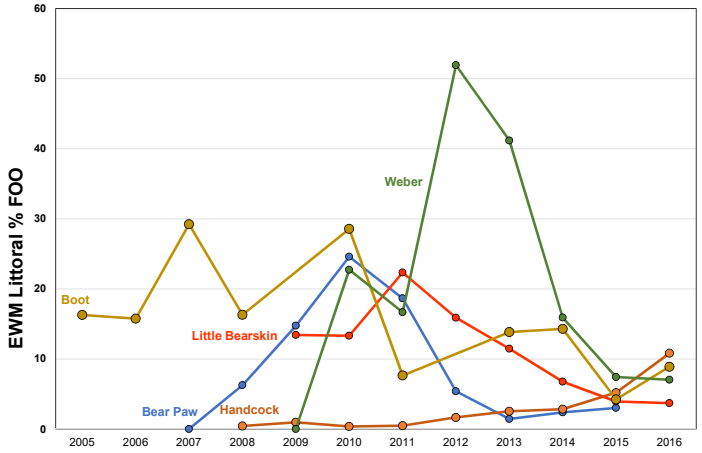
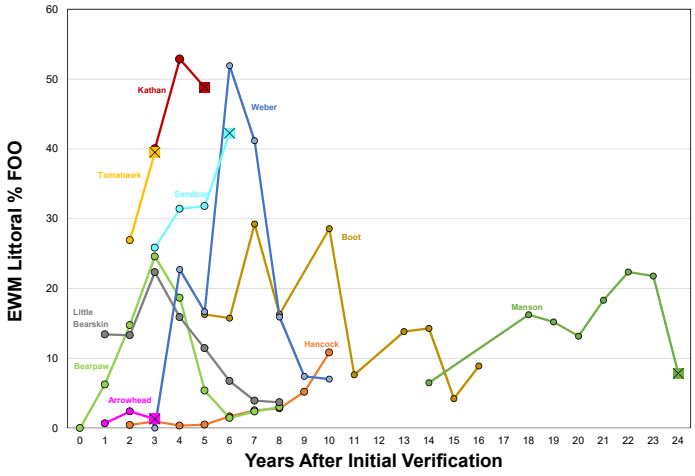
NLF Ecoregion – Unmanaged

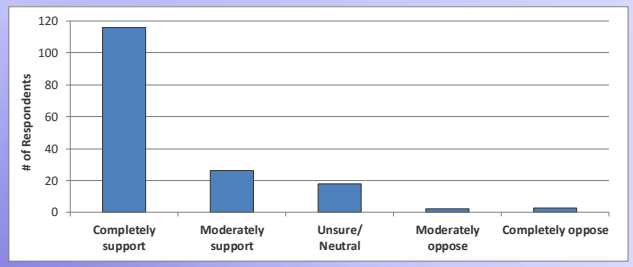


NLF Ecoregion – Unmanaged



Stakeholder Survey

- A large-scale herbicide treatment of Eurasian water milfoil was completed on South Twin Lake in 2016. How do you feel about the large-scale treatment that occurred in 2016?



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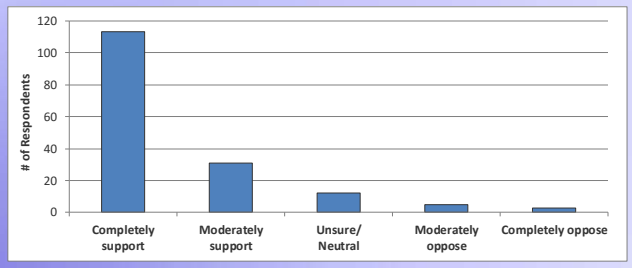
Stakeholder Survey

- What is your level of support or opposition for future aquatic herbicide use to target Eurasian water milfoil in the Twin Lakes?



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Conclusions

Water Quality & Watershed

- Overall great for lowland drainage lakes.
- Water quality appears unchanged over time, but gaps in data exist
- Watershed is in great shape and supports the great water quality
- Attention should be paid to shoreland areas to increase habitat value

Aquatic Plants

- EWM has been managed over time
- Changes in native plants, particularly on South Twin, observed in association with control efforts
- Developing next phase of EWM management required.

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Next Steps – Planning Meeting II

- More on aquatic plant management
- Fisheries data integration
- Development of goals
  - Communication strategy
  - How integrate if district formation occurs

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Implementation Plan Example

- **Management Goal: Maintain Twin Lakes' Current Water Quality Conditions**
  - Management Action: Initiate annual water quality monitoring through the Citizens Lake Monitoring Network Program.
  - Timeline: Immediately
  - Facilitator(s): ??

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B

APPENDIX B

Stakeholder Survey Response Charts and Comments

North & South Twin Lakes - Anonymous Stakeholder Survey

Surveys Distributed: 439
Surveys Returned: 171
Response Rate 39%

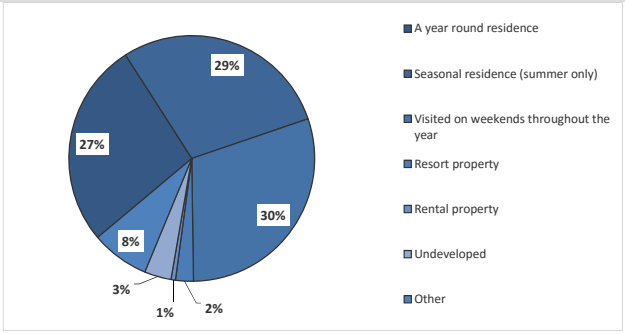
North & South Twin Lakes Property

1. Which of the Twin Lakes do you reside on or nearest?

Answer Options	Response Percent	Response Count
North Twin Lake	65.1%	110
South Twin Lake	34.9%	59
answered question		**169**
skipped question		**2**

2. How is your property on or near your lake utilized?

Answer Options	Response Percent	Response Count
A year round residence	27.1%	46
Seasonal residence (summer only)	28.8%	49
Visited on weekends throughout the year	30.0%	51
Resort property	2.4%	4
Rental property	0.6%	1
Undeveloped	3.5%	6
Other (please specify)	7.6%	13
answered question		**170**
skipped question		**1**

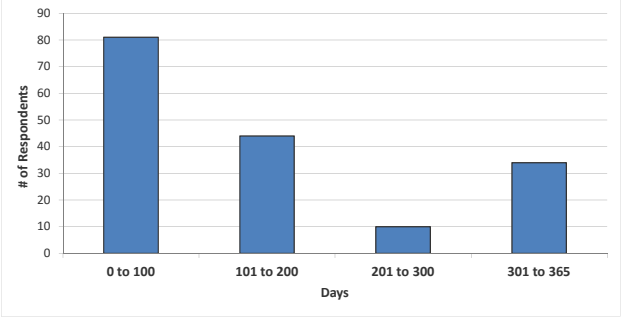


Number	Other (please specify)
1	It is a year round residence for my parents and visited on weekends in fall and winter, and many weeks in the summer by other family members.
2	Seasonal for me. Visited by kids on numerous weekends
3	Summer and a few winter weekends
4	all summer and weekends through other seasons
5	april until dec
6	More than summer, May thru Oct
7	Summer and various weeks/weekends through year
8	There various times throughout the year.
9	Inherited, and visited on occasion.
10	5-7 MONTHS A YEAR
11	Second Home used throughout the year
12	send majority of months April to October, monthly remainder of year
13	open year round and used as pleased

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

Answer Options	Response Count
	169
answered question	**169**
skipped question	**2**

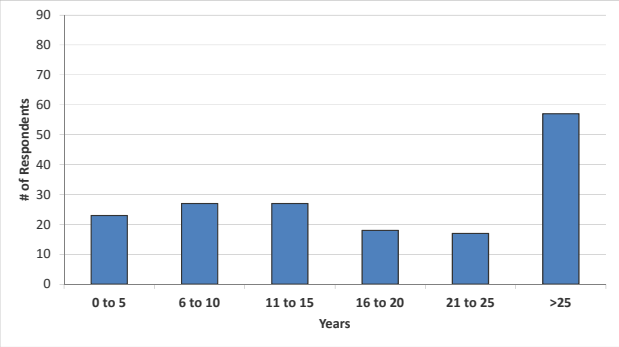
Category (# of days)	Responses	
0 to 100	**81**	**48%**
101 to 200	**44**	**26%**
201 to 300	**10**	**6%**
301 to 365	**34**	**20%**



4. How long have you owned or rented your property on your lake?

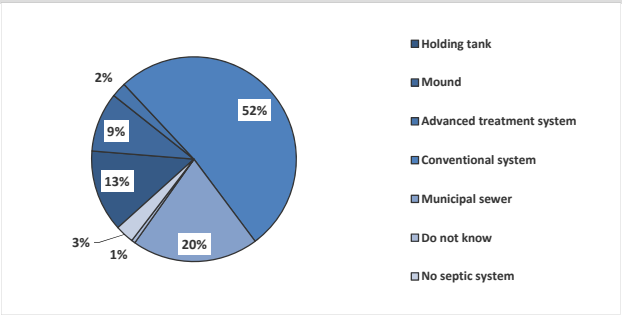
Answer Options	Response Count
	169
answered question	169
skipped question	2

Category (# of years)	Responses	% Response
0 to 5	23	14%
6 to 10	27	16%
11 to 15	27	16%
16 to 20	18	11%
21 to 25	17	10%
>25	57	34%



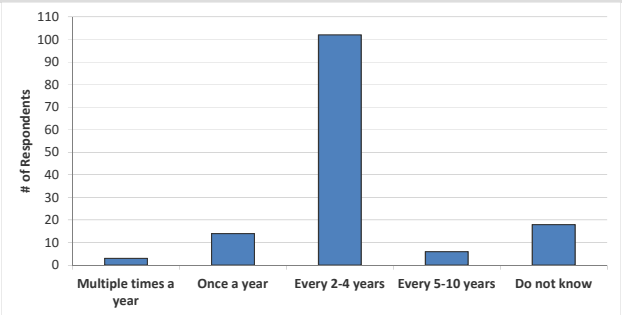
5. What type of septic system does your property utilize?

Answer Options	Response Percent	Response Count
Holding tank	12.9%	22
Mound	9.4%	16
Advanced treatment system	2.4%	4
Conventional system	51.8%	88
Municipal sewer	20.0%	34
Do not know	0.6%	1
No septic system	2.9%	5
answered question		170
skipped question		1



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

Answer Options	Response Percent	Response Count
Multiple times a year	2.1%	3
Once a year	9.8%	14
Every 2-4 years	71.3%	102
Every 5-10 years	4.2%	6
Do not know	12.6%	18
answered question		143
skipped question		28



Recreational Activity on North & South Twin Lake

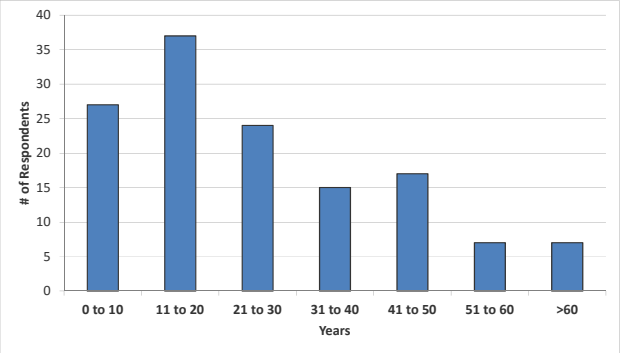
7. Have you personally fished on your lake in the past three years?

Answer Options	Response Percent	Response Count
Yes	79.2%	133
No	20.8%	35
answered question		168
skipped question		3

8. For how many years have you fished your lake?

Answer Options	Response Count
	134
answered question	**134**
skipped question	**37**

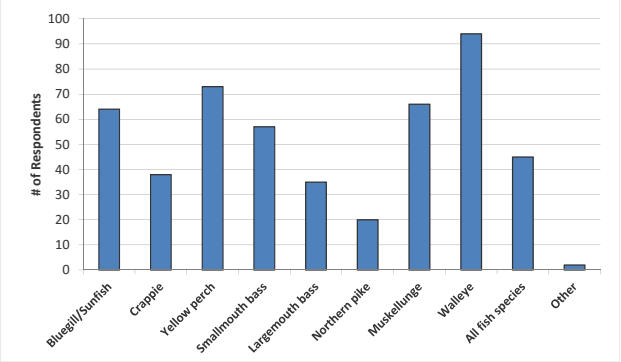
Category (# of years)	Responses	% Response
0 to 10	**27**	**20%**
11 to 20	**37**	**28%**
21 to 30	**24**	**18%**
31 to 40	**15**	**11%**
41 to 50	**17**	**13%**
51 to 60	**7**	**5%**
>60	**7**	**5%**



9. What species of fish do you like to catch on your lake?

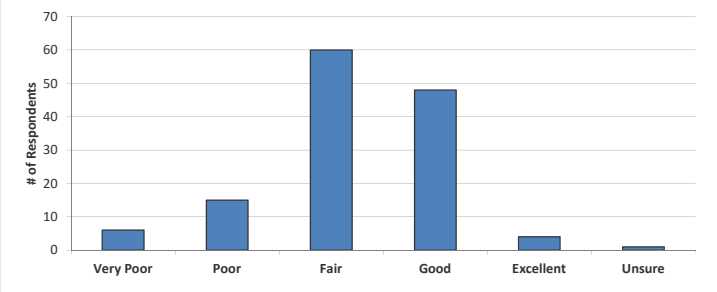
Answer Options	Response Percent	Response Count
Bluegill/Sunfish	47.8%	64
Crappie	28.4%	38
Yellow perch	54.5%	73
Smallmouth bass	42.5%	57
Largemouth bass	26.1%	35
Northern pike	14.9%	20
Muskellunge	49.3%	66
Walleye	70.1%	94
All fish species	33.6%	45
Other (please specify)	1.5%	2
answered question		**134**
skipped question		**37**

Number	Other (please specify)
1	cisco
2	Cisco



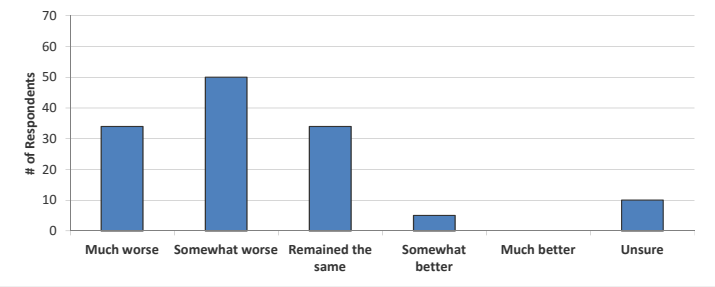
10. How would you describe the current quality of fishing on your lake?

Answer Options	Very Poor	Poor	Fair	Good	Excellent	Unsure	Response Count
	6	15	60	48	4	1	134
answered question							**134**
skipped question							**37**



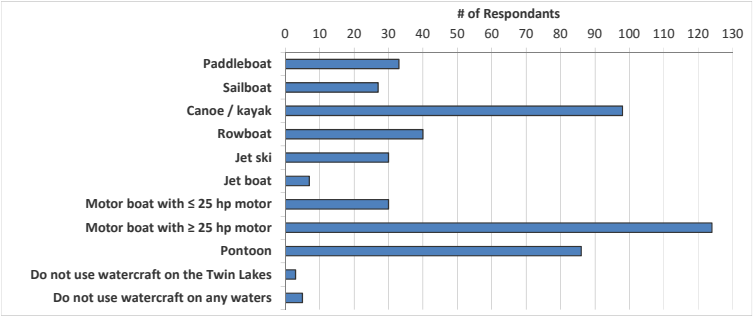
11. How has the quality of fishing changed on your lake since you have started fishing the lake?

Answer Options	Much worse	Somewhat worse	Remained the same	Somewhat better	Much better	Unsure	Response Count
	34	50	34	5	0	10	133
						answered question	**133**
						skipped question	**38**



12. What types of watercraft do you currently use on the North & South Twin Lakes?

Answer Options	Response Percent	Response Count
Paddleboat	19.5%	33
Sailboat	16.0%	27
Canoe / kayak	58.0%	98
Rowboat	23.7%	40
Jet ski (personal water craft)	17.8%	30
Jet boat	4.1%	7
Motor boat with 25 hp or less motor	17.8%	30
Motor boat with greater than 25 hp motor	73.4%	124
Pontoon	50.9%	86
Do not use watercraft on the North & South Twin Lakes	1.8%	3
Do not use watercraft on any waters	3.0%	5
answered question		**169**
skipped question		**2**



13. Do you use your watercraft on waters other than the North & South Twin Lakes?

Answer Options	Response Percent	Response Count
Yes	29.3%	48
No	70.7%	116
answered question		**164**
skipped question		**7**

14. What is your typical cleaning routine after using your watercraft on waters other than the North & South Twin Lakes?

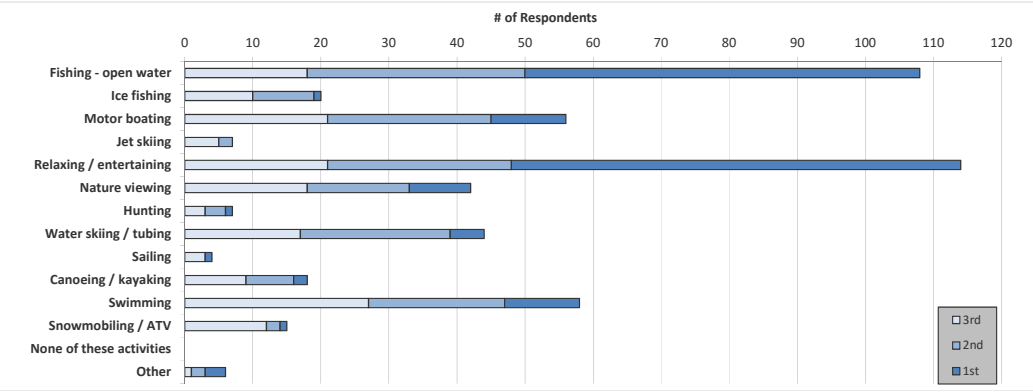
Answer Options	Response Percent	Response Count
Remove aquatic hitch-hikers (ex. - plant material, clams, mussels)	93.6%	44
Drain bilge	68.1%	32
Rinse boat	19.1%	9
Power wash boat	6.4%	3
Apply bleach	2.1%	1
Do not clean boat	4.3%	2
Other (please specify)	2.1%	1
	answered question	**47**
	skipped question	**124**

Number	Other (please specify)
1	Canoe used as is

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

Answer Options	1st	2nd	3rd	Rating Average	Response Count
Fishing - open water	58	32	18	1.63	108
Ice fishing	1	9	10	2.45	20
Motor boating	11	24	21	2.18	56
Jet skiing	0	2	5	2.71	7
Relaxing / entertaining	66	27	21	1.61	114
Nature viewing	9	15	18	2.21	42
Hunting	1	3	3	2.29	7
Water skiing / tubing	5	22	17	2.27	44
Sailing	1	0	3	2.50	4
Canoeing / kayaking	2	7	9	2.39	18
Swimming	11	20	27	2.28	58
Snowmobiling / ATV	1	2	12	2.73	15
None of these activities are important to me	0	0	0	0.00	0
Other (please specify below)	3	2	1	1.67	6
			answered question		**169**
			skipped question		**2**

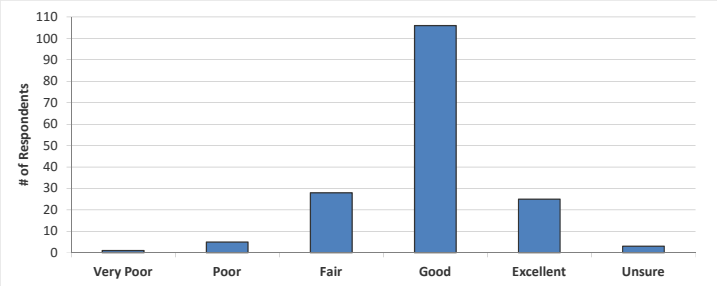
Number	"Other" responses
1	Family
2	Summer with wife, grandkids, kids, neighbors, NSTLRA
3	Inherited property
4	would love to have swimming as #1, but do to swimmers itch we cannot swim
5	Inherited property
6	cross country skiing
7	Income



North & South Twin Lakes Current and Historic Condition, Health and Management

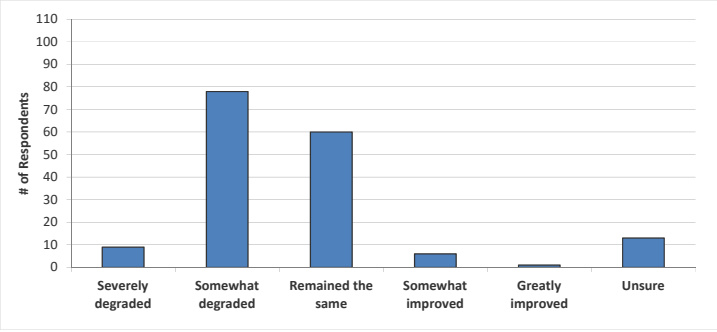
16. How would you describe the current water quality of your lake?

Answer Options	Very Poor	Poor	Fair	Good	Excellent	Unsure	Response Count
	1	5	28	106	25	3	168
						answered question	**168**
						skipped question	**3**



17. How has the water quality changed in your lake since you first visited the lake?

Answer Options	Severely degraded	Somewhat degraded	Remained the same	Somewhat improved	Greatly improved	Unsure	Response Count
	9	78	60	6	1	13	167
						answered question	**167**
						skipped question	**4**



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

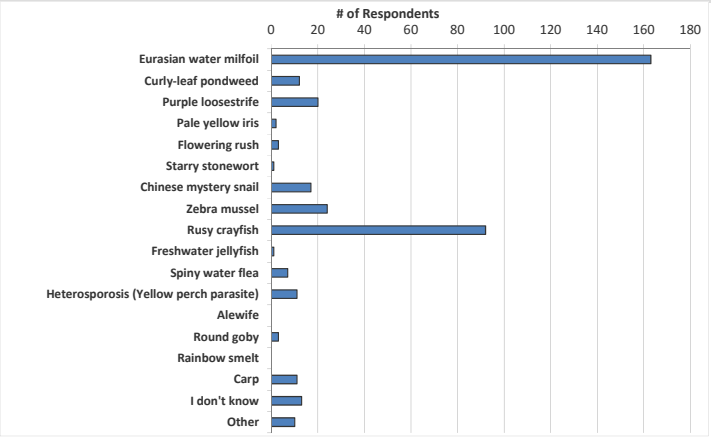
Answer Options	Response Percent	Response Count
Yes	100.0%	167
No	0.0%	0
	answered question	**167**
	skipped question	**4**

19. Do you believe aquatic invasive species are present within your lake?

Answer Options	Response Percent	Response Count
Yes	93.5%	157
I think so but am not certain	6.0%	10
No	0.6%	1
	answered question	**168**
	skipped question	**3**

20. Which aquatic invasive species do you believe are in your lake?

Answer Options	Response Percent	Response Count
Eurasian water milfoil	97.6%	163
Curly-leaf pondweed	7.2%	12
Purple loosestrife	12.0%	20
Pale yellow iris	1.2%	2
Flowering rush	1.8%	3
Starry stonewort	0.6%	1
Chinese mystery snail	10.2%	17
Zebra mussel	14.4%	24
Rusy crayfish	55.1%	92
Freshwater jellyfish	0.6%	1
Spiny water flea	4.2%	7
Heterosporosis (Yellow perch parasite)	6.6%	11
Alewife	0.0%	0
Round goby	1.8%	3
Rainbow smelt	0.0%	0
Carp	6.6%	11
I don't know but presume AIS to be present	7.8%	13
Other (please specify)	6.0%	10
answered question		**167**
skipped question		**4**

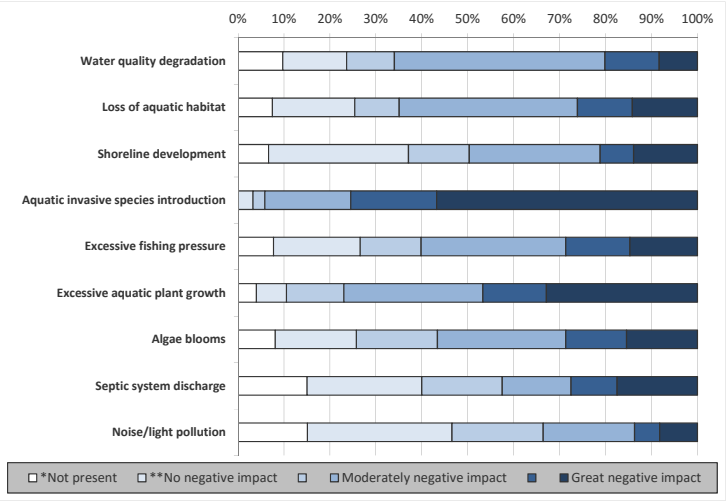


Number	"Other" responses
1	Some kind of snail that causes swimmers itch
2	swimmers itch
3	parasite that causes swimmer's itch
4	seeing snails I never saw before
5	snails infected with parasites for swimmers itch
6	Some type of Lg snail, never remember this many years ago.
7	I have heard of others
8	Swimmers itch parasites
9	duck itch parisite
10	SWIMMERS ITCH

21. To what level do you believe each of the following factors may currently be negatively impacting your lake?
*** Not present means that you believe the issue does not exist on your lake.**
**** No impact means that the issue may exist on your lake but it is not negatively impacting the lake.**

Answer Options	*Not present	**No negative impact		Moderately negative impact		Great negative impact	Unsure: Need more information	Rating Average	Response Count
Water quality degradation	14	20	15	66	17	12	19	2.31	163
Loss of aquatic habitat	10	24	13	52	16	19	28	2.25	162
Shoreline development	10	46	20	43	11	21	12	2.23	163
Aquatic invasive species introduction	0	5	4	29	29	88	9	4.00	164
Excessive fishing pressure	11	27	19	45	20	21	17	2.41	160
Excessive aquatic plant growth (excluding algae	6	10	19	46	21	50	14	3.13	166
Algae blooms	11	24	24	38	18	21	24	2.27	160
Septic system discharge	18	30	21	18	12	21	40	1.74	160
Noise/light pollution	22	46	29	29	8	12	15	1.76	161
Other (please specify)									31
								answered question	**168**
								skipped question	**3**

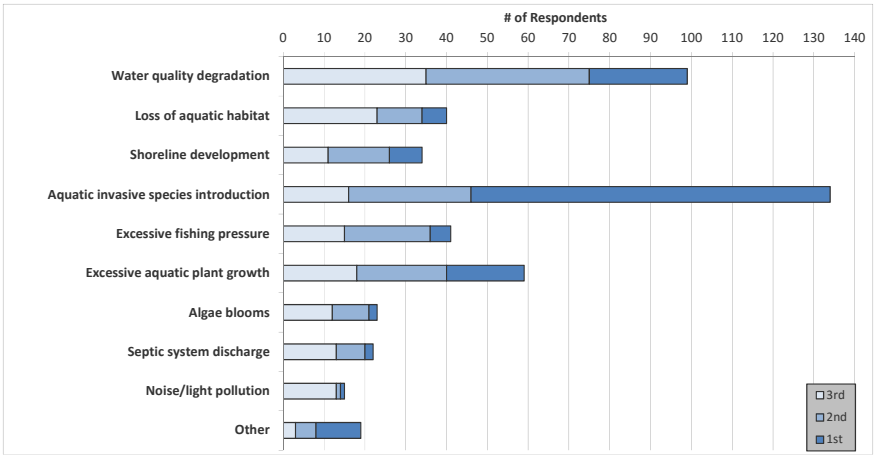
Number	Other (please specify)
1	I believe there are properties that dump their "gray water" in the ground to in septic or city sewer systems
2	Swimmer's Itch - Snails
3	Spearing is by far the worst problem on our lake
4	Snails/ ducks causing swimmers itch
5	Indian Spearing 5
6	Great impact - native spearing
7	Great impact swim itch
8	Swimmer's Itch has had a mod.negative impact
9	spearing
10	Your survey is missing two critical points, 1) impact of spring walleye spearing by indian tribe and 2) swimmers itch impact on water quality.
11	duck itch is our biggest problem
12	indian spearing
13	lack of adequate fish population
14	lights from phelps street lights at night great big negative. they could save money and reduce ambient light pollution by cutting 66% of street lights 2 hours after sunset daily.
15	spearing !!!!!!!!!!!!!!!
16	Tribal Spearing
17	swimmers itch
18	SPEARING SWIMMERS ITCH
19	greatest impact is Aquatic Invasive Species seen in 2015
20	Swimmer itch is why I consider water quality as greatly negative
21	Native American spearing
22	Swimmers Itch & Inability To Get In The Water Without Fear Of Getting It
23	EXCESSIVE FISHING PRESSURE DUE TO SPEARING
24	Swimmer's Itch - Great negative impact
25	indian spearing -great negative impact
26	Swimmers itch. And low water level some years
27	excessive tribal walleye harvest has started to turn twin lakes from a class A walleye fishery into bass dominant lakes.
28	swimmers itch has great negative impact
29	Swimmers itch. Would never buy on Twin again.
30	native american spear fishing uncounted take
31	Swimmers Itch - GREAT NEG IMPACT!



22. From the list below, please rank your top three concerns regarding your lake, with 1 being your greatest concern.

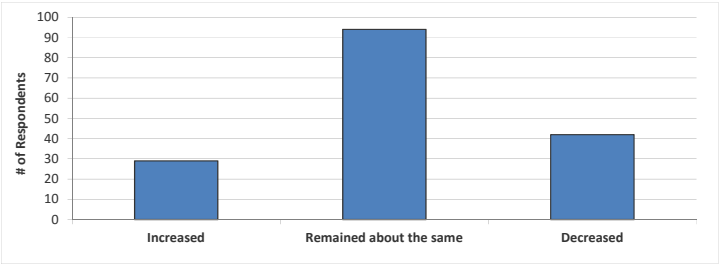
Answer Options	1st	2nd	3rd	Response Count
Water quality degradation	24	40	35	99
Loss of aquatic habitat	6	11	23	40
Shoreline development	8	15	11	34
Aquatic invasive species introduction	88	30	16	134
Excessive fishing pressure	5	21	15	41
Excessive aquatic plant growth (excluding algae)	19	22	18	59
Algae blooms	2	9	12	23
Septic system discharge	2	7	13	22
Noise/light pollution	1	1	13	15
Other (please specify)	11	5	3	19
			answered question	**168**
			skipped question	**3**

Number	"Other" responses
1	Swimmers itch
2	Spearing
3	Swimmer's Itch
4	1st - duck lice/swimmers itch
5	Future good fishing
6	Snails/ ducks causing swimmers itch
7	Indian spearing large female walleys
8	swimmers itch
9	swimmers itch
10	Swimmer's Itch
11	Over harvesting by spearing
12	spearing
13	Swimmers itch is the biggest negative to water quality and Indian spearing is the biggest contributor to excessive fishing pressure.
14	duck itch
15	Eurasian Milfoil, Spearing
16	swimmers itch
17	Pressure to form a Lake District
18	SWIMMERS ITCH SPEARING
19	spearing walleyes
20	swimmers itch
21	controlling the Eurasian Water Milfoil
22	swimmers itch
23	duck lice
24	spearing
25	need to stock with more fish
26	Native American Spearing
27	Swimmers itch and low water levels some years
28	swimmers itch
29	1st-Swimmers Itch



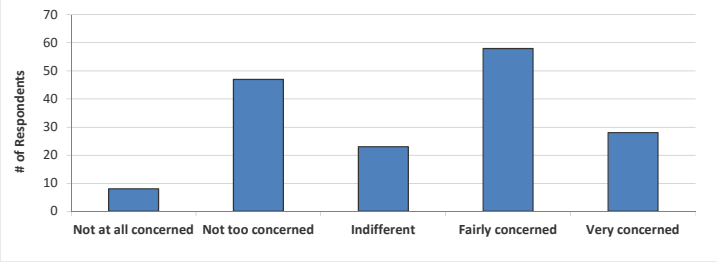
23. In the past five years (or fewer if you've owned your property for less than five years) how would you say your property value has changed?

Answer Options	Increased	Remained about the same	Decreased	Response Count
	29	94	42	165
			answered question	**165**
			skipped question	**6**



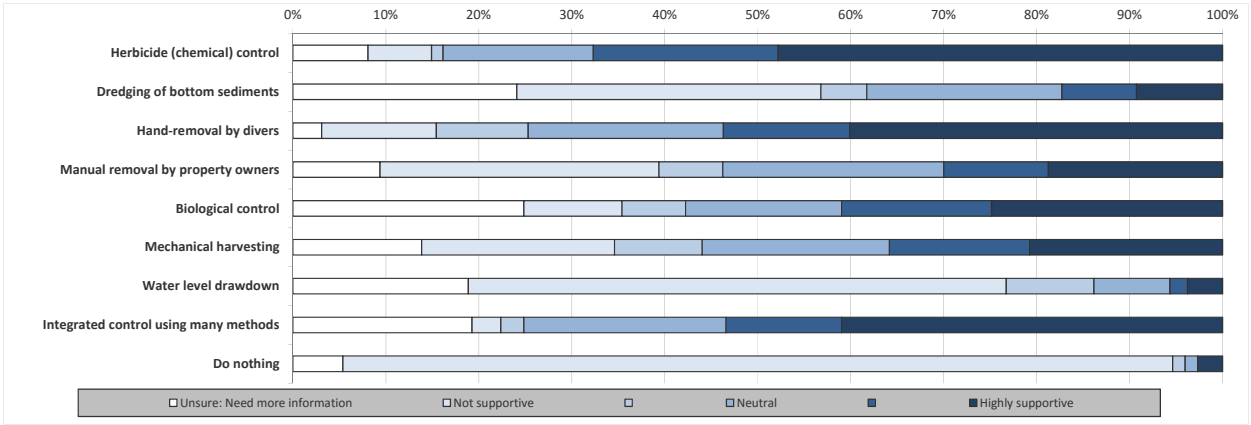
24. How concerned are you, if at all, with the current value of your property?

Answer Options	Not at all concerned	Not too concerned	Indifferent	Fairly concerned	Very concerned	Response Count
	8	47	23	58	28	164
					answered question	**164**
					skipped question	**7**



25. Aquatic plants can be managed using many techniques. Please tell us if you oppose or support the *responsible* use of the following techniques on your lake.

Answer Options	Not supportive		Neutral		Highly supportive	Unsure: Need more information	Rating Average	Response Count
Herbicide (chemical) control	11	2	26	32	77	13	3.76	161
Dredging of bottom sediments	53	8	34	13	15	39	1.84	162
Hand-removal by divers	20	16	34	22	65	5	3.50	162
Manual removal by property owners	48	11	38	18	30	15	2.54	160
Biological control (milfoil weevil, loosestrife be	17	11	27	26	40	40	2.63	161
Mechanical harvesting	33	15	32	24	33	22	2.64	159
Water level drawdown	92	15	13	3	6	30	1.28	159
Integrated control using many methods	5	4	35	20	66	31	3.28	161
Do nothing (do not manage plants)	133	2	2	0	4	8	1.09	149
						answered question		**164**
						skipped question		**7**

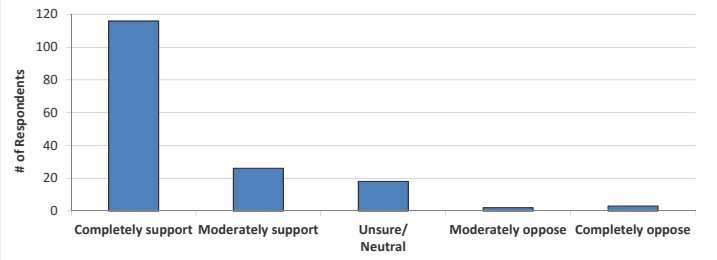


26. Aquatic herbicides have been used to control Eurasian water milfoil on the Twin Lakes. Professional monitoring of the aquatic plant community has also occurred during this time. Prior to reading this information, did you know that aquatic herbicides were being appliedin the Twin Lakes to help control Eurasian water milfoil?

Answer Options	Response Percent	Response Count
Yes	93%	153
I think so but can't say for certain	2%	4
No	5%	8
answered question		***165***
skipped question		***6***

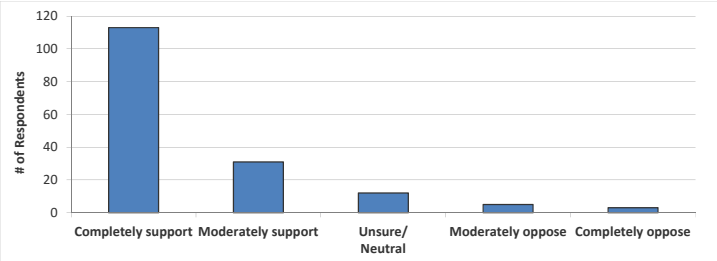
27. A large-scale herbicide treatment of Eurasian water milfoil was completed on South Twin Lake in 2016. How do you feel about the large-scale treatment that occurred in 2016?

Answer Options	Completely support	Moderately support	Unsure/ Neutral	Moderately oppose	Completely oppose	Response Count
	116	26	18	2	3	165
					answered question	**165**
					skipped question	**6**



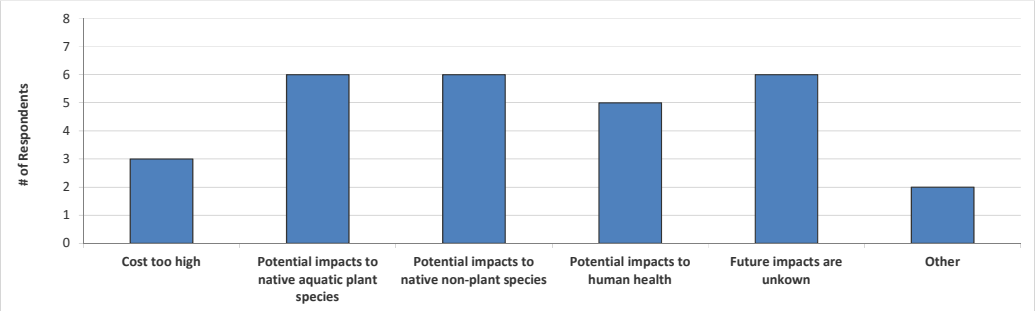
28. What is your level of support or opposition for future aquatic herbicide use to target Eurasian water milfoil in the Twin Lakes?

Answer Options	Completely support	Moderately support	Unsure/ Neutral	Moderately oppose	Completely oppose	Response Count
	113	31	12	5	3	164
					answered question	**164**
					skipped question	**7**



29. If you selected "Moderately oppose" or "Completely oppose" on the previous question, what is the reason or reasons you oppose the future use of aquatic herbicides to target Eurasian watermilfoil in the Twin Lakes?

Answer Options	Response Percent	Response Count
Cost of treatment is too high	43%	3
Potential impacts to native aquatic plant species	86%	6
Potential impacts to native (non-plant) species such as fish, insects, etc.	86%	6
Potential impacts to human health	71%	5
Future impacts are unkown	86%	6
Other (please specify)	29%	2
answered question		**7**
skipped question		**164**



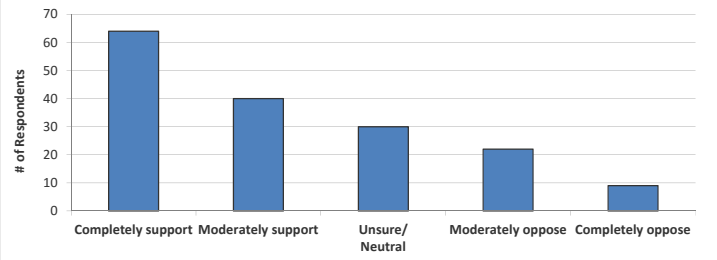
Number	"Other" responses
1	Herbacides poison the lake and the habitat for years to come. That is a fact based on history of many other lakes. I know as a fact based on experience living on other lakes. Our biggest problem is the loss of native weeds by crayfish or other species to the point where fishing is now terrible! Go ask any old-time fisherman who is in there 70s and has fished the lake as a professional for many decades. They will tell you the loss of weeds is dramatic. EWM is a nuissance but takes the place of vast areas where there used to be plenty of native weeds but now are none. Couple the lack of weeds with the fishing pressure and a once premier fishing lake is now horrible. Spearing also plays a role, but the lake sustained it for years before the weeds were destroyed. Cannot swim in many parts, including in front of our home due to water itch, water fleas, etc. How do you propose to solve that? The lakes are so deep, UWM cannot clog the access/navigation ever. It will probably help fishing.
2	killing native plants allows the more aggressive invasive to take over the treated areas. i. e. south twin in 2015

30. Hand harvesting/removal has been used to control Eurasian water milfoil in the Twin Lakes. Professional monitoring of the aquatic plant community has also occurred during this time. Prior to reading this information, did you know that hand harvesting/removal was beingconducted in the Twin Lakes to help control Eurasian water milfoil?

Answer Options	Response Percent	Response Count
Yes	88%	146
I think so but can't say for certain	3%	5
No	8%	14
answered question		**165**
skipped question		**6**

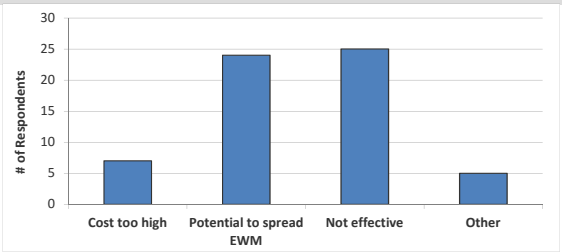
31. What is your level of support or opposition for hand harvesting/removal to target Eurasianwater milfoil in the Twin Lakes?

Answer Options	Completely support	Moderately support	Unsure/ Neutral	Moderately oppose	Completely oppose	Response Count
	64	40	30	22	9	165
answered question						**165**
skipped question						**6**



32. If you selected "Moderately oppose" or "Completely oppose" on the previous question, what is thereason or reasons you oppose the future use of hand harvesting/removal to target Eurasian water milfoil in the Twin Lakes?

Answer Options	Response Percent	Response Count
Cost of hand harvesting/removal is too high	22%	7
Potential to spread Eurasian water milfoil	75%	24
Not effective	78%	25
Other (please specify)	16%	5
answered question		32
skipped question		139

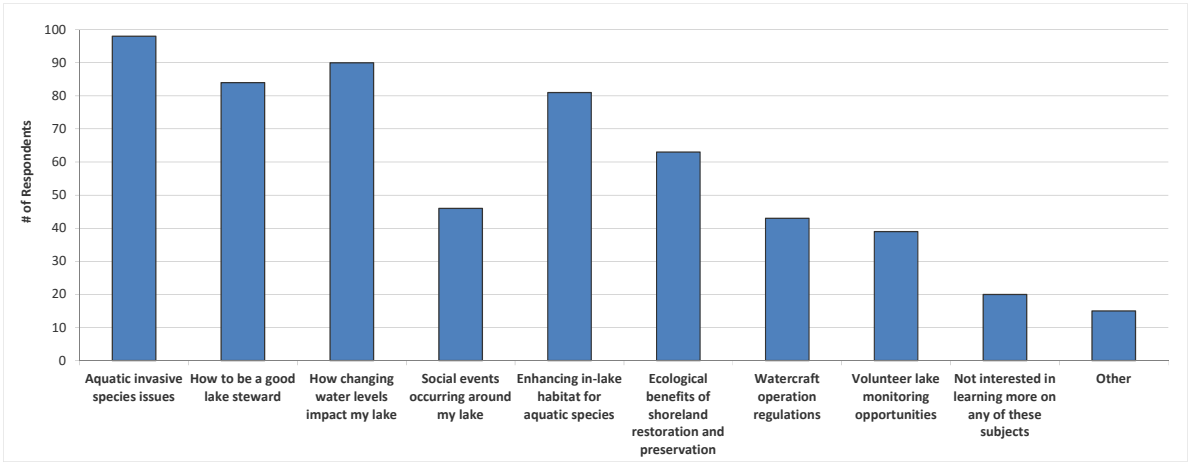


Number	"Other" responses
1	I strongly suggest their work be observed by a separate, perhaps a lake association diver, to monitor and give a hands on, eyes on, report of what activity takes place. I strongly believe fragments are allowed to float away, reseed themselves in the lake floor and regenerate. I also strongly encourage our lake association to "offer and encourage" fisherman to take a 5 gallon pail out with the and place the milfoil they snag with lures in this bucket. Could pails be provided at the landings?
2	hand harvesting spreads the milfoil it does not remove it
3	I see this as only moderately effective for small areas, similar to weeding a vegetable garden
4	Right after the harvesting(directly in front of us) the bloom exploded. Also, we observed too much slack time and goofing off.
5	Not very effective! Come on!

33. Stakeholder education is an important component of every lake management planning effort. Which of these subjects would you like to learn more about?

Answer Options	Response Percent	Response Count
Aquatic invasive species impacts, means of transport, identification, control options, etc.	59.8%	98
How to be a good lake steward	51.2%	84
How changing water levels impact my lake	54.9%	90
Social events occurring around my lake	28.0%	46
Enhancing in-lake habitat (not shoreland or adjacent wetlands) for aquatic species	49.4%	81
Ecological benefits of shoreland restoration and preservation	38.4%	63
Watercraft operation regulations – lake specific, local and statewide	26.2%	43
Volunteer lake monitoring opportunities (CBCW, Citizens Lake Monitoring Network, Loon Watch, NSTLRA programs, etc.)	23.8%	39
Not interested in learning more on any of these subjects	12.2%	20
Other (please specify)	9.1%	15
answered question		164
skipped question		7

Number	Other (please specify)
1	How to get rid of snails causing swimmer's itch
2	what can be done for duck lice problem
3	Work at boat landings
4	biological control of invasive species
5	Swimmers itch
6	How to remove parasite causing swimmer's itch
7	Manage fishing resource better
8	how to eliminate swimmer itch, how to restore our lakes walleye population
9	I feel sufficiently informed on all of these, and appreciate their significance.
10	swimmers itch
11	Deleting swimmers itch
12	Being a lake association member I am made aware of many of the above, hence they are not marked, although they may be of importance to me.
13	low level airplane operation over the lakes
14	Swimmers itch
15	restrict motor size



North & South Twin Lakes Riparian Association (NSTLRA)

34. Before receiving this mailing, had you ever heard of the NSTLRA?

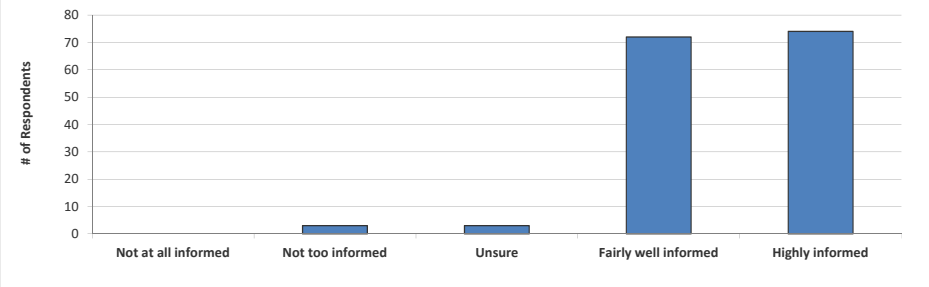
Answer Options	Response Percent	Response Count
Yes	97.0%	162
No	3.0%	5
answered question		**167**
skipped question		**4**

35. What is your membership status with the NSTLRA?

Answer Options	Response Percent	Response Count
Current member	89.5%	145
Former member	4.9%	8
Never been a member	5.6%	9
answered question		**162**
skipped question		**9**

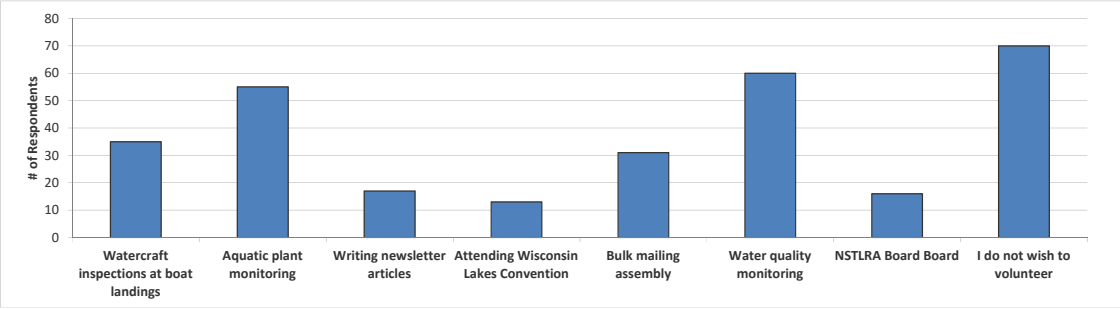
36. How informed has (or had) the NSTLRA kept you regarding issues with your lake and its management?

Answer Options	Not at all informed	Not too informed	Unsure	Fairly well informed	Highly informed	Response Count
	0	3	3	72	74	152
answered question						**152**
skipped question						**19**



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

Answer Options	Response Percent	Response Count
Watercraft inspections at boat landings	21.7%	35
Aquatic plant monitoring	34.2%	55
Writing newsletter articles	10.6%	17
Attending Wisconsin Lakes Convention	8.1%	13
Bulk mailing assembly	19.3%	31
Water quality monitoring	37.3%	60
NSTLRA Board Board	9.9%	16
I do not wish to volunteer	43.5%	70
answered question		**161**
skipped question		**10**



38. Please feel free to provide written comments concerning your lake, its current and/or historic condition and its management.

Answer Options	Response Count
	65
answered question	**65**
skipped question	**106**

Number	Response Text
1	Concerns with swimmer's itch - any solutions to minimize or eliminate?
2	2015 was significant milfoil. worse in history. Can we get handle on this? S Twin resident.
3	I believe NSTRLA has done cery well with the resourses they have. We could all do better.
4	Thank you for the opportunity to participate in your survey. I'm sorry for the delay in responding to it. I currently have my lot for sale, so, I'm not sure how much of an impact I will have as a "temporary" resident of the lake. I appreciate the time and effort that was put forth by the NSTLRA to provide us with this survey. Best regards! Dave Whiteside
5	Keep up the great work and continue to provide the information on our lakes for our future generations
6	Considering the lack of participation from lake property owners, I believe the association has done a good job keeping folks informed and trying to keep up with invasive species that are in the twin lakes.
7	I am very thankful for commitment that has been made to North and South Twin Lakes.
8	Even more than milfoil, I believe something needs to be done about the high incidence of swimmers itch It is causing my family and I great reluctance of ever swimming in North Twin. This was not the case until the mid 1990s. Let's find out why! Thank you for all your hard work already done regarding milfoil.
9	Pleased we have an active board of good lake stewards!
10	SPEARING
11	why is chemical treatment not used for swimmers itch?
12	Problem with SI when I was a boy and still is for grandkids..sad thing we r afraid to go in lake. EWM is an issue but SI is bigger
13	I believe a Lake District is critically important to managing our lakes.
14	We need to form a lake district, so that everyone is paying their fair share to keep our lakes as pristine for our use and for future generations
15	We have owned our home on South Twin for almost 40 years and feel the major reason that we have concern is the introduction of AIS from activity in/out at boat landings.
16	Immensely oppose a Lake District
17	Open membership to public for financial support and new ideas
18	Relocated to area recently
19	Eurasian milfoil growth must be contained to maintain property values of lake property, tourism to our lakes, and keep the town of Phelps alive.
20	Our lake management committee is doing an awesome job. Thank You!!
21	1) Swimmers itch has the biggest impact on property values and lake usage over all other issues yet it is not being aggressively address by the lake association nor this survey. Water quality can't be addressed with including this issue. 2) 1,000 spawning walleyes have been speared each year for 20 years with no replenishing program.
22	I believe the issue that actively burdens lake members the most is swimmers' itch. I understand that this is a bit of a different issue, although not entirely as water quality, and potential invasive species (certain non-native snails) may play a siginificant role in the presence of the cercariae. We continue to hope that one day this is an issue that can be addressed in an ecologically sound way.
23	The lake is everyone's responsibility, not just the lake owners. But, I do agree as property owners, we have the most at risk.
24	I believe that NSTRLA has done a very good job and been very helpful distributing information to the property owners. Their social events have been very good.
25	We have to do something about the duck itch problem. We can't even use the north side of the lake most of the summer
26	We are supportive of the efforts to become a Lake District and thank the Board volunteers for all their work.
27	The is Board doing a very good job of managing our lake water quality. It would be nice to get every property owner involved financially. I don't mind donating over and above what the dues are as lo ng as it is used for the good of the lakes
28	Treating the lake for milfoil in 2016 was very successful compared to hand pulling.
29	First, I am impressed by, and grateful for, this well conceived and thorough survey. I also value highly the absence of rules on skiing hours, fishing clearances, etc, that allow owners to use discretion and courtesy as an alternative. I have two suggestions regarding courtesy.I do not like the huge boats (mostly temp renters) that wake board slowly to throw up a huge wake that tears up the weed line, and smashes a moored boat against the dock. I do not like loud jet skis that go back and fourth along the shoreline; take both of these activities out to the center of the lake. Mention of these two activities in a newsletter would be helpful.
30	it is very gratifying to know we have a proactive lake association to meet concerns head on.
31	I think there should be some research done on swimmers itch and if there are ways the it could be prevented. I feel there is a major stigma on North Twin because of the swimmers itch problem. this reduces property values and the ability to draw visttors.
32	I would like to see north and south twin lakes the no jet ski zone of vilas county!! They ruin the allure of the northwoods silence
33	The responsibilty of Wisconsin Lakes is that of the DNR, and they should be keeping the lakes healthy using the taxes and fees from fishing licenses and boating permits etc. This is not a private lake, and it should not be the responsibility of the private owners surrounding the lake to fund a public lake. Unless it is designated a private lake and outside boaters are prevented from accessing the lake and spreading the milfoil, this effort will be ongoing and should be addressed by the state.
34	Our property has been for sale for over 3 years with little or no interest shown. The assessed values are not realistic.
35	This lake is a treasure. Swimmers Itch,Eurasian Milfoil, and OVER harvest of walleye by Indian spearing are my greatest concerns. I know the NSTRLA can help control one of the three.
36	Thanks for your hard work !
37	We need a way for all lake property owners to share the cost for controlling invasive species
38	We live in Dane County. Just no time right now to volenteer
39	I want to thank everyone involved in caring for our lake. I believe in what the association is doing for us and when the time comes I plan to help in areas I can. Thanks again!
40	I would not have a problem paying a launch fee that would go towards any costs associated with this effort. Has that ever been discussed. Since that is where most, if not all invasive species come from.
41	I would like further studies done on the swimmers itch issue and how to control/elimminate
42	duck lice control
43	My family has been enjoying North and South Twin Lakes for 4 generations. We must do all we can to preserve the pristine beauty of our lakes so that future generations will come to love, admire, and respect the lakes as much as we do.
44	I would like to see all boat launches monitored, not just one, for the majority of the fishing season. More education on monitoring and volunteering to assist in monitoring activities.
Number	Response Text

45	We appreciate the work of the board, and we support the formation of a Lake District so the board has the resources to keep the lake healthy.
46	We feel very strongly that those who live on, live near and use our beautiful lakes, respect them and help keep them pristine for future generations! It is a privilege to have such a beautiful place to retreat to. Thank you Board of Directors for all of your continued hard work. We support your efforts!!
47	Our family has been on the lakes since 1932. Personally I have been for almost sixty years. Over the years there are a number of aspects in which there has been a negative impact on the quality of the water. Invasive species over the years have grown to an impacting level. Swimmers itch wasn't even a consideration or thought years back. Placement of something in the waters such as a pier or lift is so different now than years ago relative to the discoloration and build up that exists within a somewhat short season of being exposed. (usually less then four months). Of concern is the quality of and the function of various septic systems that are found on the lakeshore properties. Inadequate, improper to overworked systems are present. Is this presently being monitored or investigated on a per property basis to assure that the quality of the waters on N. & S. Twin Lakes doesn't further deteriorate. Many thanks to all those who do volunteer their efforts to the cause in a variety of ways to make our waters better and develop plans for safeguarding the precious waterways that we have for our future use and enjoyment.
48	KEEP UP THE GOOD WORK! THANKS.
49	My family and friends no longer swim in the lake because of Swimmer's Itch and no longer fish for Walleye because of fishing pressure from Indian Spear Fishing. We cannot enjoy the Lake as we used to.
50	I certainly hope that all lake owners take this to heart as we have an unreplaceable treasure in these 2 lakes !!!
51	The 2016 EWM treatment on S Twin was phenomenal. Thanks for all the planning and execution. Let's keep it up.
52	You have done a good job of scaring people to the impacts of UWM. It is not good, granted, but many lakes have it and are fine. Average depth on NTwin is ~29 feet. STwin is ~24 feet. EWM can impact parts of the lake, yes, but not badly overall at those depths. How do you propose re-introducing all the native weed beds that were once great/vast across all of both lakes but are gone due to crayfish, etc? How do you propose getting rid of water itch, fleas? How do you propose limiting the fishing pressure? Many people bought property on the Twins to fish and boat/swim. Those are impacted by lack of native weeds, water fleas/other, fishing pressure/spearing. I don't want UWM, but I also don't see that as the biggest issue or even near the top. We need to greatly improve the aquatic habitat and weeds, restock fish, maybe add new species. Some don't care about fishing, but once fishing reaches a certain level of deterioration property values will drop and visitors will cease. We are close to that point now. It is sad when I have to take my family and friends to other lakes in the area in order to guarantee a decent fishing experience. Even more so with a boat, lift, dock affixed to the shore but not very usable for fishing on the Twins.
53	I'd like to thank the board members for all their interest and hard work on our behalf.
54	Currently a member of NSTLRA (since it began) currently on the board
55	no to lake district
56	Everything is always about milfoil. No one cares about the swimmers itch or the low water levels we have some years. These are my main concerns about the lake.
57	Very impressed with the condition of the lake in 2016 vs 2015
58	bass populations have exploded most notably on south twin, this could severely impact walleye populations
59	Thank you for doing a good job.
60	current association is doing a very good job monitoring lake activities. looking forward to establishment of lake district.
61	Thank you, and keep up the great work on keeping our lakes clean and inviting for all.
62	Would never buy, or recommend anyone to own on Twin because of terrible swimmers itch. To us, that's more important as milfoil.
63	where previous chemical milfoil control was used is where the most milfoil took over in 2015. killing all broadleaf weeds with the milfoil will only allow no competition against the more aggressive milfoil. hand harvest and let nature take it 's coarse or we 'll have nothing but vast beds of milfoil that will need chemical treatment every few years.
64	What is the status of all lake property owners paying for maintenance of the lake ?
65	Extremely disappointed that NSTRLA lacks focus on placing pressure on the state to take complete responsibility for monitoring and eradicating milfoil and swimmers itch! These are state waters - with invasive species most likely introduced by non-property owners.

C

APPENDIX C

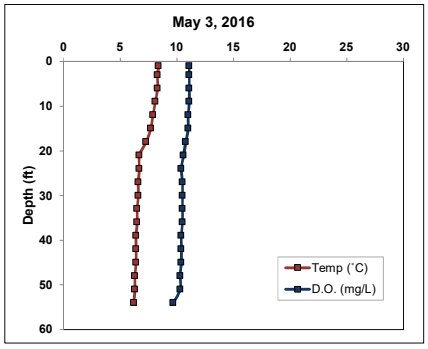
Water Quality Data

North Twin Lake

Date: 5/3/2016
Time: 9:45
Weather: 100% clouds, 55F, windy
Entry: EEH

Max Depth: 55.0
LS Depth (ft): 3.0
LB Depth (ft): 52.0
Secchi Depth (ft): 7.2

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	8.4	11.1		
3	8.3	11.1	8.1	
6	8.3	11.1		
9	8.1	11.1		
12	7.9	11.0		
15	7.7	11.0		
18	7.3	10.8		
21	6.7	10.6		
24	6.7	10.4		
27	6.6	10.5		
30	6.6	10.5		
33	6.5	10.5		
36	6.5	10.5		
39	6.4	10.4		
42	6.4	10.4		
45	6.4	10.4		
48	6.3	10.3		
51	6.3	10.3		
54	6.2	9.7		



Parameter	LS	LB
Total P (µg/L)	23.00	18.70
Dissolved P (µg/L)	2.20	1.80
Chl-a (µg/L)	3.14	NA
TKN (µg/L)	307.00	459.00
$NO_3 + NO_2$-N (µg/L)	ND	ND
NH_3-N (µg/L)	ND	19.00
Total N (µg/L)	307.00	459.00
Lab Cond. (µS/cm)	113.00	114.00
Lab pH	7.81	7.66
Alkalinity (mg/L $CaCO_3$)	44.20	44.50
Total Susp. Solids (mg/L)	ND	ND
Calcium (mg/L)	11.50	NA
Magnesium (mg/L)	4.49	NA
Hardness (mg/L)	47.10	NA
Color (SU)	10.00	NA
Turbidity (NTU)	NA	NA

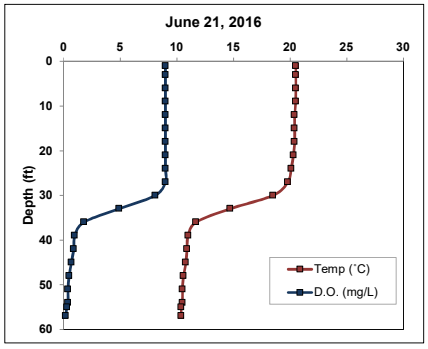
Data collected by BTB (Onterra).

North Twin Lake

Date: 6/21/2016
Time: 14:45
Weather: 75% clouds, windy, 72F
Entry: JLW

Max Depth: 58.4
LS Depth (ft): 3.0
LB Depth (ft): 55.0
Secchi Depth (ft): 11.9

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	20.5	9.0		
3	20.5	9.0		
6	20.5	9.0		
9	20.5	9.0		
12	20.4	9.0		
15	20.4	9.0		
18	20.4	9.0		
21	20.3	9.0		
24	20.1	9.0		
27	19.8	9.0		
30	18.5	8.1		
33	14.7	4.9		
36	11.7	1.8		
39	11.0	1.0		
42	10.9	0.9		
45	10.8	0.7		
48	10.6	0.5		
51	10.5	0.4		
54	10.5	0.4		
55	10.4	0.3		
57	10.4	0.2		



Parameter	LS	LB
Total P (µg/L)	19.50	91.90
Dissolved P (µg/L)	NA	NA
Chl-a (µg/L)	1.23	NA
TKN (µg/L)	NA	NA
$NO_3 + NO_2$-N (µg/L)	NA	NA
NH_3-N (µg/L)	NA	NA
Total N (µg/L)	NA	NA
Lab Cond. (µS/cm)	NA	NA
Lab pH	NA	NA
Alkalinity (mg/L $CaCO_3$)	NA	NA
Total Susp. Solids (mg/L)	NA	NA
Calcium (mg/L)	NA	NA
Magnesium (mg/L)	NA	NA
Hardness (mg/L)	NA	NA
Color (SU)	NA	NA
Turbidity (NTU)	NA	NA

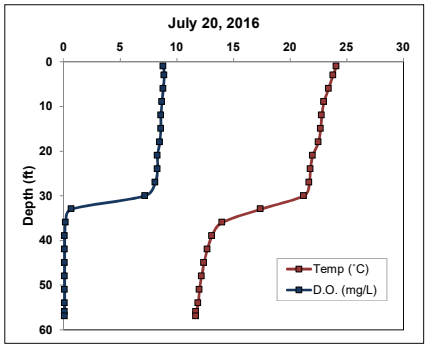
Data collected by TAH (Onterra).

North Twin Lake

Date: 7/20/2016
Time: 14:22
Weather: Windy, 50% clouds, 85F
Entry: JLW

Max Depth: 58.4
LS Depth (ft): 3.0
LB Depth (ft): 56.0
Secchi Depth (ft): 14.9

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	24.1	8.8		
3	23.8	8.9		
6	23.4	8.8		
9	23.0	8.7		
12	22.8	8.6		
15	22.7	8.6		
18	22.5	8.5		
21	22.0	8.3		
24	21.8	8.3		
27	21.7	8.1		
30	21.2	7.2		
33	17.4	0.7		
36	14.0	0.2		
39	13.1	0.1		
42	12.7	0.1		
45	12.4	0.1		
48	12.2	0.1		
51	12.0	0.1		
54	11.9	0.1		
56	11.7	0.1		
57	11.7	0.1		



Parameter	LS	LB
Total P (µg/L)	17.30	156.00
Dissolved P (µg/L)	1.80	72.70
Chl-a (µg/L)	1.31	NA
TKN (µg/L)	310.00	532.00
$NO_3 + NO_2$-N (µg/L)	ND	ND
NH_3-N (µg/L)	ND	255.00
Total N (µg/L)	310.00	532.00
Lab Cond. (µS/cm)	114.00	129.00
Lab pH	8.13	7.24
Alkalinity (mg/L $CaCO_3$)	44.30	54.00
Total Susp. Solids (mg/L)	ND	NA
Calcium (mg/L)	11.60	NA
Magnesium (mg/L)	4.71	NA
Hardness (mg/L)	48.30	NA
Color (SU)	5.00	NA
Turbidity (NTU)	NA	NA

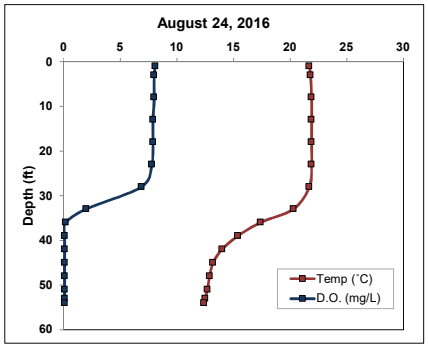
Data collected by TAH (Onterra).

North Twin Lake

Date: 8/24/2016
Time: 8:15
Weather: Overcast, ligh rain, 65F
Entry: JMB

Max Depth: 55.2
LS Depth (ft): 3.0
LB Depth (ft): 53.0
Secchi Depth (ft): 9.9

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	21.7	8.1		
3	21.8	8.0		
8	21.9	8.0		
13	21.9	7.9		
18	21.9	7.9		
23	21.9	7.8		
28	21.7	6.9		
33	20.3	2.0		
36	17.4	0.2		
39	15.4	0.1		
42	14.0	0.1		
45	13.2	0.1		
48	12.9	0.1		
51	12.7	0.1		
53	12.5	0.1		
54	12.4	0.1		



Parameter	LS	LB
Total P (µg/L)	24.10	357.00
Dissolved P (µg/L)	NA	NA
Chl-a (µg/L)	3.68	NA
TKN (µg/L)	NA	NA
$NO_3 + NO_2$-N (µg/L)	NA	NA
NH_3-N (µg/L)	NA	NA
Total N (µg/L)	NA	NA
Lab Cond. (µS/cm)	NA	NA
Lab pH	NA	NA
Alkalinity (mg/L $CaCO_3$)	NA	NA
Total Susp. Solids (mg/L)	NA	NA
Calcium (mg/L)	NA	NA
Magnesium (mg/L)	NA	NA
Hardness (mg/L)	NA	NA
Color (SU)	NA	NA
Turbidity (NTU)	NA	NA

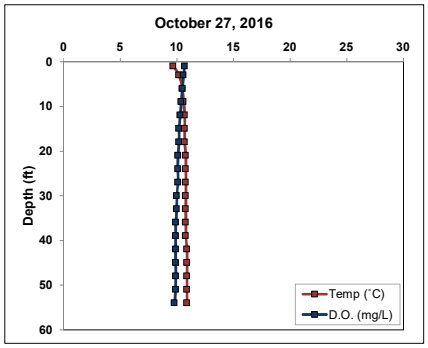
Data collected by TAH (Onterra).

North Twin Lake

Date: 10/27/2016
Time: 11:30
Weather: 100% clouds, 40F
Entry: JMB

Max Depth: 56.6
LS Depth (ft): 3.0
LB Depth (ft): 54.0
Secchi Depth (ft): 7.8

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	9.7	10.7		
3	10.2	10.6		
6	10.5	10.5		
9	10.6	10.4		
12	10.7	10.3		
15	10.7	10.2		
18	10.7	10.2		
21	10.8	10.1		
24	10.8	10.1		
27	10.8	10.1		
30	10.8	10.0		
33	10.8	10.0		
36	10.8	9.9		
39	10.8	9.9		
42	10.9	9.9		
45	10.9	9.9		
48	10.9	9.9		
51	10.9	9.9		
54	10.9	9.8		



Parameter	LS	LB
Total P (µg/L)	31.80	31.00
Dissolved P (µg/L)	NA	NA
Chl-a (µg/L)	8.00	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)	3.80	3.80
Calcium (mg/L)	NA	NA
Magnesium (mg/L)	NA	NA
Hardness (mg/L)	NA	NA
Color (SU)	NA	NA
Turbidity (NTU)	NA	NA

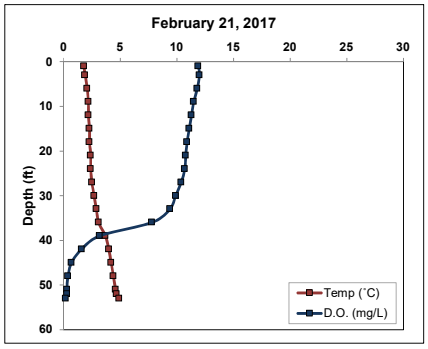
Data collected by JMB (Onterra).

North Twin Lake

Date: 2/21/2017
Time: 10:30
Weather: 0% clouds, 40F, 5mph wind
Entry: JMB

Max Depth: 55.2
LS Depth (ft): 3.0
LB Depth (ft): 52.0
Secchi Depth (ft): 28.4

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	1.8	11.9		
3	1.9	12.0		
6	2.1	11.8		
9	2.2	11.5		
12	2.2	11.3		
15	2.3	11.1		
18	2.3	10.9		
21	2.4	10.8		
24	2.4	10.7		
27	2.5	10.4		
30	2.7	9.9		
33	2.9	9.4		
36	3.1	7.8		
39	3.7	3.2		
42	4.0	1.6		
45	4.2	0.7		
48	4.4	0.4		
51	4.6	0.3		
52	4.7	0.3		
53	4.9	0.2		



Parameter	LS	LB
Total P (µg/L)	13.40	136.00
Dissolved P (µg/L)	4.60	12.40
Chl-a (µg/L)	NA	NA
TKN (µg/L)	303.00	460.00
$NO_3 + NO_2$-N (µg/L)	24.20	ND
NH_3-N (µg/L)	43.00	165.00
Total N (µg/L)	327.20	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 & JMB (Onterra). Ice depth: 1.4.

Water Quality Data

2016-2017	Surface		Bottom	
Parameter	Count	Mean	Count	Mean
Secchi Depth (feet)	6	13.4	NA	NA
Total P (µg/L)	6	21.5	6	131.8
Dissolved P (µg/L)	3	2.9	3	29.0
Chl a (µg/L)	5	3.5	0	NA
TKN (µg/L	3	306.7	3	483.7
NO_3+NO_2-N (µg/L)	3	24.2	3	ND
NH_3-N (µg/L)	3	43.0	3	146.3
Total N (µg/L)	3	314.7	2	495.5
Lab Cond. (µS/cm)	2	113.5	2	121.5
Alkal (mg/l $CaCO_3$)	2	44.3	2	49.3
Total Susp. Solids (mg/l)	3	3.8	2	3.8
Calcium (mg/L)	2	11.6	0	NA
Magnesium (mg/L)	2	4.6	0	NA
Hardness (mg/L)	2	47.7	0	NA
Color (SU)	2	7.5	0	NA
Turbidity (NTU)	0	NA	0	NA

Trophic State Index (TSI)

Year	TP	Chl-a	Secchi
1997			
1998			
1999			
2000	45.8	48.2	40.3
2001	48.9	48.0	
2002	42.7	37.7	
2003			
2004			
2005			
2006			
2007			
2008			
2009			
2010	41.1	43.0	37.9
2011	44.4	41.2	37.8
2012	43.8	46.1	39.6
2013			
2014			
2015			
2016	47.6	37.8	41.0
All Years (Weighted)	44.6	43.3	39.3
DLDL Median	49.4	49.7	46.2
NLF Ecoregion Median	48.1	47.5	45.7

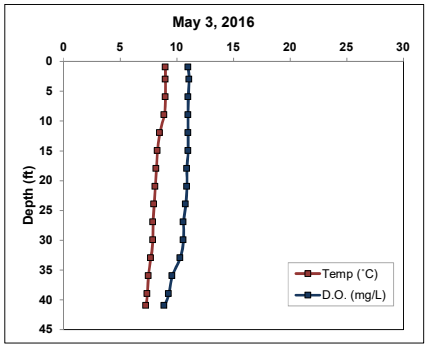
	Secchi (feet)				Chlorophyll-*a* (µg/L)				Total Phosphorus (µg/L)			
	Growing Season		Summer		Growing Season		Summer		Growing Season		Summer	
Year	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean
1973	2	8.0	1	10.0								
1974	3	8.2	1	6.5								
1997	2	10.3	0						2	25.0	0.0	
1998	2	10.5	0						2	25.5	0.0	
1999	0		0						0		0.0	
2000	4	12.0	3	12.9	4	5.8	3	6.0	4	22.3	3.0	18.0
2001	0		0		4	6.8	3	5.9	4	22.4	3.0	22.3
2002	0		0		4	4.0	3	2.1	4	16.1	3.0	14.5
2003	0		0		0		0		0		0.0	
2004	0		0		0		0		0		0.0	
2005	0		0		0		0		0		0.0	
2006	0		0		0		0		0		0.0	
2007	0		0		0		0		0		0.0	
2008	0		0		0		0		0		0.0	
2009	0		0		0		0		0		0.0	
2010	3	15.2	3	15.2	3	3.6	3	3.6	3	13.0	3.0	13.0
2011	4	14.8	3	15.3	4	4.7	3	2.9	4	18.0	3.0	16.3
2012	4	14.4	3	13.6	4	4.9	3	4.9	4	18.3	3.0	15.7
2013	0		0		0		0		0		0.0	
2014	0		0		0		0		0		0.0	
2015	0		0		0		0		0		0.0	
2016	5	10.3	3	12.2	5	3.5	3	2.1	5	23.1	3.0	20.3
All Years (Weighted)		11.9		13.2		4.7		3.9		20.1		17.2
DLDL Median				8.5				7.0				23.0
NLF Ecoregion Median				8.9				5.6				21.0

South Twin Lake

Date: 5/3/2016
Time: 10:20
Weather: 100% clouds, 55F, windy
Entry: EEH

Max Depth: 41.3
LS Depth (ft): 3.0
LB Depth (ft): 38.0
Secchi Depth (ft): 9.5

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	9.0	11.0		
3	9.0	11.1	8.6	
6	9.0	11.0		
9	8.9	11.0		
12	8.5	11.0		
15	8.3	11.0		
18	8.2	10.9		
21	8.1	10.9		
24	8.0	10.8		
27	7.9	10.6		
30	7.9	10.6		
33	7.7	10.3		
36	7.5	9.6		
39	7.4	9.3		
41	7.3	8.9		



Parameter	LS	LB
Total P (µg/L)	21.20	24.80
Dissolved P (µg/L)	1.70	ND
Chl-a (µg/L)	3.30	NA
TKN (µg/L)	288.00	224.00
$NO_3 + NO_2$-N (µg/L)	ND	ND
NH_3-N (µg/L)	ND	ND
Total N (µg/L)	288.00	224.00
Lab Cond. (µS/cm)	110.00	109.00
Lab pH	7.84	7.62
Alkalinity (mg/L $CaCO_3$)	42.70	42.80
Total Susp. Solids (mg/L)	ND	2.60
Calcium (mg/L)	11.20	NA
Magnesium (mg/L)	4.38	NA
Hardness (mg/L)	45.90	NA
Color (SU)	5.00	NA
Turbidity (NTU)	NA	NA

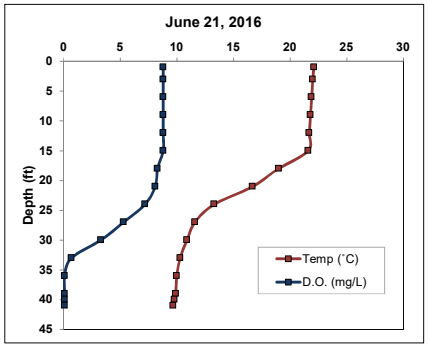
Data collected by BTB (Onterra).

South Twin Lake

Date: 6/21/2016
Time: 13:45
Weather: 75% clouds, windy, 72F
Entry: JLW

Max Depth: 42.1
LS Depth (ft): 3.0
LB Depth (ft): 40.0
Secchi Depth (ft): 10.5

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	22.1	8.8		
3	22.0	8.8		
6	21.9	8.8		
9	21.8	8.8		
12	21.7	8.8		
15	21.6	8.8		
18	19.0	8.3		
21	16.7	8.1		
24	13.3	7.2		
27	11.6	5.3		
30	10.9	3.3		
33	10.3	0.7		
36	10.0	0.1		
39	9.9	0.1		
40	9.8	0.1		
41	9.7	0.1		



Parameter	LS	LB
Total P (µg/L)	20.80	73.20
Dissolved P (µg/L)	NA	NA
Chl-a (µg/L)	3.13	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

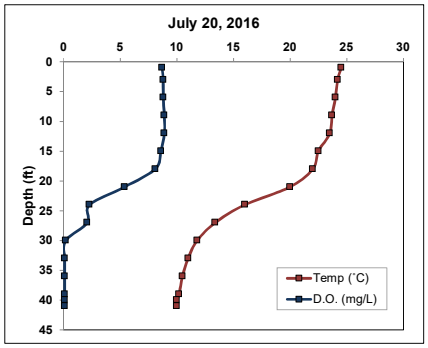
Data colelcted by TAH (Onterra).

South Twin Lake

Date: 7/20/2016
Time: 15:05
Weather: Windy, 50% clouds, 85F
Entry: JLW

Max Depth: 42.0
LS Depth (ft): 3.0
LB Depth (ft): 40.0
Secchi Depth (ft): 11.8

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	24.5	8.7		
3	24.2	8.8		
6	24.0	8.8		
9	23.7	8.9		
12	23.5	8.9		
15	22.5	8.6		
18	22.0	8.1		
21	20.0	5.4		
24	16.0	2.3		
27	13.4	2.1		
30	11.8	0.2		
33	11.0	0.1		
36	10.5	0.1		
39	10.2	0.1		
40	10.0	0.1		
41	10.0	0.1		



Parameter	LS	LB
Total P (µg/L)	16.60	102.00
Dissolved P (µg/L)	ND	27.10
Chl-a (µg/L)	1.47	NA
TKN (µg/L)	400.00	764.00
$NO_3 + NO_2$-N (µg/L)	ND	ND
NH_3-N (µg/L)	ND	367.00
Total N (µg/L)	400.00	764.00
Lab Cond. (µS/cm)	110.00	129.00
Lab pH	8.09	7.13
Alkalinity (mg/L $CaCO_3$)	43.20	55.10
Total Susp. Solids (mg/L)	ND	5.20
Calcium (mg/L)	11.10	NA
Magnesium (mg/L)	4.47	NA
Hardness (mg/L)	46.10	NA
Color (SU)	5.00	NA
Turbidity (NTU)	NA	NA

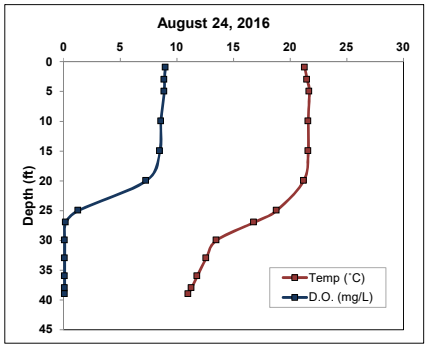
Data collected by TAH (Onterra).

South Twin Lake

Date: 8/24/2016
Time: 9:00
Weather: Overcast, light rain, 65F
Entry: JMB

Max Depth: 40.4
LS Depth (ft): 3.0
LB Depth (ft): 38.0
Secchi Depth (ft): 10.8

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	21.3	9.0		
3	21.5	8.9		
5	21.7	8.9		
10	21.6	8.6		
15	21.6	8.5		
20	21.2	7.3		
25	18.8	1.3		
27	16.8	0.2		
30	13.5	0.1		
33	12.6	0.1		
36	11.8	0.1		
38	11.3	0.1		
39	11.0	0.1		



Parameter	LS	LB
Total P (µg/L)	20.00	117.00
Dissolved P (µg/L)	NA	NA
Chl-a (µg/L)	3.09	NA
TKN (µg/L)	NA	NA
$NO_3 + NO_2$-N (µg/L)	NA	NA
NH_3-N (µg/L)	NA	NA
Total N (µg/L)	NA	NA
Lab Cond. (µS/cm)	NA	NA
Lab pH	NA	NA
Alkalinity (mg/L $CaCO_3$)	NA	NA
Total Susp. Solids (mg/L)	NA	NA
Calcium (mg/L)	NA	NA
Magnesium (mg/L)	NA	NA
Hardness (mg/L)	NA	NA
Color (SU)	NA	NA
Turbidity (NTU)	NA	NA

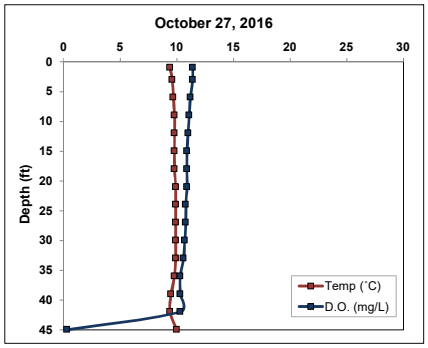
Data collected by TAH (Onterra).

South Twin Lake

Date: 10/27/2016
Time: 12:05
Weather: 100% clouds, 40F
Entry: JMB

Max Depth: 48.3
LS Depth (ft): 3.0
LB Depth (ft): 42.0
Secchi Depth (ft): 8.5

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	9.4	11.4		
3	9.6	11.4		
6	9.7	11.2		
9	9.8	11.1		
12	9.8	11.0		
15	9.8	10.9		
18	9.8	10.9		
21	9.9	10.9		
24	9.9	10.8		
27	9.9	10.8		
30	9.9	10.7		
33	9.9	10.6		
36	9.8	10.3		
39	9.5	10.3		
42	9.4	10.3		
45	10.0	0.3		



Parameter	LS	LB
Total P (µg/L)	29.20	34.10
Dissolved P (µg/L)	NA	NA
Chl-a (µg/L)	4.96	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)	2.40	2.60
Calcium (mg/L)	NA	NA
Magnesium (mg/L)	NA	NA
Hardness (mg/L)	NA	NA
Color (SU)	NA	NA
Turbidity (NTU)	NA	NA

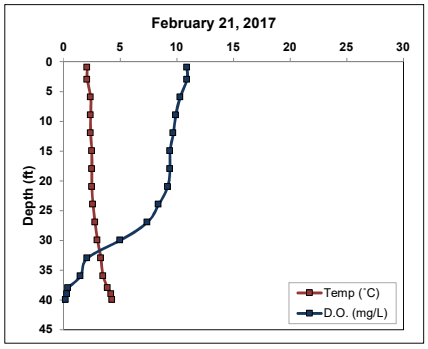
Data collected by JMB (Onterra).

South Twin Lake

Date: 2/21/2017
Time: 9:30
Weather: 0% clouds, 40F, 5mph wind
Entry: JMB

Max Depth: 41.4
LS Depth (ft): 3.0
LB Depth (ft): 38.0
Secchi Depth (ft): 24.8

Depth (ft)	Temp (˚C)	D.O. (mg/L)	pH	Sp. Cond. (µS/cm)
1	2.1	10.9		
3	2.1	10.9		
6	2.4	10.3		
9	2.4	9.9		
12	2.4	9.7		
15	2.5	9.4		
18	2.5	9.4		
21	2.5	9.2		
24	2.6	8.4		
27	2.8	7.4		
30	3.0	5.0		
33	3.3	2.1		
36	3.5	1.5		
38	3.9	0.4		
39	4.2	0.3		
40	4.3	0.2		



Parameter	LS	LB
Total P (µg/L)	16.40	38.70
Dissolved P (µg/L)	3.30	8.00
Chl-a (µg/L)	NA	NA
TKN (µg/L)	287.00	512.00
$NO_3 + NO_2$-N (µg/L)	ND	150.00
NH_3-N (µg/L)	39.70	200.00
Total N (µg/L)	287.00	662.00
Lab Cond. (µS/cm)	NA	NA
Lab pH	NA	NA
Alkalinity (mg/L $CaCO_3$)	NA	NA
Total Susp. Solids (mg/L)	NA	NA
Calcium (mg/L)	NA	NA
Magnesium (mg/L)	NA	NA
Hardness (mg/L)	NA	NA
Color (SU)	NA	NA
Turbidity (NTU)	NA	NA

Data collected by TWH & JMB (Onterra). Ice depth: 1.3.

Water Quality Data

2016-2017	Surface		Bottom	
Parameter	Count	Mean	Count	Mean
Secchi Depth (feet)	6	12.7	NA	NA
Total P (µg/L)	6	20.7	6	65.0
Dissolved P (µg/L)	3	2.5	3	17.6
Chl a (µg/L)	5	3.2	0	NA
TKN (µg/L	3	325.0	3	500.0
NO_3+NO_2-N (µg/L)	3	ND	3	150.0
NH_3-N (µg/L)	3	39.7	3	283.5
Total N (µg/L)	3	325.0	3	550.0
Lab Cond. (µS/cm)	2	110.0	2	119.0
Alkal (mg/l $CaCO_3$)	2	43.0	2	49.0
Total Susp. Solids (mg/l)	3	2.4	3	3.5
Calcium (mg/L)	2	11.2	0	NA
Magnesium (mg/L)	2	4.4	0	NA
Hardness (mg/L)	2	46.0	0	NA
Color (SU)	2	5.0	0	NA
Turbidity (NTU)	0	NA	0	NA

Trophic State Index (TSI)

Year	TP	Chl-a	Secchi
1979			37.2
1993			39.3
1994			40.0
1995			39.8
1996	40.0	38.8	39.4
1997	42.2	43.4	40.2
1998	40.4	38.9	41.7
1999	37.4	32.1	42.4
2000	44.6	39.1	39.7
2001	47.7	42.3	47.3
2002	41.1	36.9	40.0
2003	37.8	37.9	38.6
2004	42.9	49.0	43.7
2005	42.2	39.4	
2006	40.0	42.2	
2007			
2008			
2009			
2010	40.8	39.7	40.1
2011	43.8	41.7	40.9
2012	43.2	40.8	39.1
2013			42.6
2014			40.2
2015			
2016	46.7	39.8	42.5
0			
0			
0			
0			
0			
0			
All Years (Weighted)	42.2	40.0	41.2
DLDL Median	49.4	49.7	46.2
NLF Ecoregion Median	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
1979	1	16.0	1	16.0								
1993	9	13.7	8	13.8								
1994	3	13.2	3	13.2								
1995	11	13.3	9	13.3								
1996	17	11.7	8	13.7	4	4.7	2	2.3	4	14.3	2.0	12.0
1997	10	11.6	6	13.0	2	6.9	1	3.7	4	21.0	1.0	14.0
1998	8	11.8	3	11.7	4	3.6	3	2.3	7	17.1	3.0	12.3
1999	4	10.4	3	11.2	3	1.2	3	1.2	3	10.0	3.0	10.0
2000	12	13.0	10	13.4	8	3.4	6	2.4	8	18.4	6.0	16.5
2001	12	8.8	7	7.9	8	4.6	6	3.3	8	20.8	6.0	20.5
2002	4	12.4	3	13.2	8	3.6	5	1.9	8	16.9	5.0	13.0
2003	15	13.2	10	14.5	4	4.1	3	2.1	5	12.0	3.0	10.3
2004	12	10.3	7	10.1	4	7.1	3	6.5	5	17.2	3.0	14.7
2005	0		0		2	2.4	2	2.4	4	15.0	2.0	14.0
2006	0		0		3	3.3	3	3.3	3	12.0	3.0	12.0
2007	0		0		0		0		0		0.0	
2008	0		0		0		0		0		0.0	
2009	0		0		0		0		0		0.0	
2010	8	13.1	8	13.1	3	2.5	3	2.5	3	12.7	3.0	12.7
2011	7	12.3	6	12.4	4	4.6	3	3.1	4	17.5	3.0	15.7
2012	8	13.9	6	14.0	4	5.0	3	2.8	4	17.5	3.0	15.0
2013	3	11.0	3	11.0	0		0		0		0.0	
2014	1	13.0	1	13.0	0		0		0		0.0	
2015	0		0		0		0		0		0.0	
2016	5	10.2	3	11.0	5	3.2	3	2.6	5	21.6	3.0	19.1
All Years (Weighted)		12.0		12.7		4.0		2.8		16.9		14.7
DLDL Median				8.5				7.0				23.0
NLF Ecoregion Median				8.9				5.6				21.0

D

APPENDIX D

Watershed Analysis WiLMS Results

Date: 2/20/2017 Scenario: North & South Twin Lakes Current

Lake Id: North & South Twin Lakes
Watershed Id: 0

Hydrologic and Morphometric Data

Tributary Drainage Area: 10628.0 acre
Total Unit Runoff: 14 in.
Annual Runoff Volume: 12399.3 acre-ft
Lake Surface Area <As>: 3516 acre
Lake Volume <V>: 92579 acre-ft
Lake Mean Depth <z>: 26.3 ft
Precipitation - Evaporation: 5.5 in.
Hydraulic Loading: 14010.8 acre-ft/year
Areal Water Load <qs>: 4.0 ft/year
Lake Flushing Rate <p>: 0.15 1/year
Water Residence Time: 6.61 year
Observed spring overturn total phosphorus (SPO): 19 mg/m^3
Observed growing season mean phosphorus (GSM): 17.2 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	223	0.50	1.00	3.00	9.1	45	90	271
Mixed AG	0.0	0.30	0.80	1.40	0.0	0	0	0
Pasture/Grass	777	0.10	0.30	0.50	9.5	31	94	157
HD Urban (1/8 Ac)	0.0	1.00	1.50	2.00	0.0	0	0	0
MD Urban (1/4 Ac)	13	0.30	0.50	0.80	0.3	2	3	4
Rural Res (>1 Ac)	67	0.05	0.10	0.25	0.3	1	3	7
Wetlands	2521	0.10	0.10	0.10	10.3	102	102	102
Forest	7027	0.05	0.09	0.18	25.8	142	256	512
Lake Surface	3516.0	0.10	0.30	1.00	43.0	142	427	1423

POINT SOURCE DATA

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

SEPTIC TANK DATA

Description		Low	Most Likely	High	Loading %
Septic Tank Output (kg/capita-year)		0.3	0.5	0.8	
# capita-years	370				
% Phosphorus Retained by Soil		98	90	80	
Septic Tank Loading (kg/year)		2.22	18.50	59.20	1.9

TOTALS DATA

Description	Low	Most Likely	High	Loading %
Total Loading (lb)	1032.3	2189.8	5588.7	100.0
Total Loading (kg)	468.2	993.3	2535.0	100.0
Areal Loading (lb/ac-year)	0.29	0.62	1.59	0.0
Areal Loading (mg/m^2-year)	32.91	69.81	178.16	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)	713.7	1207.9	2321.2	98.1
Total NPS Loading (kg)	323.7	547.9	1052.9	98.1

Phosphorus Prediction and Uncertainty Analysis Module

Date: 2/20/2017 Scenario: 67
Observed spring overturn total phosphorus (SPO): 19.0 mg/m^3
Observed growing season mean phosphorus (GSM): 17.2 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	20	51	3	17
Canfield-Bachmann, 1981 Natural Lake	9	15	27	-2	-12
Canfield-Bachmann, 1981 Artificial Lake	10	16	26	-1	-6
Rechow, 1979 General	3	5	14	-12	-70
Rechow, 1977 Anoxic	12	26	65	9	52
Rechow, 1977 water load<50m/year	4	7	19	-10	-58
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	9	20	50	1	5
Vollenweider, 1982 Combined OECD	8	15	33	-3	-17
Dillon-Rigler-Kirchner	7	14	35	-5	-26
Vollenweider, 1982 Shallow Lake/Res.	6	12	27	-6	-33
Larsen-Mercier, 1976	8	16	41	-3	-16
Nurnberg, 1984 Oxic	6	13	32	-4	-23

Lake Phosphorus Model	Confidence Lower Bound	Confidence Upper Bound	Parameter Fit?	Back Calculation (kg/year)	Model Type
Walker, 1987 Reservoir	11	40	Tw	0	GSM
Canfield-Bachmann, 1981 Natural Lake	5	43	FIT	1	GSM
Canfield-Bachmann, 1981 Artificial Lake	5	46	FIT	1	GSM
Rechow, 1979 General	3	11	L	0	GSM
Rechow, 1977 Anoxic	15	51	FIT	0	GSM
Rechow, 1977 water load<50m/year	4	15	FIT	0	GSM
Rechow, 1977 water load>50m/year	N/A	N/A	N/A	N/A	N/A
Walker, 1977 General	10	42	FIT	0	SPO
Vollenweider, 1982 Combined OECD	7	30	FIT	0	ANN
Dillon-Rigler-Kirchner	8	28	L qs p	0	SPO
Vollenweider, 1982 Shallow Lake/Res.	6	24	FIT	0	ANN
Larsen-Mercier, 1976	10	32	P Pin	0	SPO
Nurnberg, 1984 Oxic	7	26	FIT	0	ANN

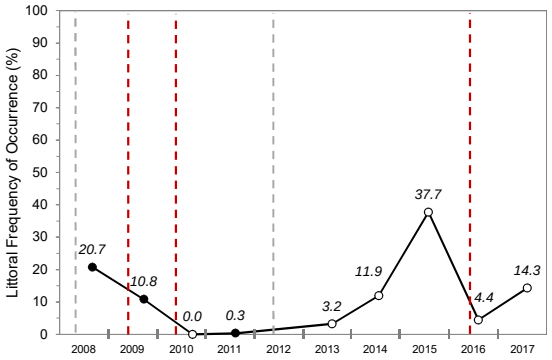
E

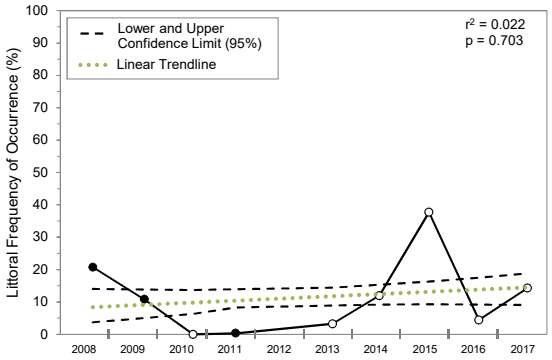
APPENDIX E

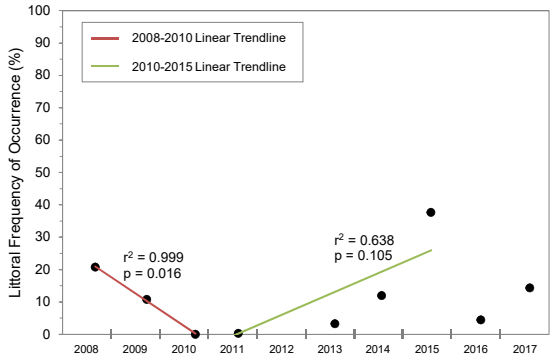
South Twin Point-Intercept Vegetation Frequencies 2008-2017

	Scientific Name	Common Name	LFOO (%)								
			2008	2009	2010	2011	2013	2014	2015	2016	2017
Dicots	*Myriophyllum spicatum*	Eurasian water milfoil	20.7	10.8	0.0	0.3	3.2	11.9	37.7	4.4	14.3
	Ceratophyllum demersum	Coontail	23.4	22.0	21.0	22.0	14.5	14.2	9.2	11.9	18.6
	Myriophyllum sibiricum	Northern water milfoil	28.3	12.9	0.0	0.0	1.9	8.6	11.8	5.1	4.2
	Bidens beckii	Water marigold	14.1	6.3	0.6	2.3	3.9	6.6	6.6	2.7	2.0
	Myriophyllum alterniflorum	Alternate-flowered water mil	3.6	4.9	0.6	1.0	1.0	1.0	5.2	3.4	5.9
	Ranunculus aquatilis	White water crowfoot	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.7
	Myriophyllum tenellum	Dwarf water milfoil	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-Dicots	*Vallisneria americana*	Wild celery	60.9	45.6	53.7	58.2	37.3	36.8	43.6	47.8	45.0
	Potamogeton gramineus	Variable-leaf pondweed	46.7	49.1	37.5	40.5	46.6	52.6	38.4	46.1	44.3
	Potamogeton robbinsii	Fern-leaf pondweed	31.3	34.5	33.7	31.6	30.9	30.8	24.9	26.1	25.7
	Najas flexilis	Slender naiad	33.2	33.1	17.2	43.4	14.8	25.8	33.4	27.8	40.7
	Chara spp.	Muskgrasses	29.3	18.1	22.3	25.3	14.5	16.9	32.1	40.3	40.7
	Elodea canadensis	Common waterweed	24.7	27.9	15.5	31.3	15.1	12.9	14.1	24.4	34.5
	Potamogeton zosteriformis	Flat-stem pondweed	31.3	27.5	5.2	16.1	26.0	20.9	12.5	7.5	10.4
	Potamogeton richardsonii	Clasping-leaf pondweed	11.5	18.5	16.8	18.1	10.9	8.9	7.9	13.2	21.5
	Heteranthera dubia	Water stargrass	22.4	9.4	4.2	8.6	9.6	13.6	16.1	10.2	11.7
	Potamogeton praelongus	White-stem pondweed	10.5	10.5	10.4	7.6	10.3	5.6	7.9	10.2	9.8
	Potamogeton pusillus	Small pondweed	18.4	13.2	2.6	1.6	10.3	8.9	4.3	2.0	2.0
	Eleocharis acicularis	Needle spikerush	5.9	4.2	5.5	1.6	3.2	7.0	9.8	4.4	5.2
	Isoetes spp.	Quillwort spp.	3.9	2.8	5.5	3.3	0.6	1.3	6.9	6.1	10.4
	Schoenoplectus acutus	Hardstem bulrush	1.0	3.1	2.9	3.0	2.3	1.0	3.9	0.3	1.6
	Potamogeton amplifolius	Large-leaf pondweed	3.6	3.8	0.6	0.7	1.0	0.3	0.0	2.4	2.3
	Potamogeton friesii	Fries' pondweed	9.2	3.5	0.6	0.3	0.0	0.0	0.0	0.0	0.0
	Nitella spp.	Stoneworts	2.3	2.8	0.6	2.6	0.0	0.7	0.0	2.0	7.5
	Potamogeton strictifolius	Stiff pondweed	0.0	0.3	0.3	2.6	0.6	0.0	0.7	1.0	0.7
	Potamogeton hybrid 1	Pondweed Hybrid 1	0.7	0.3	1.0	0.0	1.9	2.6	0.0	0.0	2.0
	Sagittaria sp. (rosette)	Arrowhead sp. (rosette)	2.0	0.7	0.0	0.0	0.3	0.3	0.0	0.0	0.0
	Juncus pelocarpus	Brown-fruited rush	0.0	0.0	0.3	1.6	0.0	0.0	0.7	0.3	0.0
	Sagittaria graminea	Grass-leaved arrowhead	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Stuckenia pectinata	Sago pondweed	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.0
	Potamogeton illinoensis	Illinois pondweed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
	Eriocaulon aquaticum	Pipewort	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Elatine minima	Waterwort	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

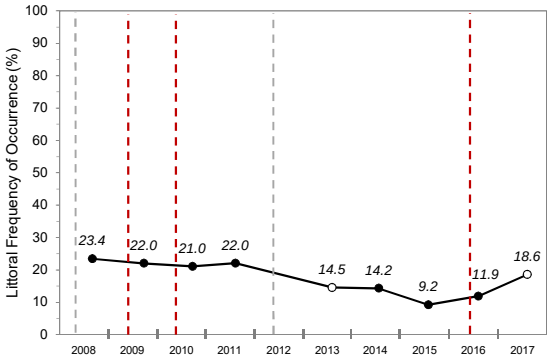
Eurasian watermilfoil (*Myriophyllum spicatum*)

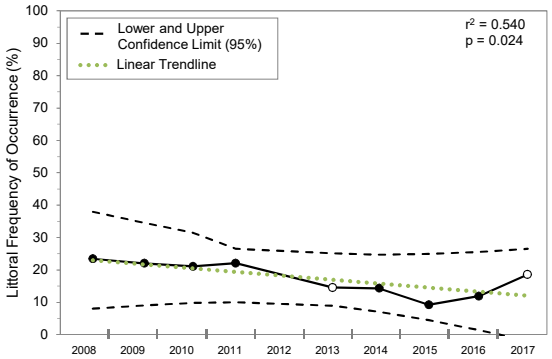


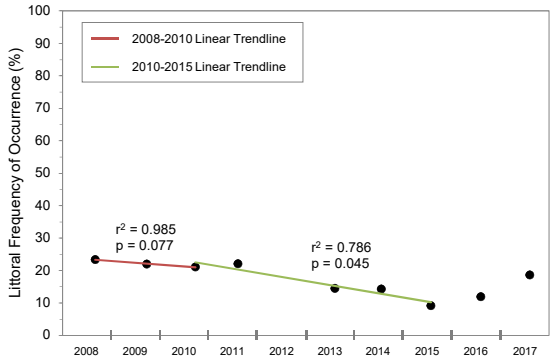




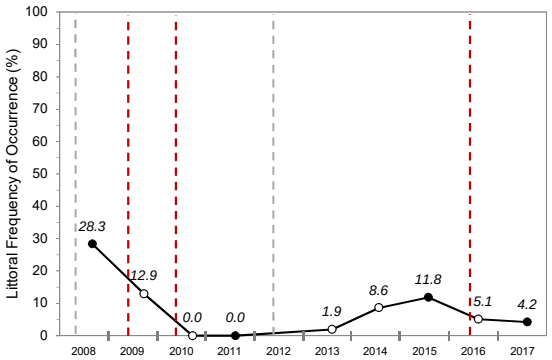
Coontail (*Ceratophyllum demersum*)

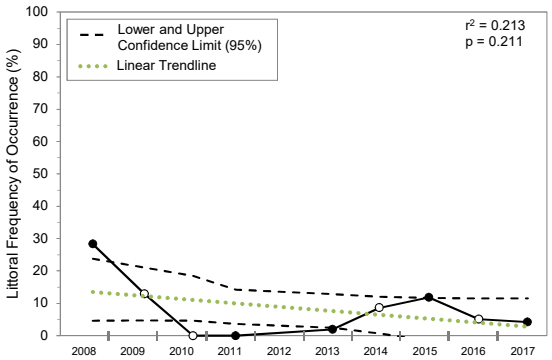


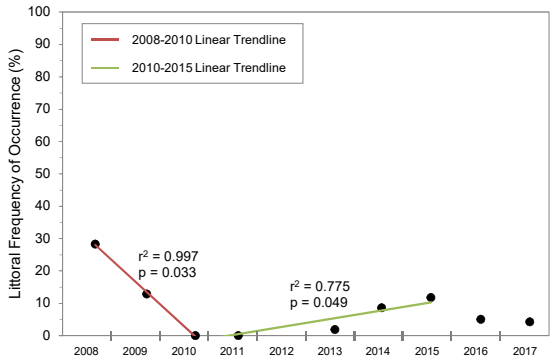




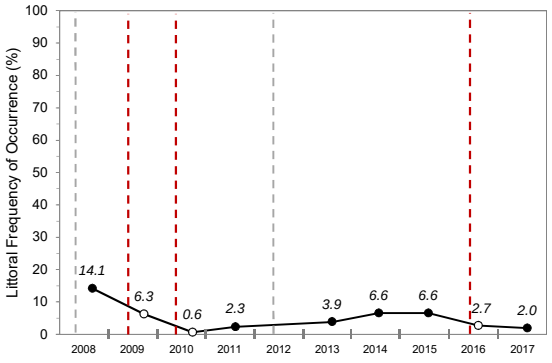
Northern watermilfoil (*Myriophyllum sibiricum*)

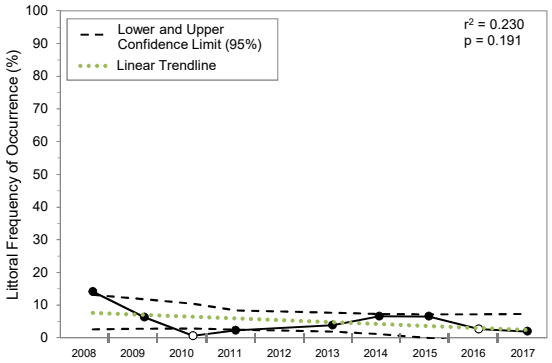


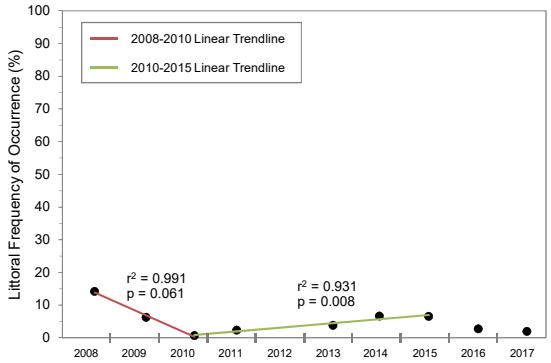




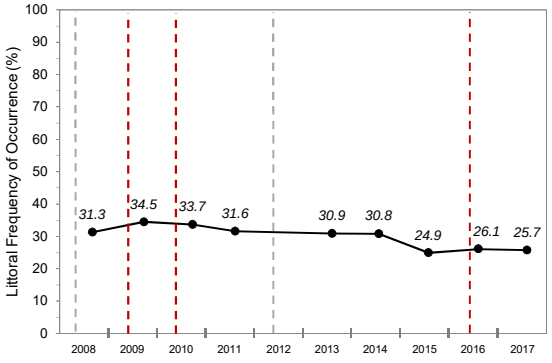
Water marigold (*Bidens beckii*)

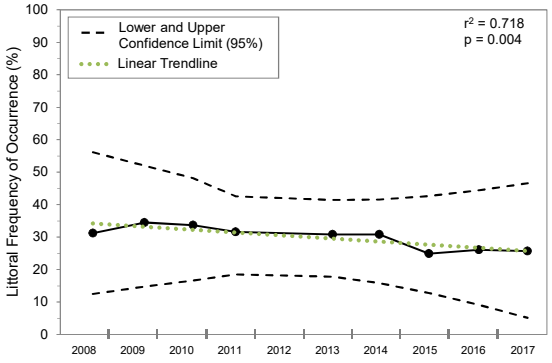


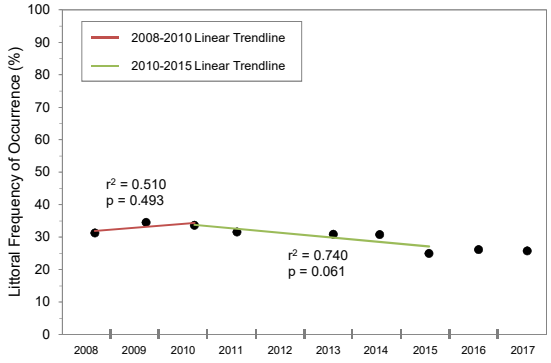




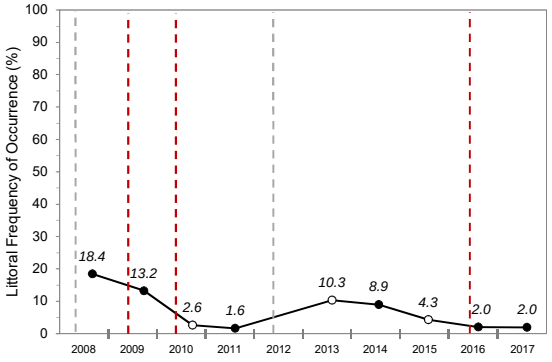
Fern-leaf pondweed (*Potamogeton robbinsii*)

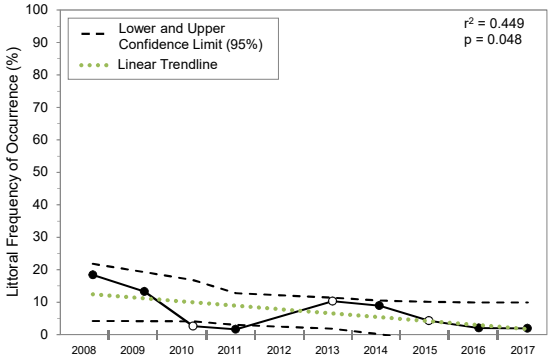


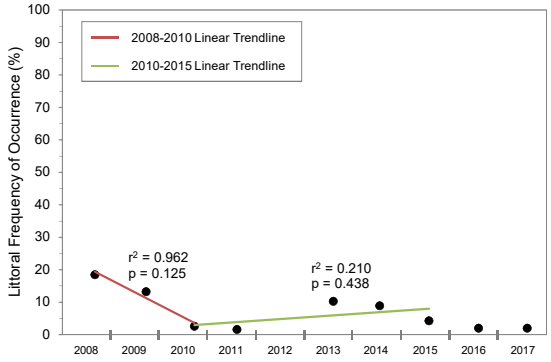




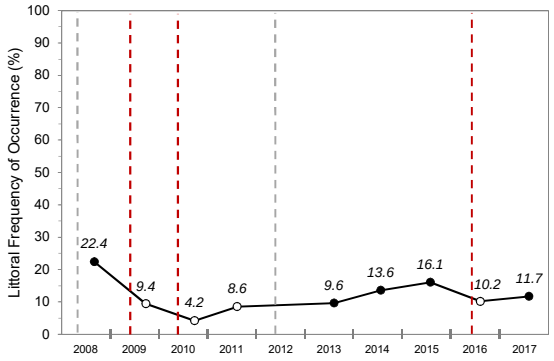
Small pondweed (*Potamogeton pusillus*)

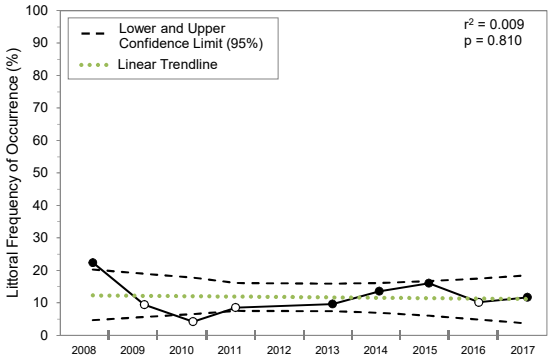


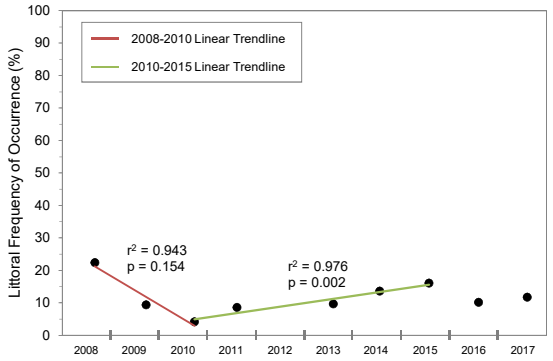




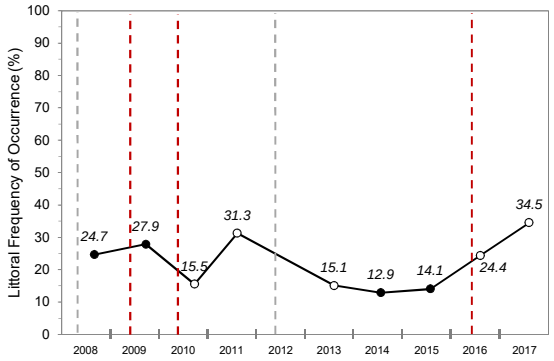
Water stargrass (*Heteranthera dubia*)

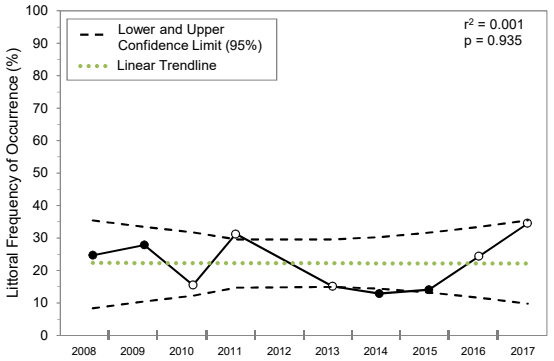


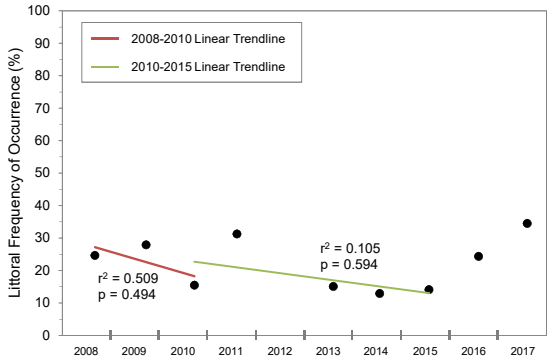




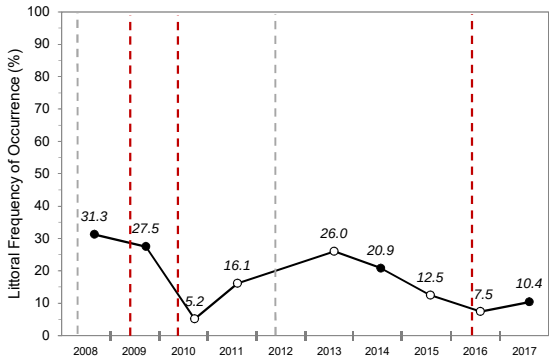
Common waterweed (*Elodea canadensis*)

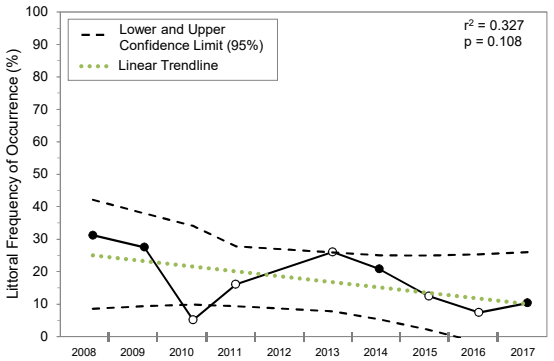


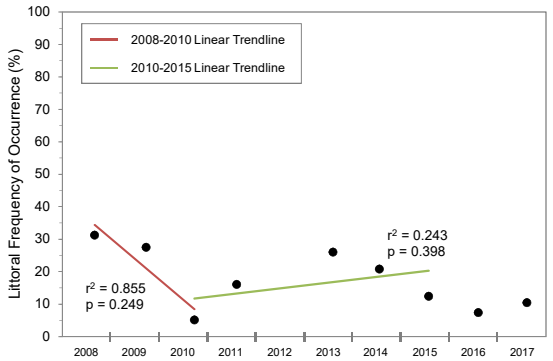




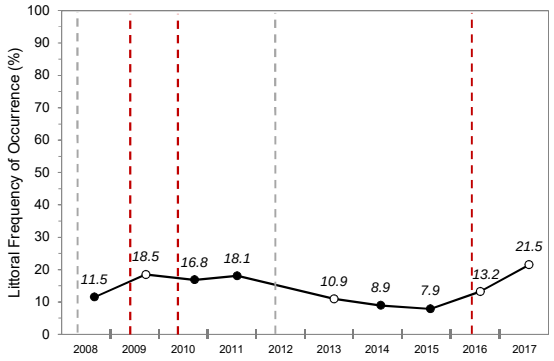
Flat-stem pondweed (*Potamogeton zosteriformis*)

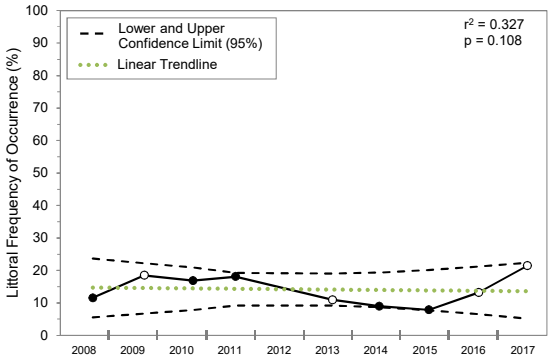


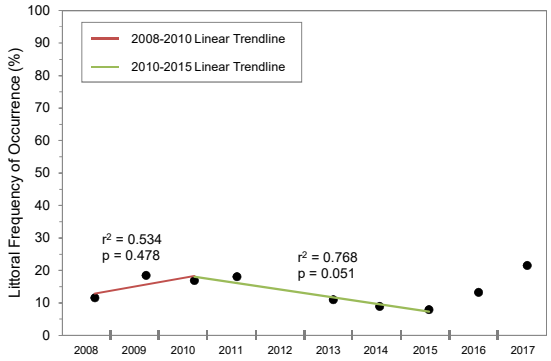




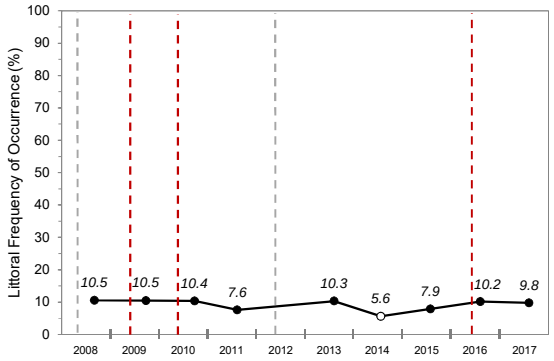
Clasping-leaf pondweed (*Potamogeton richardsonii*)

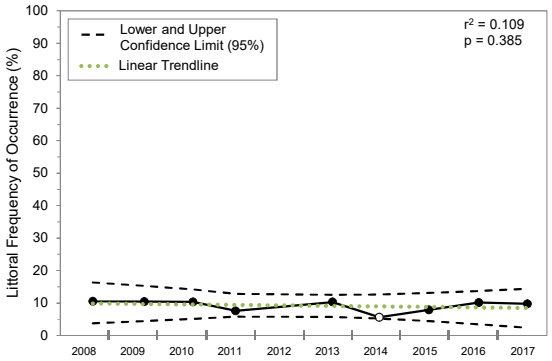


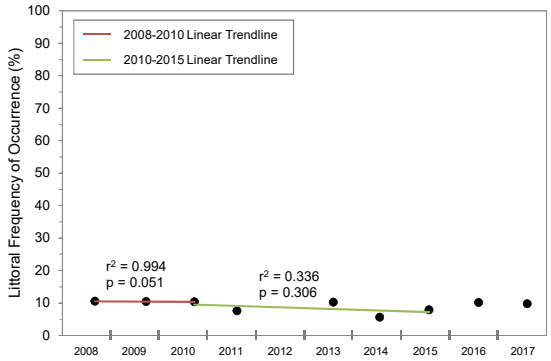




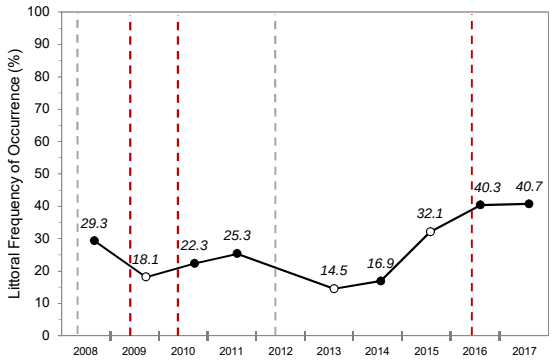
White-stem pondweed (*Potamogeton praelongus*)

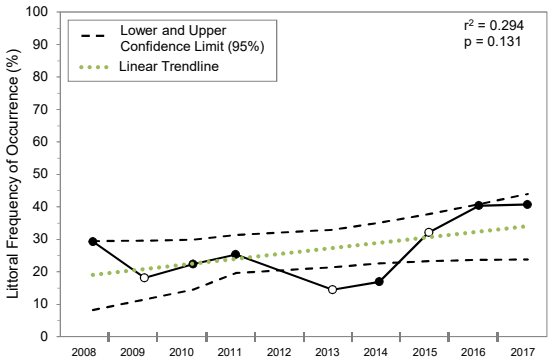


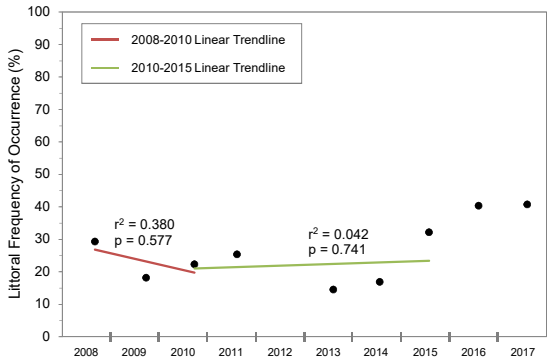




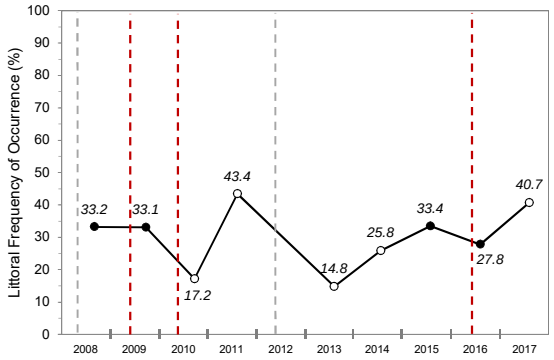
Muskgrasses (*Chara* spp.)

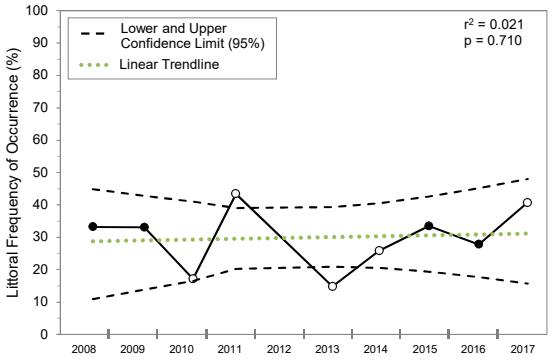


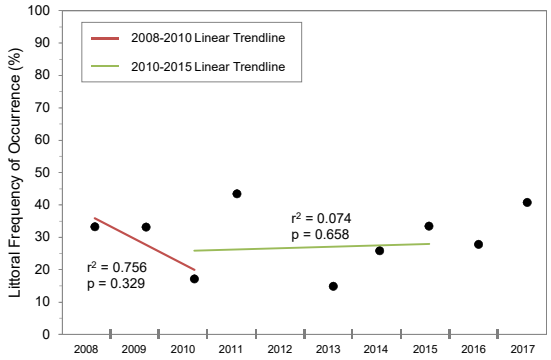




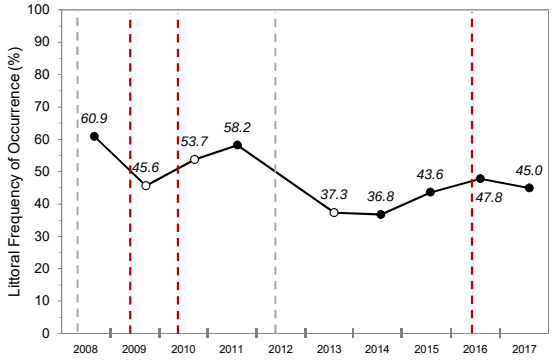
Slender naiad (*Najas flexilis*)

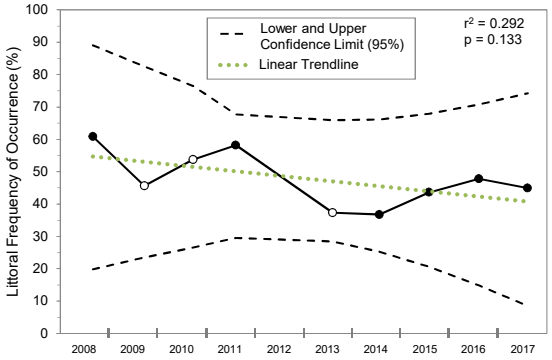


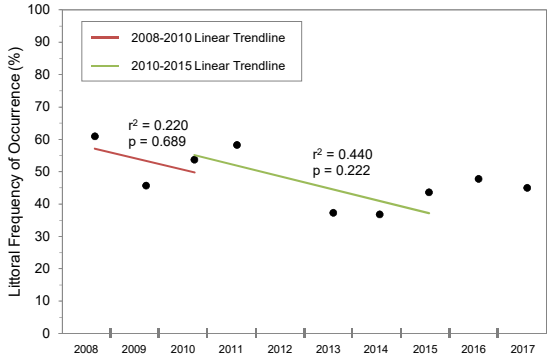




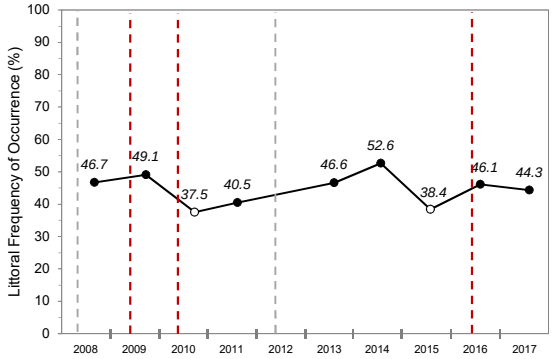
Wild celery (*Vallisneria americana*)

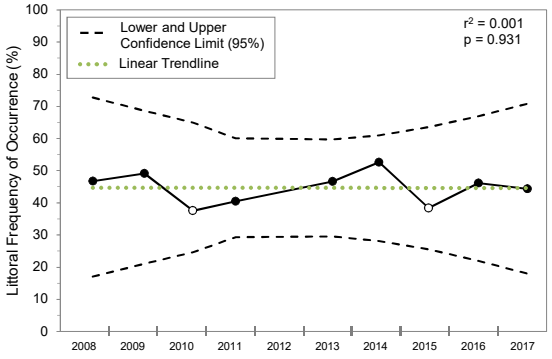


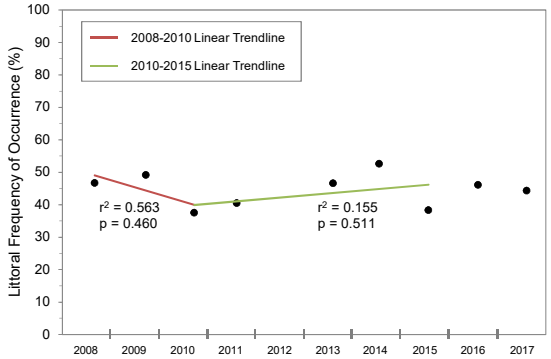




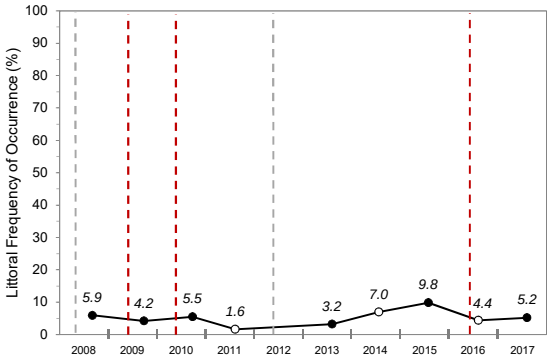
Variable-leaf pondweed (*Potamogeton gramineus*)

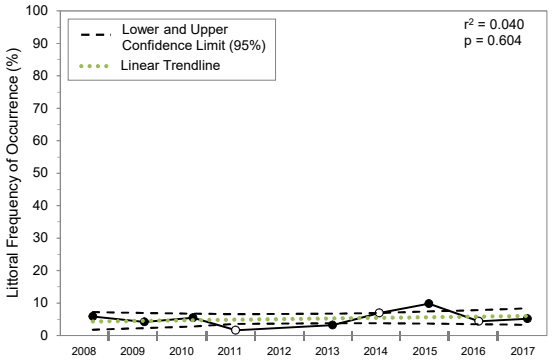


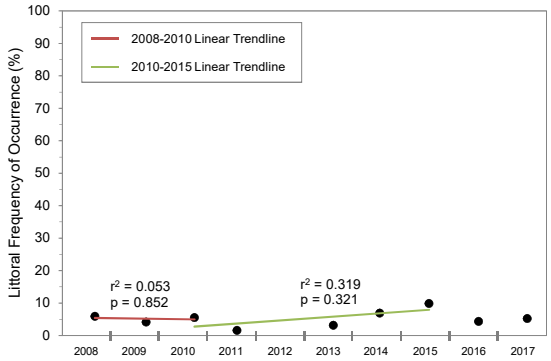




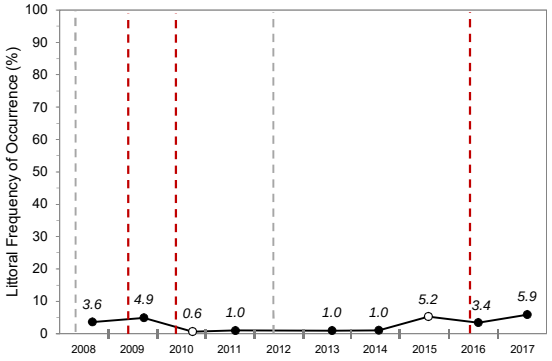
Needle spikerush (*Eleocharis acicularis*)

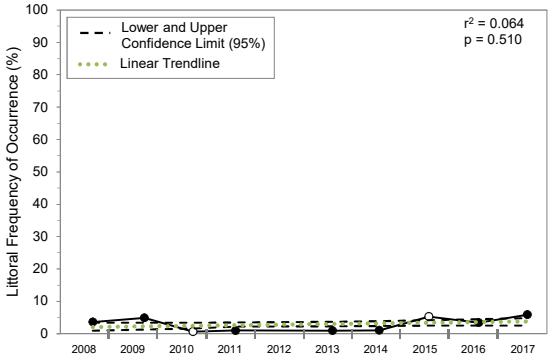


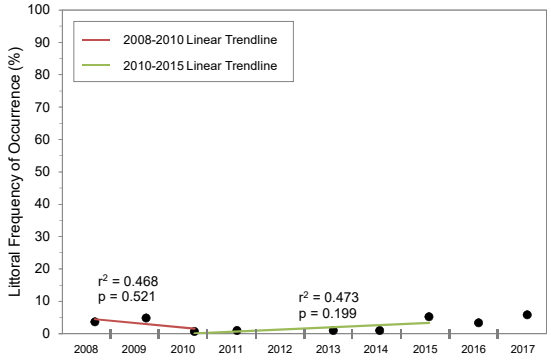




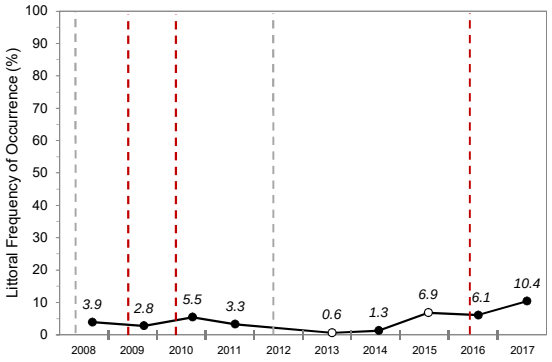
Alternate-flowered watermilfoil (*Myriophyllum alterniflorum*)

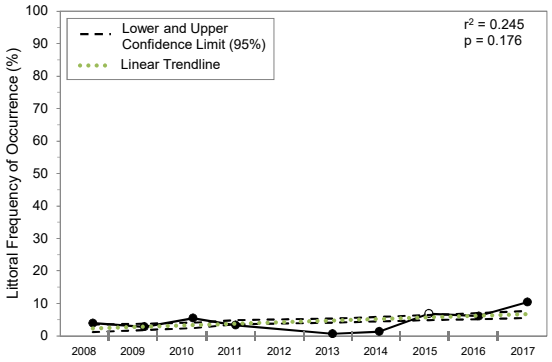


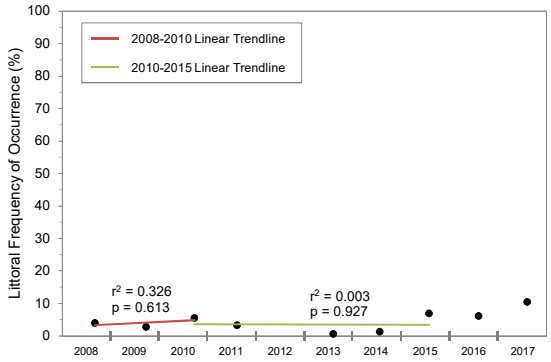




Quillwort spp. (*Isoetes* spp.)







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APPENDIX F

Herbicide Toxicology Materials

- **WDNR Aquatic Herbicide FAQ**
- **WDNR Chemical Fact Sheet (Fluridone)**
- **SePRO Sonar Risk Assessment**

Frequently Asked Questions about Aquatic Herbicide Use in Wisconsin

Prepared by Wisconsin Dept. of Natural Resources, Dept. of Health Services and Dept. of Agriculture, Trade, and Consumer Protection

June 23, 2011

Why are herbicides used in Wisconsin lakes and rivers?

Aquatic herbicides are used to reduce the abundance of invasive species to reduce spread to new water bodies, to help maintain a healthy native plant community that is beneficial for fish and other aquatic organisms, to improve navigational access to lakes and rivers and make boat navigation safer, and to control nuisance plant and algae growth that can pose a hazard to swimmers.

How is aquatic herbicide use regulated in Wisconsin?

In order to be used in Wisconsin, an aquatic herbicide must be all of the following:

1) Labeled and registered with U.S. EPA's office of Pesticide Programs;
2) Registered for sale and use by the Department of Agriculture, Trade, and Consumer Protection (DATCP);
3) Permitted by the Department of Natural Resources (DNR); and
4) Applied by a DATCP-certified and licensed applicator, with few exceptions.

Step 1) U.S. EPA's office of Pesticide Programs reviews the chemical and label.

Federal law requires herbicides to be registered with the Environmental Protection Agency (EPA) before they can be sold or used. The registration process determines potential risk to human health and the environment. The human health assessment includes sensitive groups such as infants, and risk is evaluated for both short-term and chronic effects. Ultimately, the EPA registers the herbicide if it determines that use of the pesticide will result in "no unreasonable adverse effects" as defined in federal law. This means that the benefits of using the pesticide according to the label outweigh the risks. Once an herbicide is registered, it is re-assessed by EPA every fifteen years.

Step 2) Herbicides must be registered by DATCP prior to sale or use in Wisconsin.

Most EPA-registered herbicide products are eligible to be registered for sale and use in Wisconsin by DATCP-licensed manufacturers and labelers. DATCP will not register an herbicide for use if it is prohibited for sale, use or distribution in Wisconsin, even if it is registered by EPA.

Step 3) DNR evaluates requests for use of chemicals in public waters when a permit application is submitted.

> When making a decision whether or not to issue a permit, the Department considers the appropriateness of the herbicide selected at the site, the likely non-target organism effects, the potential for adverse effects on the water body, as well as the potential hazard to humans. DNR may then issue the permit, issue the permit with conditions, or deny the permit. Permit conditions are frequently used to make sure that the herbicide is used responsibly and in accordance with best management practices for the plant being managed.

Step 4) Applied by a certified applicator.

> Most herbicide applications to water bodies in Wisconsin must be done by certified applicators. To become certified, an individual must complete a training course and pass a written exam. Businesses that provide herbicide application services must also be licensed by DATCP. A certified applicator is not needed only if the treatment area is less than ¼ acre in size and the product being applied is a granular herbicide.

Are herbicides safe?

The distinction between "EPA registered" and the terms "approved" or "safe" is important. Registration by the EPA does not mean that the use of the herbicide poses no risk to humans or the environment, only that for use in the U.S., the benefits have been determined to outweigh the risks. Because product use is not without risk, the EPA does not define any herbicide as "safe". It is prudent to minimize herbicide exposure whenever possible.

When an herbicide is registered, the EPA sets use requirements to minimize risk that are given on the herbicide label. When using herbicides it is important to follow the label instructions exactly, and never use an herbicide for a use not specified on the label.

What does the DNR do to minimize herbicide use and ensure that herbicides are used responsibly?

The Department of Natural Resources evaluates the benefits of using a particular chemical at a specific site vs. the risk to non-target organisms, including threatened or endangered species, and may stop or limit treatments to protect them. The Department frequently places conditions on a permit to require that a minimal amount of herbicide is needed and to reduce potential non-target effects, in accordance with best management practices for the species being controlled. For example, certain herbicide treatments are required by permit conditions to be in spring because they are more effective, require less herbicide and reduce harm to native plant species. Spring treatments also means that, in most cases, the herbicide will be degraded by the time peak recreation on the water starts.

The DNR encourages minimal herbicide use by requiring a strategic Aquatic Plant Management (APM) Plan for management projects over 10 acres or 10% of the water body or any projects

receiving state grants. DNR also requires consideration of alternative management strategies and integrated management strategies on permit applications and in developing an APM plan, when funding invasive species prevention efforts, and by encouraging the use of best management practices when issuing a permit.

The Department also supervises treatments, requires that adjacent landowners are notified of a treatment and have an opportunity to request a public meeting, requires that the water body is posted to notify the public of treatment and usage restrictions, and requires reporting after treatment occurs.

How long do the chemicals stay in the water?

The amount of time an herbicide will stay in the water varies greatly based on a number of different factors, including the type of herbicide used. Residues may only be present in the water for a few hours, or for as long as a few months. Each herbicide has different characteristics that affect where the chemical moves (e.g. if it stays in the water column or settles into the sediment), how it is broken down, and how long it can be detected in water, sediments, and aquatic organisms. For more information on the environmental fate of a particular herbicide, please see the individual chemical fact sheets, available by request from your local lake coordinator (http://dnr.wi.gov/lakes/contacts/Contacts.aspx?role=LAKE_COORDINATOR). These are currently being updated and will be available online soon, as well.

Should I let my kids swim in the water?

None of the aquatic herbicides licensed for use in Wisconsin have swimming restrictions. Dilute amounts of herbicide may be present in the water, but EPA has determined that minimal exposure would result from adults or children swimming in treated waters.

Use restrictions for treated water vary by herbicide, but will always be listed on the herbicide label. To find out how to read an herbicide label, see http://www.epa.gov/pesticides/label/. Restrictions must be posted at public access points to the water body for at least one day near an herbicide treatment and sent to shoreline landowners in advance of the treatment. To minimize your risk of direct exposure, it is wise to stay a safe distance from the area being treated while herbicide applications are being made.

What if I accidently ingest some of the water while swimming or my pet drinks the water?

When assessing the risk posed by swimming in treated water, the EPA considers exposure from accidental swallowing of water, as well as from other routes such as through the skin. Any exposure to herbicide in the water while swimming or through accidental ingestion would be small and would not have toxic effects. Similarly, your pet should not have any side effects from swimming in or drinking treated water, so long as any applicable use restriction period is over.

Are there risks to drinking water?

In Wisconsin, most drinking water supplies come from groundwater, not surface water. For water bodies that are used for drinking water, treatments are required to be a minimum distance from any existing intakes (usually ¼ of a mile). Wells are not considered to be intakes, and therefore the setback distance does not apply. Some aquatic herbicides can move through the sediment into the groundwater, but even those that do move through soil have not been detected above drinking water thresholds in wells.

Campers that are treating surface water for drinking should obtain water from an alternate location until after any posted drinking water restrictions have passed.

Can I eat the fish?

There are no restrictions on eating fish for any currently registered aquatic herbicides following application to water. That does not mean you would not be exposed to the herbicide, just that the amount of herbicide that you might be exposed to is not toxic. A common concern with eating fish from treated water is that the herbicide concentration may be higher in fish tissues than in the water, and therefore exposure may be greater from fish than from exposure to lake water. The potential for bioaccumulation in fish varies by herbicide, and is evaluated by the EPA during the registration process.

Can I water my lawn/garden with lake water?

Many of the herbicides used in lakes and ponds are broadleaf herbicides which will damage garden plants including fruits and vegetables. Some aquatic herbicides will also affect grass. Whether you are watering your lawn or your garden, follow water usage restrictions to avoid any unintended damage. These restrictions on watering will be listed on the herbicide label and posted at boat landings and beaches. The limits vary widely, from no restriction to 120 days. If you are unsure about the herbicide used on the lake near your home, the safest option is to use water from your municipal supply or private well to water plants.

How can I find out if an aquatic herbicide treatment is scheduled for my lake, or has occurred recently?

Notices of herbicide applications and the use restrictions of the herbicides used are required to be posted along shore adjacent to a treatment area, as well as at public access points for the day of treatment through the end of the restricted use period. Additionally, landowners adjacent to a treatment area should be sent advance notification of the treatment by mail, email or newsletter. For a large-scale treatment (over 10 acres or over 10% of the area of the lake) all landowners around the lake would receive advance notification.

How can I be notified in advance of when and where an application will occur, even if I am not adjacent to the treatment area?

The DNR will notify any interested person of upcoming applications if they request to be notified in writing each year. To request notification, contact your local DNR aquatic plant management coordinator (http://dnr.wi.gov/lakes/contacts/Contacts.aspx?role=AP_MNGT).

Why can one person or group of people receive a permit to treat my lake if I don't want the treatment?

Any individual or group can request a permit from the DNR for a treatment since water bodies in the state are public property. The DNR is charged with evaluating any proposed treatments to consider the impact on the environment, and permits can be denied.

The permitting process requires that all landowners adjacent to the treated area be notified of the treatment. If you receive the notice and don't want the treatment to occur, you can send a written request to the applicant and the DNR requesting a public informational meeting on topics of concern to you regarding the treatment and alternatives. If 5 or more such requests are received within 5 days of the notice, the applicant is required to conduct such a meeting in a location near the water body.

What can I do to reduce the need for aquatic herbicide use?

Individuals can help reduce requests for herbicide use to control aquatic plants and algae by implementing best management practices on their property to prevent nutrients from running into the water and by preventing the spread of invasive species. To reduce runoff eliminate the use of fertilizers adjacent to a water body, rake leaves out of the street and off the lawn, plant a buffer strip of native vegetation on shore to reduce erosion and filter water coming off lawns, create a rain garden to filter and slow down water from driveways or rooftops, use a rain barrel to collect water from rooftops to use to water plants, or use a pervious option to pave driveways and sidewalks. To prevent the introduction of new invasive species and stop the spread of existing invasives, when boating remove plants, animals, and mud from your boat when leaving a boat launch, drain all water from your boat, and rinse your boat and equipment with hot or high pressure water or allow to dry for at least five days before moving to another water body.

Where can I find more information about a specific herbicide?

The DNR keeps a fact sheet on file for each herbicide used in aquatic systems. These fact sheets can be requested from your local DNR lake coordinator (http://dnr.wi.gov/lakes/contacts/Contacts.aspx?role=LAKE_COORDINATOR), and will be updated and available online soon, as well.

The EPA's risk assessments are available at http://www.epa.gov/pesticides/reregistration/status.htm.

Additional information can be found with these resources:

http://www.co.thurston.wa.us/health/ehipm/ehipm_aquaticreview.html
Health assessment of aquatic herbicides by Thurston County, Washington, Public Health and Social Services

http://extoxnet.orst.edu/pips/ghindex.html
Specific information on pesticides as well as toxicology

http://npic.orst.edu/
Information about pesticides, supported by EPA and Oregon State University

http://www.datcp.wi.gov/Plants/Pesticides/
WI Department of Agriculture, Trade, and Consumer Protection

Fluridone Chemical Fact Sheet

Formulations

Fluridone is an aquatic herbicide that was initially registered with the EPA in 1986. The active ingredient is 1-methyl-3-phenyl-5-3-(trifluoromethyl)phenyl|-41H|-pyridinone. Both liquid and slow-release granular formulations are available. Fluridone is sold under the brand names Avast!, Sonar, and Whitecap (product names are provided solely for your reference and should not be considered endorsements).

Aquatic Use and Considerations

Fluridone is an herbicide that stops the plant from making a protective pigment that keeps chlorophyll from breaking down in the sun. Treated plants will turn white or pink at the growing tips after a week and will die in one to two months after treatment as it is unable to make food for itself. It is only effective if plants are growing at the time of treatment.

Fluridone is used at very low concentrations, but a very long contact time is required (45-90 days). If the fluridone is removed before the plants die, they will once again be able to produce chlorophyll and grow.

Fluridone moves rapidly through water, so it is usually applied as a whole-lake treatment to an entire waterbody or basin. There are pellet slow-release formulations that may be used as spot treatments, but the efficacy of this is undetermined. Fluridone has been applied to rivers through a drip system to maintain the concentration for the required contact time.

Plants vary in their susceptibility to fluridone, so typically some species will not be affected even though the entire waterbody is treated.

Plants have been shown to develop resistance to repeated fluridone use, so it is recommended to rotate herbicides with different modes of action when using fluridone as a control.

Fluridone is effective at treating the invasive Eurasian watermilfoil (*Myriophyllum spicatum*). It also is commonly used for control of invasive hydrilla (*Hydrilla verticillata*) and water hyacinth (*Eichhornia crassipes*), neither of which are present in Wisconsin yet. Desirable native species that are usually affected at concentrations used to treat the invasives include native milfoils, coontail (*Ceratophyllum demersum*), naiads (*Najas* spp.), elodea (*Elodea canadensis*) and duckweeds (*Lemna* spp.). Lilies (*Nymphaea* spp. and *Nuphar* spp.) and bladderworts (Utricularia spp.) also can be affected.

Post-Treatment Water Use Restrictions

There are no restrictions on swimming, eating fish from treated water bodies, human drinking water or pet/livestock drinking water. Depending on the type of waterbody treated and the type of plant being watered, irrigation restrictions may apply for up to 30 days. Certain plants, such as tomatoes and peppers and newly seeded lawn, should not be watered with treated water until the concentration is less than 5 parts per billion (ppb).

Herbicide Degradation, Persistence and Trace Contaminants

The half-life of fluridone (the time it takes for half of the active ingredient to degrade) ranges from 4 to 97 days depending on water conditions. After treatment, the fluridone concentration in the water is reduced through dilution due to water movement, uptake by plants, adsorption to the sediments, and break down from light and microbial action.

There are two major degradation products from fluridone: n-methyl formamide (NMF) and 3-trifluoromethyl benzoic acid. NMF has not been detected in studies of field conditions, including those at the maximum label rate.

Fluridone residues in sediments reach a maximum in one to four weeks after treatment and decline in four months to a year depending on environmental conditions. Fluridone adsorbs to clay and soils with high organic matter, especially in pellet form, and can reduce the concentration of fluridone in the water. Adsorption to the sediments is reversible; fluridone gradually dissipates back into the water where it is subject to chemical breakdown.

Impacts on Fish and Other Aquatic Organisms

Fluridone does not appear to have any apparent short-term or long-term effects on fish at application rates.

Fish exposed to water treated with fluridone absorb fluridone into their tissues. Residues of fluridone in fish decrease as the herbicide disappears from the water. The EPA has established a tolerance for fluridone residues in fish of 0.5 parts per million (ppm).

Studies on Fluridone's effects on aquatic invertebrates (i.e. midge and water flea) have shown increased mortality at label application rates.

Studies on birds indicate that fluridone would not pose an acute or chronic risk to birds. No studies have been conducted on amphibians or reptiles.

Human Health

The risk of acute exposure to fluridone would be primarily to chemical applicators. The acute toxicity risk from oral and inhalation routes is minimal. Concentrated fluridone may cause some eye or skin irritation. No personal protective equipment is required on the label to mix or apply fluridone.

Fluridone does not show evidence of causing birth defects, reproductive toxicity, or genetic mutations in mammals tested. It is not considered to be carcinogenic nor does it impair immune or endocrine function.

There is some evidence that the degradation product NMF causes birth defects. However, since NMF has only been detected in the lab and not following actual fluridone treatments, the manufacturer and EPA have indicated that fluridone use should not result in NMF concentrations that would adversely affect the health of water users. In the re-registration assessment that is currently underway for fluridone, the EPA has requested additional studies on both NMF and 3-trifluoromethyl benzoic acid.

For Additional Information

Environmental Protection Agency
Office of Pesticide Programs
www.epa.gov/pesticides

Wisconsin Department of Agriculture, Trade, and Consumer Protection
http://datcp.wi.gov/Plants/Pesticides/

Wisconsin Department of Natural Resources
608-266-2621
http://dnr.wi.gov/lakes/plants/

Wisconsin Department of Health Services
http://www.dhs.wisconsin.gov/

National Pesticide Information Center
1-800-858-7378
http://npic.orst.edu/

Hamelink, J.L., D.R. Buckler, F.L. Mayer, D.U. Palawski, and H.O. Sanders. 1986. Toxicity of Fluridone to Aquatic Invertebrates and Fish. Environmental Toxicology and Chemistry 5:87-94.

Fluridone ecological risk assessment by the Bureau of Land Management, Reno Nevada:
http://www.blm.gov/pgdata/etc/medialib/blm/wo/Planning_and_Renewable_Resources/veis.Par.91082.File.tmp/Fluridone%20Ecological%20Risk%20Assessment.pdf

SONAR*
An Effective Herbicide That Poses Negligible Risk To Human Health And The Environment

Sonar is a highly effective aquatic herbicide used to selectively manage undesirable aquatic vegetation in freshwater ponds, lakes, reservoirs, rivers and canals. Sonar is absorbed through the leaves, shoots, and roots of susceptible plants, and destroys the plant by interfering with its ability to make and use food. As with any substance introduced into the environment, concerns arise about possible harmful effects on humans who may come into contact with it, and about its effects on wildlife and plants that we wish to protect and preserve. The following discussion, presented in a "Question and Answer" format, provides information regarding Sonar and evidence that Sonar presents negligible risk[1] to human health and the environment when applied according to its legally allowed uses and label directions.

Q1. What are the legally approved uses of Sonar?

A1. Sonar has been approved for use by the U.S. Environmental Protection Agency (USEPA) since 1986 for the management of aquatic vegetation in freshwater ponds, lakes, reservoirs, drainage canals, irrigation canals and rivers. Four different formulations have been approved for use—an aqueous suspension known as Sonar A.S. (USEPA Registration Number 67690-4) and three pellet forms known as Sonar SRP (USEPA Registration Number 67690-3), Sonar PR Precision Release (USEPA Registration Number 67690-12), and Sonar Q Quick Release (USEPA Registration Number 67690-3). There are no USEPA restrictions on the use of Sonar-treated water for swimming or fishing when used according to label directions. The Agency has approved Sonar's application in water used for drinking as long as residue levels do not exceed 0.15 parts per million (ppm) or 150 part per billion (ppb). For reference, one (1) ppm can be considered equivalent to roughly one second in 12 days or one foot in 200 miles, and (0.1) ppm can be considered approximately equal to one second in 120 days or one foot in 2,000 miles.

Sonar's USEPA-approved labeling states that in lakes and reservoirs that serve as drinking water sources, Sonar applications can be made up to within one-fourth mile (1,320 feet) of a potable water intake. For the control of Eurasian watermilfoil, curlyleaf pondweed and hydrilla where treatment concentrations are 0.01 to 0.02 ppm (10 to 20 ppb), this setback distance of one-fourth mile from a potable water intake is not required. Note that these effective treatment concentrations are well below the 0.15 ppm (150 ppb) allowable limit in water used for drinking.

Local public agencies may require permits for use of an herbicide in public waters. Therefore, the Sonar label states that the user must consult appropriate state or local water authorities before applying the herbicide.

[1]Throughout this document, we use the phrases "negligible risk" or "no significant risk." We use these terms because it is beyond the capabilities of science to prove that a substance is absolutely safe, i.e., that the substance poses no risk whatsoever. Any substances, be it aspirin, table salt, caffeine, or household cleaning products, will cause adverse health effects at sufficiently high doses. Normal exposures to such substances in our daily lives, however, are well below those associated with adverse health effects. At

some exposure, risks are so small that, for all practical purposes, no risk exists. We consider such risks to be negligible or insignificant.

*Trademark of SePRO Corporation

Q2. How does a product such as Sonar gain approval for use? (How does it become registered?)

A2. Federal law requires that an aquatic herbicide be registered with the USEPA before it can be shipped or sold in the United States. To obtain registration, manufacturers are required to conduct numerous studies (i.e., over 120 studies depending upon the intended uses) and to submit a thorough and extensive data set to USEPA to demonstrate that, under its conditions of use, the product will not pose a significant risk to human health and the environment and that the herbicide is effective against the target weeds or plants.

Individual states can establish registration standards that are more strict than federal standards, but not less strict.

Q3. What types of information must be submitted to regulatory agencies before an herbicide is registered?

A3. To register a herbicide, the manufacturer must submit information that falls into the following categories: product chemistry (for example, solubility, volatility, flammability and impurities), environmental fate (for example, how the substance degrades in the environment), mammalian toxicology (studies in laboratory animals used to assess potential health risks to humans), and wildlife and aquatic (for example, bird and fish) toxicology. If there are any residues in the environment, their levels must be determined. A manufacturer also conducts studies of product performance (or efficacy as a herbicide).

Q4. Have all of the data required for registration of Sonar been submitted to regulatory agencies, and have those agencies found the data acceptable?

A4. The data required for registration of Sonar by the USEPA is complete and has been accepted by the USEPA and by all states.

Q5. What happens to Sonar when it is used according to approved labeling -- that is, what is its environmental fate or what happens to Sonar once it is released or applied to the water?

A5. Tests under field conditions show that Sonar disappears from treated water in a matter of weeks or months, depending on a number of environmental factors such as sunlight, water temperature and depth. In lakes, reservoirs, rivers and canals where only a portion of the water body is treated, dilution reduces the level of Sonar relatively quickly following application.

Sonar does not persist in the environment. Its disappearance from aquatic environments is accomplished by several processes. First, the plants that are being

treated absorb Sonar, thereby removing a portion of it from the water. Second, Sonar degrades or breaks down in the presence of sunlight by a process called "photo degradation." Photo degradation is the primary process contributing to the loss of Sonar from water. Third, adsorption of Sonar to hydrosoil (sediments) also contributes to its loss from water. As Sonar is released from hydrosoil back into the water, it is photo degraded.

Study results indicate that Sonar has a low bioaccumulation potential and therefore is not a threat to the food chain. Specifically, studies have shown that Sonar does not accumulate in fish tissue to any significant degree. The relatively small amounts of Sonar that may be taken up by fish following application are eliminated as the Sonar levels in water decline. In a study of crops irrigated with Sonar treated water, no residues of Sonar were found in any human food crops, and only very low levels were detected in certain forage crops. Consumption by livestock of Sonar-treated water and crops irrigated with Sonar-treated water was shown to result in negligible levels of Sonar in lean meat and milk. Sonar-treated water can be used immediately for watering livestock.

To ensure that residue levels of Sonar pose no significant risk, USEPA has established tolerances, or maximum legally allowable levels, in water, fish, and crops irrigated with Sonar-treated water, and other agricultural products (including eggs, milk, meat, and chicken). For example, the 0.15 ppm (150 ppb) concentration in water mentioned in the answer to Question #1 is the tolerance limit for water that is used for drinking. The recommended application rates of Sonar (detailed on the label) are established to ensure the product will do its job and that tolerance limits won't be exceeded.

Q6. How might people come into contact with Sonar after it is applied to an aquatic site?

A6. People could come into contact with Sonar by swimming in water bodies treated with the herbicide, by drinking water from treated lakes or reservoirs, by consuming game fish taken from treated waters, and by consuming meat, poultry, eggs or milk from livestock that were provided water from treated surface water sources.

Q7. Is it likely that people will be harmed because of those contacts?

A7. Extensive studies have demonstrated that contact with Sonar poses negligible health risks when the herbicide is used according to label instructions. The label for Sonar carries no restrictions for swimming or fishing in treated water or against drinking water treated with Sonar. Sonar does not build up in the body.

The conclusion that Sonar poses negligible health risks is evidenced by USEPA's toxicity rating for Sonar. The USEPA classifies herbicides according to their acute toxicity or potential adverse health effects and requires that a "signal word" indicating the relative toxicity of the herbicide be prominently displayed on the product label. Every herbicide carries such a signal word. The most acutely toxic herbicide category requires the signal word DANGER. However, if the product is especially toxic, the additional word POISON is displayed. Herbicides of moderate acute toxicity require the signal word WARNING. The least toxic products require the signal word CAUTION. Sonar labels display the word CAUTION, the USEPA's lowest acute toxicity rating category.

Q8. How do we know that humans are not likely to experience any harmful effects from Sonar's temporary presence in the environment?

A8. Companies that develop new herbicides are required to: 1) conduct extensive investigations of the toxicology of their product in laboratory animals; 2) characterize the ways by which people may contact the herbicide after it has been applied to an aquatic site; 3) determine the amount of exposure resulting from these possible contacts; and 4) demonstrate the fate of the herbicide in the environment. Before USEPA will register a herbicide, the Agency must establish with a high degree of certainty that an ample safety margin exists between the level to which people may be exposed and the level at which adverse effects have been observed in the toxicology studies.

Investigations of the toxicity of Sonar have been performed in laboratory animals under a variety of exposure conditions, including exposure to very high doses for short periods (acute studies), as well as repeated exposures to lower doses (which are still far in excess of any exposures that humans might actually receive) throughout the lifetime of the laboratory animals (chronic studies). Other special studies have been performed to evaluate the potential for Sonar to cause reproductive effects, cancer, and genetic damage. Study results indicate a low order of toxicity to mammalian species following acute exposures and repeat-dose exposures for up to a lifetime. In addition, repeated doses of Sonar did not result in the development of tumors, adverse effects on reproduction or on development of offspring, or genetic damage.

In characterizing the toxicity of a compound and its safety margin for exposures of humans and wildlife, toxicologists attempt to identify the maximum dose at which a chemical produces no toxicity. Another way of stating this is how much of the chemical can an organism be exposed to before it reaches a toxic level (recall from the footnote to the introduction on page 1 that all substances are toxic at some dose or level). This maximum non-toxic dose is usually established by studies in laboratory animals and is reported as the "no-observed-effect level" or NOEL. The dietary NOEL for Sonar (that is, the highest dose at which no adverse effects were observed in laboratory animals fed Sonar) is approximately 8 milligrams of Sonar per kilogram of body weight per day, abbreviated 8 mg/kg/day. This NOEL was derived from a study in rats that were fed Sonar in their regular diets every day for their entire two-year lifetime.

To put this NOEL into perspective, a 70-kg adult (about 150 pounds) would have to drink over 1,000 gallons of water containing the maximum legally allowable concentration of Sonar in potable water (0.15 ppm) daily for a significant portion of their lifetime to receive a dose equivalent to the 8 mg/kg/day NOEL. At most, adults drink about 2 quarts (one-half gallon) of water daily, which means that even if a person were drinking water with the maximum legally allowable concentration of Sonar, their margin of safety would still be at least 2,000. Similarly, a 20-kg child (about 40 pounds) would have to drink approximately 285 gallons of Sonar-treated water every day to receive a dose equivalent to the NOEL. Because children drink only about one quart of water daily, this provides a safety margin of greater than 1,000.

The above example calculation of safety margins is based on the assumption that potable water will contain levels of Sonar at its maximum allowable concentration of 0.15 ppm (150 ppb). In fact, the Sonar concentration achieved under typical applications is closer to 0.02 ppm (20 ppb), thereby providing a safety margin seven times greater. The

point is that adults and children who drink water from potable water sources that have been treated with Sonar according to label instructions are at negligible risk.

Similarly, the levels of Sonar allowed in various food products pose negligible risk to human health. For example, even if Sonar were present at the maximum allowable limit of 0.05 ppm in meat, poultry, eggs, and milk, a 70-kg adult would have to consume almost 25,000 pounds of these foods daily (and again for a significant portion of a lifetime) to receive a dose equivalent to the dietary NOEL for Sonar. A child would have to consume over 7,000 pounds of these foods daily.

Because Sonar is used only intermittently in any one area, and because it disappears from the environment, there is virtually no way that anyone will be exposed continuously for a lifetime. Because the NOEL derives from a study involving daily exposures for a lifetime, the actual safety margin for people is, in fact, much greater than is suggested by the above illustrative examples.

Q9. How complete is the toxicology information upon which this conclusion rests?

A9. All toxicity studies required by the USEPA to obtain registration approval for Sonar have been completed.

Q10. What about the people who apply Sonar—are they at risk?

A10. The Sonar label states that individuals who use Sonar should avoid breathing spray mist or contact with skin, eyes, or clothing; should wash thoroughly with soap and water after handling; and should wash exposed clothing before reuse. These precautions are the minimum recommendations for the application of any pesticide. If Sonar is used according to label instructions, exposures to the product should be minimal and use should pose negligible risks to applicators.

Sonar has been shown to be of low acute toxicity in laboratory animal studies (that is, toxicity from a high dose exposure for a short period of time). Therefore, any exposure to the product (even undiluted) that might occur during use is unlikely to lead to adverse effects as long as label instructions are followed. As discussed in Question #7, Sonar's label carries the signal word CAUTION that corresponds to the USEPA's lowest acute toxicity rating category.

Studies in laboratory animals show that the lethal dose from a single oral exposure of Sonar is greater than 10,000 mg/kg. To put this into perspective, an adult would have to drink over one million gallons of Sonar-treated water (at the 0.15 [150 ppb] ppm maximum allowable limit) to receive a dose of 10,000 mg/kg; a 20-kg child would have to drink approximately 350,000 gallons.

Because applicators are more likely to contact the undiluted material than the general population, questions about the toxicity of Sonar following direct skin contact have been raised. A laboratory study of the toxicity of an 80 percent solution of Sonar applied to rabbit skin (a standard model to predict effects in humans) suggests that Sonar is minimally toxic by this route. In this study, when Sonar was repeatedly applied to the skin of rabbits for 21 days (in the largest amounts that could be applied practically), there were no signs of toxicity and only slight skin irritation was observed. Further, the dermal

administration of the 80 percent solution of Sonar did not induce sensitization in guinea pigs.

Q11. Has there been any investigation of the possible harmful effects of Sonar on fish, wildlife, pets and livestock?

A11. The toxicity of Sonar has been investigated in laboratory studies in birds (including the bobwhite quail and mallard duck), in the honey bee (as a representative insect) and in the earthworm (as a representative soil organism), in five different species of freshwater and marine fish, and in other aquatic animals. These studies have involved exposures to high concentrations for brief periods as well as exposures lasting as long as an entire lifetime, including during reproduction.

Extensive studies have also been performed to evaluate the effects of Sonar on various aquatic and terrestrial plants (both those considered undesirable aquatic weeds and those native plants that we wish to protect). Studies in laboratory animals designed primarily to assess potential health risk in humans are also relevant to the assessment of potential health effects in mammalian wildlife, livestock, and pets.

In addition, **Sonar** has been monitored in water, plants and fish during field trials. This provides firsthand information on residue levels in the environment following application of Sonar.

Q12. What do these investigations reveal?

A12. A combination of the toxicity studies and residue monitoring data reveals that Sonar poses negligible risks to aquatic animals including fish, wildlife, pets, and livestock when used according to label directions.

As was done with laboratory mammals, toxicity studies were conducted to establish a dietary no-observed effect level (NOEL) for birds. This maximum, non-toxic chronic dose is 1,000 ppm in the diet. One thousand (1,000) ppm is 2,500 times the highest average concentration of total residue found in fish (0.40 ppm), about 2,100 times the highest concentration found in aquatic plants (0.47 ppm), and about 11,500 times the highest average concentration of Sonar found in the water at field trial sites (0.087 ppm). Because the residue levels in these “bird food” items are so far below the NOEL, it can be concluded is that there are negligible risks to birds that might be exposed to Sonar in their diet following application of Sonar.

The highest average Sonar concentration found in Sonar-treated water is below the lowest NOEL values for both short and long term exposures from freshwater and marine fish. Honeybees and earthworms are not particularly sensitive to Sonar. Sonar caused no deaths in honey bees when they were dusted directly with the herbicide, and earthworms were not affected when they were placed in soil containing more than 100 ppm Sonar.

Extensive testing of Sonar in laboratory animals used to assess potential risks to human health indicates that a large safety margin exists for mammalian species in general. Thus, Sonar poses negligible risk to pets, livestock, and mammalian wildlife that might drink from water treated with Sonar.

Q13. Can Sonar be used in environmentally sensitive areas?

A13. Sonar has been used in a wide range of aquatic environments in the United States without incident for almost 15 years. Florida canals and rivers are examples of environmentally sensitive areas that have been treated with Sonar. Some sites are habitats for the endangered Florida manatee. Although toxicity testing data for the manatee, or for other endangered species, cannot be collected directly, questions about whether Sonar treatment will pose any significant risk to the manatee can be answered with results of the mammalian toxicity studies.

The Florida manatee is an aquatic mammal that consumes up to 20% (one-fifth) of its body weight per day in aquatic plants. Treatment of canal water with Sonar according to label directions is expected to result in a maximum Sonar concentration of 0.15 ppm in the water and from 0.8 to 2.6 ppm in aquatic plants. Calculations show that it would be impossible for a manatee to ingest enough Sonar in its diet to cause any adverse effects, based on results of laboratory studies in other mammals. To reach the maximum non-toxic dose or NOEL for sensitive mammalian species, a manatee would have to drink more than 40 times its body weight per day in treated water, or eat at least 3 to 10 times its body weight per day in aquatic plants. This calculation indicates that treatment with Sonar in manatee habitats—as one example of an environmentally sensitive area—will pose negligible risk. In fact, application to Florida canals and rivers has been approved by the U.S. Fish and Wildlife Service, Florida Department of Environmental Protection, and the Florida Game and Fresh Water Fish Commission.

Sonar has also been used in other environmentally sensitive areas such as Disney World, Ducks Unlimited MARSH projects, Sea World, state and federal parks, and numerous fish and waterfowl management areas.

Q14. What is it that makes Sonar an effective aquatic herbicide while being a compound of relatively low toxicity to humans?

A14. Sonar inhibits a plant's ability to make food. Specifically, Sonar inhibits carotenoid synthesis, a process specific only to plants. Carotenoids (yellow, orange and red pigments) are an important part of the plant's photosynthetic (food making) system. These pigments protect the plant's green pigments (called chlorophyll) from photo degradation or breakdown by sunlight. When carotenoid synthesis is inhibited, the chlorophyll is gradually destroyed by sunlight. As a plant's chlorophyll decreases, so does its capacity to produce carbohydrates (its food source) through photosynthesis. Without the ability to produce carbohydrates, the plant dies.

Humans do not have carotenoid pigments. Therefore, the property of Sonar that makes it an effective herbicide at low doses does not affect the human body.

Q15. Will Sonar have an adverse effect on water quality?

A15. Extensive testing of a wide range of water bodies has shown no significant changes in water quality after Sonar treatment. In fact, Sonar has a practical advantage over certain other aquatic herbicides in this area. Specifically, the dissolved oxygen content of the water does not change significantly following Sonar treatment because the relatively slow herbicidal activity of the product permits a gradual decay of the treated vegetation. Maintaining adequate dissolved oxygen levels are critical to fish and other

aquatic animals, which require oxygen to survive. This contrasts with the changes in water quality that can arise from the application of certain other aquatic herbicides that are "fast-acting." The sudden addition of large amounts of decaying plant matter to the water body can lead to decreased oxygen levels and result in a fish kill. To avoid depressions in dissolved oxygen content, label directions for certain "fast-acting" aquatic herbicides recommend that only portions of areas of dense weeds be treated at a time. Because Sonar does not have any substantial impact on dissolved oxygen, it is possible to treat an entire water body with Sonar at one time.

Q16. Is there any reason for concern about the inert ingredients used in Sonar?

A16. Inert ingredients are those components of the product that do not exhibit herbicidal activity; that is, the components other than Sonar. Water is the primary inert ingredient in Sonar A.S., making up approximately 45% of the formulation. The second largest (approximately 10%) inert is propylene glycol; a compound used in facial creams and other health and beauty products. Other inert ingredients are added to serve as wetters, dispersants, and thickeners in the formulation. Trace amounts of an antifoaming agent and a preservative are also added. The primary inert ingredient in the pelleted formulations is clay, which makes up approximately 89% of the formulation. Small amounts of a binder or coating solution are also added to reduce the dustiness of the pellets. None of the inert ingredients in Sonar formulations are on the USEPA's list of "Inerts of Toxicological Concern" or list of "Potentially Toxic Inerts/High Priority for Testing." Thus, there is no reason for concern about the inert ingredients used in Sonar.

Q17. Is it important to follow label directions for use and disposal of Sonar?

A17. Yes. It is a violation of federal law to use products, including Sonar, in a manner inconsistent with product labeling or to improperly dispose of excess products or rinsate. Although the results of extensive toxicity testing in the laboratory and in field trials indicate a low order of toxicity to non-target plants, animals, and people, Sonar, like all chemicals, will cause adverse effects at sufficiently high exposure levels. Failure to follow label directions for use and disposal of Sonar could result in environmental levels that exceeds the tolerances for Sonar established to be protective of human health and the health of pets, livestock and other wildlife. In addition, improper use of Sonar could result in unintended damage to non-target plants.

Q18. If Sonar is used in conformance with label directions, is there any reason to be concerned that Sonar will pose risk to human health or the environment?

A18. As discussed in the answers to the previous questions, results of laboratory and field studies and extensive use experience with Sonar in a wide range of water bodies strongly support the conclusion that Sonar will pose negligible risks to human health and the environment when used in conformance with label directions.

In summary, it can be said that Sonar has a favorable toxicological profile for humans. It has an overall low relative toxicity and it is not a carcinogen, mutagen or reproductive toxicant. Sonar also has a very good environmental profile for an aquatic product because of: 1) its low toxicity to non-target organisms; 2) its non-persistent behavior when applied to water bodies (i.e., it readily breaks down to carbon, hydrogen, oxygen, nitrogen and fluorine); and 3) its low bioaccumulation potential, which means it does not build up in the body or in the food chain.

G

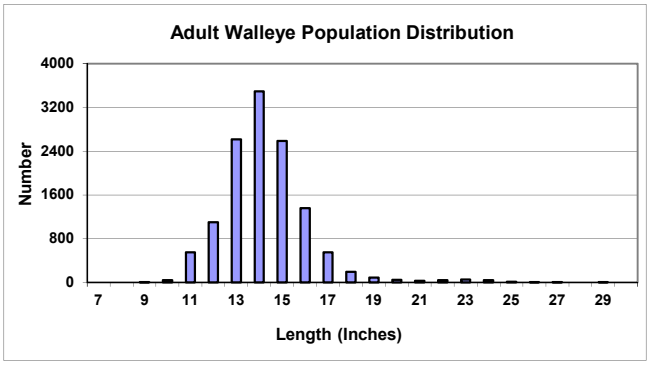
APPENDIX G

Twin Lakes 2017 Fish Survey Summary (WDNR)

WISCONSIN DNR
FISHERIES INFORMATION SHEET

LAKE: TWIN L CHAIN **COUNTY:** VILAS **YEAR:** 2017

The Department of Natural Resources surveyed North and South Twin Lakes (Twin Chain), Vilas County, from April 13th through June 7th, in order to assess the status of the gamefish populations. The Twin Chain is a drainage system with predominant sand and gravel substrates. It has a surface area of 3,430 acres, 14.1 miles of shoreline, and a maximum depth of 60 feet. The Twin Chain's walleye and musky populations are sustained through natural reproduction.



* Note: Adult walleye are defined as all sexable walleye (regardless of length) and those of unknown sex ≥ 15 inches in length.

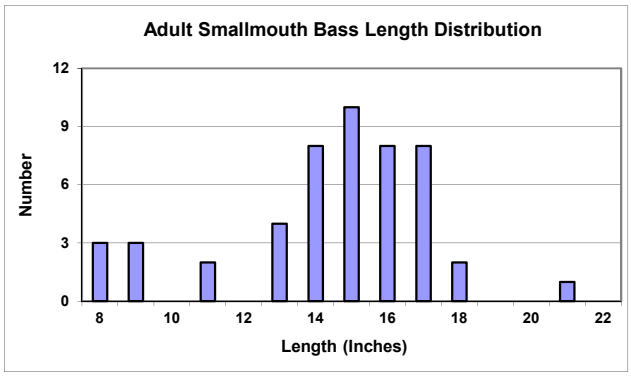
Walleye

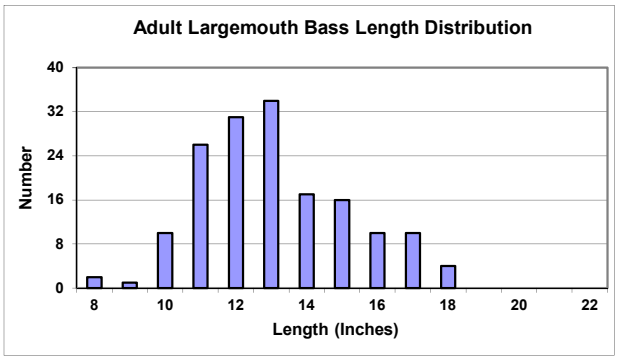
During 10 days of fyke netting, 4,004 adult walleye were captured and marked with a fin clip. Three crews then sampled with electrofishing boats and captured 983 adult walleye. During electrofishing 31% (301 of 983) of captured walleye bore the fin clip given during fyke netting. The largest walleye we captured was a 29.2-inch female.

Based on those results, the Twin Chain was estimated to contain 12,814 adult walleye (3.7/acre). An estimated 39% of adult walleye were 15 inches long or larger.

Smallmouth Bass

Survey crews were unable to capture and mark a sufficient number of smallmouth bass from the Twin Chain to estimate the population size. During sampling conducted through June 7th, 48 smallmouth bass eight inches or larger were captured. Of those smallmouth captured, 75% were 14 inches long or larger. The largest smallmouth captured was 21.1 inches long.





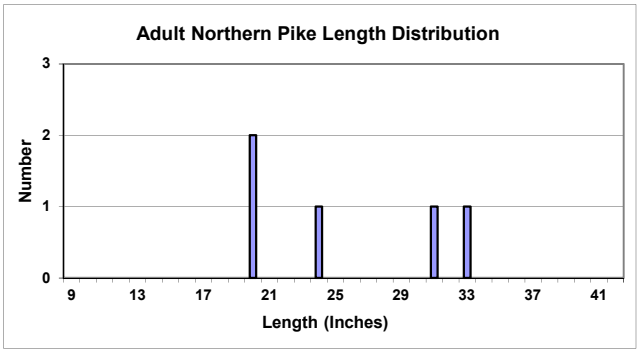
Largemouth Bass

Survey crews were also unable to capture and mark a sufficient number of largemouth bass from the Twin Chain to estimate the population size. During sampling conducted through June 7th, 161 largemouth bass eight inches or larger were captured. Of those largemouth captured, 35% were 14 inches long or larger. The largest largemouth captured was 18.9 inches long.

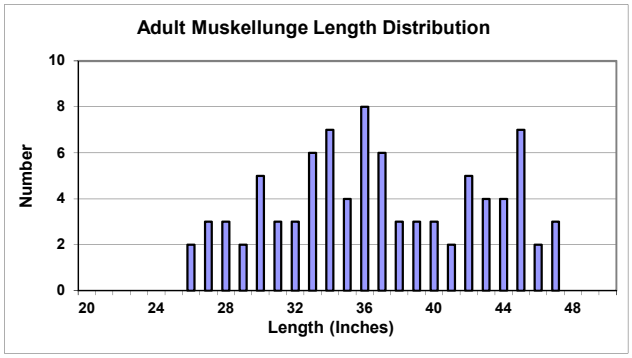
Drafted: August 2017
By: Lawrence Eslinger

Northern Pike

Just five adult northern pike were captured during our surveys of the Twin Chain. The largest northern pike captured was a 33.7-inch female.



* Note: Adult northern pike are defined as all sexable northern pike and those of unknown sex ≥ 12 inches in length.



Muskellunge

During our fyke netting and electrofishing sampling of the Twin Chain, 85 adult muskellunge were captured. Of the muskelluge captured, 35% (30 of 85) were 40 inches long or larger, with the largest being a 47.4-inch female. Additionally, 6 juvenile muskellunge (13.7 - 29.7) were also captured.

* Note: Adult muskellunge are defined as all sexable muskellunge and those of unknown sex ≥ 30 inches lin length.

Other Species

In addition to the game fish mentioned above, 13 species of fish were captured during fyke netting and electrofishing sampling of the Twin Chain. Yellow Perch (range: 2.1" - 9.9") and Rock Bass (3.8" - 8.9") were common in our catches. Also caught were moderate numbers of White Sucker. Other species sampled included Black Crappie, Bluegill (3.8" - 7.4"), Pumpkinseed (4.6" - 7.4"), Burbot, Golden and Common Shiner, Logperch, Bluntnose Minnow, Mimic Shiner, and Mottled Sculpin.

A creel survey will be conducted on the Twin Chain throughout the 2017-18 fishing season. Creel clerks Rich Cechal and Marty Kiepke will count and interview anglers and examine their catch. The information gathered will be used to estimate fishing effort in addition to angler catch and harvest.

Table 1. General Fishing Regulations for North and South Twin Lakes, Vilas County, 2017-18.

FISH SPECIES	OPEN SEASON	DAILY LIMIT	MINIMUM LENGTH
Walleye	May 6 - March 4	3	15" min. length, 20-24" no harvest slot, 1 fish over 24" allowed
Largemouth Bass	May 6 - March 4	5 in total with SMB	14 inches
Smallmouth Bass	May 6 - June 16 (C&R) June 17 - March 4 (Harvest)	5 in total with LMB; harvest season only	14 inches
Muskellunge	May 27 - Nov. 30	1	40 inches
Northern Pike	May 6 - March 4	5	None

A brief summary of selected fishing regulations for the Twin Chain is included above (Table 1). While the regulatory information provided was current at the time the surveys were conducted, it is not comprehensive and should not be used as a substitute for the current fishing regulation pamphlet. You may obtain a copy of current fishing regulations when you purchase your fishing license, or download a copy from our web site at:

http://dnr.wi.gov/topic/fishing/regulations/

This report is interim only; Watch for finalized summaries at: http://dnr.wi.gov/topic/fishing/north/trtysprngsrvys.html. Creel survey results should be available by August 2018 at: http://dnr.wi.gov/topic/fishing/north/trtycrlsrvys.html. For questions, contact:

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Woodruff, WI 54568
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For answers to questions about fisheries management activities and plans for the Twin Chain, Vilas County, contact:

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Drafted: August 2017
By: Lawrence Eslinger

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APPENDIX H

Official Comments on Draft Documents

Comments to North and South Twin Lake Draft Comprehensive Management Plan – November 2017

Response Comments by Eddie Heath

Overview WDNR Comments from Kevin Gauthier (WDNR Water Resources Management Specialist)

- There haven't been many lakes in the state where DNR has funded 4 whole-lake treatments. (Three whole-lake treatments have occurred on South Twin Lake: 2009, 2010, 2016.) To the best of our knowledge there haven't been any in North District. There have been a number of projects statewide that have funded multiple large-scale EWM/HWM treatments, even some in the Northern District such as Sandbar Lake (3 large-scale 2,4-D treatments since 2010). Arguably, the concept of "whole-lake" treatment is less than a decade old and we suspect that a number of treatments before that time were actually large-scale. For instance, the 2009 treatment on South Twin was not designed as a whole-lake treatment. Curly-leaf pondweed management programs in the western part of the state (some in the Northern District) include numerous consecutive large-scale treatments. No action taken to management plan document.
    - The goal with groups that have needed repeat whole-lake treatments has often been to discuss the incorporation of a mechanical harvesting program as the treatments become more regular. We are unaware of the WDNR's "goal" stated here. Mechanical harvesting was discussed with the lake group within the alternative analysis and the NSTLRA's goals are not narrowly focused on nuisance control, as would be mitigated through a mechanical harvesting plan. No action taken to management plan document.
- A threshold of 10-15% EWM cover for initiating whole-lake/large-scale treatment isn't mandated by the department. In fact the DNR considers any treatment that covers more than 10% of the littoral zone as a large-scale treatment. This means that there is additional concern about potential ecological impacts if a treatment with large-scale, but doesn't indicate that a treatment should necessarily take place if the AIS is found in more than 10% of the littoral zone. Large-scale management should be considered when a lake use is becoming impaired or the invasive is causing ecological impairment. The rationale for conducting a large-scale treatment is outlined within the Implementation Plan Section and is unrelated to the WDNR's 10% threshold for considering a treatment "large-scale." The trigger outlined within the Implementation Plan Section also incorporates EWM colonial density as measured by a mapping survey. Additional text has been added to the Implementation Plan Section to justify why the NSTLRA devised the trigger. The NSTLRA would like the WDNR reviewer to understand that "this trigger is for purposes of engaging in discussion if and/or when and why a treatment or other management practices outlined in the LMP. It is not a hard trigger that we must treat."
- Currently the objective is to reduce EWM by 70% measured the year after a treatment. For a revised goal you may consider incorporating the number of years of control expected. The Implementation Plan Section outlines that a goal of 3-5 years of control is anticipated from a large-scale treatment that meets the NSTRLA's goals. No action taken to management plan document.
- A revised EWM management objective may also incorporate the level of plant density or surface matting. Rake fullness from the PI survey could be used as an estimate.
    - Incorporating the nearness of EWM to the water surface during PI surveys could also serve as an estimate of the amount of surface matted milfoil. DNR uses categories (of at, near, or

below the surface) to estimate this in PI surveys. The qualitative add-on to the point-intercept survey is noted, but this project will use the EWM mapping surveys to understand density and matting. No action taken to management plan document.

- What happens if the target EWM control objective is not met? It would be helpful to have a process for planning. Additional statement added to the Implementation Plan Section discussing population management vs nuisance control.
- Given the decline in some native aquatic plant species since the beginning of aggressive aquatic plant management in South Twin Lake, the Technical Review Team feels that the trigger level of EWM cover before discussing a large-scale treatment could be increased in this plan. Noted.
- Page 89 states "While the survey response rate may not be sufficient to be a statistical representation of the population, the NSTLRA believe the sentiments of the stakeholder respondents is sufficient to provide a generalized indication of riparian preferences and concerns." There is not justification to support "sufficient to provide a generalized indication of riparian preferences and concerns" with this return rate from a survey. The NSTLRA acknowledge the context of the results and believe (i.e. it is their opinion) that they provide generalized indication of preferences and concerns for their use in direction their actions. Additional text has been added to strengthen the NSTLRA's position. We understand that it is difficult to reach a 60% response rate without additional funding to do scientific level surveying. However, we suggest that you frame the support by saying at "at least 27% (40% of respondents * 68% support) of those that were sent the survey indicated they were supportive of responsibly using herbicides in the Twin Lakes…" We would suggest that you make these changes wherever you are using survey percentages to justify proposed management actions. The portrayal of the stakeholder survey results was correct within the report and will continue to display in that manner. Using the framework, the WDNR outlines above, it could also be said that at least 3.2% are unsupportive of a treatment (40% of respondents * 8% unsupported). The authors contend that both examples show bias towards the results. No action taken to management plan document.
    - As whole-lake treatments become more frequent, mechanical harvesting likely becomes a more cost-effective management tool and should be considered. The NSTLRA have developed a population management goal, which mechanical harvesting is not an applicable action to reach that goal. No action taken to management plan document.
    - A Note - Chemical treatments or mechanical harvesting to provide seasonal nuisance relief are not eligible for AIS EPC grants. Without state funding assistance, the incentive to adopt a nuisance control strategy is even less appealing to lake groups.

Jordan Petchenik Comments (WDNR Resource Sociologist)

- Page 7 -- Good to see the inclusion of the response rate to the stakeholder survey, as well as acknowledging the lower than desired rate. Please elaborate more clearly the implications of the low response rate; something like: "Due to the lower than desired response rate, and without the conduct of a non-response bias check, we cannot state that the survey results are a statistically accurate (unbiased) representation of stakeholder behavior, opinions or preferences." This text was added verbatim per your request, as we could not have drafted more appropriate language than what you provided.
- Also, a consequence of the low response rate is that you cannot use language such as "a majority of stakeholders" – you did not receive responses from a majority of stakeholders. Your results are applicable only to the respondents. Please review and where there are references to

"stakeholders," replace with "survey respondents." A few incorrect uses of "stakeholders" vs "stakeholder respondents" were noted in the document and changes were made.

Michelle Nault Comments (WDNR Water Resources Management Specialist)

- Figure 3.3-3 (pg. 47 in PDF): While I like the idea of putting the Twin Lakes CWH numbers into a bigger picture context, I do not believe that the sub-set of 75 lakes which were used to create this box plot figure were necessarily 'randomly selected', and thus I have some concerns with labeling this figure caption as "State-wide comparative data". I would suspect that the 75 lakes included in this sub-set may have a high bias towards waterbodies located in the northern portion of the state (where the consultant tends to primarily work) as well as lakes that have some level of public access and/or residential development (as a lake assoc. would likely be present in order to hire the consultant). In order to truly have "State-wide comparative data" the sub-set should include a representatively balanced number of lakes in the central/southern portion of the state, as well as lakes without any sort of development (i.e. 'natural' lakes). Wording changed to reflect the comment. The figure has also been updated to include a larger database that is now available. Previous studies by Christensen et al. 1996* found significantly more CWH on undeveloped lakes (mean 555 logs/km [893 logs/mi]) than in developed lakes. This literature reported mean CWH on undeveloped lakes is much higher (8x) than the top outlier in the current sub-set of 75 lakes (~110 logs/mi). I would suggest that they compare the CWH numbers on the Twin Lakes with other available published CWH studies that accounted for potential site selection biases (assuming the methodologies employed in those studies are the same or very similar to the consultants methodology); or at minimum more explicitly state that these sub-set of 75 lakes may not be very representative of WI lakes across the entire state, but it's the best quantitative standardized data that they currently have in order to try and provide some context. Some additional text was added as disclaimer. As an aside, Onterra used to compare with Christensen et al but the methodology is so different that it wasn't an appropriate comparison. For instance, the CWH methodology within the NSTwin Plan may identify a single piece of CWH as having a full canopy when Christensen et al would have counted each branch of that canopy that was greater than 5 cm and fell along the transect line parallel to shore (at 0.5 m depth contour) as a CWH "piece."

It also seems that the overall size of CWH on the Twin Lakes is relatively small (almost all the CWH was <8 in, with very few pieces >8 inches) and lacks complexity (almost all the CWH had no branching or minimal branching). So even though there's CWH present, the quality (i.e. size and complexity) of the CWH is perhaps less than we see in other less developed systems (i.e. there's wood present, but not very much for "good wood"). This point might be good to mention in the text since not all wood is equal in terms of potential habitat (and the report does cite the main findings of Newbrey et al. 2005 to support this). Additional text regarding these observations have been included.

- Pg. 61 in PDF – first paragraph: "The Simpson's Diversity Index value from the Twin Lakes is compared to data collected by Onterra and the WDNR Science Services on 77 lakes withn [sic] the Southeast Wisconsin Till Plan ecoregion and on 392 lakes throughout Wisconsin". The Twins Lakes are located in the Northern Lakes & Forest (NLF) ecoregion, not the SWTP. I believe this is just a small typo as the text/graphs on pg. 69-73 seem to reference to the correct NLF ecoregion. Change has been made. The dataset used is the NLFL ecoregion (lakes) as opposed to the NLFF (flowages).

- Figure 3.4-5 (pg. 66 in PDF): Legend text states data is from 2008-2016, yet 2017 data is included in this figure. Need to update legend text. Change made. The 2017 data was added to the report after the preliminary drafts were created and used in the planning process.

- Figure 3.4-7 (pg. 68 in PDF): What is the rationale behind comparing the 2011 PI data to the 2016 PI data? The 2011 PI data would be reflecting the two large-scale 2,4-D treatments which occurred in 2009 & 2010, and so I don't think this is appropriate to use as "baseline" native plant data to compare to the 2016 PI. I think it would make more sense to use the 2008 PI data as the native plant "baseline", as this was the data collected prior to the two large-scale management activities. Instead of choosing two years of data to compare pre vs. post, I would suggest that they look at linear trends over time, seeing that S. Twin has PI surveys on an annual basis (minus 2012). Linear trends are easy to calculate with the PI data currently available, and would give a better picture to the long-term changes in the aquatic plant community over time. Some text has been added to increase clarity, but figure 3.4-7 is from **NORTH** Twin and includes data from the only 2 available point-intercept surveys.

- Figure 3.4-8 (pg. 69 in PDF): The text states: "Figure 3.4-8 displays the average littoral frequency….plants within South Twin Lake from 2008-2017 compare to the 2017 whole-lake point-intercept survey…". However, the figure legend states: "South Twin Lake aquatic plant….from 2008-2016…red circle represents 2016 littoral frequency…". Please clarify if this figure is looking at 2016 data or 2017 data (I think it's actually 2017 data but the figure legend was not updated). Change made. The 2017 data was added to the report after the preliminary drafts were created and used in the planning process. Also added a "Legend" to this figure to hopefully increase clarity.

- Figure 3.4-10, 3.4-11, & 3.4-12 (pg. 71-72 in PDF): Legend text states data is from 2008-2016, yet 2017 data is included in these figures. Need to update legend text. Change made. The 2017 data was added to the report after the preliminary drafts were created and used in the planning process.

- Figure 3.4-13 (pg. 73 in PDF): Legend text states data is from 2016, yet 2017 data is included in this figure. Need to update legend text. Change made. The 2017 data was added to the report after the preliminary drafts were created and used in the planning process.

- Pg. 75 in PDF: Consider rephrasing this sentence to better capture the variability we see in EWM growth at both a spatial and temporal scale. There are certainly some lakes where EWM does not exhibit this 'nuisance' growth (but rather behaves much more like a native plant), and also lakes where this 'nuisance' growth may be observed in some years, but not in other years. Example revision: "In addition to its propagation method, EWM has two other competitive advantages… and 2) once its stems reach the water surface, it oftentimes does not stop growing like most native plants…"Change made. Also added additional text to soften the message, as the intent is not sensationalism.

- Pg. 76 in PDF: I feel that the Kujawa et al. 2017 quote and associated text is somewhat taken out of context here. The study found that at a broad scale (i.e. comparing managed lakes vs. unmanaged lakes; "new" lakes vs. "established" lakes) that management "appears to be particularly effective in recently invaded lakes, where it can be used with lower frequency and overall magnitude to maintain low M. spicatum abundance." However, the text does not quote the other finding of the study, which is that at an individual lake-scale, "the specific effects of individual treatments can be unpredictable." If this quote is used, it should be modified to better indicate that this finding was at a broad spatial-scale, and not at an individual lake-scale. Change made to increase clarity.

EWM in South Twin was first reported in 2001, and it falls very close to the temporal cut-off between established and new used in Kujawa et al. (i.e. pre or post year 2000). This temporal pre/post temporal cut-off was relatively arbitrarily choosen, and it should also be noted that the four lakes in the established (pre-2000) group were located in the central/south (Loon, Little Green, Kettle Moraine, & Turtle), and 3 of the 4 lakes have confirmed HWM. In contrast, only 2 of the 10 lakes in the 'new' (post-2000) group have confirmed HWM (Arrowhead & Berry), and they are all in the northern portion of the state. So we may potentially be seeing an artifact of comparing 'apples to oranges' with our comparison here [this is mentioned in the discussion section of the paper]. Some additional text was added to acknowledge this interpretation and critique of Kujawa.

One point that I think also probably gets lost in the Kujawa et al. study is that many of these lakes that treated "early" after EWM was discovered (i.e. the 'newly' discovered lakes) did not have low EWM littoral %FOO at the time of treatment. Lakes in this group included Tomahawk (40%), Sandbar (42%), Kathan (49%), and Berry (18%). In many aspects, these lakes did indeed wait for several years monitoring EWM population levels before ultimately managing, and so I do not see "postponing active management until an EWM population reaches a certain threshold" as being "an alternative philosophy" to what is currently presented in Kujawa et al. The text in this section has been made clearer to avoid the unintentional comparison the reviewer thought was being made.

- Pg. 76 in PDF: Was the personal communication with Allen Niebur referring to additional lakes other than specifically Shawano Lake (i.e, "some Wisconsin lakes") and management opinions other than his own beliefs (i.e. "local fish managers"). Since this is cited as 'personal communication' it should be clear if this was Al's personal thoughts on a specific lake mgmt. project(s) or if this is actually a more widespread belief across numerous staff and waterbodies. I think it's appropriate to cite personal comm. if you are referencing Al's own personal beliefs/observations, but I'm not sure if citing what other people think is an appropriate use of personal communication. If it's more than just Al who believes this, then additional fisheries staff names should also be listed here as personal communication. This paragraph has been restructured after additional communications with statewide fisheries managers brought upon by this review comment.

- Figure 3.4-16 through 3.4-20 (pg. 77-80 in PDF): As mentioned in a previous comment, since we have really good annual PI data on South Twin, I would like to see some sort of long-term plant community analysis vs. just looking at pre vs. post for two individual years at a time. This could be easily accomplished by looking at simple linear trends over time, and seeing if those trends are statically significant or not. While some of the individual year 1 vs. year 2 chi-square comparisons do not yield significant differences, if you look at the overall trend over time since the beginning of data collection in 2008, there are several species that seem to be displaying a decrease over time (i.e. small pondweed, water marigold, NWM) while others are displaying an increase over time (i.e. chara), and yet others that have been very steady over time (i.e. fern pondweed, white-steam pondweed). I would like to see some further quantitative analysis and discussion of long-term trends in the plant community over time included in this report. This additional analysis was conducted and is included as part of Appendix E. The goal was to fulfill the request of the commenter but to limit the additional length of the discussion as well as keep the discussion "accessible" to the non-scientific reader.

- Figure 3.4-21 (pg. 82 in PDF): Legend text states data is from 2010-2016, yet 2007-2017 data is included in this figure. Need to update legend text. Change made. The 2017 data was added to the report after the preliminary drafts were created and used in the planning process.

- Pg. 83 in PDF: In spot-treatment scenarios, is the required CET for a 2,4-D/endothall combination really much shorter than the required CET for straight 2,4-D? Are there published studies to support this? Based upon the 2,4-D herbicide conc. data the combo appears to have dissipated very rapidly, and the pre/post control might be considered 'less than good' (~56% reduction pre vs. post). It sounds like this combo spot-treatment approach may be tried again in 2018 on N. Twin, but it seems to me that it wasn't incredibly effective when tried in 2017. The NSTLRA's original plan, which will be upheld even though their AIS-EPC Grant was denied, is to make full evaluations of the strategy not by looking solely at the *year of treatment* (2017), but also by investigating the *year after treatment* (2018) results in absence of a treatment. This is more clearly spelled out within the Implementation Plan Section of the second draft. The reviewer's comments are acknowledged and it appears likely that the CET was insufficient to cause complete EWM control in this area.

- Pg. 93 in PDF (last paragraph): The 'Nault in press' paper has now been published (currently only available online, but will be in print very soon). The final published paper looked at 28 treatments (not 22) and the half-life range was 4-76 days (not 59 days). An expanded discussion on half-lives is included.

- Pg. 119 in PDF: The trigger of 10-15% EWM littoral FOO seems too low to me based upon previous management activities and observed rebound of EWM, I think it will be difficult for this lake to reach and continue to maintain that low EWM % goal over time. How was this % determined? Are there discussions on revising this 'trigger'? Seeing that 14.3% EWM is currently present and that the trigger has 'flexibility', have there been discussions on delaying treating in 2018 and waiting until 2019 (or later) when it's more clear that this EWM target goal has been exceeded? The reviewer's opinion is acknowledged. Additional information on how the trigger was developed is included within the Implementation Plan Section.

Susan Knight Comments (Interim Director Trout Lake Station, UW-Madison Center for Limnology)

- South Twin has widespread EWM, and North Twin has small dense patches of EWM at its south end. The FOO in South Twin has been as high as 37%, but less than 2% in North Twin. South Twin has been treated 4 times in 8 years (though some treatments were not whole lake) and North Twin has been treated 8 times in 11 years (no whole-lake treatments), with a variety of chemicals. Although there are no guidelines on how often a lake should be treated, or with what chemical, this seems excessive in both lakes. The plan says the committee is trending towards adopting a large-scale tricholpyr treatment for South Twin, which has been a component of the treatment cocktail for 4 of the 8 treatments. The plan states they want to rotate chemicals, "to increase efficacy as long-term goals were not being met", but I do not see why this should be expected to be an effective strategy. The historic small scale spot treatments conducted on North Twin were largely ineffective because they did not reach CETs. The goal of rotating herbicide strategies on North Twin was to find an herbicide that may require a lower/shorter CET. The conclusion is that no currently available systemic herbicides could hold CETs sufficient for control. However, new herbicides and use patterns are emerging, including a new spot treatment systemic herbicide by SePRO.

  Three large-scale 2,4-D treatments occurred on South Twin. Large-scale treatments require a completely different CET than spot treatments and the results are not transferable between the two use patterns. One potential reason the large-scale 2,4-D treatment was not met may be that the ET (Exposure Time) is not being met even though the C (Concentration) is. Triclopyr's mode of degradation (only applies to large-scale treatments) may result in a longer ET for control. No action taken to management plan document.

- The plan does not include maps of the EWM in North Twin through time, but my impression (could be wrong) is that the patches are a consistent size (if not density), and do not seem to be spreading to other parts of the lake. Why treat these dense patches with so much chemical? Could lake users avoid these relatively small patches? The NSTLRA's motivation for controlling EWM within North Twin is largely for population management.
- I appreciate Onterra's efforts to capture public sentiment regarding treatment of EWM. But the lake committee alone should not dictate what is done. The 2017 EWM FOO in South Twin was 14.3, a level I feel does not warrant another whole lake treatment. The plan discusses the advantages of whole-lake treatments but neglects to say that these should not be done every year. I believe the committee should set some thresholds of when to consider a whole-lake treatment (with EWM FOO>>14%), and consider a maximum frequency of whole lake treatments (perhaps at most every 3 years). While I understand the choice of chemical is not an exact science, there should be some rationale for the chosen chemical or cocktail. The second draft contains detailed discussion on the justification and selection of the large-scale herbicide use pattern the NSTLRA is currently pursuing.
- The challenge tests are informative (though in this case, ambiguous), but do not include effects on native plants. Reviewer's comment is noted. No action taken to management plan document.

Native Plant Results

From Appendix E, LFOO '08 thru '17 South Twin

Species	30-50% change in LFOO '08 to '09 (first treatment)	Change in '13, '14, 15 (no treatment)
Myr sib	decrease	increase
Bid bec	decrease	increase
Val	decrease	increase
Chara	decrease	increase
Het dub	decrease	increase
Pot pu	decrease	No, continued decrease
Pot fri	decrease	None
Myr spic	decrease	increase
Pot rich	increase	No, about same

The message here is that several species are negatively affected by treatments, and many show signs of recovery when there are no treatments. This is not surprising but is a solid demonstration of a perception. Since these are whole-lake results, this represents a more complete picture of what is going on lake-wide in South Twin, rather than a result of pre/post evaluations in EWM target areas. I find these results warrant a chemical treatment schedule less frequent what is currently occurring. Attempts were made within the second draft to demonstrate the impacts of native plants (and rebound) in association with the large-scale treatments on South Twin Lake.

Comments to North and South Twin Lake Draft Comprehensive Management Plan – May 2018

Response Comments by Eddie Heath

Overview WDNR Comments from Kevin Gauthier (WDNR Water Resources Management Specialist)

- P. 129 – Change "once the population exceeds 10-15%" to a single value (10 or 15%). One can take the exceedance of a range of numbers to mean exceeding the first or last number in the range. Clarifying this will help everyone speak the same language. Change made to 12%.
- P 129 – Last paragraph. Suggest reaching out WDNR before a vote by the Board of Directors. The sentence was changed to state: "based upon data collected and communication with the WDNR regarding the NSTLRA's intent, prior to a vote of the Board of Directors to move forward with such action."