A

APPENDIX A

Public Participation Materials

Management Planning Project Overview

- Foster holistic understanding of Mid Lake ecosystem
- Collect & analyze data
  - Technical & sociological
- Construct long-term & useable plan
  - Living plan subject to revision over time
- Onterra's role is to provide technical direction
  - Not really recommendations

Onterra LLC Lake Management Planning

Comprehensive Management Plan Outline

- 1.0 Introduction
- 2.0 Stakeholder Participation
- 3.0 Study Results
  - 3.1 Water Quality
  - 3.2 Watershed
  - 3.3 Shoreland Condition
  - 3.4 Aquatic Plants
  - 3.5 AIS
  - 3.6 Fishery
- 4.0 Summary & Conclusions
- 5.0 Implementation Plan
- 6.0 Methods
- 7.0 Literature Cited

Onterra LLC Lake Management Planning

Comprehensive Management Plan Outline

Planning Meeting I

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- 4.0 Summary & Conclusions

Planning Meeting II

- 5.0 Implementation Plan
- 6.0 Methods
- 7.0 Literature Cited

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Management Planning Project Overview

Collect and compile information about Mid Lake

Includes both environmental & sociological
Historical & current information
Past management actions

Planning Meeting I
Report Sections

Create a realistic and implementable management plan

Challenges facing lakes and lake groups
Create goals that will address challenges
Develop actions that will meet goals
Assign timeframes & facilitators

Planning Meeting II
Implementation Plan

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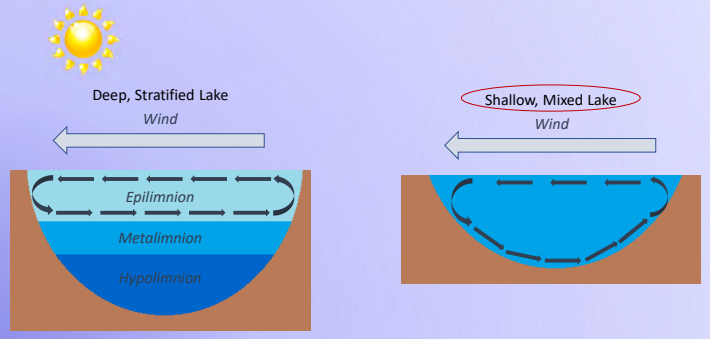
Wisconsin Lakes Classification



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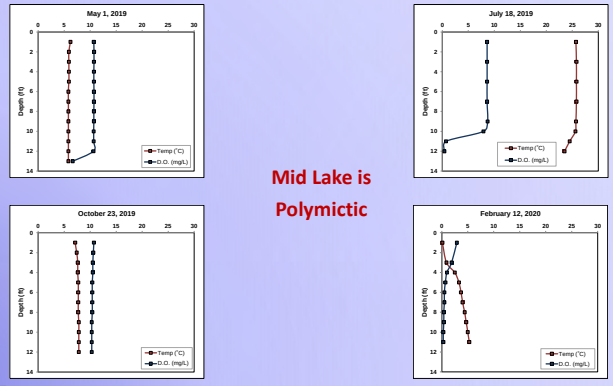
Temperature & Dissolved Oxygen



Mid Lake is Polymictic

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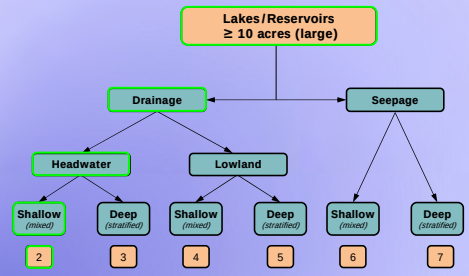
Natural Community Types

Categorization of lakes with similar features that influence water quality



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Ecoregions

An area containing similar geology, physiography, hydrology, climate, and soils. As well as common terrestrial and aquatic fauna.

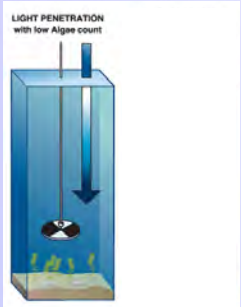
Introduction to Lake Water Quality

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

N:P Ratio: 20:1 – Phosphorus Limited

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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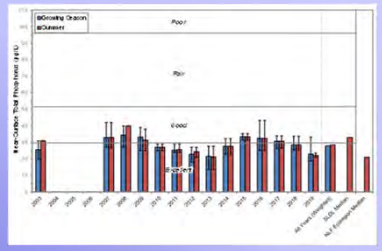
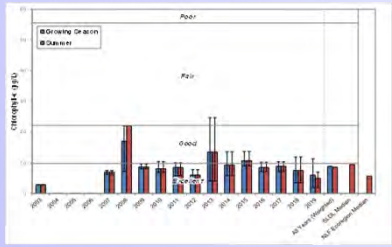
Mid Lake Water Quality

Near-Surface Total Phosphorus



Total Phosphorus ave summer = 28.4 µg/L
- ***Excellent*** **for Shallow Headwater Drainage Lakes**
- **Slightly higher than the Ecoregion Median**

Chlorophyll-a



Chlorophyll-a Ave summer = 8.6 µg/L
- ***Excellent*** **for Shallow Headwater Drainage Lakes**
- **Slightly higher than the Ecoregion Median**

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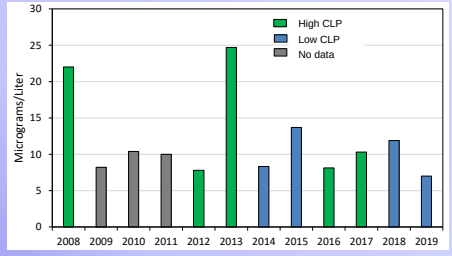
Mid Lake Water Quality

Chlorophyll-a



Highest August chlorophyll-a values came in years of high CLP Populations

- **Phosphorus release in early-July when CLP senesces**
- **Released phosphorus is likely utilized by periphyton, not as much by phytoplankton**

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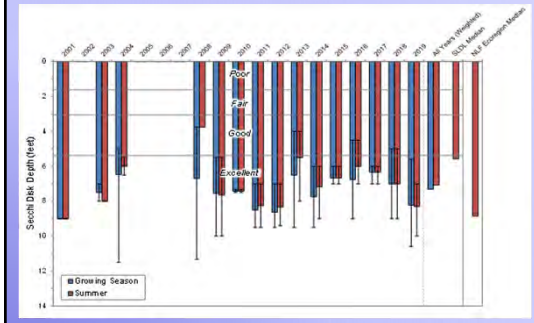
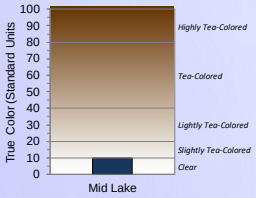
Mid Lake Water Quality

Secchi Disk Transparency





Secchi Disk Ave summer =7.1feet

- ***Excellent* for Shallow Headwater Drainage Lakes**
- **A little shallower than the Ecoregion Median**
- **Minimally impacted by organic acids (staining)**

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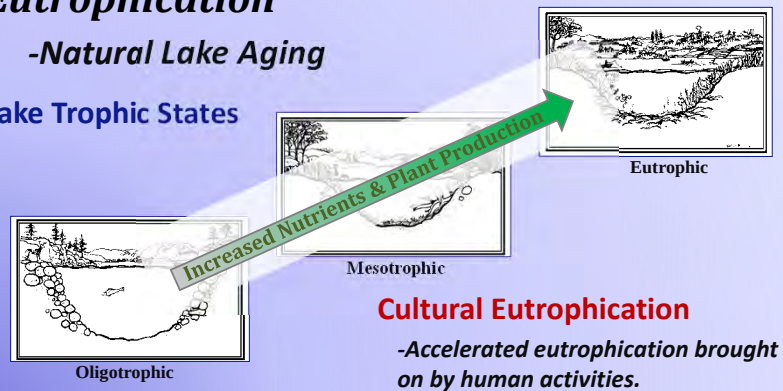
Eutrophication

-Natural Lake Aging

Lake Trophic States



Cultural Eutrophication

-Accelerated eutrophication brought on by human activities.

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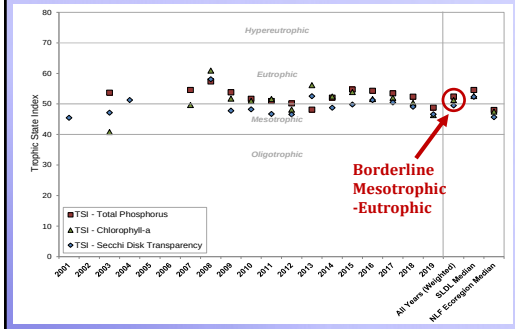
Mid Lake Water Quality



Trophic State Index

A method to relate the trophic parameters – phosphorus, chlorophyll-a, and Secchi transparency, and understand the trophic lake of a lake.

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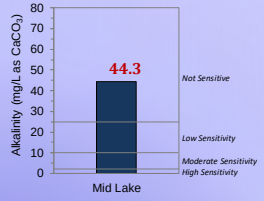
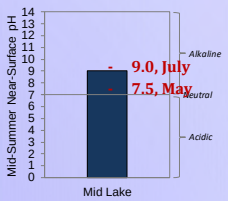
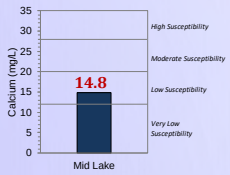
Additional Water Quality Parameters



Not sensitivity to acid rain
Hardness = moderately hard



High photosynthesis during summer & during day increases pH



Calcium is a little low for ZM susceptibility. pH is ideal for ZMs (7-9)

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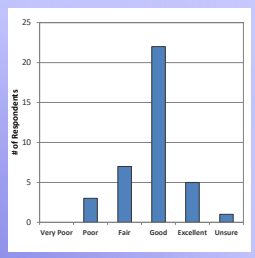
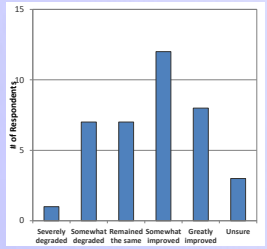
Stakeholder Perceptions of Water Quality

45% Response Rate

How would you describe the current water quality of Mid Lake?



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



~79% of stakeholder survey respondents indicated that *water clarity (clearness of water)* is the single most important aspect when considering water quality, whereas aquatic plant growth was most important to ~81% of respondents (Appendix B Question #19).

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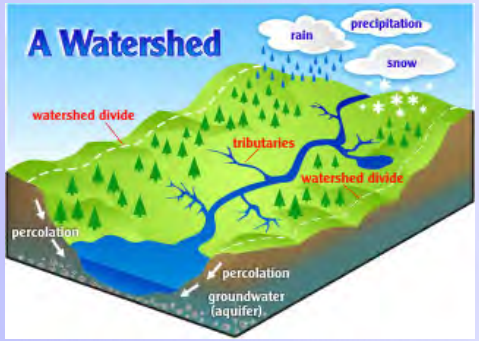
Watershed

- Geographic area within which all water drains to a common point



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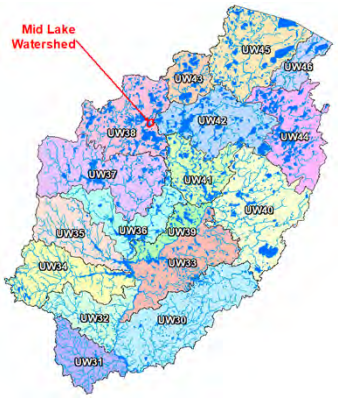
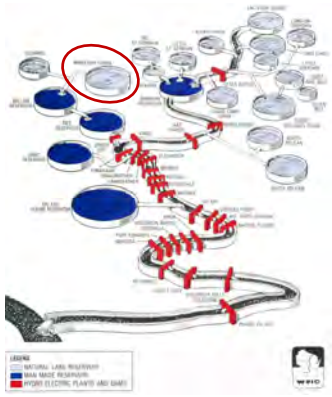
Upper Wisconsin River Watershed



Code	Name	Acres
UW-43	St Germain River	44,872
UW-38	Upper Tomahawk River	119,569
UW-44	Eagle River	116,286
UW-42	Sugar Camp Creek	120,316
UW-41	Rhinelander Flowage	76,610
UW-40	Pelican River	169,524
UW-36	Lower Tomahawk River	85,676
UW-39	Woodboro	39,671
UW-33	Noisy and Pine Creeks	114,783
UW-37	Middle Tomahawk River	140,313
UW-35	Somo River	90,435
UW-30	Prairie River	168,955
UW-32	New Wood River	74,070
UW-34	Spirit River	108,175
UW-31	Copper River	65,949
UW-45	Tamarack Pioneer River	133,954
UW-46	Deerskin River	36,410
Total		1,714,568

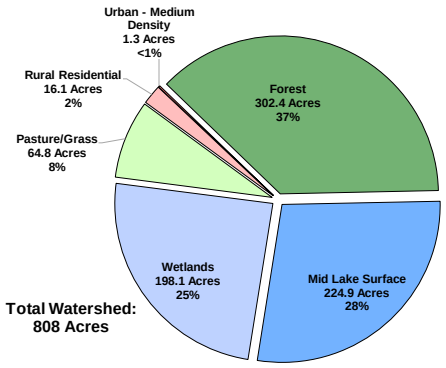


Mid Lake Watershed

808 acres
WS:LA = 4:1
Residence Time: ~2 yr
Flushing Rate: 0.42 times per year

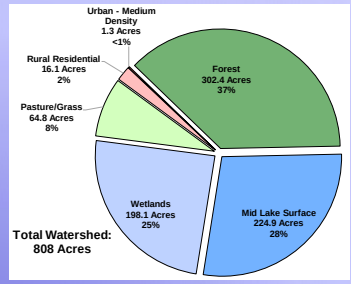
Groundwater inputs may increase flushing rate

Mid Lake Watershed

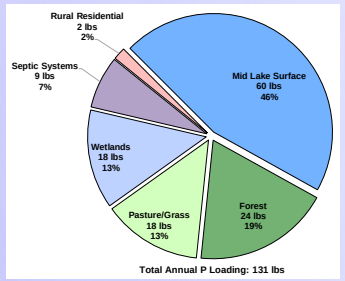


Watershed Modeling

Septic Info from Stakeholder Survey



Model



Model over predicts amount of phosphorus entering lake, as parts of watershed may be phosphorus sinks into groundwater
Additional phosphorus sources include internal loading from CLP senescence and backflow from Thoroughfare

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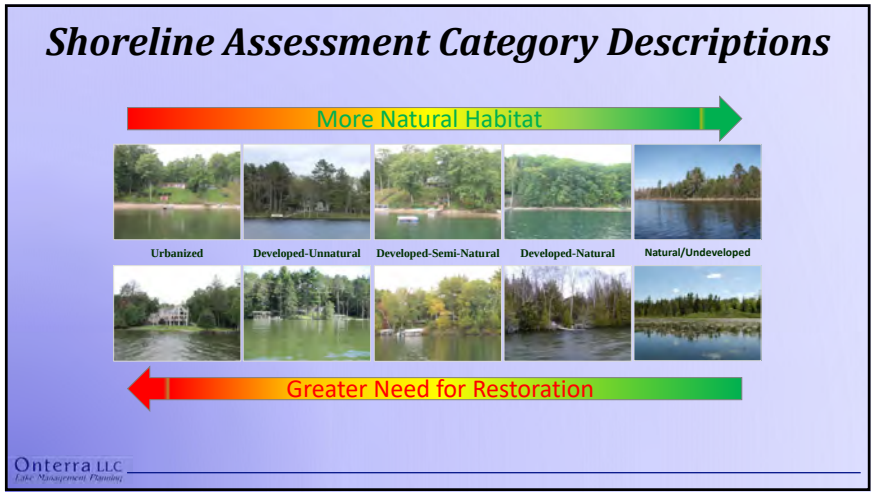
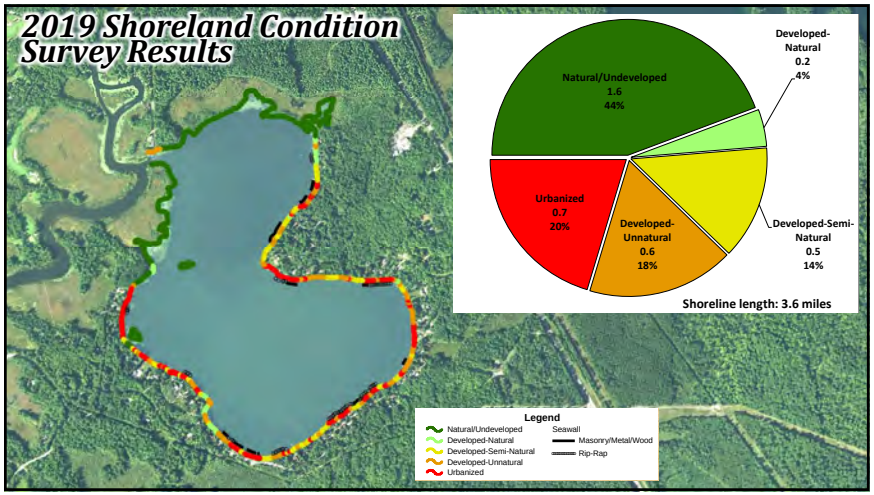
Shoreland Assessment

- 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

Shoreline Assessment Category Descriptions





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 Mid Lake

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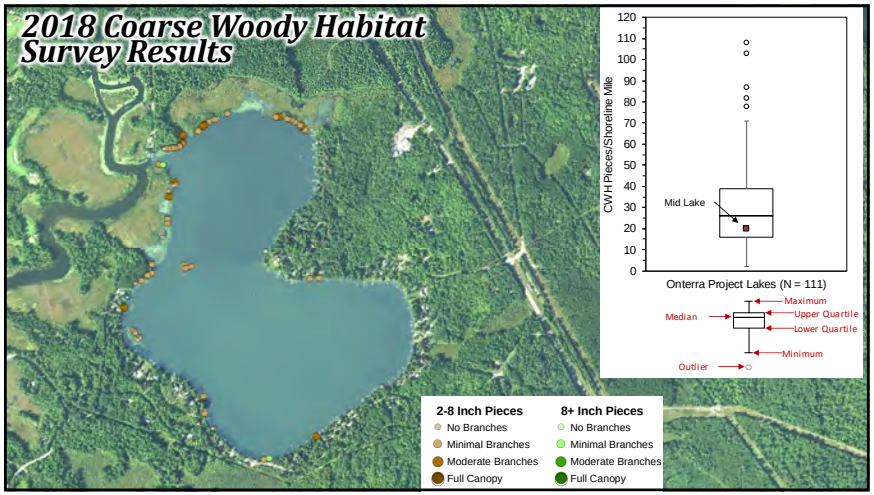
2018 Coarse Woody Habitat Survey Results



Aquatic Plant Surveys

- Determine changes in plant community from past surveys
- Assess both native and non-native populations
- Numerous surveys used in assessment
  - Early-Season AIS Survey (CLP, EWM, PYI)
  - Whole-Lake Point-Intercept Surveys
  - Emergent/Floating-Leaf Community Mapping Survey

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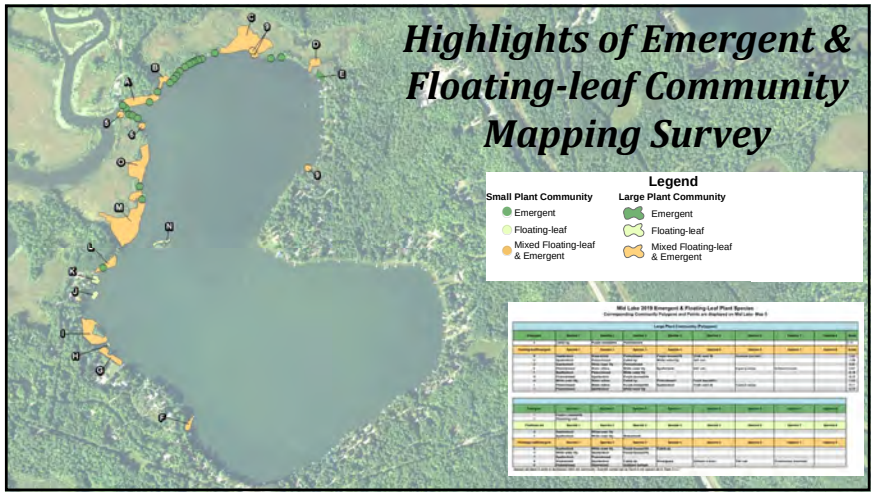
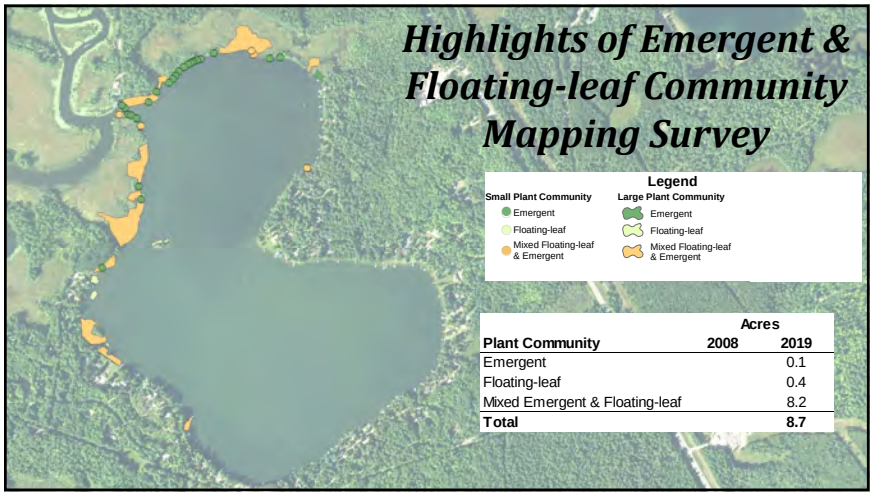

Highlights of Emergent & Floating-leaf Community Mapping Survey
Legend
Small Plant Community
Emergent
Floating-leaf
Mixed Floating-leaf & Emergent
Large Plant Community
Emergent
Floating-leaf
Mixed Floating-leaf & Emergent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Legend
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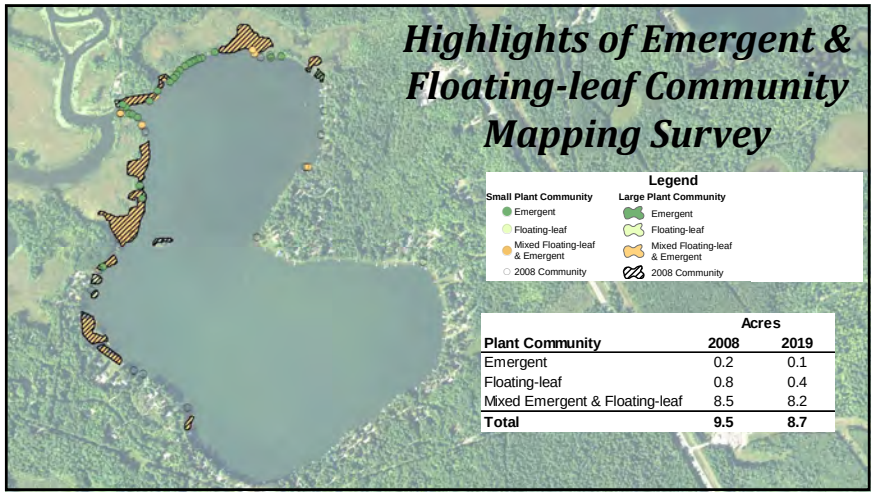
Emergent
Floating-leaf
Mixed Floating-leaf & Emergent
Large Plant Community
Emergent
Floating-leaf
Mixed Floating-leaf & Emergent
Acres
Plant Community 2008 2019
Emergent 0.1
Floating-leaf 0.4
Mixed Emergent & Floating-leaf 8.2
Total 8.7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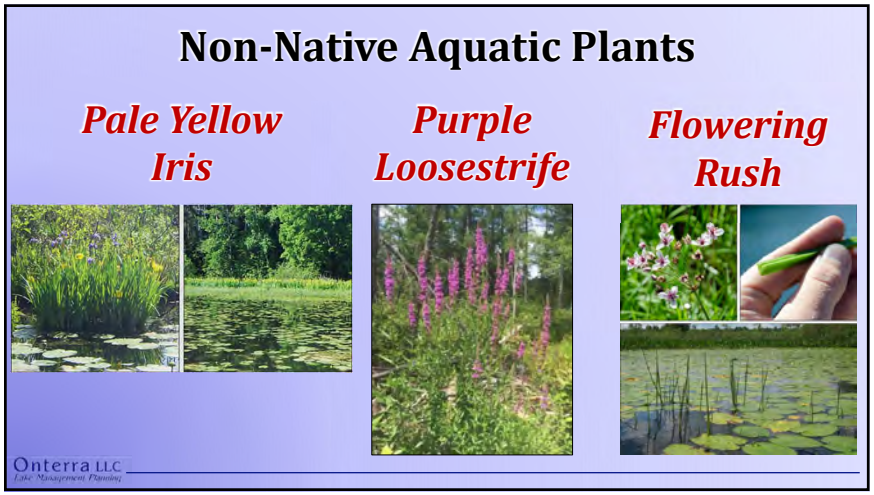
Mixed Floating-leaf & Emergent
2008 Community
Large Plant Community
Emergent
Floating-leaf
Mixed Floating-leaf & Emergent
2008 Community
Acres
Plant Community 2008 2019
Emergent 0.2 0.1
Floating-leaf 0.8 0.4
Mixed Emergent & Floating-leaf 8.5 8.2
Total 9.5 8.7


Non-Native Aquatic Plants
Pale Yellow Iris
Purple Loosestrife
Flowering Rush
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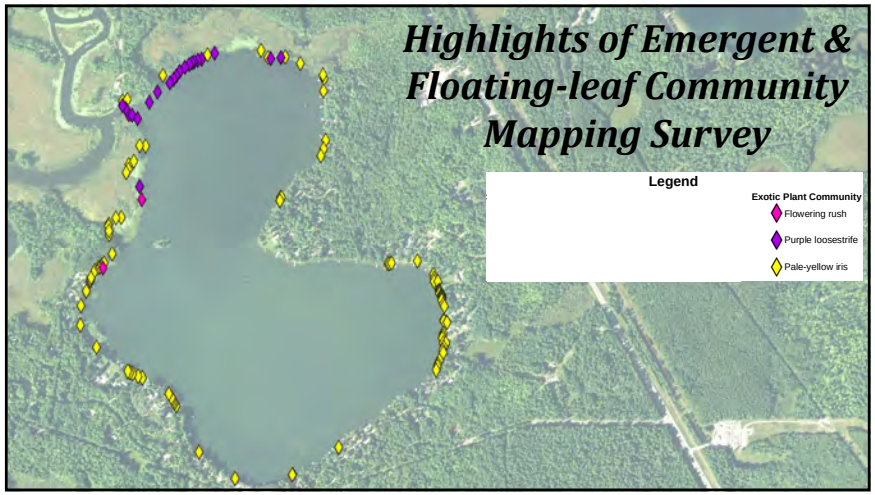
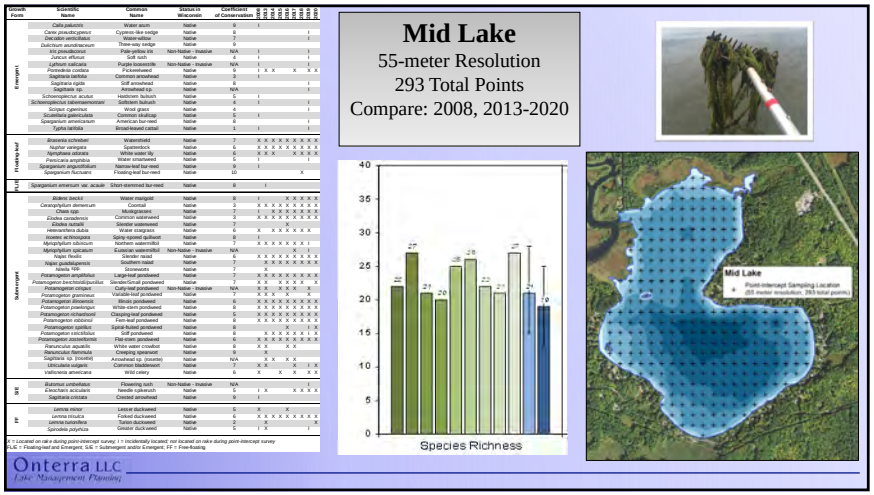
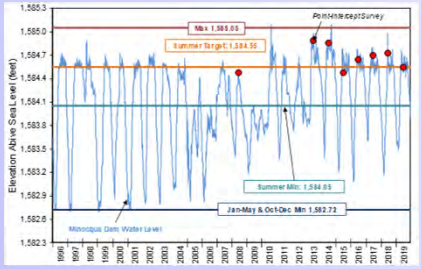




Factors that Impact Aquatic Plants on Mid Lake

- **Natural Environmental Changes**
  - Climactic conditions
  - Water levels
- **Aquatic Plant Management**
  - Mechanical harvesting



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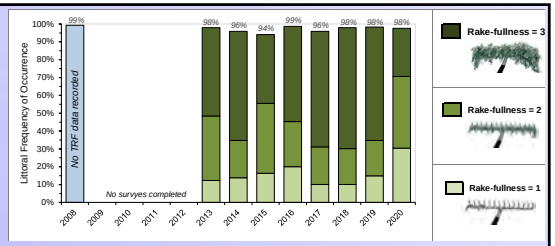
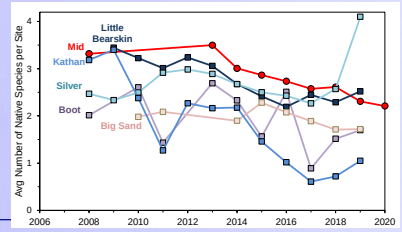
Vegetation Trend Analysis

Mid Lake overall quantity of vegetation has remained between 94-99% over period of study. Slight shift in reduced TRF in 2020



This metric reduced from ~3.5 in 2012 to slightly above 2 in 2020. Similar trends on several other area lakes



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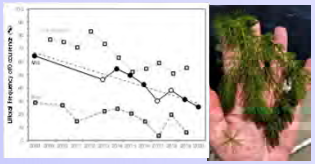
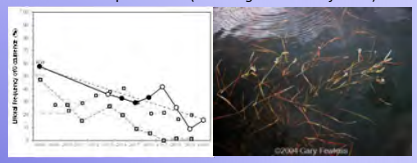
Vegetation Trend Analysis

Slender & Southern naiad (*Najas flexilis & N. guadalupensis*)

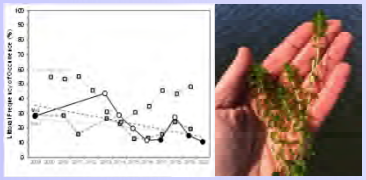
Coontail (*Ceratophyllum demersum*)



Flat-stem pondweed (*Potamogeton zosteriformis*)



Common waterweed (*Elodea canadensis*)



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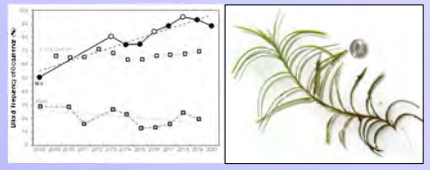
Vegetation Trend Analysis

Fern-leaf pondweed (*Potamogeton robbinsii*)



Forked duckweed (*Lemna trisulca*)

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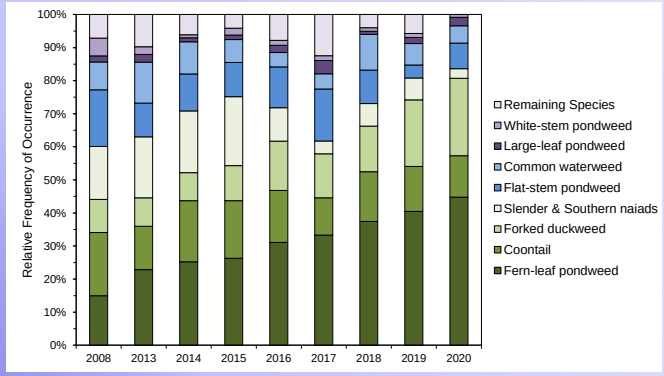
Vegetation Trend Analysis



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Vegetation Trend Analysis

Scientific Name	Common Name	Mean Summer Air Temp (°F)	Avg Daily Snow Depth (in)	Mean Summer Total Phosphorus (µg/L)	Mean Summer Chlorophyll-α (µg/L)	Mean Summer Secchi Disk Depth (ft)
Ceratophyllum demersum	Coontail	-0.64	0.37	0.62	0.87	-0.73
Elodea canadensis	Common waterweed	-0.23	0.51	-0.19	0.57	-0.44
Lemna trisulca	Forked duckweed	0.18	-0.47	0.04	-0.14	0.08
Najas guadalupensis	Southern naiad	-0.65	0.37	0.30	0.72	-0.55
Potamogeton amplifolius	Large-leaf pondweed	-0.22	-0.66	0.02	0.26	-0.44
Potamogeton praelongus	White-stem pondweed	-0.64	-0.03	0.61	0.97	-0.88
Potamogeton pusillus	Small pondweed	-0.26	-0.45	0.50	0.68	-0.79
Potamogeton robbinsii	Fern-leaf pondweed	0.81	-0.20	-0.65	-0.88	0.75
Potamogeton zosteriformis	Flat-stem pondweed	-0.52	-0.11	0.73	0.90	-0.94

r value

-1 0 1

Strong Negative Correlation — No Correlation — Strong Positive Correlation

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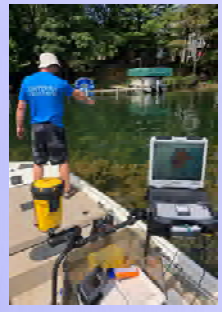
Professional AIS Mapping



Point-Based Mapping

- Single or Few Plants
- Clumps of Plants
- Small Plant Colony

Polygon-Based Mapping

- Highly Scattered
- Scattered
- Dominant
- Highly Dominant
- Surface Matting

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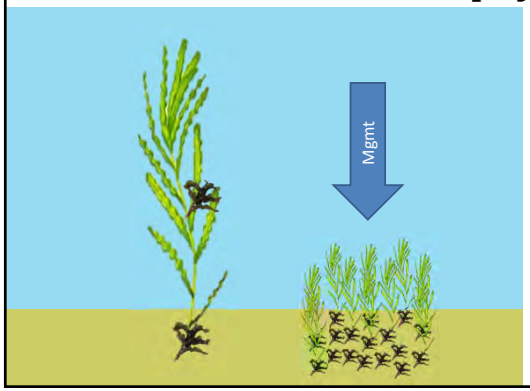
Non-Native Aquatic Plants

Curly-Leaf Pondweed

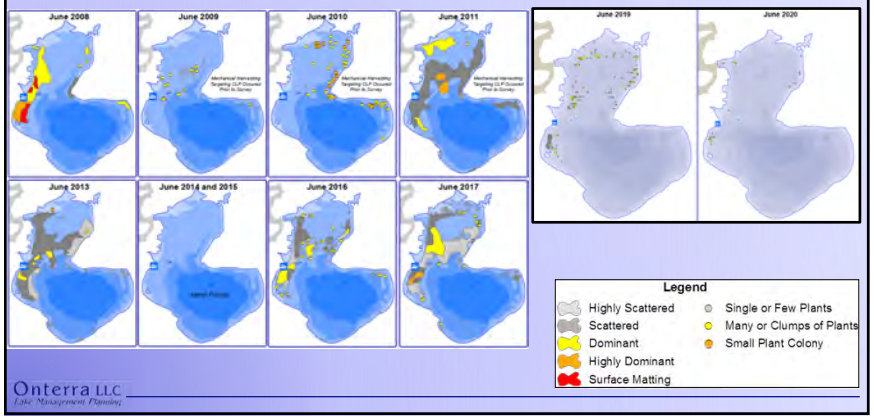
- **First "officially" documented in 1979**
- **Point-intercept surveys timed in late-June before CLP senescence occurs, but still capture native plant abundances**

CLP Life-Cycle & Control Strategy Philosophy



- Established populations typically have 5-10 years of viable turions in sediment
- Unless documented ecological impacts, established populations not targeted for lake-wide management
- Dies off around July 4th

CLP Population



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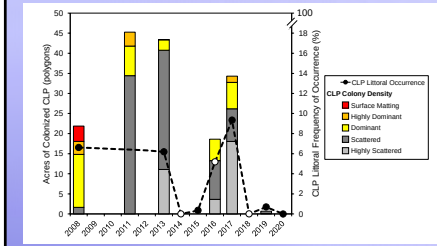
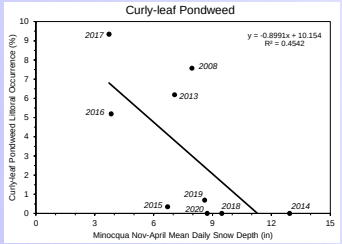
CLP Population





CLP populations appear to be impacted by previous winter's snow depth

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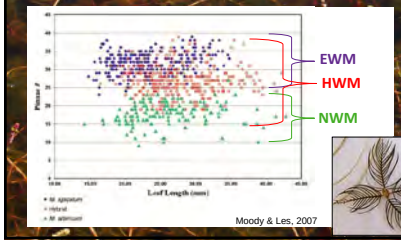
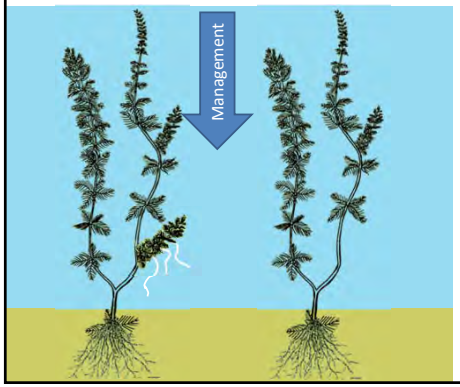
Non-Native Aquatic Plants
Eurasian Watermilfoil

- First "officially" documented in 2011, but in Minocqua Chain for at least a decade earlier
- Single hybridity test (2013) indicates pure-strain EWM (not hybrid)
- Pure strain & hybrid strains documented from Minoc Chain.



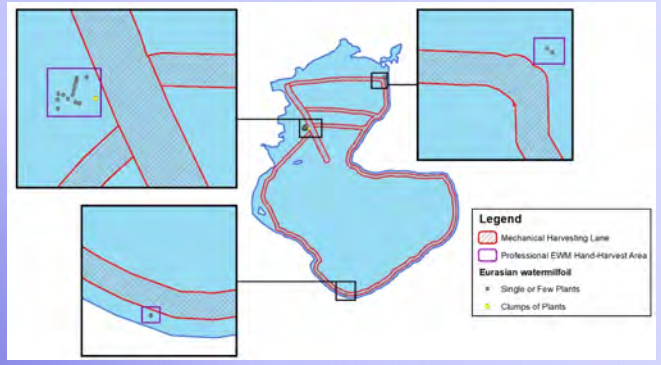
EWM Life-Cycle & Control Strategy Philosophy



- Strategy is straight-forward compared to CLP management
- Herbicide needs to translocate to root crown (*hard to kill with herbicides*)
- Hand-harvesting is analogous to single treatment (*extremely time intensive)*
- Winter drawdown can be effective if completely de-water and desiccate/freeze roots.

2019 EWM Population

None found in 2020



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AIS Management Perspectives

1. **No Coordinated Active Management (Let Nature Take its Course)**
   - Focus on education of manual removal by property owners
2. **Reduce AIS Population on a lake-wide level (Population Management)**
   - Would likely rely on herbicide treatment and/or winter drawdown (risk assessment)
   - Will not "eradicate" AIS
   - Set triggers (thresholds) of implementation and tolerance
3. **Minimize navigation and recreation impediment (Nuisance Control)**
   - May be accomplished through hand-harvesting or mechanical harvesting

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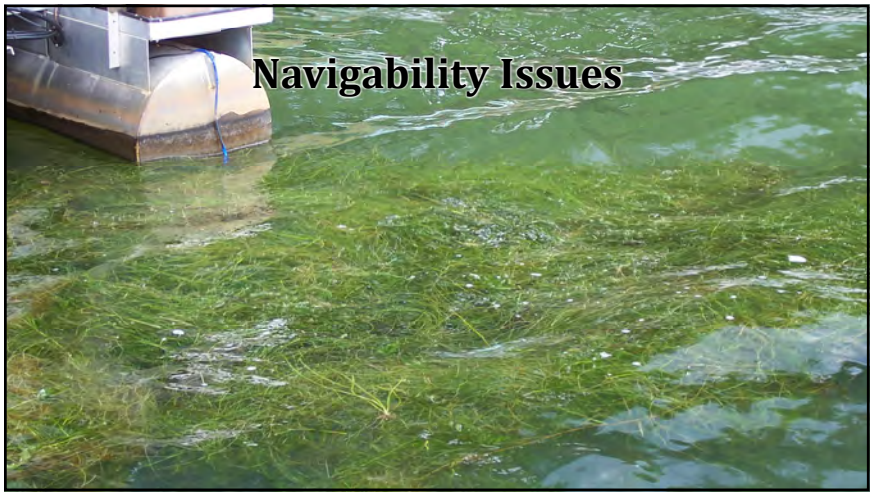
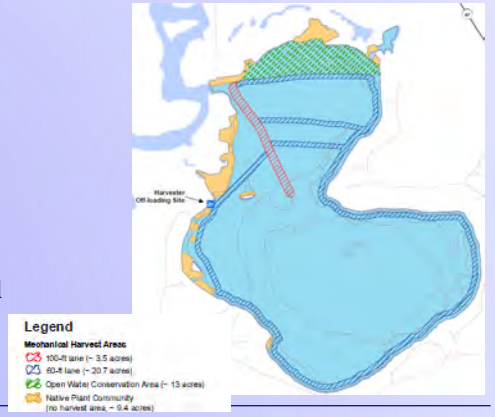


Mechanical Harvesting Plan

- No harvest before June 1
- Submersed plants only
- Harvest of CLP is acceptable
- Permit (w/map) on board
- Limited to areas on map
- Minimize fish bi-catch
- Recording/reporting required
- Disinfection procedures
- Multi-year permit w/ *Plan*



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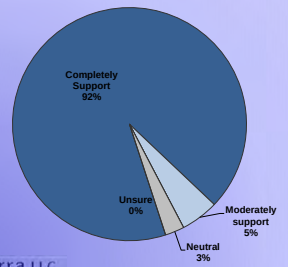
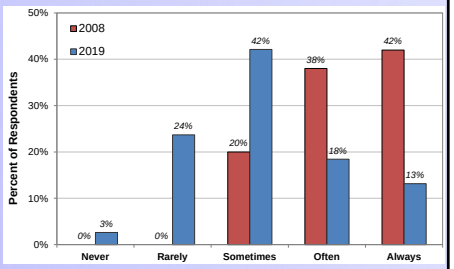
Stakeholder Perceptions of Mechanical Harvesting

45% Response Rate

How do you feel about the past use of mechanical harvesting to control nuisance aquatic plants in previous years?



During open water season how often does aquatic plant growth negatively impact your enjoyment of Mid Lake?



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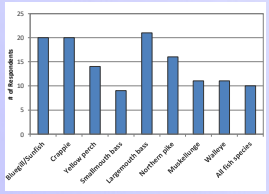
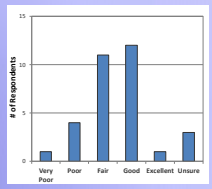
Stakeholder Perceptions of Fisheries

45% Response Rate

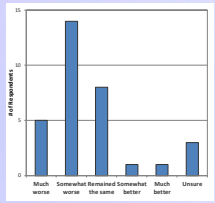
What species of fish do you like to catch on Mid Lake?



How would you describe the current quality of fishing on Mid Lake?



How has the quality of fishing changed on Mid Lake since you started fishing the lake?



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Fisheries Data

Walleye	Population reduction in recent years, cease all harvest since 2014.
Muskellunge	Thought to utilize Mid Lake, particularly the northern part of the lake for spawning. A1 – potential for trophy fish are high
Northern Pike	Considered present
Bass	Largemouth are most prevalent gamefish in – ave 13 in (8-17.7 in)
Panfish	Pumpkinseed most common, bluegill common, hybrid BG x PS present. Yellow perch and black crappie also present.

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4.0 Initial Conclusions

Water Quality, Watershed, Shoreland

- Overall "excellent" for Shallow Headwater Drainage Lake
- Small watershed, but in relatively good condition
- Additional TP from CLP senescence and backflow from Thoroughfare
- Shoreland protection and enhancement important to long-term health

Aquatic Plants

- Changes in native plant metrics have been observed, changes in where aquatic plants exist in water column
- "Let nature take its course" for CLP, eradication strategy for EWM
- Relatively high abundance of wetland emergent AIS
- Navigation impediments exists, but reduced in recent years

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Planning Meeting II

Primary Objective: Create implementation plan framework

Steps to Achieve Objective:

1. Discuss challenges facing lakes and lake groups
2. Convert challenges to management goals
3. Create management actions to meet management goals
4. Determine timeframes and facilitators to carry out actions

Assignment for Planning Meeting II

1. Create list of challenges facing lake and lake group (keep to yourself)
2. Review stakeholder survey results
3. Send potential report section edits and questions to Onterra

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Thank You

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B

APPENDIX B

2019 Riparian & MLPMD Member Stakeholder Survey Response Charts & Comments

Mid Lake - Anonymous Stakeholder Survey

Surveys Distributed: 88
Surveys Returned: 40
Response Rate: 45%

Mid Lake Property

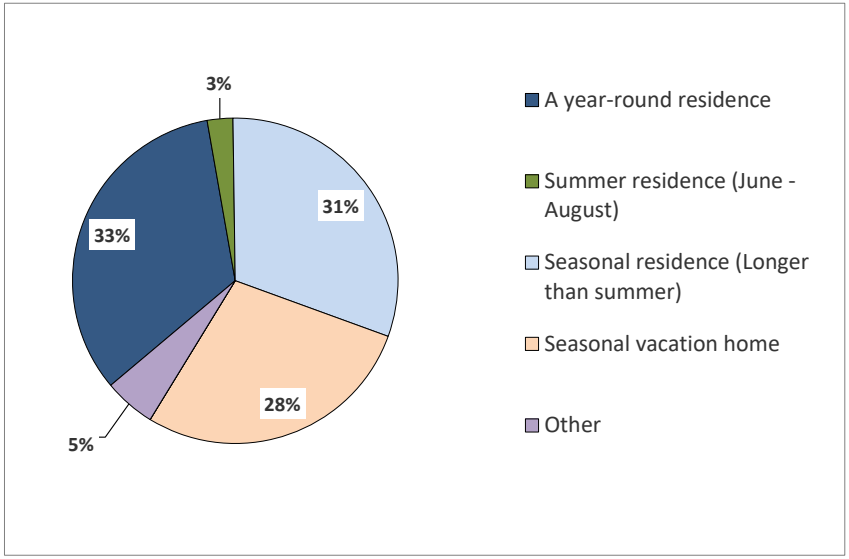
1. Is your property on the lake or off the lake? Please select one choice.

Answer Options	Response Percent	Response Count
On the lake	100.0%	39
Off the lake	0.0%	0
answered question		39
skipped question		1

2. How is your property on Mid Lake utilized?

Answer Options	Response Percent	Response Count
A year-round residence	33.3%	13
Summer residence (June - August)	2.6%	1
Seasonal residence (Longer than summer)	30.8%	12
Seasonal vacation home	28.2%	11
Resort property	0.0%	0
Rental property	0.0%	0
Undeveloped	0.0%	0
Other	5.1%	2
answered question		39
skipped question		1

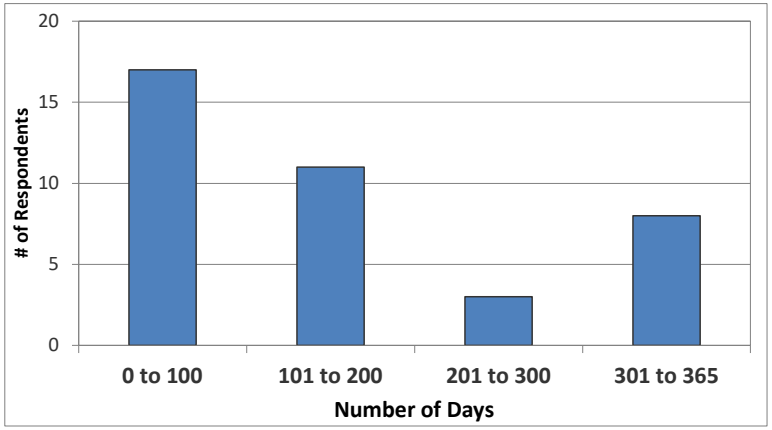
Number	Other (please specify)
1	Year-round vacation home
2	Used all year by all members of our family... on long weekends and vacations.



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

Answer Options	Response Count
	39
answered question	39
skipped question	1

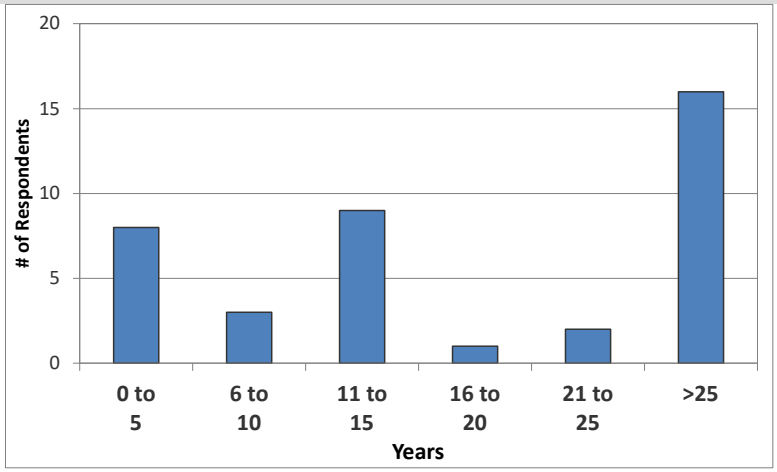
Category (# of days)	Responses	
0 to 100	17	44%
101 to 200	11	28%
201 to 300	3	8%
301 to 365	8	21%



4. How long have you owned your property on or near Mid Lake?

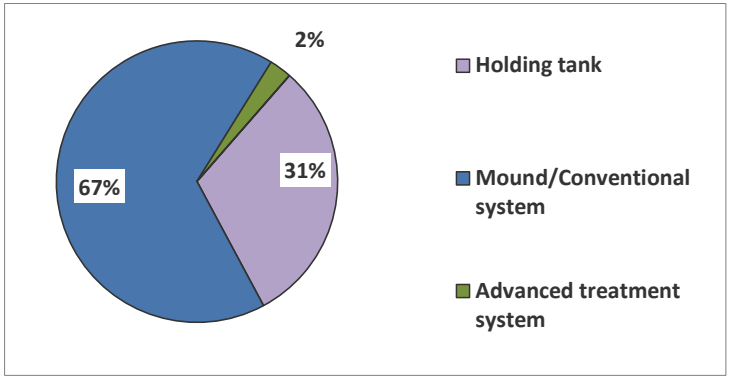
Answer Options	Response Count
	39
answered question	39
skipped question	1

Category (# of years)	Responses	% Response
0 to 5	8	21%
6 to 10	3	8%
11 to 15	9	23%
16 to 20	1	3%
21 to 25	2	5%
>25	16	41%



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

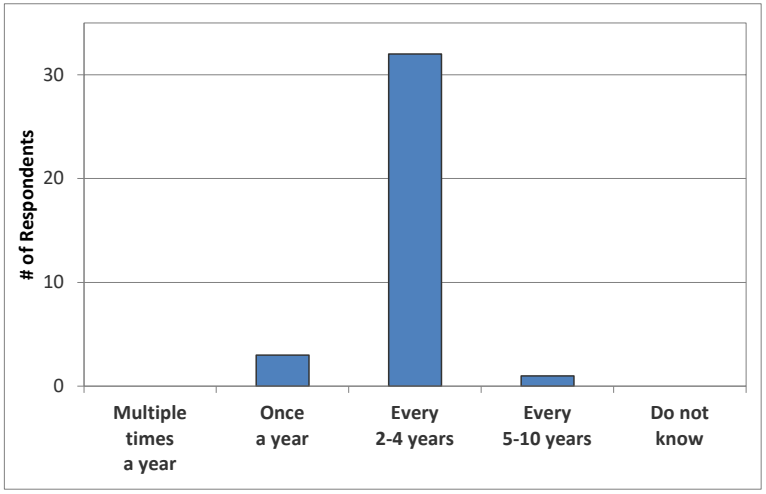
Answer Options	Response Percent	Response Count
Holding tank	30.8%	12
Municipal sewer	0.0%	0
Mound/Conventional system	66.7%	26
Advanced treatment system	2.6%	1
Do not know	0.0%	0
No septic system	0.0%	0
answered question		39
skipped question		1



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

Answer Options	Response Percent	Response Count
Multiple times a year	0.0%	0
Once a year	7.9%	3
Every 2-4 years	84.2%	32
Every 5-10 years	2.6%	1
Do not know	0.0%	0
Other	5.3%	2
answered question		38
skipped question		2

Number	Other (please specify)
1	two systems, one conventional, one tank pumped 5-10
2	Not applicable
3	

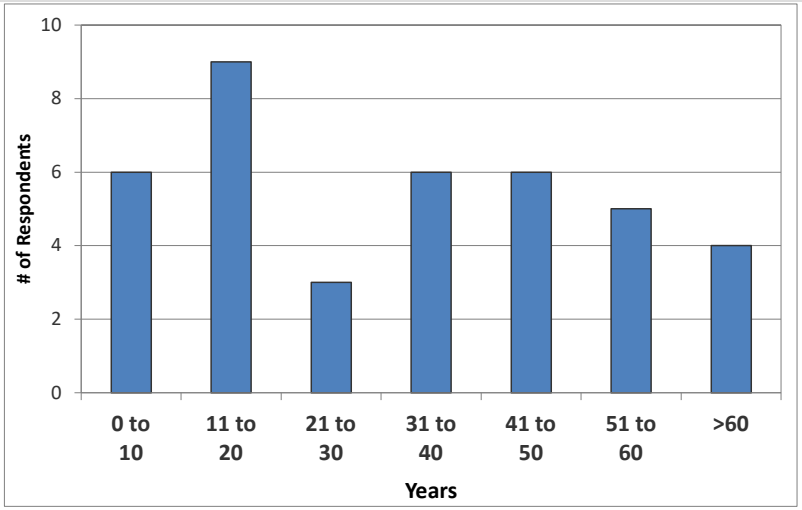


Recreational Activity on Mid Lake

7. How many years ago did you first visit Mid Lake?

Answer Options	Response Count
	39
answered question	**39**
skipped question	**1**

Category (# of years)	Responses	% Response
0 to10	**6**	**15%**
11 to20	**9**	**23%**
21 to30	**3**	**8%**
31 to40	**6**	**15%**
41 to50	**6**	**15%**
51 to60	**5**	**13%**
>60	**4**	**10%**

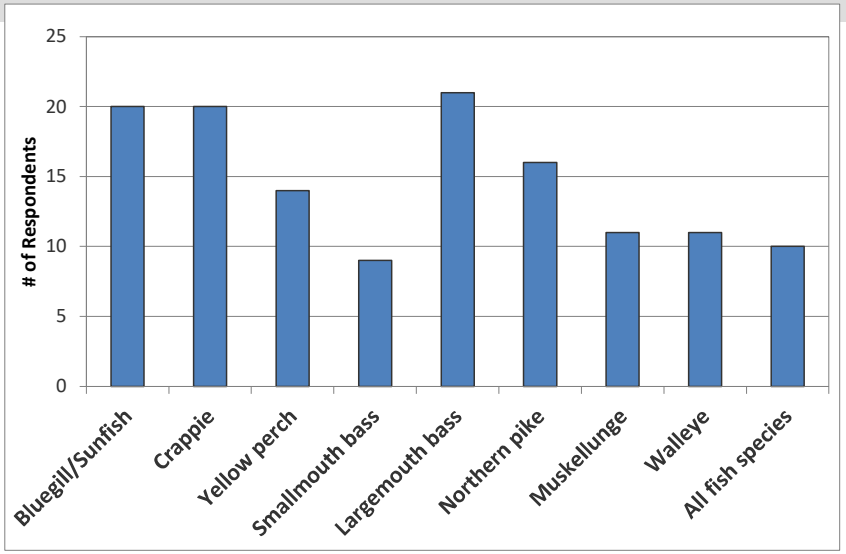


8. Have you personally fished on Mid Lake in the past three years?

Answer Options	Response Percent	Response Count
Yes	84.6%	33
No	15.4%	6
answered question		**39**
skipped question		**1**

9. What species of fish do you like to catch on Mid Lake?

Answer Options	Response Percent	Response Count
Bluegill/Sunfish	60.6%	20
Crappie	60.6%	20
Yellow perch	42.4%	14
Smallmouth bass	27.3%	9
Largemouth bass	63.6%	21
Northern pike	48.5%	16
Muskellunge	33.3%	11
Walleye	33.3%	11
All fish species	30.3%	10
Other	0.0%	0
answered question		33
skipped question		7

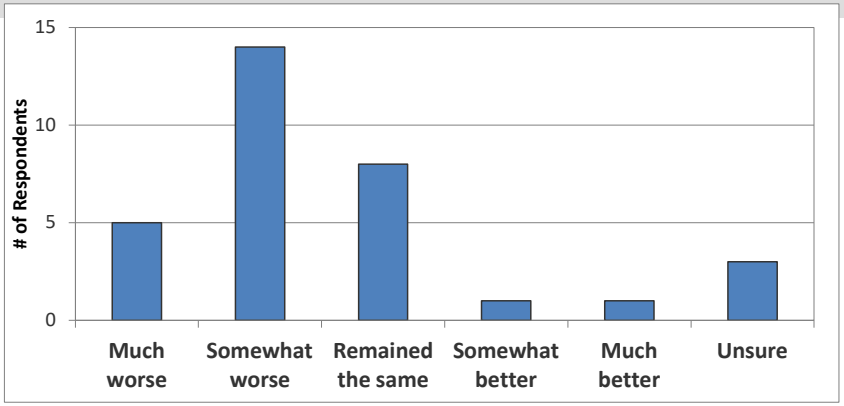


10. How would you describe the current quality of fishing on Mid Lake?

Answer Options	Very Poor	Poor	Fair	Good	Excellent	Unsure	Response Count
	1	4	11	12	1	3	32
answered question							32
skipped question							8

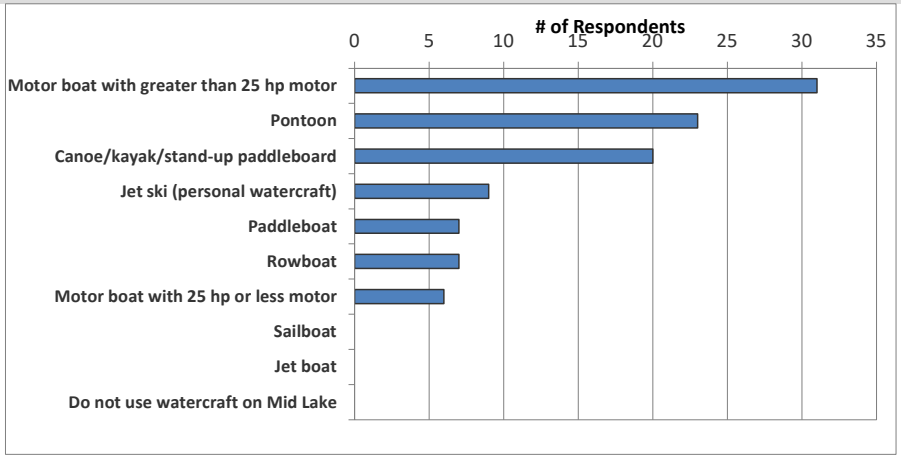
11. How has the quality of fishing changed on Mid Lake since you have started fishing the lake?

Answer Options	Much worse	Somewhat worse	Remained the same	Somewhat better	Much better	Unsure	Response Count
	5	14	8	1	1	3	32
						answered question	**32**
						skipped question	**8**



12. What types of watercraft do you currently use on Mid Lake?

Answer Options	Response Percent	Response Count
Motor boat with greater than 25 hp motor	79.5%	31
Pontoon	59.0%	23
Canoe/kayak/stand-up paddleboard	51.3%	20
Jet ski (personal watercraft)	23.1%	9
Paddleboat	18.0%	7
Rowboat	18.0%	7
Motor boat with 25 hp or less motor	15.4%	6
Sailboat	0.0%	0
Jet boat	0.0%	0
Do not use watercraft on Mid Lake	0.0%	0
answered question		**0**
skipped question		**0**



13. Do you use your watercraft on waters other than Mid Lake?

Answer Options	Response Percent	Response Count
Yes	79.0%	30
No	21.1%	8
answered question		**38**
skipped question		**2**

14. What is your typical cleaning routine after using your watercraft on waters other than Mid Lake?

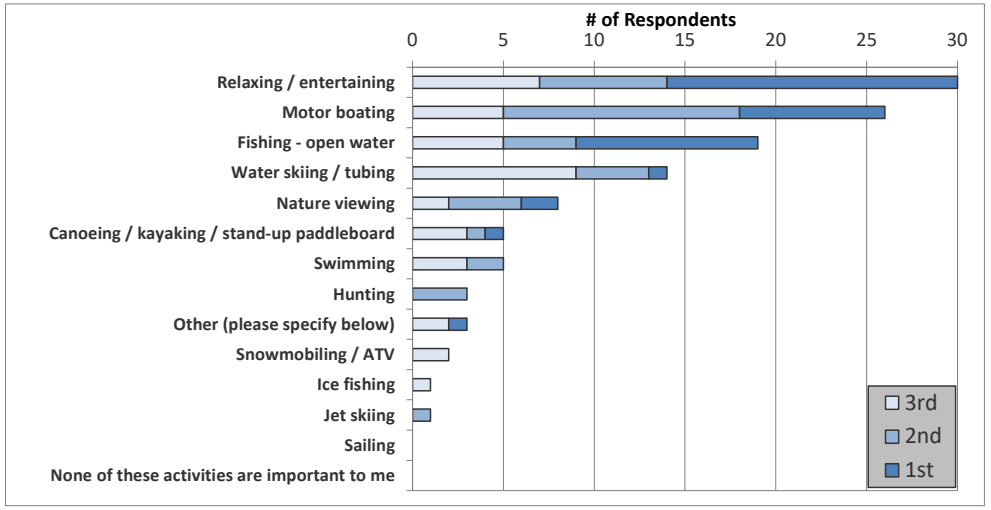
Answer Options	Response Percent	Response Count
Remove aquatic hitchhikers (ex. plant material, clams, mussels)	50.0%	15
Drain bilge	40.0%	12
Rinse boat	20.0%	6
Power wash boat	3.3%	1
Apply bleach	0.0%	0
Air dry boat for 5 or more days	16.7%	5
Do not clean boat	10.0%	3
Other	33.3%	10
answered question		**30**
skipped question		**10**

Number	Other (please specify)
1	only use on lakes in Minocqua chain
2	Plus rinse down with vinegar water
3	Only use on chain
4	commercially cleaned for storage
5	I only use it on the chain. I don't take it out of the water.
6	Stays on MidLake
7	No cleaning...We remain within our chain.
8	I leave mid lake but stay on chain
9	only use the Minocqua Chain
10	Do not leave the Minocqua chain

15. For the list below, rank up to three activities that are important reasons for owning your property on Mid Lake, with 1 being the most important.

Answer Options	1st	2nd	3rd	Weighted Average	Response Count
Relaxing / entertaining	16	7	7	1.7	30
Motor boating	8	13	5	1.88	26
Fishing - open water	10	4	5	1.74	19
Water skiing / tubing	1	4	9	2.57	14
Nature viewing	2	4	2	2	8
Canoeing / kayaking / stand-up paddleboard	1	1	3	2.4	5
Swimming	0	2	3	2.6	5
Hunting	0	3	0	2	3
Other (please specify below)	1	0	2	2.33	3
Snowmobiling / ATV	0	0	2	3	2
Ice fishing	0	0	1	3	1
Jet skiing	0	1	0	2	1
Sailing	0	0	0	0	0
None of these activities are important to me	0	0	0	0	0
			answered question		3
			skipped question		Answered

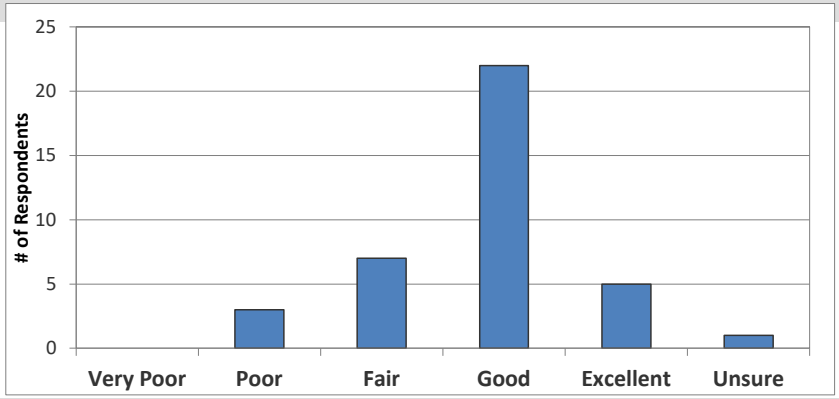
Number	"Other" responses
1	Family Gathering
2	All of the above should be listed
3	Swimming, canoeing/paddle board and boating as well



Mid Lake Current and Historic Condition, Health and Management

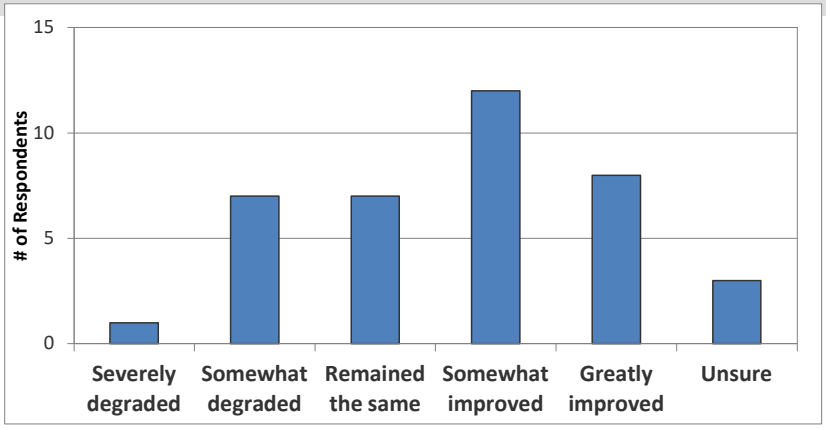
16. How would you describe the overall current water quality of Mid Lake?

Answer Options	Very Poor	Poor	Fair	Good	Excellent	Unsure	Response Count
	0	3	7	22	5	1	38
						answered question	**38**
						skipped question	**2**



17. How has the overall water quality changed in Mid Lake since you first visited the lake?

Answer Options	Severely degraded	Somewhat degraded	Remained the same	Somewhat improved	Greatly improved	Unsure	Response Count
	1	7	7	12	8	3	38
						answered question	**38**
						skipped question	**2**



18. Considering how you answered the questions above, what do you think of when describing water quality?

Answer Options	Response Percent	Response Count
Water clarity	78.4%	29
Aquatic plant growth	81.1%	30
Water color	21.6%	8
Algae blooms	46.0%	17
Smell	27.0%	10
Water level	29.7%	11
Fish kills	21.6%	8
Other	5.4%	2
answered question		37
skipped question		3

Number	"Other" responses
1	Plant life is diminished this year
2	suckers and crayfish have disappeared, snails declining
3	

19. Based on your answer above, which of the following is the single most important aspect when considering water quality?

Answer Options	Response Percent	Response Count
Water clarity	42.1%	16
Aquatic plant growth	44.7%	17
Water color	0.0%	0
Algae blooms	10.5%	4
Smell	0.0%	0
Water level	2.6%	1
Fish kills	0.0%	0
Other	0.0%	0
answered question		38
skipped question		2

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

Answer Options	Response Percent	Response Count
Yes	100.0%	38
No	0.0%	0
answered question		38
skipped question		2

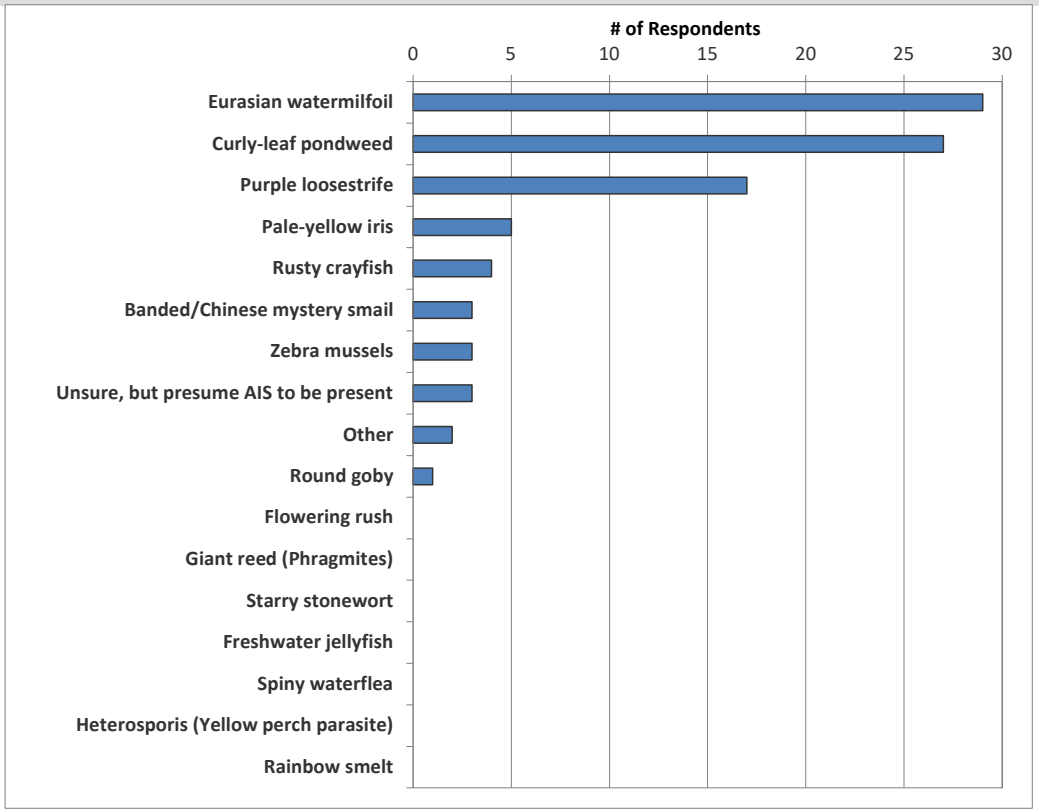
21. Do you believe aquatic invasive species are present within Mid Lake?

Answer Options	Response Percent	Response Count
Yes	71.1%	27
I think so but am not certain	26.3%	10
No	2.6%	1
answered question		38
skipped question		2

22. Which aquatic invasive species do you believe are in Mid Lake?

Answer Options	Response Percent	Response Count
Eurasian watermilfoil	78.4%	29
Curly-leaf pondweed	73.0%	27
Purple loosestrife	46.0%	17
Pale-yellow iris	13.5%	5
Rusty crayfish	10.8%	4
Banded/Chinese mystery smail	8.1%	3
Zebra mussels	8.1%	3
Unsure, but presume AIS to be present	8.1%	3
Other	5.4%	2
Round goby	2.7%	1
Flowering rush	0.0%	0
Giant reed (*Phragmites*)	0.0%	0
Starry stonewort	0.0%	0
Freshwater jellyfish	0.0%	0
Spiny waterflea	0.0%	0
Heterosporis (Yellow perch parasite)	0.0%	0
Rainbow smelt	0.0%	0
Carp	0.0%	0
answered question		**37**
skipped question		**3**

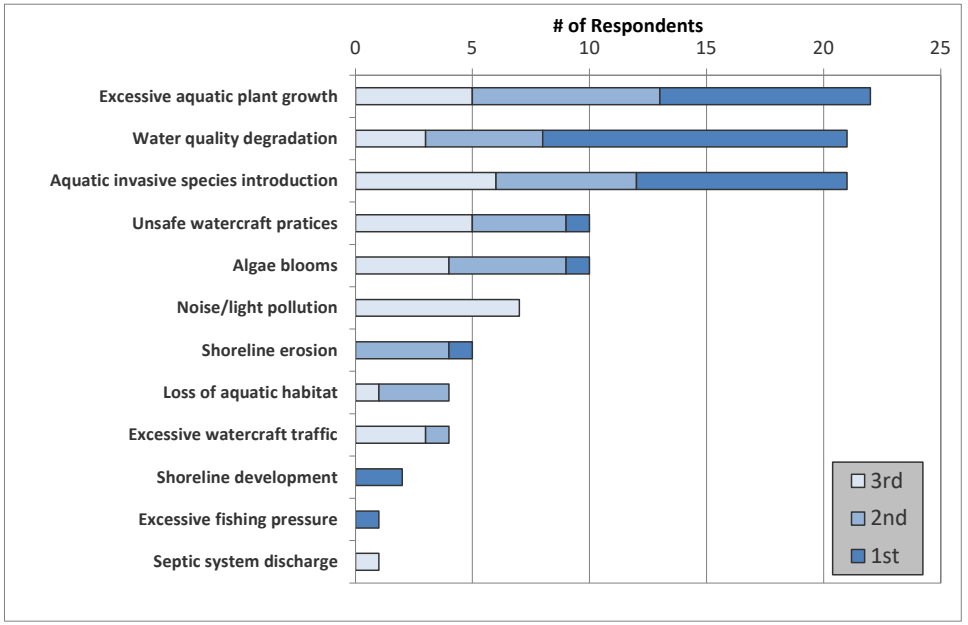
Number	"Other" responses
1	not sure of others
2	We have no clue



23. From the list below, please rank your top three concerns regarding Mid Lake, with 1 being your greatest concern.

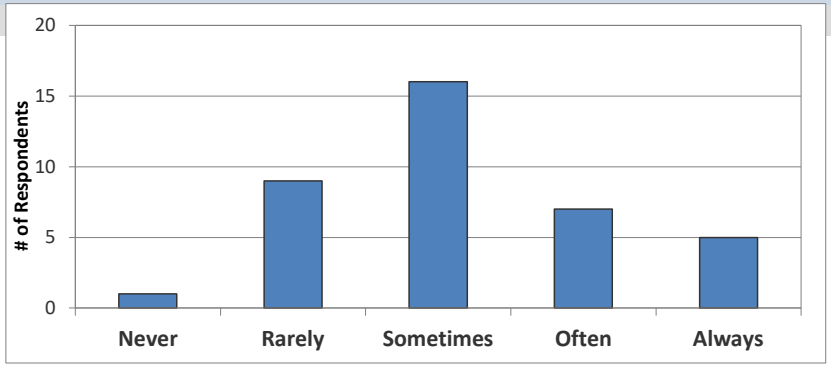
Answer Options		1st	2nd	3rd	Response Count
Excessive aquatic plant growth	(excluding algae)	9	8	5	22
Water quality degradation		13	5	3	21
Aquatic invasive species introduction		9	6	6	21
Unsafe watercraft pratices		1	4	5	10
Algae blooms		1	5	4	10
Noise/light pollution		0	0	7	7
Shoreline erosion		1	4	0	5
Loss of aquatic habitat		0	3	1	4
Excessive watercraft traffic		0	1	3	4
Shoreline development		2	0	0	2
Excessive fishing pressure		1	0	0	1
Septic system discharge		0	0	1	1
Other (please specify)		0	1	0	1
				answered question	**37**
				skipped question	**3**

Number	"Other" responses
1	again all of the above/anything that affects lake quality
2	I'm concerned that our weeds are no longer picked up on a regular basis.



24. During open water season how often does aquatic plant growth (excluding algae) negatively impact your enjoyment of Mid Lake?

Answer Options	Never	Rarely	Sometimes	Often	Always	Response Count
	1	9	16	7	5	38
					answered question	38
					skipped question	2

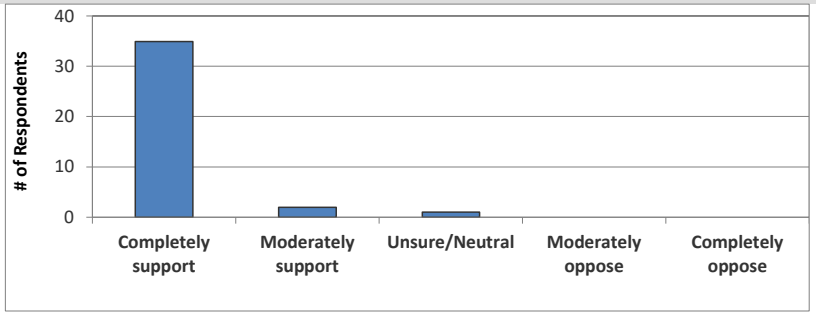


25. Before the present year, mechanical harvesting has been used to control nuisance aquatic plants (excludes algae) on Mid Lake. Prior to reading this information, were you aware mechanical harvesting had been occurring on Mid Lake?

Answer Options	Response Percent	Response Count
Yes	100.0%	38
I think so but can't say for certain	0.0%	0
No	0.0%	0
answered question		38
skipped question		2

26. How do you feel about the past use of mechanical harvesting to control nuisance aquatic plants in previous years?

Answer Options	Response Percent	Response Count
Completely support	92.1%	35
Moderately support	5.3%	2
Unsure/Neutral	2.6%	1
Moderately oppose	0.0%	0
Completely oppose	0.0%	0
answered question		38
skipped question		2



LakeGroup (Mid Lake Protection and Management District)

27. Before receiving this mailing, had you ever heard of the Mid Lake Protection and Management District?

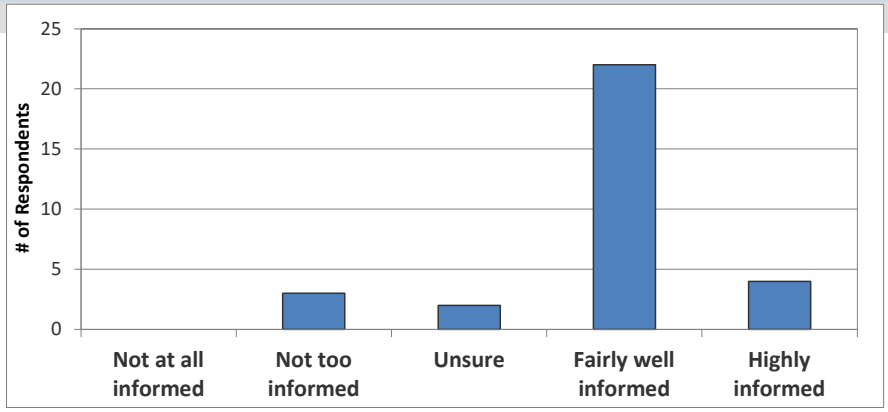
Answer Options	Response Percent	Response Count
Yes	92.1%	35
No	7.9%	3
answered question		**38**
skipped question		**2**

28. What is your membership status with the Mid Lake Protection and Management District?

Answer Options	Response Percent	Response Count
Current member	90.9%	30
Former member	0.0%	0
Never been a member	9.1%	3
answered question		**33**
skipped question		**7**

29. How informed has (or had) the Mid Lake Protection and Management District kept you regarding issues with Mid Lake and its management?

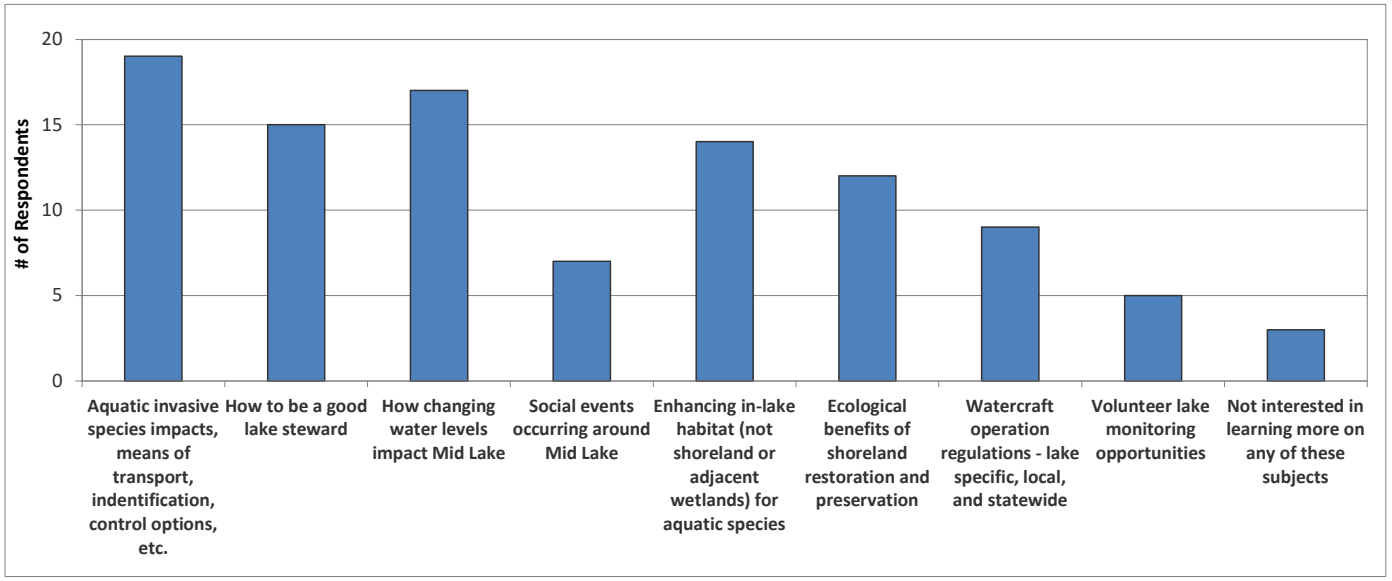
Answer Options	Answer Options	Not at all informed	Not too informed	Unsure	Fairly well informed	Highly informed	Response Count
		0	3	2	22	4	31
					answered question		**31**
					skipped question		**9**



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

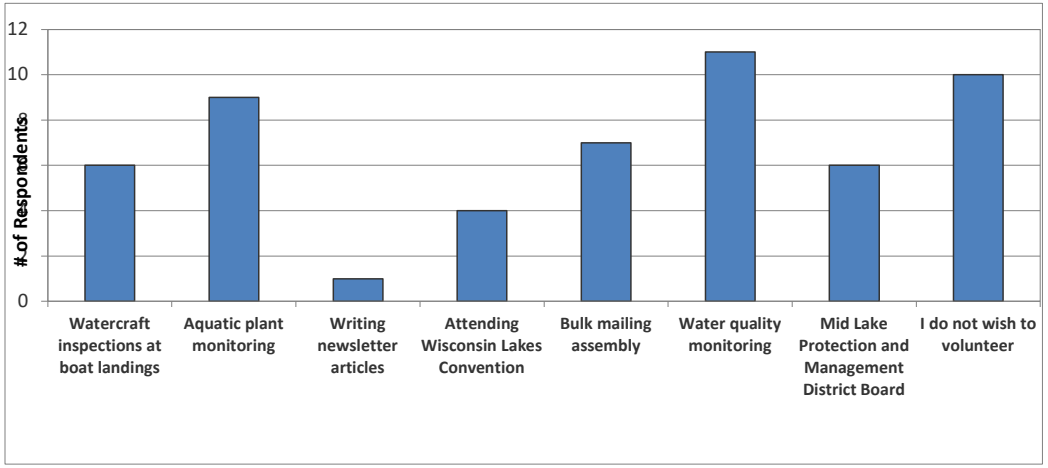
Answer Options	Response Percent	Response Count
Aquatic invasive species impacts, means of transport, indentification, control options, etc.	52.8%	19
How to be a good lake steward	41.7%	15
How changing water levels impact Mid Lake	47.2%	17
Social events occurring around Mid Lake	19.4%	7
Enhancing in-lake habitat (not shoreland or adjacent wetlands) for aquatic species	38.9%	14
Ecological benefits of shoreland restoration and preservation	33.3%	12
Watercraft operation regulations - lake specific, local, and statewide	25.0%	9
Volunteer lake monitoring opportunities (clean Boats Clean Waters, Citizens Lake Monitoring Network, Loon Watch, LakeGroup programs, etc.)	13.9%	5
Not interested in learning more on any of these subjects	8.3%	3
Some other topic	5.6%	2
	answered question	**36**
	skipped question	**4**

Number	Other (please specify)
1	All of the above
2	Lake user conflicts



31. The effective management of Mid Lake will require the cooperative efforts of numerous volunteers. Please circle the activities you would be willing to participate in if the Mid Lake Protection and Management District requires additional assistance.

Answer Options	Response Percent	Response Count
Watercraft inspections at boat landings	17.1%	6
Aquatic plant monitoring	25.7%	9
Writing newsletter articles	2.9%	1
Attending Wisconsin Lakes Convention	11.4%	4
Bulk mailing assembly	20.0%	7
Water quality monitoring	31.4%	11
Mid Lake Protection and Management District	17.1%	6
I do not wish to volunteer	28.6%	10
answered question		35
skipped question		5



32. Please feel free to provide written comments concerning Mid Lake, its current and/or historic condition and its management.

Answer Options	Response Count
	19
answered question	19
skipped question	21

Number	Response Text
1	The lake should be "slow no wake" mornings.
2	Fishermen should not be allowed to cast at docked boats or piers. They should be at least 25' away from there or more. They should respect owner's privacy. We have had this problem several times. These young men have told us they can do anything they want on the lake. We are five generations starting in 1945 at the same home.
3	I was President of the District for 9 years and am very familiar with Mid Lake and its former problems. I have been on the lake since 1960 and my wife's family built the place in 1931. We have been on the lake a long time. Improvement of the water quality and lack of weeds the last few years is even a mystery to the DNR. I have one suggestion. Officers of the Mid Lake District should be persons who live on Mid Lake for at least the entire summer and 5-6 months or a preference.
4	I support our lake association. I was an officer for nine years and tested the water for ten. I would help again if an emergcy occurred.
5	The current board has done a great job stabilizing funds for future needs and purchasing the new harvester. We would like lake quality updates more often than the July meeting. We would also like weed clean up to begin in June not 4th of July weekend or after.

6	We believe the current board is doing a nice job of managing the issues before the lake association. Keep up the good work.
7	I have seen great improvement in the water quality over the last couple years, particularly this current year. The weeds seem to be well under control. I am concerned over the size and horsepower of the boats using the lake. The lake is too small for the size of some of these crafts and is really taking its toll on our shoreline. Is there something that can be done to control this in some way?
8	I have been witness to many years on Mid Lake. Weeds have almost always been a problem at times, especially on the Northeast end. Herbicide treatment was done but I'm afraid that is not the answer. Mechanical harvesting seems to be the most effective means by which to control nuisance weeds. However, presently I'm more concerned as to why there seems to be less weeds in our lake and this pattern has gone on now for the last couple of years. I think we need to know more information as to why this has and is occurring. I fear it could be a sign of another problem. Could boat traffic, especially "wakeboard boats" disturbing the shore lines, jet skis, or water quality be somewhat responsible because of our mean depth of about 6 feet? Many years ago the weeds in the northeast section made boat traffic almost impossible. Today I see a significant reduction. I'm somewhat worried about shallow lake sedimentary problems if too much weed loss is occurring. Perhaps it may be weather related. In conclusion I guess the future will tell and think mechanical harvesting should continue to be our best remedy. I'm totally against "herbicide treatment" and have many reasons for my saying so.
9	District Board is doing a good job however the mil rate is too high considering the amount of money on account. Mil rate should have been lowered considering this extreme excess. Property owners need to be more considerate when operating their boats. Too many high powered boats creating massive wakes and waves. Mid lake is not the peaceful place it once was. Too many illegal fireworks before, during and after the 4th of July. Not enough people willing to help with shore pickup, same faces at annual meeting, which I would say represents less than half owners. More people need to become involved.
10	We bought a new Harvester and Elevator. Why the same striking blue color and not a natural blend in color i.e. brown or green.
11	The weeds are a problem. When we fish, we sink the anchor and pounds of muck and weeds have to be hauled up with it which is difficult and filthy and ruins the fishing experience.
12	the weed level in the lake is down. it has been declining for the last 2 years. while this is great for recreational activities, it is reducing the habitat/cover for fish and small fry. it would be interesting to find out the cause. if the lake becomes barron it will be devestating to the fisherie. One thought/possible cause is the increased popularity of Wake boats. These boats are large and are opporated at a pitch of 10 to 15 degrees... this combined with the 15 degree pitch of the drive make an effective bottom blaster in waters under 10 feet deep (most of Mid Lake). I believe this agitating of the bottom is a prime cause of the reduction of vegetation. It would be interesting to find out if this is the case...
13	Question #31 could have included the element, "attend annual lake association meeting", to promote more vigorous attendance. Encourage adoption of natural shoreland buffers to improve the health and aesthetics of the lake.
14	Thank you to the board for all the efforts you make to protect our lake. We appreciate it!!
15	owning our own weed harvesting equipment has made a tremendous difference in the lake.
16	Wave-runners, wake boats, heavy boat traffic, no consideration of rules or courtesy, noisy boats, loud music, fireworks, algae, etc. Getting worse every year
17	We have experienced dramatic improvement of MidLake water quality , quality of life and property value increase over the last 47 years. KUDOS to those responsible.
18	I would recommend that we get back on a consistent schedule of picking up weeds on Saturday morning. We get a lot of weeds on the north end of the lake and we are vigilant about cleaning out our area. It was great that they were picked up regularly. I don't understand what happened and why this was discontinued. I haven't seen the weed cutter out much this year and am baffled as to why. We just purchased the new machine and we should be using it. Keeping Mid Lake as clean as we can only enhances our lake and keeps home values up. The north end is the weediest part of the lake and it needs attention. I would have rather kept the mill rate where it was and keep the level of service where it was the past few years.
19	Concerned about aquatic plant growth in the lake, seems like it has increased significantly. In addition to mechanical, chemical options should be reviewed.

C

APPENDIX C

Water Quality Data Summary

	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
2001	1	9.0	1	9.0	1	6.5	1	6.5	1	29.0	1.0	29.0
2002	0		0		0		0		0		0.0	
2003	2	7.5	1	8.0	1	2.8	1	2.8	2	25.5	1.0	31.0
2004	7	6.5	2	6.0	0		0		0		0.0	
2005	0		0		0		0		0		0.0	
2006	0		0		0		0		0		0.0	
2007	0		0		3	7.0	3	7.0	4	33.0	4.0	33.0
2008	3	6.7	1	3.8	3	17.0	1	22.0	3	34.3	1.0	40.0
2009	6	7.5	5	7.7	3	8.6	3	8.6	4	33.3	3.0	31.3
2010	4	7.4	4	7.4	3	8.0	3	8.0	3	27.0	3.0	27.0
2011	3	8.5	2	8.3	3	8.5	3	8.5	4	25.3	3.0	25.7
2012	4	8.6	3	8.3	3	6.0	3	6.0	4	22.8	3.0	24.3
2013	4	6.5	3	5.5	3	13.5	3	13.5	4	21.6	3.0	21.1
2014	4	7.8	3	7.2	3	9.2	3	9.2	4	27.7	3.0	27.7
2015	3	6.7	3	6.7	3	10.7	3	10.7	3	33.4	3.0	33.4
2016	4	6.8	3	6.0	3	8.5	3	8.5	3	32.4	3.0	32.4
2017	3	6.3	3	6.3	3	8.9	3	8.9	3	30.7	3.0	30.7
2018	3	7.0	3	7.0	3	7.5	3	7.5	3	28.4	3.0	28.4
2019	5	8.2	3	8.3	6	6.0	4	5.0	7	22.8	4.0	22.1
All Years (Weighted)		7.3		7.1		8.8		8.5		27.9		28.5
SLDL Median				5.6				9.4				33.0
NLF Ecoregion Median				8.9				5.6				21.0

D

APPENDIX D

Point-Intercept Aquatic Macrophyte Survey Data

	Scientific Name	Common Name	LFOO (%)								
			2008	2013	2014	2015	2016	2017	2018	2019	2020
Dicots	*Ceratophyllum demersum*	Coontail	64.5	46.4	54.5	49.7	42.6	30.1	38.2	31.3	25.6
	Nuphar variegata	Spatterdock	1.0	1.7	1.0	2.1	1.7	1.4	1.4	1.7	2.1
	Myriophyllum sibiricum	Northern watermilfoil	1.4	1.4	1.7	1.0	0.3	1.0	0.3	0.0	0.0
	Brasenia schreberi	Watershield	0.7	1.4	0.7	0.3	0.7	1.0	0.3	1.0	0.3
	Ranunculus aquatilis	White water crowfoot	2.4	1.4	0.0	0.0	0.7	1.4	0.0	0.0	0.0
	Nymphaea odorata	White water lily	0.7	0.3	0.7	0.0	0.0	0.7	0.3	1.0	0.3
	Bidens beckii	Water marigold	0.0	0.0	0.0	0.0	0.3	0.7	0.7	0.3	0.3
	Utricularia vulgaris	Common bladderwort	0.3	0.7	0.0	0.0	0.0	0.7	0.0	0.0	0.0
	Utricularia purpurea	Large purple bladderwort	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
	Myriophyllum spicatum	Eurasian watermilfoil	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0
	Myriophyllum heterophyllum	Various-leaved watermilfoil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
	Ranunculus flammula	Creeping spearwort	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-dicots	*Potamogeton robbinsii*	Fern-leaf pondweed	50.5	80.8	74.7	75.0	84.4	88.6	95.1	93.1	88.6
	Lemna trisulca	Forked duckweed	33.8	30.2	25.0	30.2	40.5	35.3	35.1	46.2	48.1
	Najas flexilis & N. guadalupensis	Slender & Southern naiads	54.0	65.3	55.2	59.4	27.3	10.4	17.4	15.3	5.9
	Potamogeton zosteriformis	Flat-stem pondweed	57.8	36.1	33.0	29.5	33.6	41.9	25.7	9.0	15.9
	Najas guadalupensis	Southern naiad	0.0	56.0	53.8	57.3	27.0	9.3	17.0	13.2	5.5
	Elodea canadensis	Common waterweed	28.2	43.6	28.8	19.8	11.8	12.1	27.4	14.9	10.7
	Najas flexilis	Slender naiad	54.0	11.3	3.5	2.4	0.3	1.0	0.7	2.8	0.3
	Potamogeton amplifolius	Large-leaf pondweed	6.3	8.2	3.5	3.8	5.9	10.7	2.4	4.2	5.2
	Potamogeton praelongus	White-stem pondweed	18.1	8.2	2.8	5.9	4.2	3.8	2.8	2.8	1.7
	Potamogeton berchtoldii, P. pusillus, & P. strictifolius	Narrow-leaved pondweeds	5.6	10.7	4.9	3.5	4.2	7.6	3.5	0.0	1.7
	Potamogeton crispus	Curly-leaf pondweed	6.6	6.2	0.0	0.3	5.2	9.3	0.0	0.7	0.0
	Potamogeton pusillus	Small pondweed	5.6	3.4	0.0	1.7	1.7	5.2	2.4	0.0	1.0
	Potamogeton strictifolius	Stiff pondweed	0.0	7.6	4.9	1.7	2.4	2.4	1.0	0.0	0.3
	Potamogeton illinoensis	Illinois pondweed	1.4	2.1	1.4	1.0	1.4	2.8	0.3	3.5	1.4
	Potamogeton richardsonii	Clasping-leaf pondweed	1.4	1.4	1.0	2.1	0.3	1.0	1.4	0.7	1.7
	Filamentous algae	Filamentous algae	0.0	2.1	3.1	0.0	1.7	0.7	0.0	0.0	1.0
	Vallisneria americana	Wild celery	0.7	0.0	0.0	0.3	0.0	1.0	0.0	1.7	1.7
	Heteranthera dubia	Water stargrass	1.0	0.0	0.7	1.0	1.0	1.4	1.4	0.7	0.0
	Chara spp.	Muskgrasses	0.0	0.0	1.7	0.3	0.7	1.0	0.3	0.3	0.7
	Potamogeton gramineus	Variable-leaf pondweed	1.0	0.3	1.0	0.0	1.4	0.0	0.0	0.3	0.0
	Fissidens spp. & Fontinalis spp.	Aquatic Moss	0.0	0.3	0.0	0.3	0.0	0.7	0.7	0.7	0.3
	Eleocharis acicularis	Needle spikerush	0.0	0.7	0.0	0.0	0.0	0.7	0.3	0.3	0.7
	Pontederia cordata	Pickerelweed	0.0	0.3	0.3	0.0	0.0	0.3	0.0	0.7	0.7
	Lemna turionifera	Turion duckweed	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.7
	Sagittaria sp. (rosette)	Arrowhead sp. (rosette)	0.0	0.7	0.3	0.0	0.3	0.3	0.0	0.0	0.0
	Potamogeton spirillus	Spiral-fruited pondweed	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.3
	Potamogeton berchtoldii	Slender pondweed	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.3
	Lemna minor	Lesser duckweed	0.7	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
	Elodea nuttallii	Slender waterweed	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
	Spirodela polyrhiza	Greater duckweed	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Potamogeton hybrid 1	Pondweed Hybrid 1	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Potamogeton epihydrus	Ribbon-leaf pondweed	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
	Sparganium fluctuans	Floating-leaf bur-reed	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
	Nitella spp.	Stoneworts	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

E

APPENDIX E

WDNR Fisheries Materials

2009 Comprehensive Fisheries Survey of Minocqua Chain

2015 Fisheries Information Sheet

2019 Minocqua Chain Project Trifold

Comprehensive Fisheries Survey of Minocqua Chain, Oneida County Wisconsin during 2009.

Waterbody Identification Codes: Little Tomahawk 1543900, Mud 1544000, Tomahawk 1542700, Mid 1542600, Minocqua 1542400, Kawaguesaga 1542300.

John Kubisiak
Senior Fisheries Biologist
Rhinelander
March, 2010
Minor revisions in June, 2011

WISCONSIN
DEPT. OF NATURAL RESOURCES

SPORT FISH RESTORATION

Your purchase of fishing equipment and motor boat fuel supports boating access and Sport Fish Restoration.

Comprehensive Fisheries Survey of Minocqua Chain, Oneida County Wisconsin during 2009.

John Kubisiak
Senior Fisheries Biologist
March, 2010
Minor revisions in June, 2011

EXECUTIVE SUMMARY

A comprehensive fisheries survey was conducted on the Minocqua Chain during spring and fall, 2009. Largemouth bass (Tomahawk population estimate, PE = 3.5 adults per acre) and smallmouth bass (Tomahawk PE = 3.9 adults per acre), were the dominant gamefish, along with moderate numbers of walleye (combined PE = 1.7 adults per acre), muskellunge (Tomahawk PE = 0.055 adults per acre) and northern pike. All game species showed good size and appeared to be in excellent condition. Panfish species were also abundant, with good size. We found moderate catches of black crappie, bluegill, pumpkinseed, rock bass and yellow perch, along with low numbers of black bullhead, bluegill x pumpkinseed hybrids and yellow bullhead. Non-game species in the catch include bowfin, cisco, golden shiner, grass pickerel and white sucker. I recommend managing Minocqua Chain for walleye, muskellunge, bass and panfish. Walleye are at moderate abundance except in Tomahawk, where walleye recruitment is likely suppressed by cisco and the fishery is supplemented by stocking. Supplemental walleye stocking is also recommended on Minocqua and Kawaguesaga due to poor recent recruitment. All three lakes have very good numbers of quality- and trophy-size walleye. The low-density muskellunge population has trophy size potential and would also benefit from stocking. Bass are abundant with moderate size.

Lakes and location:
Minocqua Chain includes Little Tomahawk, Mud, Tomahawk, Mid, Minocqua and Kawaguesaga lakes. Four additional lakes are connected by navigable channels but are not generally named with the Minocqua Chain: A non-flowing constructed channel connects Tomahawk to Katherine Lake; a wetland channel in Kemps Bay connects Tomahawk and unnamed Lake 30-6; a constructed channel connects Minocqua to Jerome Lake; and a wetland channel connects Kawaguesaga with Baker Lake. Minocqua Chain is located in north-central Oneida County, with the village of Lake Tomahawk and City of Minocqua on its shores. The Chain is part of the Upper Wisconsin River watershed, and forms the headwaters of the Tomahawk River. Mud, Little Tomahawk and Mid are considered spring lakes (no inlets and flowing outlets), and the Chain is also fed by the Minocqua Thoroughfare. A dam on Kawaguesaga with 5 feet of head is owned and operated by Wisconsin Valley Improvement Company (WVIC) to help regulate flow in the Tomahawk River. The Minocqua Chain reservoir maximum elevation is 1585.05 ft MSL with a summer minimum of 1584.05 ft (June 1 – September 30) and a winter minimum elevation of 1582.72 ft (October 1 – May 31). The summer target elevation is 1584.55 ft MSL. (Dave Coon, WVIC, personal communication).

Physical/Chemical attributes (Andrews and Threinen 1966 except as noted):
Morphometry: area 5841 acres with maximum depth of 84 feet in Tomahawk (from lake maps; excluding the Tomahawk Thoroughfare).
Watershed: 89 square miles, including 602 acres of adjoining wetlands.
Lake type: drainage (except Little Tomahawk, Mud and Mid are spring lakes).
Basic water chemistry: Soft – weighted average alkalinity 43 mg/l, conductance 100 μmhos.
Water clarity: Clear water of moderate transparency.

Littoral substrate: weighted average of 57% sand, 19%, gravel, 13% rubble, 10% muck with some boulders present.
Aquatic vegetation: moderate to abundant. Eurasian water milfoil is present.
Winterkill: Mid Lake experiences periodic winterkill.
Boat landings: Little Tomahawk has a roadside carry-in along Bird Lake Road. Tomahawk has paved ramps in Town of Lake Tomahawk on Coffen Lane (fee, parking lot has 21 trailer stalls and 28 additional vehicles) and at Indian Mounds State Forest Campground (15 trailer stalls and 15 additional vehicles; launch may be shallow due to sand). There is a paved ramp on Tomahawk Thoroughfare at Thoroughfare Road (fee, 6 trailer stalls). Mid Lake has a gravel ramp at the end of Grundy Point Road (room for 2-3 trailers). Minocqua has a paved ramp at Brunswick Road on Stacks Bay (11 trailer stalls and 8 additional vehicles); gravel ramp at Cedar Street (fee, roadside parking); paved ramp at Chicago Street (fee, about 8 trailer stalls at the Minocqua city lot); paved ramp at Park Street (fee, 4 trailer stalls). Kawaguesaga has a paved ramp at Dam Road (5 trailer stalls).

Purpose of Survey: Assess status of game species and develop management recommendations.
Dates of fieldwork: Walleye netting, April 21 to May 1 2009. Muskellunge netting, April 27 to May 15. Electroshocking (entire shoreline): April 27 (Kawaguesaga walleye); April 28 (Minocqua walleye); May 3 (Tomahawk walleye); June 4 and 8 (Tomahawk bass). Cisco gillnetting in Tomahawk, September 10-11.

BACKGROUND

Half-page spring netting records from Tomahawk during April and May of 1948, 53, 54, 56 and 57 appear to be from northern pike removals and spawning operations. A large number of similar records are from the Minocqua Thoroughfare or Tomahawk Thoroughfare during 1947-54 and 56. The records list species, size range and number of fish by date. A spawning record sheet for Minocqua Thoroughfare in 1952 contains a sketch of 2 net locations west of the Hwy 47 bridge, 2 locations around the railroad bridge and 2 locations on islands just east of the bridges. Northern pike were apparently being removed during these operations. The 1947 sheets (one from each thoroughfare) both have headings of "Northern Pike". A single-page memorandum dated April 18, 1956 in the Minocqua file deals with northern pike removal from the Minocqua Thoroughfare. It indicates that "various people in Minocqua" were concerned about northern pike removal, but agreed to allow it for a period of three years as long as pike growth rates were tracked for any changes. Presumably the removal of northern pike was intended to improve growth rates on the remaining fish, but no results are contained in the file.

Mid-June netting on Mid Lake during 1955, 56 and 59 found an average catch rate per net night (average respective length from 1955 and 56 in parentheses) of 1.1 walleye (20.0 and 18.9 inches), 1.3 largemouth bass (9.9 and 7.6 inches), 0.06 smallmouth bass (N/A and 11.8 inches), 1.9 northern pike (15.7 and 17.4 inches), 0.03 muskellunge (one fish, 28.5 inches), 7.5 crappies, 107 bluegill, 31 "sunfish" (likely pumpkinseed), 13 yellow perch, 1.4 rock bass, 5.1 bullheads and 0.53 suckers.

Seining with a 2000 foot shoreline seine was conducted in Minocqua and Tomahawk during 1959. The July 20 Minocqua catch included a 23.1-inch muskellunge and four 3.3-6.2 inch walleye, along with (in decreasing abundance) perch, rock bass, bluegill, "sunfish", and crappie. Electroshocking 1 mile for 6 hours (compared to a current target of 2 miles per hour) on July 27 resulted in observations of 2,800 walleye, 250 largemouth bass, 60 smallmouth bass, 23 northern pike and 6 muskellunge. Also listed were 3,500 yellow perch, 2,100 bluegill, 1,500 rock bass, 1,200 crappies,

and abundant suckers and minnows. Tomahawk was seined on July 21, and estimated numbers of fish include 91 walleye, 154 smallmouth, 7 "sunfish", 1,012 bluegill and 1,138 yellow perch.

Tomahawk was stocked with yearling lake trout in 1962 (10,000), 1963 (10,000, 6-9 inches) and 1964 (8,000). Two nights of gill netting during July 14-15, 1964 did not find any lake trout, but yielded 255 cisco (5.5 to 11.5 inches), 3 perch (3-4 inches) and 2 "muddlers" (likely mottled sculpin, 2.5 inches) (Radonski 1964). Electroshocking for lake trout in May 1965 only resulted in observations of walleye and suckers (Radonski 1965). Two lake trout were captured in a 1967-68 survey (McKnight and Theis 1968, below)

A survey using fyke nets, gill nets, seining and electrofishing was conducted on Tomahawk during May and September of 1967 and April of 1968 (McKnight and Theis 1968). A primary focus of the survey was a walleye assessment and mark-recapture population estimate (although not enough recaptures were obtained to complete the walleye population estimate). The spring walleye catch of 31.2 per net night was a little lower than the walleye catch during four years of spawning operations during mid-1950s of 33.4 to 46.5 per net night. Walleye reproduction was considered adequate and stocking was recommended only during years of spawn taking. "Plant-back" stocking into broodstock lakes was a standard practice at that time. Two lake trout (25 and 27 inches) were captured, but midsummer temperature and oxygen were judged to be marginal for trout. Experimental stocking of splake was recommended and 15,300 yearling splake were subsequently stocked in 1968. Their catch of 237 cisco had modes at 6.75 and 11 inches (2,250 feet of bottom-set gillnet had bar-measure mesh sizes of 0.75 and 1.25 inches).

Although spawning habitat in Tomahawk for muskellunge and northern pike is described as "good," McKnight and Theis (1968) also suggest that "Periodic support stocking of muskellunge is recommended." The report indicates that muskellunge and northern pike were spawned during most recent years in the Tomahawk Thoroughfare, and northern pike were removed at the same time, with removal numbers given for 1964-68. The report seems to question the usefulness of removing northern pike, but recommends continuing the program:

> "III. Fish Removal
> As part of the muskellunge management program, northern pike are being removed from the chain. This is to decrease competition between the species. Whether this program is as effective as intended is difficult to assess. Catch records (see V, "Past Management") do not reveal the answer. There are considerable amounts of northern pike spawning areas where removal is not carried on. The result, therefore, may merely be the removal of a "harvestable surplus". Since this removal program coincides with spawn-taking operations, however, continuation is recommended. Intensification of this effort might be considered." (McKnight and Theis 1968)

A netting and shocking survey of Minocqua in 1973 to assess the walleye population found 24 walleye per net night with a good size distribution. The report indicates that little effort was spent on other species, but mentions large numbers of bluegill and small yellow perch and a good number of muskellunge measuring 18.0 to 47.5 inches (Wendt 1974).

A netting and shocking survey of Tomahawk was conducted in 1978 "with the main purpose of evaluating the present state of the walleye population and determining whether several years of walleye spawn-taking … had an adverse impact on the walleye population." (Serns 1979). The May fyke net catch was moderate, with 10.5 walleye, 0.02 largemouth bass, 1.2 northern pike and 0.3 muskellunge per net-night. Walleye fry had been stocked annually

since 1971, along with fingerling stockings of 595 in 1973, 21,186 in 1974 and 40,000 in 1976. The report recommends continued fry stocking, along with 10 to 25 fingerlings per acre for a period of 9 years. Muskellunge stocking was also recommended. Serns (1979) commented "Based on the 1967-68 survey, splake were introduced, but they contributed little to the sport-fishery in subsequent years and no additional stocking of this species was done."

A page of data and map from a May 18, 1983 electroshocking survey of 4.4 shoreline miles on Minocqua found 33.6 walleye, 3.6 largemouth, 1.1 muskellunge, 0.23 northern pike and 0.45 grass pickerel per mile. Notes in the margin indicate "Windy & light rain – poor night for shocking. Looks like a good bunch of black crappie 7-9 inches coming up."

Several surveys were conducted to assess the walleye population in Tomahawk with the onset of spearing by Chippewa tribal members. A 1986 survey estimated 3.7 adult walleyes per acre, while a survey the following year estimated 1.9 per acre. Walleye net catch was 13.2 in 1986 and 10.0 in 1987. A catch of 97 muskellunge ranging 11.5 to 44.0 inches was reported in 120 fyke net lifts (0.73 per net night) during April 16-23 1986 (Newman 1987). Muskellunge were marked with the same clip as walleye in the 1987 survey (Newman 1988), with a catch of 184 muskellunge ranging from 15.5 to 46.5 inches in 224 fyke net lifts (0.8 per net night); 7 were recaptures of previously-marked fish.

A spring, 1992 survey estimated the adult walleye populations (per acre) of Tomahawk = 2.5, Mid = 0.86, Minocqua = 5.6 and Kawaguesaga = 4.4. The area-weighted average across the four lakes = 3.4 per acre (or 3.5 if Mid Lake is excluded). A walleye survey in 1998 (excluding Mid Lake) found similar populations of Tomahawk = 2.5, Minocqua = 4.6 and Kawaguesaga = 5.2 per acre. The area-weighted average was again 3.4 per acre.

Great Lakes Indian Fish & Wildlife Commission (GLIFWC) estimated the combined Tomahawk and Little Tomahawk walleye populations in 2000, 2002 and 2004 at 1.4, 2.4 and 2.2 per acre, respectively.

A muskellunge survey on Tomahawk during 2005 and 2006 estimated a population of 339 fish 30 inches and larger, or 0.10 per acre (Kubisiak 2007).

Nine-month angler creel surveys were conducted during the open gamefish season, May through early March (excluding the low-effort month of November) of 1987-88, 1992-93, 1998-99 and 2009-10 (reported separately)

Most fall electroshocking surveys target juvenile walleyes, and in some cases other species are not handled. Fall surveys are also used as an index of muskellunge recruitment, but muskellunge catch rates are higher at colder water temperatures and faster boat speed than typical for walleye surveys. Current DNR standards during fall young-of-year (YOY) surveys are to collect juvenile gamefish, including walleye under 15 inches, bass under 14 inches and northern pike and muskellunge under 20 inches. Recent GLIFWC surveys recorded only walleyes. Fall YOY electroshocking surveys were conducted on Little Tomahawk (1991-96 and 2008), Tomahawk (1965, 78, 83, 85 and 86), Mid (1962, 92 and 2003) and Minocqua (1973 and 86). In 1987 and annually from 1990 to present, fall surveys were conducted by either DNR or GLIFWC on Tomahawk, Minocqua (except missed in 1992) and Kawaguesaga. Fall survey trends are discussed further in the walleye and muskellunge results, below.

A baseline survey was conducted on Tomahawk, Mid, Minocqua and Kawaguesaga in 2003, consisting of 35 mini-fyke net-nights targeting small and young-of-year fishes in August and electroshocking in September. All sizes of gamefish were targeted during electroshocking, and all species were picked up on 11, 0.5-mile stations. The catch included 25 species, dominated by young-of-year bluegill and bluntnose minnow, along with good numbers of young largemouth and smallmouth bass.

METHODS

Eight standard fyke nets (¾-inch mesh, bar measure) were set on Kawaguesaga and ten nets on Minocqua on April 21, 2009. Tomahawk was set with 8 nets on April 25 and another 18 nets on April 26 (daily walleye net numbers on Tomahawk then fluctuated from 25 to 27). These nets targeted walleye. Net numbers were reduced by 2 on Kawaguesaga on April 25 and by two on Minocqua on April 28 and the remaining nets moved to muskellunge locations on April 27 (Kawaguesaga) and April 28 (Minocqua). The Tomahawk nets were reduced to 18 and moved to muskellunge locations on May 1. Two muskellunge nets set in Little Tomahawk for 9 nights are included with the Tomahawk results; two muskellunge nets were set in Mid on May 1. Nets were pulled on May 3 (Kawaguesaga and Mid), May 5 (Minocqua) and May 13-15 (Tomahawk, 6 pulled each day). Effort totaled 249 net nights targeting walleye and 350 net nights targeting muskellunge.

WDNR-standard alternating current electrofishing boats were used to collect gamefish, targeting walleye on April 27 (Kawaguesaga, 2 boats), April 28 (Minocqua, 3 boats) and May 3 (Tomahawk, 5 boats). Tomahawk received additional nights of electrofishing targeting bass on June 4 (2 boats) and June 8 (4 boats). One boat also targeted bass with hook-and-line on June 2 and June 5.

A seven-panel gillnet was set in 78 feet of water on Tomahawk during September 10-11 (about 24 hours), targeting cisco. Each panel was 10 feet wide and reached from surface to bottom. Mesh sizes were 19, 25, 32, 38, 51, 64 and 89 mm, bar measure.

Length or length category (nearest half-inch) was recorded for all gamefish. Adult gamefish were given a half-fin clip (half-clips provide an adequate mark and regenerate better than fully-removed fins) and juveniles were given a top-tail clip for use in mark-recapture population estimates. The clips were right ventral (Kawaguesaga), right pectoral (Minocqua), bottom caudal (Mid), left ventral (Tomahawk) and left pectoral (Little Tomahawk). Age structures (scales or spines) were removed from ten gamefish per species, per half-inch group for the three largest lakes.

RESULTS AND DISCUSSION

Walleye

During walleye netting, 938 walleye were captured on Kawaguesaga, 805 on Minocqua and 1,384 on Tomahawk for a total of 3,127 in 249 net-nights. This includes 487 recaptures and 5 juvenile fish (walleye of unknown sex shorter than 15 inches), at a rate of 13.9 walleye per net night (Table 1). The electrofishing recapture sample yielded 800 walleye (13.2 fish per mile), including 15 juveniles. An additional 307 walleye were handled during muskellunge netting.

The mark-recapture population estimates are 2,274 adult walleye (± 184 SD), or 3.4 per acre on Kawaguesaga; 2,764 (± 463) or 2.0 per acre on Minocqua and 4,321 (± 523) or 1.3 per acre on Tomahawk. For Kawaguesaga and Minocqua, this compares to predicted values of 3.4 and 3.3 per acre for 670 and 1,360-acre lakes supported by natural reproduction. The walleye population in

Tomahawk is supported by stocking, and in past surveys the walleye fishery averaged 2.4 per acre, mid-way between the predicted populations in similar-sized stocked lakes (1.2 per acre) and naturally reproducing lakes (3.2 per acre). Taken together, the three lakes averaged 1.7 walleye per acre in 2009. I consider around one walleye per acre a minimum value for a "fishable" population, where an angler has a reasonable chance of catching a walleye.

Walleye showed excellent size structure, with a 19.7-inch average adult length. Forty percent of adult walleye were 20 inches or larger, while 17% were at least 25 inches (Figure 1). Walleye growth rates were good, with male length-at-age ahead of the regional average through age 8, and about average at older ages. Female length-at age was average or a little behind. Both sexes showed incredible longevity. We captured good numbers of males out to age 15 and females to age 20 (Appendix A).

Despite the presence of good spawning gravel, natural recruitment by walleye in Tomahawk is low as shown by low catch of YOY walleye in fall surveys (Figure 2). This may be due to competition or predation on walleye fry by cisco. Hatchery walleye were marked with Oxytetracycline (OTC, an antibiotic that leaves a stain on bones) in 2001, 04, 06 and 08. The OTC-marked fish respectively contributed 80, 100, 93.5 and 67% of the fall YOY catch. However, after a high catch of 70.1 YOY per mile in 2000, fall catch averaged only 2.0 during subsequent stocked years and 0.6 during non-stocked years.

In northern Wisconsin, fall catch of YOY walleye in lakes supported by natural reproduction averages 34 per mile of shoreline. Over the 20 years of fall surveys from 1990 through 2010, Minocqua and Kawaguesaga have not shown the high numbers of YOY walleye typical of many other naturally reproducing lakes (Figure 2). Nevertheless, recruitment produced above-average adult walleye densities on the two lakes with estimates that ranged from 4.4 to 5.6 per acre in 1992 and 1998. Seven consecutive years of low recruitment has had an impact. The current walleye populations in Tomahawk, Minocqua and Kawaguesaga are about half of historic values, although still within the range of normal fluctuation. Tomahawk requires supplemental stocking, and the low level of recruitment trickling in to Minocqua and Kawaguesaga may also require supplemental stocking to maintain the populations until strong yearclasses return.

Figure 1. Length-frequency of adult walleye during 2009 in Minocqua Chain, Oneida County WI.

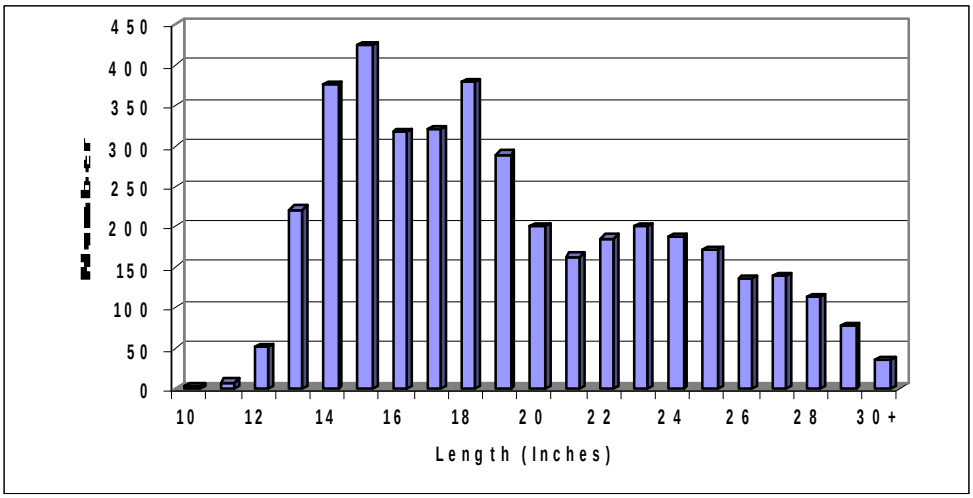
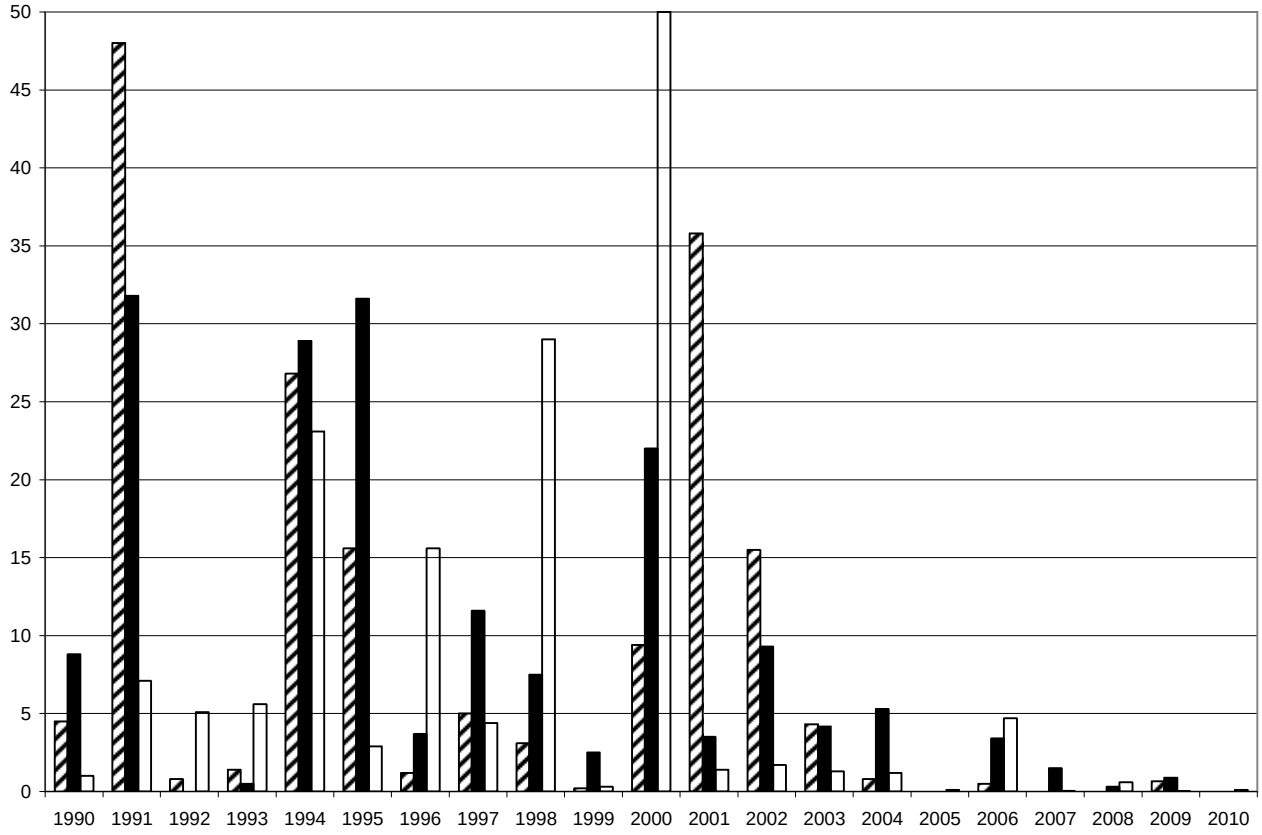


Table 1. Fish catch per unit effort during a 2009 survey of Minocqua Chain, Oneida County WI. Netting catch rates are reported as number of fish per net night, while electrofishing catch rates are number of fish per mile of shoreline. Only gamefish were collected during shocking runs and the bass marking run only covered about half the shoreline.

species	walleye netting	muskellunge netting	walleye recapture shocking	bass marking shocking (Tomahawk)	bass recapture shocking (Tomahawk)
walleye	13.9	0.85	13.2		
largemouth bass	0.39	2.4	4.8	26.5	14.3
muskellunge	0.21	0.15	0.12		
northern pike	0.48	0.22	0.43		
smallmouth bass	0.40	0.91	1.7	31.0	10.8
black bullhead	0	0.0086			
black crappie	4.9	3.4			
bluegill	2.3	32.6			
hybrid bluegill x pumpkinseed	0.0040	0.47			
bowfin	0.22	0.66			
cisco	0.016	0.0057			
golden shiner	0	0.0086			
grass pickerel	0.040	0.21			
pumpkinseed	0.73	6.4			
rock bass	2.7	8.9			
white sucker	0.44	0.28			
yellow bullhead	0.50	2.0			
yellow perch	45.5	10.8			

Figure 2. Young-of-year walleye catch in Kawaguesaga (striped), Minocqua (solid) and Tomahawk (clear bars) during 1990 through 2010. Minocqua was not surveyed in 1992; the Tomahawk catch of 70.1 per mile in 2000 was truncated for scale.



Largemouth and Smallmouth Bass

The bass catch included 2,058 largemouth and 1,360 smallmouth bass during spring sampling, including recaptures of 112 largemouth and 40 smallmouth that were previously-marked, and 70 juvenile largemouth and 191 juvenile smallmouth smaller than 8 inches in length. Bass were not marked for a population estimate during shocking runs on Minocqua and Kawaguesaga. Mark-recapture population estimates were calculated for Tomahawk at 11,891 adult largemouth bass (± 1,849 SD), or 3.5 per acre and 13,082 adult smallmouth (± 3,281 SD) or 3.9 per acre. Both species of bass had good numbers of fish up to 16 or 17 inches, with low numbers of larger fish (Figures 3 and 4). The longest largemouth bass were 19.9 inches from Mid and 19.8 inches from Kawaguesaga. Twenty-one percent of largemouth were 14 inches and larger. The longest smallmouth was 19.7 inches from Tomahawk and 12% were 14 inches or larger. Length-at-age of largemouth was at or slightly above the regional average, while smallmouth length-at-age was slightly below average (Appendix A).

Northern Pike

We captured 211 northern pike (including 11 recaptures of previously-marked fish and 1 immature fish less than 12 inches in length). Average size of northern pike was 23.5 inches and 30% of adult pike were 26 inches or larger while 9.9% were at least 30 inches (Figure 4). The largest northern pike was a 37.7-inch female from Kawaguesaga. Abundant northern pike have been shown to inhibit muskellunge recruitment, but the netting catch rates below 0.5 per net-night suggest a low-density population.

Figure 3. Length-frequency of largemouth bass during 2009 in Minocqua Chain, Oneida County WI.

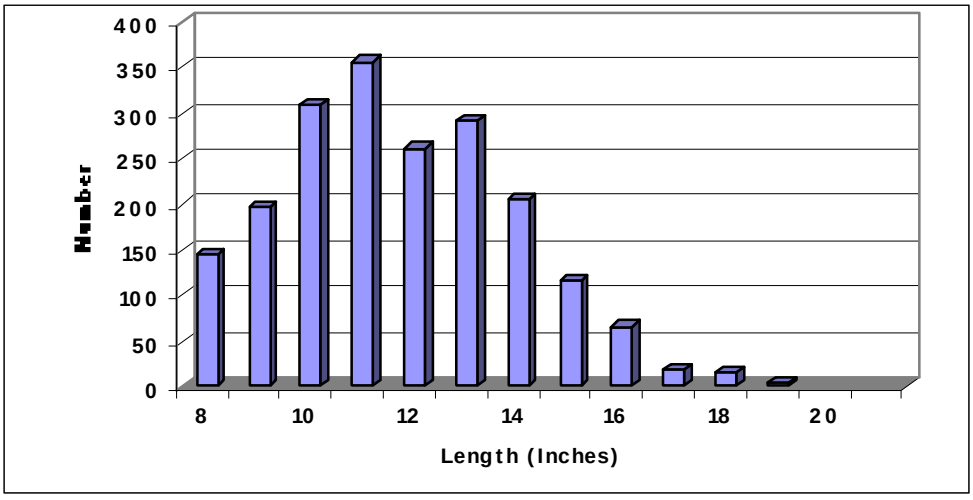


Figure 4. Length-frequency of smallmouth bass during 2009 in Minocqua Chain, Oneida County WI.

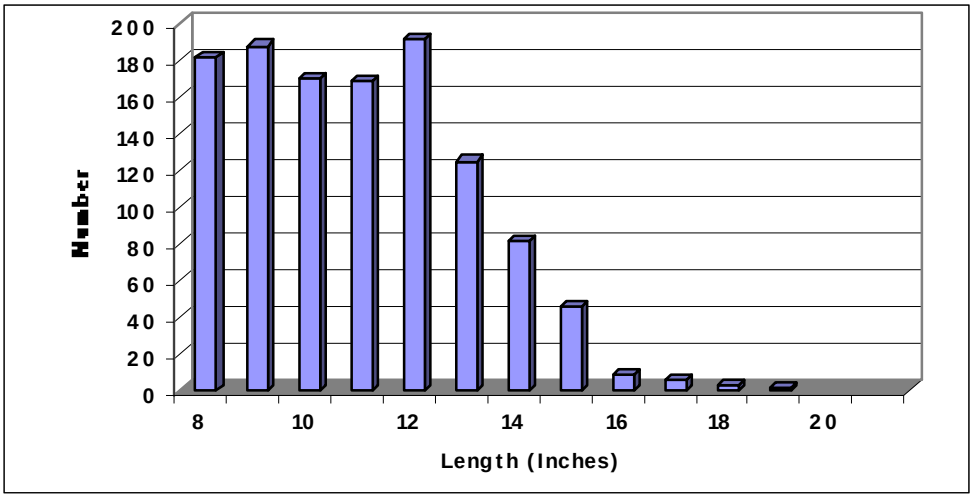
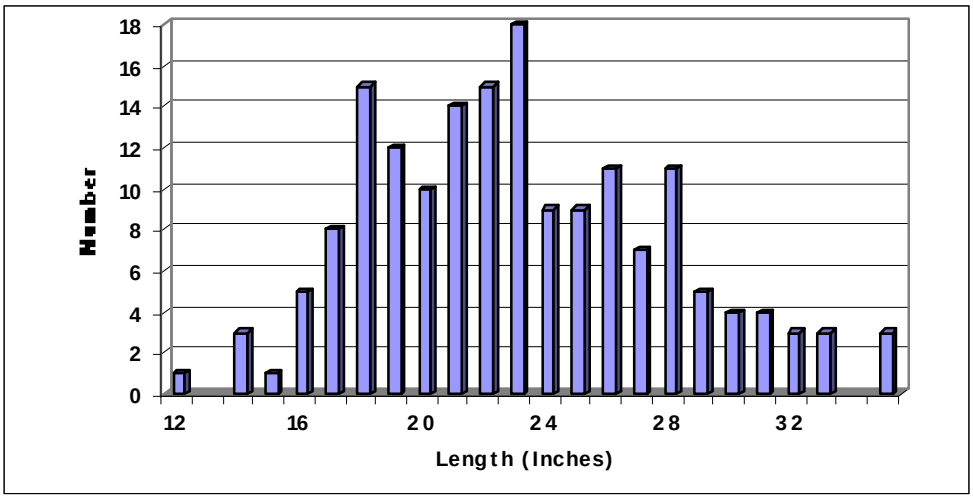


Figure 5. Length-frequency of adult northern pike during 2009 in Minocqua Chain, Oneida County WI.



Muskellunge

One hundred and six muskellunge were captured during the survey, including three recaptures of previously-marked fish and one juvenile smaller than 30 inches in length. Only Tomahawk had a large enough sample to attempt a population estimate. Eight of 24 muskellunge recaptured in Tomahawk in 2010 bore the fin clip, resulting in a population estimate of 186 (± 47 SD), or one fish every 18 acres. This is very low density, even for muskellunge. Muskellunge ranged from 23.0 to 50.5 inches in length, with 57% at least 40 inches in length and 15% at least 45 inches (Figure 5). The largest fish was a 50.5 inch, 35.1 pound female from Tomahawk, aged at 18 from a scale. Scale ages tend to underestimate the age of older muskellunge, but accurate age structures like otoliths and cleithral bones require the fish to be sacrificed (Crossman and Casselman 2000). One 40.5-inch male muskellunge that died in the net was aged at 19 from a cleithrum.

Large fingerling muskellunge were stocked in Minocqua Chain as recently as 2001 (Table 2). The contribution of natural reproduction is difficult to assign prior to 2001 because of consecutive years of muskellunge stocking. Thus, the contribution of stocked fish to relatively strong yearclasses (based on catch in fall surveys) in 1989, 90 and 91 is unknown. No muskellunge were stocked during another strong yearclass in 1993. In 2009, any fish less than age 8 can be assumed to have recruited from natural reproduction. However, only 9 of 30 male, 4 of 62 female and 2 of 3 unknown-gender muskellunge were assigned age 8 or younger (Appendix A), suggesting low recruitment from natural reproduction. In addition, length-frequency modes at 38 and 41 inches (Figure 6) correspond to modes at 33 and 35 inches in 2005-06 (Kubisiak 2007), suggesting that the existing fish are growing longer over time but few young fish are coming in. The low population estimate also shows that recruitment is lagging, and muskellunge stocking should be resumed.

Trophy muskellunge potential is discussed by Kubisiak (2007). Some additional large fish were documented during 2009. On July 1, 2009 I received a photograph of a large muskellunge reported to be 51-52 inches in length, recently caught and kept from Minocqua Chain; LAX Taxidermy plans to save a cleithrum. The Tomahawk creel clerk saw photographs of a 50+ inch muskellunge caught and released on August 14, and he measured a 49.1-inch muskellunge with 21.5-inch girth, caught and released on August 25. On September 8, the same clerk helped an angler release a 44-inch fish, he found a dead 43-inch muskellunge that appeared to have been badly hooked on Tomahawk and a partly decomposed mid-30's fish on Little Tomahawk.

Figure 6. Length-frequency of adult muskellunge during 2009 in Minocqua Chain, Oneida County WI.

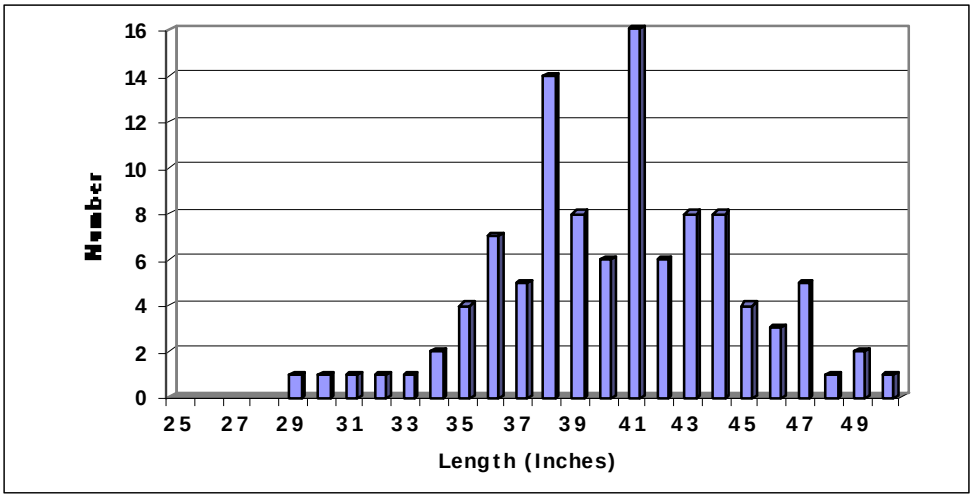


Table 2. Fish stocking record during 1995 through 2009 in Minocqua Chain, Oneida County WI.

Year	Lake	Species	Size	Number	Comments
1995	Tomahawk	walleye	fry	2,500,000	
1995	Tomahawk	muskellunge	fry	225,000	
1995	Tomahawk	walleye	small fingerling	85,902	
1996	Tomahawk	walleye	fry	1,000,000	
1996	Tomahawk	muskellunge	fry	82,400	
1996	Tomahawk	walleye	small fingerling (1.5 inch)	100,000	
1996	Minocqua	walleye	fry (0.3 inch)	500,000	
1996	Kawaguesaga	muskellunge	large fingerling (10 inch)	670	
1997	Tomahawk	walleye	fry	3,000,000	
1997	Tomahawk	muskellunge	fry	334,000	
1997	Tomahawk	muskellunge	large fingerling	1,500	
1997	Mid	muskellunge	fry	25,000	
1997	Minocqua	walleye	fry	2,000,000	
1997	Minocqua	muskellunge	large fingerling	680	
1997	Kawaguesaga	muskellunge	fry	100,000	
1998	Tomahawk	walleye	fry	5,300,000	
1998	Tomahawk	muskellunge	fry	56,750	
1998	Tomahawk	walleye	small fingerling (1.3 inch)	339,206	
1998	Minocqua	muskellunge	fry	79,900	Thoroughfare
1998	Kawaguesaga	muskellunge	large fingerling (12 inch)	670	
1999	Tomahawk	walleye	fry	4,700,000	
1999	Tomahawk	muskellunge	large fingerling (12.1 inch)	1,000	
1999	Minocqua	muskellunge	fry	121,500	Thoroughfare
1999	Minocqua	muskellunge	large fingerling	680	
2000	Tomahawk	walleye	fry (0.3 inch)	6,500,000	
2000	Tomahawk	muskellunge	fry (0.5 inch)	42,100	
2000	Tomahawk	walleye	small fgl. (1.7 & 2.3 inch)	311,889	
2000	Tomahawk	walleye	fingerling (4-6 inch)	1,500	private funds
2000	Minocqua	walleye	fry (0.5 inch)	3,000,000	
2000	Minocqua	muskellunge	fry (0.3 inch)	85,050	
2000	Kawaguesaga	muskellunge	large fingerling (10.9 inch)	670	
2001	Tomahawk	walleye	small fingerling (1.3 inch)	330,000	marked with Oxytetracycline
2001	Tomahawk	walleye	large fingerling (8 inch)	800	private funds
2001	Tomahawk	muskellunge	large fingerling (12.0 inch)	850	
2001	Minocqua	muskellunge	large fingerling (12 inch)	700	private funds
2004	Tomahawk	walleye	small fingerling (1.3 inch)	169,676	marked with Oxytetracycline
2006	Tomahawk	walleye	small fingerling (1.7 inch)	118,700	marked with Oxytetracycline
2007	Tomahawk	walleye	fry (0.3 inch)	1,660,000	
2008	Tomahawk	walleye	small fingerling (1.6 inch)	118,404	marked with Oxytetracycline

Cisco

The gillnet captured 370 cisco, 1 smallmouth bass, 1 black crappie and 1 bluegill. Forty-four percent of the cisco were 3.3 to 4.0 inches in length and were captured in the 19 mm mesh. Modes in length that likely correspond to yearclasses were also present at 6.75 and 9.75 inches (Figure 7). The largest cisco was 13.8 inches. Cisco appear to inhibit walleye recruitment by preying on or

competing with the fry, although peer-reviews studies are lacking. Cisco are also an important forage fish for large walleye and muskellunge. The heaviest catch of cisco was 30 to 40 feet below the surface, near the thermocline. However, some cisco were scattered through the upper water column and a few cisco that may have been chasing minnows were captured within a foot of the surface. We noted schools of small minnows holding near the net at the surface, and minnows were regurgitated by several cisco.

Figure 7. Length-frequency of cisco during September 10-11, 2009 gillnetting in Tomahawk Lake, Oneida County WI.

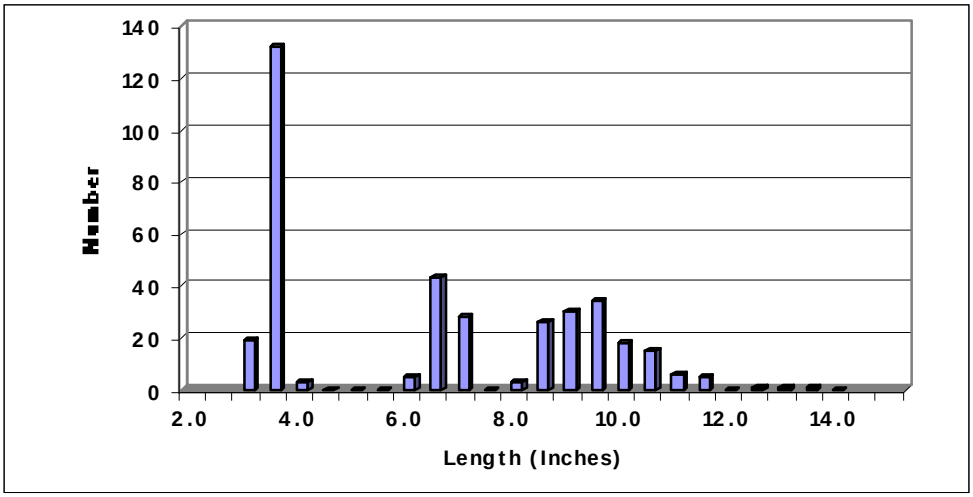


Table 3. Temperature and dissolved oxygen profile of Tomahawk Lake, Oneida County WI on September 10, 2009.

Depth below surface (feet)	Dissolved Oxygen (mg/l)	Temperature (°C)	Temperature (°F)
0 (Surface)	8.2	22.2	72.0
5	8.3	21.8	71.2
10	8.3	21.5	70.7
15	8.7	20.3	68.5
20	8.5	19.5	67.1
25	8.0	19.1	66.4
30	7.3	18.7	65.7
35	5.9	18.0	64.4
40	1.6	13.9	57.0
45	1.3	12.3	54.1
50	1.1	11.3	52.3
55	1.0	10.9	51.6
60	0.8	10.6	51.1
65	0.8	10.3	50.5
70	0.7	10.0	50.0
75	0.5	9.7	49.5
78 (bottom)			

Panfish

Minocqua Chain has many well-vegetated bays and shorelines and supports good populations of panfish. This survey did not target panfish, but we found a high catch of yellow perch during

walleye netting, good bluegill numbers during muskellunge netting and moderate numbers of rock bass and black crappie (Table 1).

MANAGEMENT RECOMMENDATIONS

Minocqua Chain supports a diverse fishery. Smallmouth and largemouth bass were the dominant gamefish. Abundance of walleye was moderate and muskellunge was low, but both species showed excellent numbers of quality- and trophy-size fish. Northern pike were also low density. Yellow perch and bluegill dominated the panfish catch, while rock bass and black crappie were moderate in abundance. Low numbers of black bullhead, bluegill x pumpkinseed hybrids, pumpkinseed and yellow bullhead were also present. Forage and non-game species include bowfin, cisco, golden shiner, grass pickerel and white sucker. Minocqua Chain is best managed for walleye, muskellunge, bass and panfish. Supplemental stocking of walleye has been a long-term practice on Tomahawk, due to suspected interference with walleye recruitment by cisco. It is also recommended on Minocqua and Kawaguesaga until natural recruitment improves. Muskellunge stocking is also recommended due to low natural recruitment after the last stocked yearclass in 2001.

ACKNOWLEDGEMENTS

Mike Coshun and Dennis Scholl supervised the field work for this survey with field assistance from Jeff Blonski, Steve Gilbert, Fred Hagstrom, Rick Halder, Jason Halverson, Wes Jahns, Marty Kiepke, Steve Kramer, Tracy Kusek, Aaron Nelson, Jeff Reissmann, Ben Rolling, Steve Timler, Tim Tobias, Joelle Underwood, Mike Vogelsang, Keith Worrall, Scott Yonker and me. Steve Kramer assigned fish ages from spines and scales and Mike Coshun calculated the walleye and bass population estimates.

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APPENDIX A
FISH AGE RESULTS

The aged subsamples were applied against the full length-frequency to eliminate bias from a non-random subsample of age structures.

Table A.1. Male walleye length at age in Minocqua Chain, Oneida County Wisconsin during 2009.

Age	Number of fish	avg. length	Northern WI avg.
2	6	12.4	11.3
3	40	13.7	11.9
4	17	14.6	13.3
5	32	15.1	14.2
6	23	16.0	15.6
7	31	17.0	16.6
8	21	18.3	17.6
9	14	18.3	18.7
10	12	19.2	19.2
11	11	19.6	19.4
12	9	19.7	20.0
13	5	20.1	
14	9	21.2	
15	2	21.3	

Table A.2. Female walleye length at age in Minocqua Chain, Oneida County Wisconsin during 2009.

Age	Number of fish	avg. length	Northern WI avg.
3	1	12.8	13.3
4	9	15.4	15.0
5	26	16.4	16.2
6	24	17.7	17.8
7	30	18.9	19.6
8	36	19.8	21.0
9	21	20.8	22.5
10	27	22.1	23.5
11	37	23.3	24.7
12	25	23.6	25.4
13	24	24.5	26.5
14	37	25.4	27.4
15	30	27.3	27.7
16	20	27.8	
17	11	28.0	
18	12	28.6	
19	7	29.1	
20	5	29.6	

Table A.3. Largemouth bass length at age in Minocqua Chain, Oneida County Wisconsin during 2009.

Age	Number of fish	avg. length	Northern WI avg.
2	11	6.1	6.6
3	40	9.3	8.9
4	57	11.2	10.5
5	40	12.7	12.1
6	48	13.7	13.6
7	51	15.0	14.9
8	21	15.7	15.8
9	8	17.0	16.2
10	11	17.6	17.1
11	6	18.7	17.8
13	1	19.8	18.3

Table A.4. Smallmouth bass length at age in Minocqua Chain, Oneida County Wisconsin during 2009.

Age	Number of fish	avg. length	Northern WI avg.
2	4	7.4	6.9
3	25	9.1	9.3
4	32	11.1	11.8
5	39	13.0	13.5
6	14	14.2	15.2
7	11	15.4	16.1
8	4	15.5	17.1
9	1	18.3	17.7
10	1	18.7	18.3

Table A.5. Male muskellunge length at age in Minocqua Chain, Oneida County Wisconsin during 2009.

Age	Number of fish	avg. length	Northern WI avg.
4	2	30.3	27.3
5	1	30.2	29.2
6			31.5
7	3	34.7	33.3
8	3	35.5	34.4
9	2	36.1	35.8
10	5	37.0	37.3
11	7	38.4	37.9
12	4	38.3	39.0
13			38.9
14	1	37.2	43.5
15	1	41.0	39.0
19	1	40.5	

Table A.6. Female muskellunge length at age in Minocqua Chain, Oneida County Wisconsin during 2009.

Age	Number of fish	avg. length	Northern WI avg.
5	1	32.6	31.9
6			33.7
7	1	36.5	35.8
8	2	38.3	38.1
9	8	40.5	39.5
10	14	41.0	41.0
11	11	42.5	43.2
12	6	42.2	43.7
13	7	44.0	44.3
14	6	46.7	
15	1	47.0	
16	2	47.4	
17	1	47.4	
18	1	50.5	
19			
20	1	49.3	

WISCONSIN DNR
FISHERIES INFORMATION SHEET

LAKE: Mid **COUNTY:** Oneida **YEAR:** 2015

The Department of Natural Resources surveyed MId Lake, Oneida County with a boomshocker on 05/28/2015. Panfish and nongame fishes were only collected along two half-mile reaches of shoreline. Mid Lake has a surface area of 222.9 acres, 3.28 miles of shoreline and a maximum depth of 12 feet.

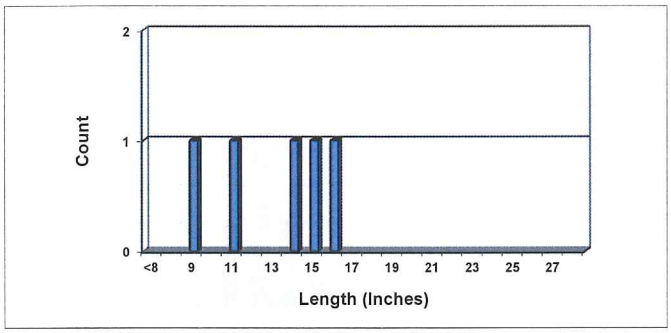

Figure 1. Length frequency distribution of 5 walleye captured during a survey of Mid Lake, Oneida County, 05/28/2015.

Walleye

We captured 5 walleye ranging in length from 9.5 to 16.3 inches. The largest walleye was just over 16 inches in length.

Largemouth bass

Largemouth bass were the most abundant game species in our catch. We captured 83 largemouth bass in Mid Lake, ranging from 8 to 17.7 inches in length. Peak abundance was at 13 inches.

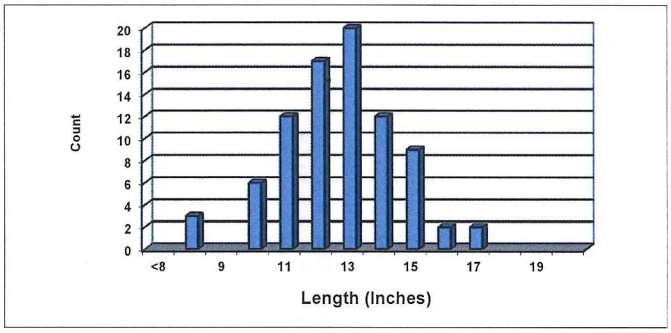

Figure 2. Length frequency distribution of 83 largemouth bass captured during a survey of Mid Lake, Oneida County, 05/28/2015.

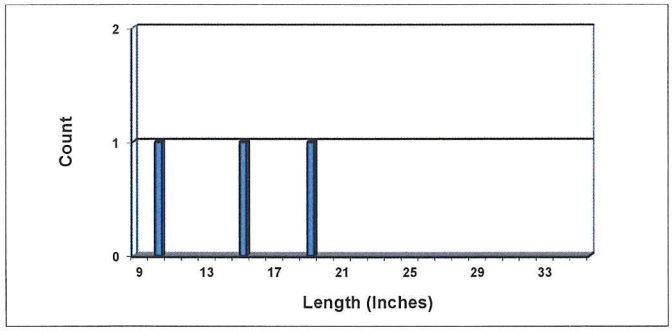

Figure 3. Length frequency distribution of 3 northern pike captured during a survey of Mid Lake, Oneida County, 05/28/2015.

Northern Pike

We captured 3 northern pike in Mid Lake, ranging from 10 to 19.3 inches in length.

Black crappie

We captured 6 black crappie, ranging from 5 to 9.2 inches.

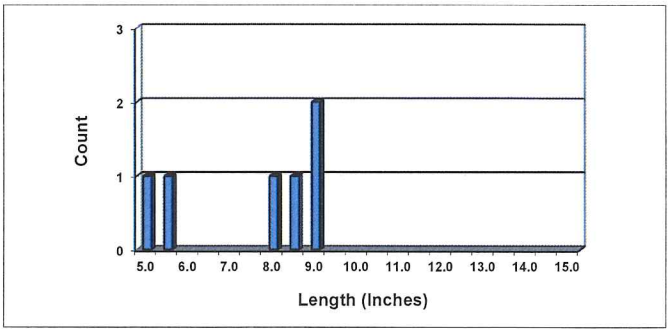

Figure 4. Length frequency distribution of 6 black crappie captured during a survey of Mid Lake, Oneida County, 05/28/2015.

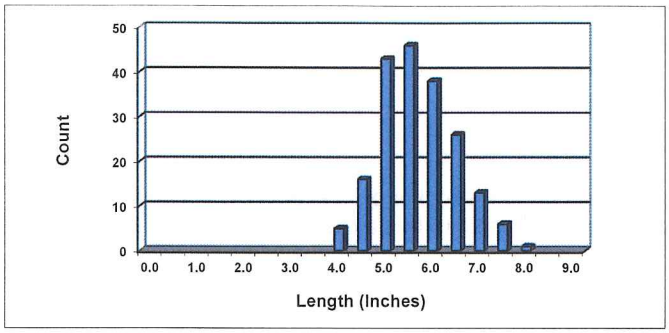

Figure 5. Length frequency distribution of 194 bluegill captured during a survey of Mid Lake, Oneida County, 05/28/2015.

Bluegill

We captured 194 bluegill, measured between 4 and 8.2 inches with a modal length of 5.7inches.

Pumpkinseed

We captured 243 pumpkinseed during the survey of Mid Lake measuring in length from 4.0 to 7.2 inches while the most abundant size was 5.8 inches.

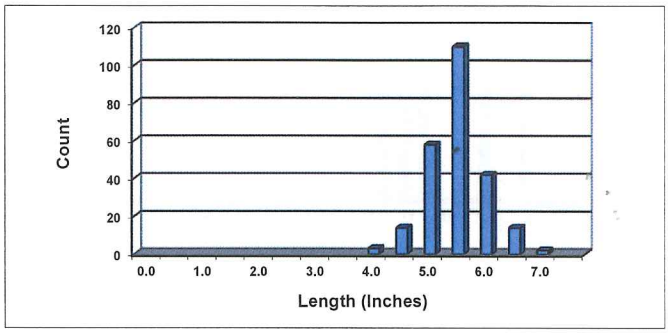

Figure 6. Length frequency distribution of 243 pumpkinseed captured during a survey of Mid Lake, Oneida County, 05/28/2015

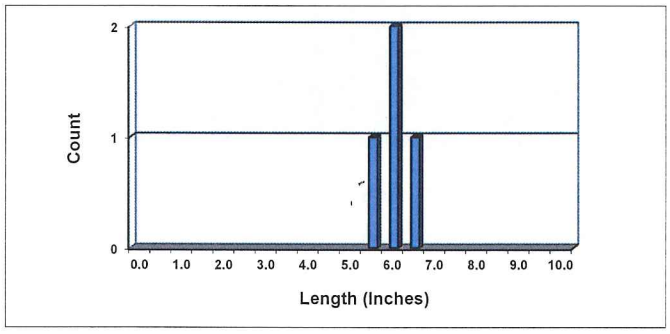

Figure 7. Length frequency distribution of 4 yellow perch captured during a survey of Mid Lake, Oneida County, 05/28/2015.

Yellow perch

We captured 4 yellow perch ranging from 5.5 to 6.7 inches in length.

Other Species

We captured 10 varieties of fish in our electrofishing sample of Mid Lake. In addition to the species listed above, we caught 24 hybrid bluegill x pumpkinseed, 10 yellow bullhead, and 7 golden shiners.

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Wisconsin Department of Natural Resources
107 Sutliff Avenue
Rhinelander, WI 54501
(715) 365-8919
Email: JohnF1.Kubisiak@wisconsin.gov

MWBCODE: 1542600
YEAR: 2015
LAKE: Mid
COUNTY: Oneida

Crew: Timler
Kubisiak
Tobias

Walleye		Largemouth bass		Northern pike		Black crappie		Yellow perch	
Length (in)	Count	Length (in)	Count	Length (in)	Count	Length (in)	Count	Length (in)	Count
<8		<8				0.0		0.0	
8		8	3	9		0.5		0.5	
9	1	9		10	1	1.0		1.0	
10		10	6	11		1.5		1.5	
11	1	11	12	12		2.0		2.0	
12		12	17	13		2.5		2.5	
13		13	20	14		3.0		3.0	
14	1	14	12	15	1	3.5		3.5	
15	1	15	9	16		4.0		4.0	
16	1	16	2	17		4.5		4.5	
17		17	2	18		5.0	1	5.0	
18		18		19	1	5.5	1	5.5	1
19		19		20		6.0		6.0	2
20		20		21		6.5		6.5	1
21		21		22		7.0		7.0	
22		22		23		7.5		7.5	
23		23		24		8.0	1	8.0	
24		24		25		8.5	1	8.5	
25		25+		26		9.0	2	9.0	
26				27		9.5		9.5	
27				28		10.0		10.0	
28				29		10.5		10.5	
29				30		11.0		11.0	
30+				31		11.5		11.5	
				32		12.0		12.0	
				33		12.5		12.5	
				34		13.0		13.0	
				35+		13.5		13.5	
						14.0		14.0	
						14.5		14.5	
						15.0		15.0	

Total	5	Total	83	Total	3	Total	6	Total	4

MWBCODE: 1542600 Crew: Timler
YEAR: 2015 Kubisiak
LAKE: Mid Tobias
COUNTY: Oneida

Bluegill		Pumpkinseed		Yellow bullhead		hybrid BG X PKS	
Length (in)	Count	Length (in)	Count	Length (in)	Count	Length (in)	Count
0.0		0.0		0.0		0.0	
0.5		0.5		0.5		0.5	
1.0		1.0		1.0		1.0	
1.5		1.5		1.5		1.5	
2.0		2.0		2.0		2.0	
2.5		2.5		2.5		2.5	
3.0		3.0		3.0		3.0	
3.5		3.5		3.5		3.5	
4.0	5	4.0	3	4.0		4.0	2
4.5	16	4.5	14	4.5		4.5	
5.0	43	5.0	58	5.0		5.0	1
5.5	46	5.5	110	5.5		5.5	2
6.0	38	6.0	42	6.0		6.0	6
6.5	26	6.5	14	6.5		6.5	5
7.0	13	7.0	2	7.0		7.0	5
7.5	6	7.5		7.5	1	7.5	3
8.0	1	8.0		8.0	2	8.0	
8.5		8.5		8.5	3	8.5	
9.0		9.0		9.0	3	9.0	
9.5		9.5		9.5		9.5	
10.0		10.0		10.0		10.0	
10.5		10.5		10.5		10.5	
11.0		11.0		11.0	1	11.0	
11.5		11.5		11.5		11.5	
12.0		12.0		12.0		12.0	
12.5		12.5		12.5		12.5	
13.0		13.0		13.0		13.0	
13.5		13.5		13.5		13.5	
14.0		14.0		14.0		14.0	
14.5		14.5		14.5		14.5	
15.0		15.0		15.0		15.0	
				15.5			
Total	**194**	**Total**	**243**	**Total**	**10**	**Total**	**24**

Other species Observed	count	lengths
Golden shiner	7	4-6.3

The challenges of the chain

While the downward trends in walleye recruitment and abundance on the Minocqua Chain have not been fully explained, the following factors might have contributed to these declines and could influence the rehabilitation process as well:

- **Low adult density**--Little natural reproduction has occurred since the early 2000s, which has led to adult densities well below their historical levels. Angler and tribal harvest may have also played roles in keeping adult densities low.
- **Changes in the fish community**--Centrarchids (bass/crappie) likely responded to declining walleye levels and appear to be present at higher levels than they were historically. Currently, the Minocqua Chain provides good habitat for centrarchids.
- **Availability of spawning habitat**--Minocqua and Lake Kawaguesaga do not have a large amount of walleye spawning habitat. However, Walleyes For Tomorrow has added rock habitat to enhance walleye spawning areas on Lake Minocqua.

Support Ethical/Responsible Fishing – Report Violations
Call 1-800-TIP-WDNR (1-800-847-9367)

Project cooperators

Headwater Basin Chapter of Walleyes for Tomorrow

www.wfthwb.com

Lac du Flambeau Band of Lake Superior Chippewa Indians

www.ldftribe.com

Great Lakes Indian Fish and Wildlife Commission

www.glifwc.org

Wisconsin Valley Improvement Company

www.wvic.com

Wisconsin Department of Natural Resources

www.dnr.wi.gov

Wisconsin Department of Natural Resources
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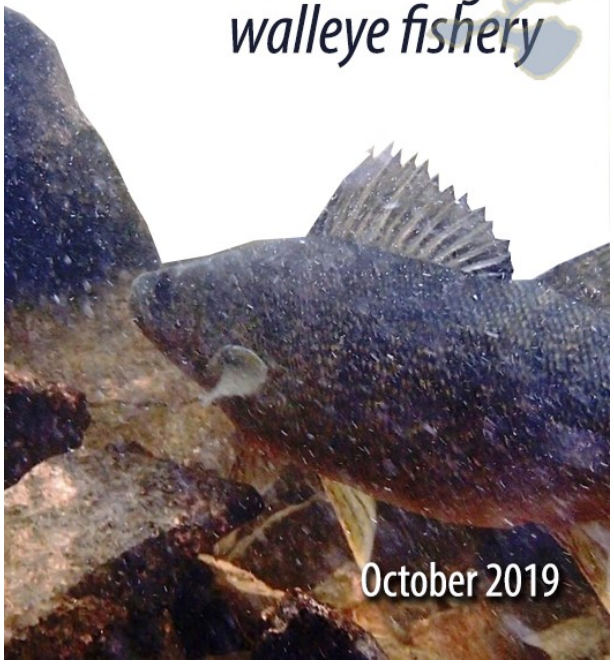
Revised 1/16/2019

The Minocqua Chain Project

Revitalizing a walleye fishery



October 2019

The revitalization of the Minocqua Chain walleye fishery

PROBLEM The adult walleye population and natural reproduction of the Minocqua Chain of Lakes in Oneida County has experienced a substantial decline since the early 1990s because of low recruitment of young fish into the population.

Adult walleye density (no/acre) in the Minocqua Chain, 1992 - 2019.

Lake	1992	1998	2009	2015	2019
Minocqua	5.6	4.6	2.0	1.0	3.8
Kawaguesaga	4.4	5.2	3.4	1.3	2.6
Tomahawk	2.5	2.5	1.3	0.7	—

WDNR/GLIFWC survey data

SOLUTION Implement a cooperative rehabilitation project that seeks to restore healthy, self-sustaining walleye populations. (A density of at least three adult fish per acre in lakes Minocqua and Kawaguesaga, and at least 2 adult fish per acre in Lake Tomahawk).

What we're doing

1. **Protecting adult fish** — Increased minimum length limit on walleye from 15" to 18" in 2011. No harvest of walleye from 2015 - 2020. Harvest of 2 walleye 18" or longer beginning in 2020.

2. **Increasing angler harvest on competing bass** — Removed minimum length limit on bass in 2011 to encourage angler harvest.

3. **Stocking fish** —Stocked large (7-8 inch) fingerling walleye in 2012, 2014, 2016 and 2018 in Lake Tomahawk and 2013, 2015 and 2017 in lakes Minocqua and Kawaguesaga. Continue stocking in alternate years after 2019 until natural reproduction can support a self sustaining fishery.

Stocking: what we've seen to date

- Stocked walleye are starting to show up in the fishery
- Immature fish are showing up in good numbers during fall fisheries surveys.
- Anglers have reported catching the stocked walleye

Proposed walleye harvest plan

March 2015 to March 2020:

- **NO HARVEST** on the Minocqua Chain (catch and release only). No tribal walleye harvest.

NOW

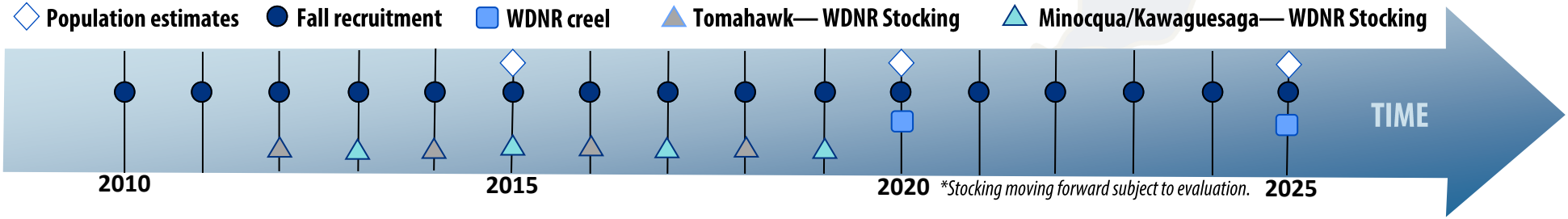
March 2020 to March 2025:

- **Limited harvest.** Regulations will depend on the response of the fishery. A conservative 2-bag limit and 18" minimum length limit on walleye will go into effect in 2020. Tribal walleye harvest may occur with appropriate guidelines.

March 2025 and forward:

- **Sustainable harvest.** Increase from a 2 to 3 bag limit and length limit adjustment based on survey analysis results. Tribal walleye harvest will continue with appropriate guidelines.

Monitoring and stocking the fishery



F

APPENDIX F

Comment Response Document for the Official First Draft

Comments to Mid Lake Draft Comprehensive Management Plan (6/25/2021)

Response by Eddie Heath (Onterra, LLC)
Response by Brenton Butterfield (Onterra, LLC)
Response by Andrew Senderhauf (Onterra, LLC)

WDNR Official Comments: Scott Van Egeren (Lakes Biologist), Madeline Mathes (AIS Specialist), & Ty Krajewski (APM Specialist) - Received 2/17/2022

[Our comments] are fairly minor overall and we thought that the plan was well done and the implementation goals/recommendations seem appropriate. Thank you for all of your work on this management plan and for Mid Lake!

In the introduction section, we think it would be beneficial to add a sentence or two to explain why this plan is being written. Also there is a mention of a previous control grant that Mid Lake received, if you could add a sentence about what control methods were used and when, that would be good. The following was added to the introduction: "*MLPMD completed a Comprehensive Lake Management Plan in March 2013 (LPL-1202-08, LPL-11203-08). The MLPMD implemented the management goals and actions within that plan, including aquatic invasive species (AIS) management and monitoring through several additional WDNR grant-funded projects (AEPP-270-11, AEPP-390-13, ACEI-147-14). While these grants were obtained with the intent to initiate a multi-year herbicide control strategy targeting invasive curly-leaf pondweed, the population was found to have declined naturally to levels that did not warrant treatment. The MLPMD worked with the WDNR to modify their mechanical harvesting strategy to include areas of curly-leaf pondweed.*

In an effort to reassess the ecological condition of Mid Lake and update management goals and actions as necessary, the MLPMD utilized remaining funds from one of the AIS management grants (ACEI-147-14) to complete an Updated Comprehensive Lake Management Plan, of which this document is the final deliverable. The primary focus of this update was to reassess the lake's aquatic plant community, both native and non-native, water quality, shoreland condition, stakeholder perceptions, and to update management and monitoring goals. The Summary and Conclusions Section (4.0) provide a succinct overview of the health of Mid Lake (Click Here)."

On page 18 it says "…CLP increases the potential for a larger nutrient release exists – but found that CLP die off isn't correlated to algal concentrations" …. and then goes on to say "The higher than normal algal levels in August of some years…are likely the result of a combination of factors including CLP levels…." We would just suggest to clarify this language so that isn't not assumed that CLP causes algae blooms. This was modified to, "*As will be discussed in the vegetation section, the amount of CLP in Mid Lake varies from year to year. The acreage of CLP in Mid Lake was plotted against summer average total phosphorus and chlorophyll concentrations to see if years with higher CLP acreage were correlated with years with higher phosphorus and chlorophyll concentrations. As illustrated in Figure 3.1-6, years with higher CLP did not necessarily correlate to years with higher chlorophyll concentrations in August. At present, it does not appear that the CLP population in Mid Lake has a significant impact on the lake's water quality.*"

- There are a few mentions of watercraft use and how it can have harmful effects on plants, such as contributions to spread of EWM and can cut/uproot native plants. However, there is no mention of this in the recommendation/goal section of the plan. We advise that you add something about this in the goals section – e.g. Responsible watercraft use/harmful effects of excessive watercraft in the educational section – or any other way you see fit. Thanks for the suggestion. This has been added to the bullet points for educational topics under Goal 1.
- It appears that CLP surveys weren't done in 2012 or 2018 (Maps 6-7). Figure 3.4-15 includes these years, but you can't tell if there is no CLP on the graph because surveys didn't occur or because there was no CLP found. If no surveys occurred I would either remove the year from the graph or in some way indicate that no surveys occurred during those years. If CLP mapping surveys did occur in these years then include the maps for those years. "No Survey" has been added to 2009, 2010, and 2012 on Figure 3.4-15. A point-intercept and early-season mapping survey were completed in 2018, but no CLP was located.
- Page 71 – It is true the most aquatic plant surveys were conducted in early summer. However, the 2008 PI survey was collected in mid-July during the recommended time to collect aquatic plant data for most species.
    - It seems that PI surveys during peak summer plant growth would be warranted given the harvesting taking place in the lake. Which plants are most abundant during peak aquatic plant times and in the summer when people will most use the lake? The protocol recommends surveys take place between early July and mid-August. We would recommend that PI surveys take place during this timeframe, but understand that surveys specifically targeting CLP may need to happen earlier (in June). Could the management action (under Goal 3) describe how often plant point-intercept surveys would happen for the entire plant community and how often for CLP timing? Comment acknowledged and integrated. Based upon Onterra's experience, conducting the point-intercept survey a month or so later may yield slightly higher occurrences of some native species, but probably not of a magnitude where the overall trends or relationships would change.
- Page 105 - Chris Bartelt is the Warden Supervisor. This should be changed to Audrey Royce – 715-614-3288. Audrey is the conservation warden for Vilas/Oneida Counties. Change made
- Page 105 - John Kubisiak is no longer the fisheries biologist for Oneida County. Zach Woiak has also moved to another position and the fisheries biologist position for Oneida County is being covered by the new Fisheries Supervisor (Royce Zehr) until another biologist is hired. This should be changed to Royce Zehr at 715-531-8054 or Royce.zehr@wi.gov Change made
- On page 106 under goal #2 it says there will be monitoring of AIS plants and animals (like rusty crayfish), it is suggested that you add how the monitoring will be done. Eg. Monitor AIS plants through PI surveys and monitor AIS animals by volunteers checking near their pier etc. Some general text added.
- Maps 3-5 – Could you put the dates that the surveys were completed on the maps? Dates added to Map Legend or Map Sources

WDNR Official Comments: Zachariah Woiak (Fisheries Biologist) & John Kubisiak (Regional Fisheries Supervisor) - Received 7/28/2021

- (J. Kubisiak) P. 86-87, You might include muskellunge stocking on the chain. P. 94. Walleye fishing is not closed on Minocqua Chain as indicated in your fishing regulations table. It is open first Sat in May through first Sun in March, but it is restricted to catch and release only. The bass regulations are also a little off – the season opens the 1st Sat in May. You can only keep Largemouth in May and early June, while Smallmouth are catch and release until the 3rd Sat in June. Fishing regulations table on pg 96 has been updated with the 2021-2022 fishing season dates. Corrections were also made to the walleye and bass regulations.
- (J Kubisiak) The C&R regulation for walleye was extended last fall using the emergency rule process, and on June 23 the Natural Resources board approved a permanent rule to extend catch and release for walleye until May of 2025, followed by a very restrictive protective slot regulation. Pending approval by Governor's office and Legislature, this rule will keep C&R in place for the full 10 years of the Minocqua Chain walleye rehabilitation plan (2015-2025). If we take no further action, then in May of 2025 the walleye rule will change to: 18-inch minimum length limit, but walleye from 22 to 28 inches may not be kept. One walleye daily bag limit. I added a few sentences regarding the catch and release extension and possible harvest limit starting in 2025.
- (Z. Woiak) On page 89 in the Walleye paragraph there is a sentence that reads " Size regulations for largemouth bass have been removed to decrease predation on young walleye". The size regulation was changed for both largemouth and smallmouth bass. Also, the regulation was changed to decrease the potential predation on young walleye along with interspecific competition. I think a sentence along the lines of "Size regulations for largemouth and smallmouth bass have been removed to decrease the potential predation on young walleye and reduce interspecific competition for resources" would be better suited. Updated the sentence with Zach's suggestion.
- (Z. Woiak) Otherwise as John pointed out in his earlier email, there has been recent changes to the Minocqua Chain Walleye Rehabilitation Plan and now the next comprehensive fish community survey (population estimates and indexes) and angler reel survey will be performed in 2025. The annual fall electrofishing surveys will remain the same. Updated the conclusion section with new survey date