Steve McComas: *Pickerel Plants and White Water Lilies in Round Lake*, **2010**

Lake Management Plan for the Pike Lake Chain of Lakes Price and Vilas Counties, Wisconsin

[Pike Lake Chain includes Pike Lake, Round Lake, Amik Lake, and Turner Lake]

2012

Prepared by Steve McComas, Blue Water Science
with significant contributions from the Pike Lake Chain of Lakes Association, and Wisconsin Department of Natural Resources

Funded in part by the Wisconsin Lake Management Planning Grants Program

Lake Management Plan
for Pike Lake Chain of Lakes
Price and Vilas Counties, Wisconsin

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ACKNOWLEDGMENTS

Members of the Pike Lake Chain of Lakes Association and many others contributed in various ways to the work effort on the projects that formed the basis for this Management Plan. They include:

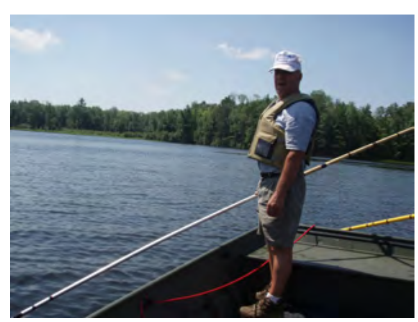
PROJECT MANAGEMENT

Bill Ave'Lallemant, Pike Lake Chain of Lakes Association
James Krietlow, WDNR, Northern Region Lakes Specialist, Projects Coordinator/Advisor

Pictures of some of the Pike Lake Chain of Lakes Volunteers





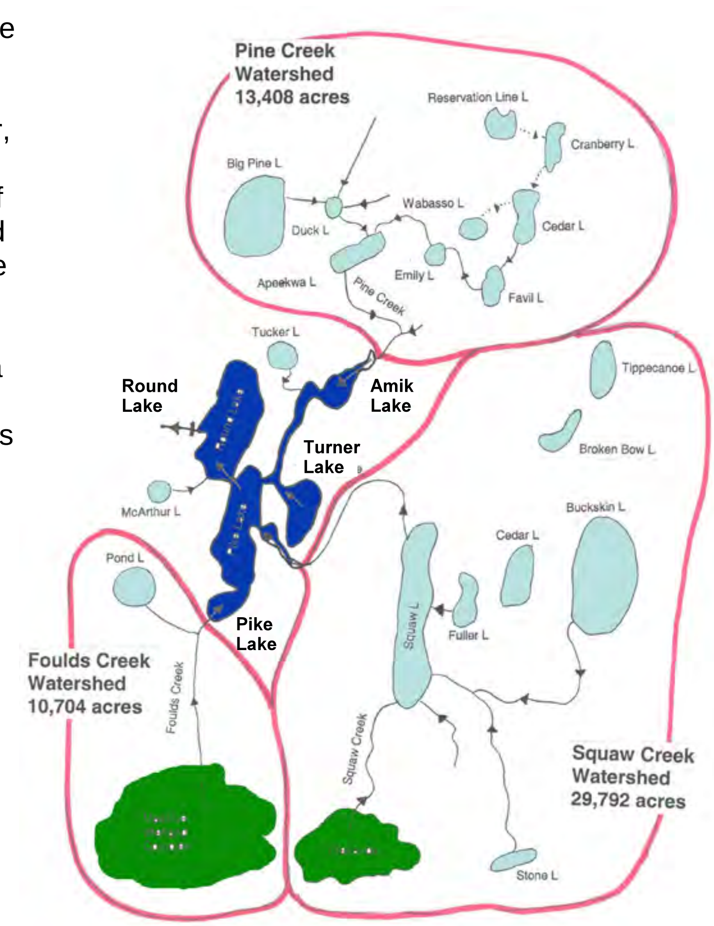



Pike Lake Chain of Lakes Report
PRICE AND VILAS COUNTIES, WISCONSIN
Summary of the Lake Management Study

Prepared by Blue Water Science, St. Paul, MN, 2012

Wetlands Impact Lake Water Quality in Major Ways

The Pike Lake Chain of Lakes is water rich. The large drainage area (over 61,000 acres), generates a large quantity groundwater and surface water runoff. Pike Lake has the largest watershed and Turner Lake has the smallest. However, Turner Lake may receive water from Amik Lake and maybe even Pike Lake. If this is the case, the "potential" watershed of Turner Lake would be much larger. Wetlands in the watershed comprise the largest land use category. The springs that come out of the wetlands carry wetland breakdown products which produce a brownish-red stain to the water. This is a natural occurrence. The 'bog' stain will be extra heavy when there is a "wet" year (a lot of rain) following a "dry" year (below average rain). The wetlands are purged and the reddish color as well as phosphorus, have a high concentration that reaches the lakes. This occurred in 2010.



Approximate watersheds (red outline) and wetlands (green) and other lakes in the Pike Lake Chain of Lakes.

Lake and Watershed Statistics

Amik Lake

Lake size (acres)	224
Mean depth (feet)	5
Maximum depth (feet)	8
Full watershed area (not including lake)	15,023
Water clarity (feet)(Secchi disc)(2010)	4.6
Lake phosphorus (parts per billion)(2010)	36

Pike Lake

Lake size (acres)	806
Mean depth (feet)	11
Maximum depth (feet)	17
Full watershed area (not including lake)	58,596
Water clarity (feet)(Secchi disc)(2010)	3.3
Lake phosphorus (parts per billion)(2010)	44

Round Lake

Lake size (acres)	726
Mean depth (feet)	16
Maximum depth (feet)	24
Full watershed area (not including lake)	61,274
Water clarity (feet)(Secchi disc)(2010)	4.6
Lake phosphorus (parts per billion)(2010)	31

Turner Lake

Lake size (acres)	149
Mean depth (feet)	8
Maximum depth (feet)	12
Full watershed area (not including lake)	567
Water clarity (feet)(Secchi disc)(2010)	6.6
Lake phosphorus (parts per billion)(2010)	24

Stream Characteristics

Pine Creek

Watershed area (ac)	13,408
Average runoff (11 inches = 0.92 ft)	0.92
Amount of water (ac-ft)	12,290
Average flow rate over the year (cubic ft per second)	17

Foulds Creek

Watershed area (ac)	10,704
Average runoff (11 inches = 0.92 ft)	0.92
Amount of water (ac-ft)	9,848
Average flow rate over the year (cubic ft per second)	14

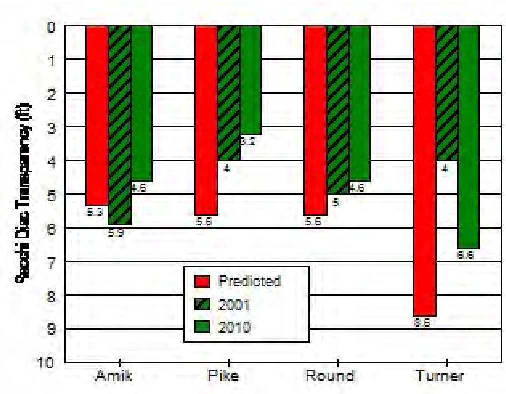
Squaw Creek

Watershed area (ac)	29,792
Average runoff (11 inches = 0.92 ft)	0.92
Amount of water (ac-ft)	27,408
Average flow rate over the year (cubic ft per second)	37

Water Quality Influenced by Watershed Inputs and Lake Processes

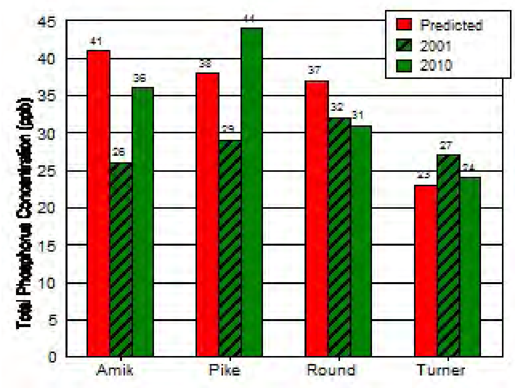
The water quality of the Pike Lake Chain of Lakes is fair and water is not as clear as in other area lakes, but the water flow and nutrient inputs are greater than other lakes due to the large watershed. However, not all of the Pike Lake Chain of Lakes are impacted the same way. Pike Lake may have the biggest response to stream inflows. Both the Foulds Creek and Squaw Creek watershed flows enter Pike Lake. On the other hand, Turner Lake has a smaller watershed but has soft lake sediments. Boat traffic and wind mixing may contribute to the lower-than-predicted lake clarity.

Clarity (Secchi Disc)



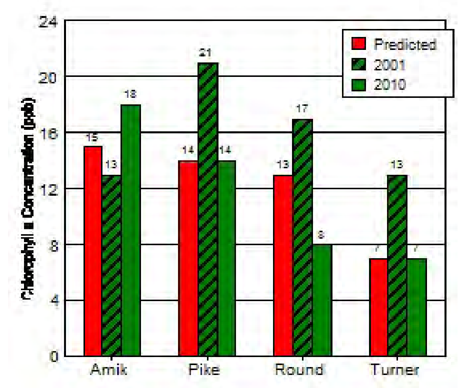
Clarity is not as good as predicted for the four lakes. This is due, in part, to the "bog" stain that colors the water and reduces transparency in Pike and Round.

Total Phosphorus



Total phosphorus is somewhat high, but close to what would be predicted, based on stream phosphorus concentrations.

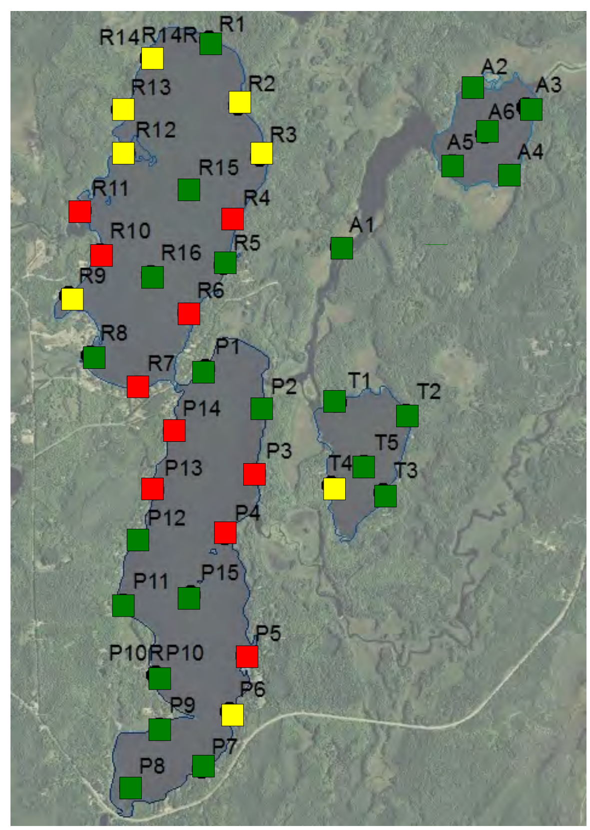
Algae (Chlorophyll)



The algae concentration was close to predicted or slightly higher than expected in 2001.

Lakes Are Located In a Natural Setting

The land use in the watershed of the Pike Lake Chain of Lakes is dominated by natural areas of forests, wetlands, and lakes. Although water quality is not at US EPA Lake and Forest Ecoregion benchmarks for clarity (8-15 feet), total phosphorus (14-27 ppb), or chlorophyll (less than 10 ppb), the existing water quality of the Pike Lake Chain of Lakes reflect a naturally eutrophic condition. There is not much that can be done to lower the phosphorus concentration in the lakes. The lake phosphorus concentrations are close to what would be predicted based on stream phosphorus levels measured in 2001 and in 2010 (results are shown in the graphs above) and stream phosphorus levels are at natural background levels. In addition, in Pike and Round, there may be some phosphorus release from the lake sediments as well. Lake sediments were tested in 2010 and phosphorus release potential is shown to the right. Ongoing lake protection projects should be continued, such as maintaining shoreland buffers and maintaining onsite systems. Expensive lake restoration projects to reduce stream phosphorus concentrations would not be practical at this time.



Lake sediment sample locations are shown with color squares. Colored squares represent phosphorus release potential at that site. Key: Green = low; Yellow = moderate; and Red = high.

Interesting Lake Facts

- Estimated 90% of the Pike Lake Chain of Lakes shoreline has a natural vegetative buffer.
- There is enough water flowing out of Round Lake to supply a City of 780,000 (at 65 gallons per person per day)

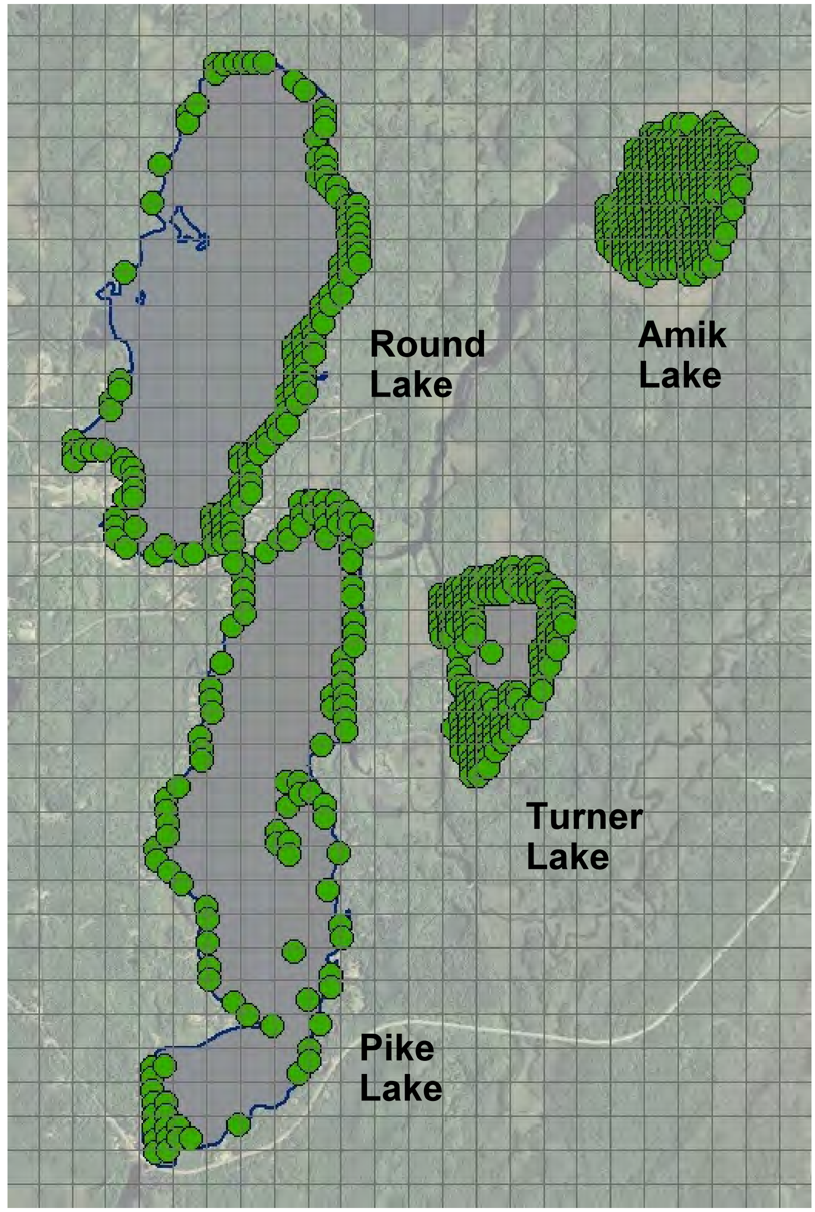
Updated Aquatic Plant Surveys Shows Fair Diversity in All Four Lakes

The number of aquatic plant species found in the four Pike Lake Chain of Lakes ranges from 15 (Round) to 19 (Pike). However the depth of water that plants grow to varies. Amik is a shallow lake and plants were found throughout the lake. Turner had pretty good plant distribution with growth out to 11 feet of water depth. Plant growth in Pike and Round Lakes did not go much deeper than 9 feet. Because Pike and Round drop off relatively quickly, aquatic plant growth is restricted to the nearshore areas at these two lakes.

Plant assemblages (groups of plant species) were similar for Pike and Round Lakes and water celery was the most common plant. Amik and Turner Lakes had different dominant plants which likely reflects different bottom conditions and shallower depths. The dominant plant in Amik was fern pondweed and the dominant plant in Turner was elodea.

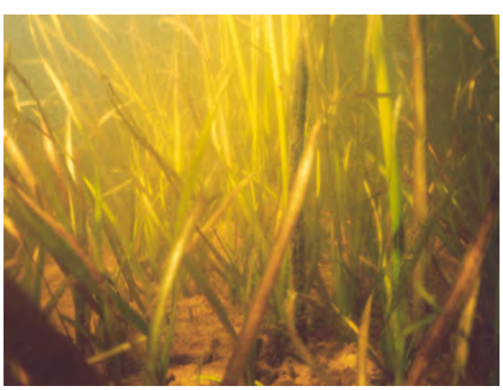
No submerged aquatic invasive plant species (curlyleaf pondweed or Eurasian watermilfoil) were observed in the four lakes.

Aquatic plants are essential for sustaining good water quality and maintaining a good fishery. No aquatic plant projects are needed at this time, but plant surveys every few years would help track potential declines with a call for improvement projects.



Native Plant Distribution (shown in green) in the Pike Lake Chain, 2010.

Three most common aquatic plants in the Pike Lake Chain are shown below.



Water Celery (dominant plant in Pike and Round)

Fern Pondweed (dominant in Amik)

Elodea (dominant in Turner)

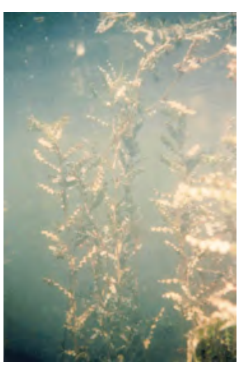
Aquatic Invasive Species Potential for Significant Growth is Low

Based on lake characteristics that were evaluated for this report, it was found that a majority of the invasive species of concern will not grow very well in the Pike Chain of Lakes. For example, two submerged non-native aquatic plants, curlyleaf pondweed and Eurasian watermilfoil, have specific sediment chemistry requirements and sediment samples from all four Pike Lake Chain of Lakes indicate the chemistry may not be optimal. For curlyleaf, it was found most of the lake sediments had high iron which is correlated to light growth of curlyleaf. For Eurasian watermilfoil, a majority of the lake sediments had low to moderate nitrogen concentrations which is correlated with light growth of milfoil.

For another invasive species of concern, the zebra mussel, it was found the calcium concentration in the water column, which is critical for shell production, was moderate. Therefore, zebra mussel growth would not likely reach optimal conditions. However, it is still important to implement and maintain good AIS prevention programs on an ongoing basis.

Overview of eight aquatic invasive species that could impact The Pike Lake Chain are listed below. As of 2010, curlyleaf pondweed, Eurasian watermilfoil, and zebra mussels have not been observed in the Pike Lake Chain.

Species	Pike Lake Chain Status	Potential for Nuisance Colonization in the Pike Lake Chain	Management Action	
			Short Term	Long Term
Plants				
1. Curlyleaf pondweed	Not in the Pike Lake Chain of Lakes	low	annual surveys by consultant or residents	selective treatment for nuisance growth conditions
2. Eurasian watermilfoil	Not in the Pike Lake Chain of Lakes	low to moderate	annual surveys by consultant or residents	selective treatment for nuisance growth conditions
3. Purple loosestrife	In the area	moderate	annual surveys by residents	spot control and use of beetles for large area control
Invertebrate				
4. Zebra mussels	Absent, but in Price County	moderate	mussel monitoring devices for early detection	contingency funds for aggressive rapid response
5. Rusty crayfish	Present in Turner Lake	low to moderate	crayfish traps to monitor the population	use existing fish to control rusty crayfish
6. Chinese mystery snail	Present in Pike Lake	moderate	no action needed	no action needed
Species to Watch				
7. VHS	absent	moderate to high	information and education	
8. Hydrilla	absent	low to moderate	information and education	



Curlyleaf Pondweed, an invasive aquatic plant, is not found in the Pike Lakes Chain. It has a low to moderate growth potential.

Eurasian Watermilfoil, an invasive aquatic plant, is not found in the Pike Lakes. It has a low growth potential in the Pike Chain.

Zebra Mussel, an invasive aquatic mollusk, is not found in the Pike Lakes. It has a low to moderate growth potential in the Pike Lake Chain.

1. Introduction and Project Setting

This lake report updates a Lake Management Plan that was completed in 2003. Much of the 2003 report is still valid and this report adds new information in the areas of aquatic plant surveys, assessing aquatic invasive species, and evaluating the impact of wetlands on lake water quality.

The Pike Lake Chain of Lakes is located in Price and Vilas Counties, Wisconsin (Figure 1). Lake sizes and depths are shown in Table 1.

The objectives of this study were to characterize existing lake conditions to compare present conditions to past conditions, and to make recommendations to protect and improve the lake environment where feasible.

Table 1. Lake statistics for the four principle lakes in this study.

	Pike	Round	Amik	Turner
Size (acres)	806	726	224	149
Mean depth (ft)	11	16	5	8
Maximum depth (ft)	17	24	8	12

Figure 1. Pike, Round, and Amik and Turner Lakes are located in Price and Vilas Counties, Wisconsin.

2. Recent Lake History

A comprehensive lake history report has been prepared by John Berg and is available as a "stand alone" book which was published in 2003 and is available from the Lake Association. John Berg's book has provided a definitive history of the Pike Lake Chain. A brief summary of the history of Pike Lake is summarized below.

?-1850s: Land inhabited by native Americans.
1870s: Logging begins in Price County
1876: Log dam is in place at outlet of Round Lake. Army Corps of Engineers estimated a drainage area at Round Lake dam of 102 square miles (65,280 acres).
1884-85: Rock cribs are built and sunk in Pike and Round Lakes. They were used to anchor a steamboat as it winched a boom of logs from Pike Lake to the Round Lake outlet. The steamboat had several "stops" or mooring points and there were several rock cribs installed.
1921-28: Steam-powered sawmill processes all types of timber. Located in bay on the southwest shore of Pike Lake.
1930s-present: Lakeshore construction of cabins and resorts picks up and continues to the present.

Figure 2a. Discarded wooded slabs from the sawmill operation are still found in a southern bay of Pike Lake.

Figure 2b. Pike Lake Club house in one form or another has been a fixture on Pike Lake since the early 1900s.

3. Watershed Features

3.1. Drainage Area to the Lakes

Drainage areas to individual lakes are listed in Table 2 and watershed-to-lake area ratios are shown in Table 3. The size of the direct drainage watersheds that drain to the lakes are typical for northern Wisconsin glacial lakes.

However, of the four lakes in the Chain of lakes, Turner Lake is a somewhat isolated lake within the chain and has no indirect watershed draining into it. It has the smallest watershed area to lake area ratio (Table 3). There are large contributing watershed areas for Amik, Pike, and Round Lakes. This is not typical for glacial seepage lakes but is fairly common for drainage lakes.

Table 2. Watershed areas for Pike, Round, and Amik and Turner (prepared by Blue Water Science).

	Lake Size (ac)	Direct Watershed (not including lake)(ac)	Contributing Watershed (ac)	Total Watershed Area (not including lake)(ac)	Total Watershed (including lake) (ac)
Turner	149	567	0	567	716
Amik	224	991	14,032	15,023	15,247
Pike	806	2,137	56,459	58,596	59,402
Round	726	1,872	59,402	61,274	62,000

<u>Definitions:</u>
Direct watershed: *land area that drains to the lake by runoff*
Contributing watershed: *land areas that drain to the lake by way of a defined channel or stream.*
Total watershed: *this is the direct drainage watershed area plus the contributing watershed area.*

Table 3. Watershed area to lake surface area ratios.

	Direct Drainage Watershed to Lake Ratio	Total Watershed (not included) to lake ratio	Comments
Turner	4	4	Only lake of the four with no contributing watershed.
Amik	4	67	Receives water from Tucker Lake and lakes to the north.
Pike	3	73	Receives water from Amik drainage, Turner Lake, and Squaw and Foulds Creeks.
Round	3	84	Main flow is from Pike Lake.

A breakdown of drainage units to each lake is shown in Table 4 and a map showing watershed delineations is shown in Figure 3 and another map showing a stylized watershed is shown in Figure 4. Although Turner Lake does not have a distinct inflow from a larger contributing watershed, Turner Lake may receive some inflow from the Amik watershed discharge (Figures 3 and 4).

Table 4. Summary of watershed sizes (in acres).

Turner	
Direct drainage	567
Total watershed subtotal	567
Lake	149
TOTAL WATERSHED	716
Amik	
Pine Creek	13,408
Tucker Lake	624
Contributing watershed	14,032
Direct drainage	991
Total watershed subtotal	15,023
Lake	224
TOTAL WATERSHED	15,247
Pike	
Foulds Creek	10,704
Squaw Creek	29,792
Amik Lake	15,247
Turner lake	716
Contributing watershed	56,459
Direct drainage	2,137
Total watershed subtotal	58,596
Lake	806
TOTAL WATERSHED	59,402
Round Lake	
Pike Lake	59,402
Direct drainage	1,872
Total watershed subtotal	61,274
Lake	726
TOTAL WATERSHED	62,000

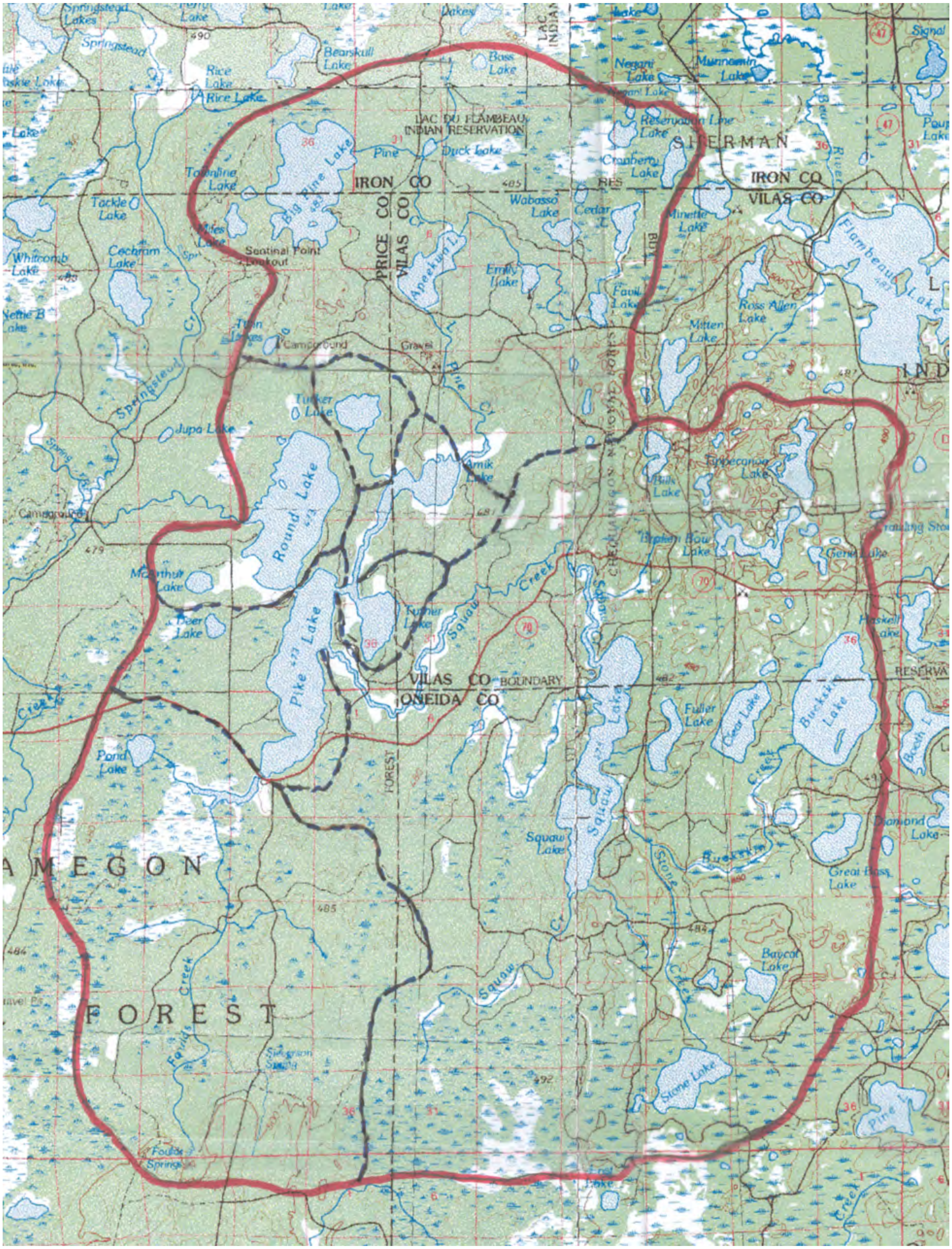


Figure 3. Watershed delineation for Pike, Round, Amik, and Turner Lakes.

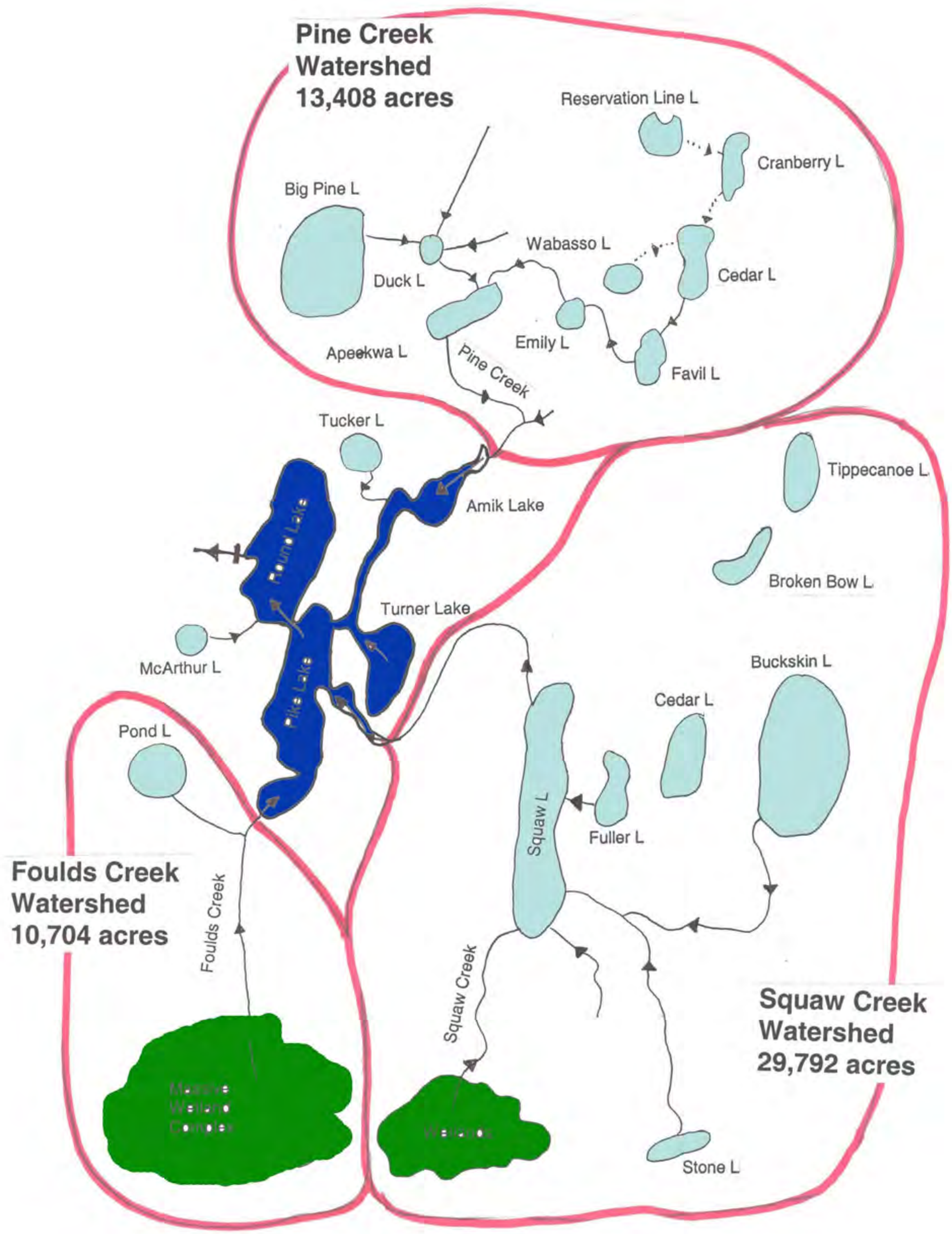


Figure 4. The three major subwatersheds draining to the Chain of Lakes and the direction of flow is shown above. There are at least 18 named lakes in the subwatershed.

3.2. Amount of Water Flowing to the Lakes

Source of water to all four lakes is from rainfall, groundwater that seeps into the lakes from fringe wetlands, stream flows, and lake outlets. The amount of water flowing into and out of the lakes is substantial. Flows have been estimated for the major streams along with other water sources. The estimated flows from the three major subwatersheds are listed below in Table 5.

Table 5. Estimated flows of the three streams draining the three major subwatersheds.

	Pine Creek	Foulds Creek	Squaw Creek
watershed size (ac)	13,408	10,704	29,792
Average runoff (11 inches = 0.92 ft)	0.92	0.92	0.92
Amount of water (ac-ft)	12,290	9,848	27,408
Average flow rate over the year (cubic ft per second)	17 cfs	14 cfs	37 cfs
measured flow on April 25, 2001		30-40 cfs	40-60 cfs
measurement method		culvert 10' wide, 4 ft deep, flow = 1 ft per sec	culvert 10' wide, 3' deep, flow = 1.5 to 2 ft per sec.

It's a water rich watershed.

The estimated outflow at the dam at Round Lake is substantial and averages about 79 cubic feet per second. The total amount of water leaving Round Lake is calculated by assuming an average of 11 inches of rainfall per year makes its way off the land area of the 62,000 acre watershed. This is equal to 56,833 acre-feet of water.

This would be enough water to supply drinking water to a city with a population of 780,000 on a yearly basis (assuming 65 gallons per person per day).

3.3. Amount of Phosphorus in the Streams Flowing to the Lakes

The drainage areas to the chain of lakes are dominated by forests and wetlands. Although the forests have been clear cut at least once in the last 150 years, existing conditions are dominated by undeveloped land use. This condition allows the potential for good water quality to runoff the land and into the lakes.

Because of the extensive wetland areas that are undeveloped, as well as a portion of the watershed within the national forest, nutrient levels in the incoming streams are close to natural background concentrations.

However, due to the "lay-of-the land", there is an exceptionally large drainage area to the lakes and an exceptional amount of water that runs into Amik, Pike, and Round Lakes. Although the stream flows have relatively low phosphorus concentrations because of the large quantity of flow, there is a relatively large amount of phosphorus entering the chain.

Phosphorus Loading from Stream Inputs in 2001 and in 2010: Phosphorus is a nutrient that is closely monitored in lake systems because it is the nutrient most likely to generate algae blooms. The amount of phosphorus entering the Chain of Lakes is estimated for 2001 and 2010 and is shown in Tables 6 and 7. Flows were estimated based on average yearly runoff values from the US Geological Survey. An average runoff value of 11 inches per year was used. Stream phosphorus concentrations were based on stream grab samples and phosphorus results were averaged for 2001 and 2010. The average stream phosphorus concentrations were higher in 2010 compared to 2001. The stream flows represent the most important source of phosphorus to the lakes.

Table 6. Phosphorus concentrations and phosphorus loads for four major incoming surface flows to Pike, Amik, and Round Lakes in 2001. Turner Lake does not have a perennial surface inflow.

	Pine Creek (flows into Amik Lake) (phos in ppb)	Fould's Creek (flows into Pike Lake) (phos in ppb)	Squaw Creek (flows into Pike Lake) (phos in ppb)	Pike Lake outlet (flows into Round Lake) (phos in ppb)
4.25.01*	--	15	24	--
5.30.01	38	16	24	--
6.25.01	29	30	35	--
7.11.01	31	29	43	--
8.20.01	35	25	34	--
9.18.01	33	28	58	--
May-Sept Average (phosphorus conc)	33	26	39	31
Watershed size (acres)	13,408	10,704	29,792	59,402
Average runoff per year (inches)	11" = 0.92 ft	11" = 0.92 ft	11" = 0.92 ft	11" = 0.92 ft
Amount of water (ac-ft)	12,290	9,848	27,408	54,650
Phosphorus load = p conc x amount of water = pounds of P	1,100 pounds (500 kg)	700 pounds (316 kg)	2,900 pounds (1,318 kg)	4,600 pounds (2,090 kg)

*DOC for Fould's Creek = <0.1 mg/l and for Squaw Creek = 14 mg/l

Table 7. Phosphorus concentrations and phosphorus loads for four major incoming surface flows to Pike, Amik, and Round Lakes in 2010. Turner Lake does not have a perennial surface inflow.

	Little Pine Creek (flows into Amik Lake) (phos in ppb)	Fould's Creek (flows into Pike Lake) (phos in ppb)	Squaw Creek (flows into Pike Lake) (phos in ppb)	Pike Lake Outlet (flows into Round Lake) (phos in ppb)
5.17.10	23	33	32	--
6.25.10	75	43	49	--
7.28.10	39	--	55	--
9.4.10	40	72	70	--
May-Sept Average (phosphorus conc)	44	49	52	44
Watershed size (acres)	13,408	10,704	29,792	59,402
Average runoff per year (inches)	11" = 0.92 ft	11" = 0.92 ft	11" = 0.92 ft	11" = 0.92 ft
Amount of water (ac-ft)	12,290	9,848	27,408	54,650
Phosphorus load = p conc x amount of water = pounds of P	1,467 pounds (667 kg)	1,319 pounds (600 kg)	3,867 pounds (1,758 kg)	6,529 pounds (2,968 kg)

3.4. Shoreland Status

The shoreland area encompasses three components: the upland fringe, the shoreline, and shallow water area by the shore. A photographic inventory of the Pike, Round, Amik, and Turner shorelines was conducted in 2001 with photographs taken by volunteers of the Pike Lake Association, with analysis by Blue Water Science. The objective of the survey was to characterize existing shoreland conditions, which will serve as a benchmark for future comparisons.

For each photograph, the shoreline and the upland condition were evaluated. Examples of shoreland conditions are shown in Figure 5. The criteria for natural conditions were the presence of 50% native vegetation in the understory and at least 50% natural vegetation along the shoreline in a strip at least 15 feet deep. Although buffer strips 25 feet deep have been recommended since 2000, when the first shoreline surveys were conducted by Blue Water Science in the 1990's, a 15-foot buffer strip was acceptable and offered some nutrient reduction benefits. The 15-foot buffer strip was used in the Pike Chain inventory so results could be compared to other inventories. Shorelands were evaluted at the 75% natural level as well.

A summary of the inventory results is shown in Table 8. Based on subjective criteria, over 95% of the parcels in the Round, Amik and Turner, Pike Lakes shoreland area meet the natural rankings for shorelines and upland areas. This is good for a lake in northern Wisconsin. Proactive volunteer native landscaping should maintain existing conditions and improve other parcels. It would be interesting to conduct another shoreland inventory to compare to the original. However, subjective observations made in 2010 indicate that the native shoreline conditions are mostly intact.

The full 2001 shoreland inventory is found in a separate report with copies at the WDNR-Rhinelander and with the lake association archives.

Table 8. Summary of buffer and upland conditions in the shoreland area of Pike, Round, Amik and Turner Lakes. Approximately 772 parcels were examined in 2001.

Pike Chain of Lakes	Natural Shoreline Condition		Natural Upland Condition		Undevel Photo Parcels	Shoreline Structure Present	
	>50%	>75%	>50%	>75%		riprap	wall
TOTALS (no. of parcels = 722)	95% (684)	91% (654)	92% (633)	87% (626)	53% (380)	5% (33)	0.1% (1)

Figure 5. [top] This parcel would rate as having a shoreline with a buffer greater than 50% of the lot width and an understory with greater than 50% natural cover.
[bottom] This parcel would not qualify as having a natural shoreline buffer greater than 50% of the lot width. Also, understory in the upland area would be rated as having less than 50% natural cover.

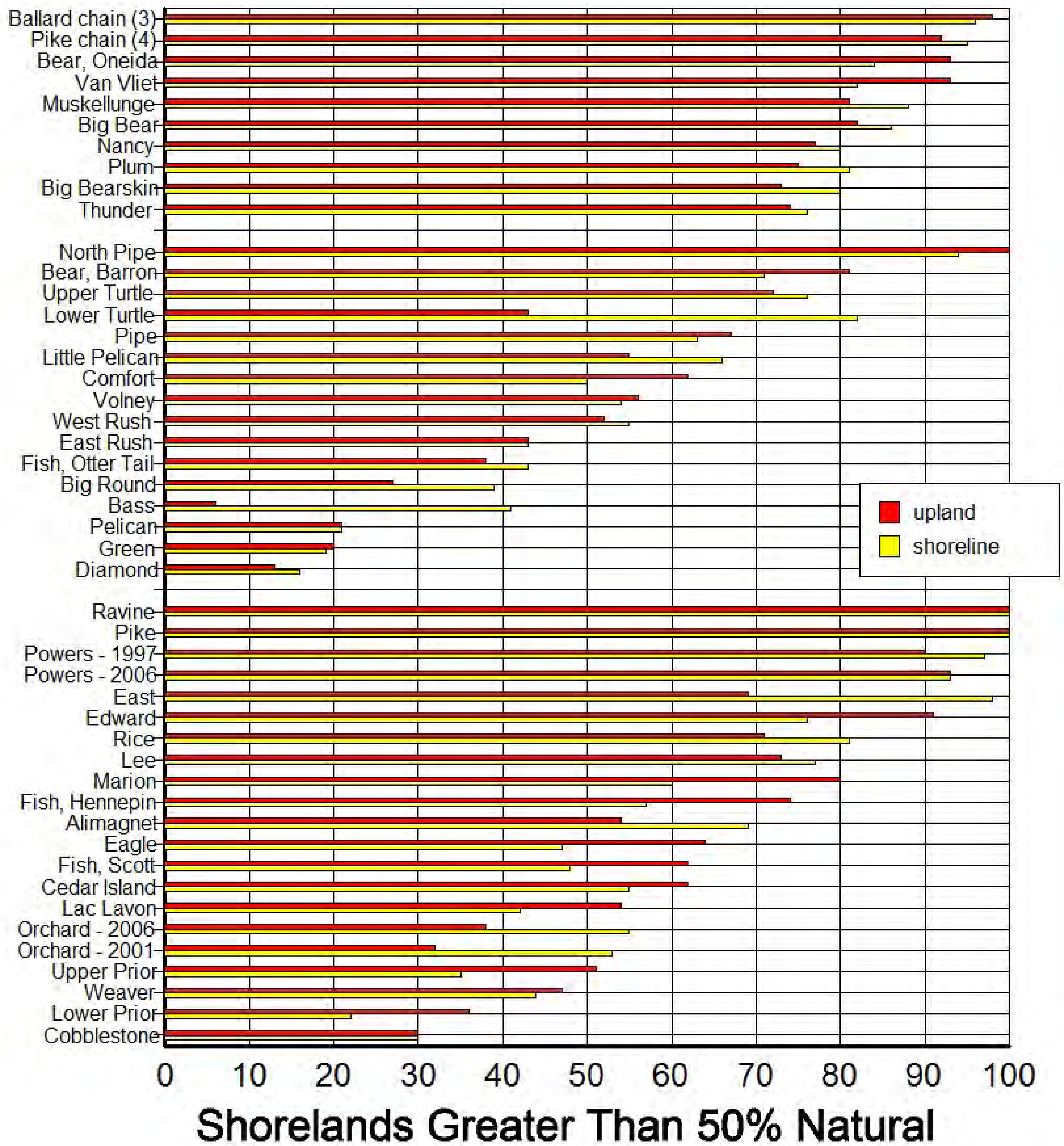


Figure 6. A summary of shoreland inventory results for lakes using an evaluation based on shoreland photographs. For each lake the percentage of shoreline and upland conditions with greater than 50% natural conditions is shown. The first tier of lakes are located in northern Wisconsin. The lower tier of lakes are in the Twin City Metropolitan area and are considered urban lakes. Although several lakes are "urban" lakes most of the shoreland is owned by the city and there is a high percentage of natural conditions. The middle tier of lakes are about an hour's drive from the Twin Cities, and are not considered to be urban lakes, they are "country" lakes.

Pike Chain of Lakes are northern Wisconsin lakes.

3.5. On-site Wastewater Treatment Systems Status

The status of on-site wastewater treatment systems in the watershed are rated as satisfactory. A typical on-site system is shown in Figure 7.

There may be some movement of septic effluent toward the Chain of Lakes, but this occurs in nearly all lake settings. The septic tanks are not polluting the lakes. This is based on several factors:

- soils have infiltration capacity so any overland septic flow would be rare.
- homes and drainfields are set back from the lake allowing adequate septic tank effluent treatment.
- there is a low density of residences around the lakes.

With existing regulations in place for Price and Vilas Counties, water pollution problems from on-site systems are not anticipated in the future.

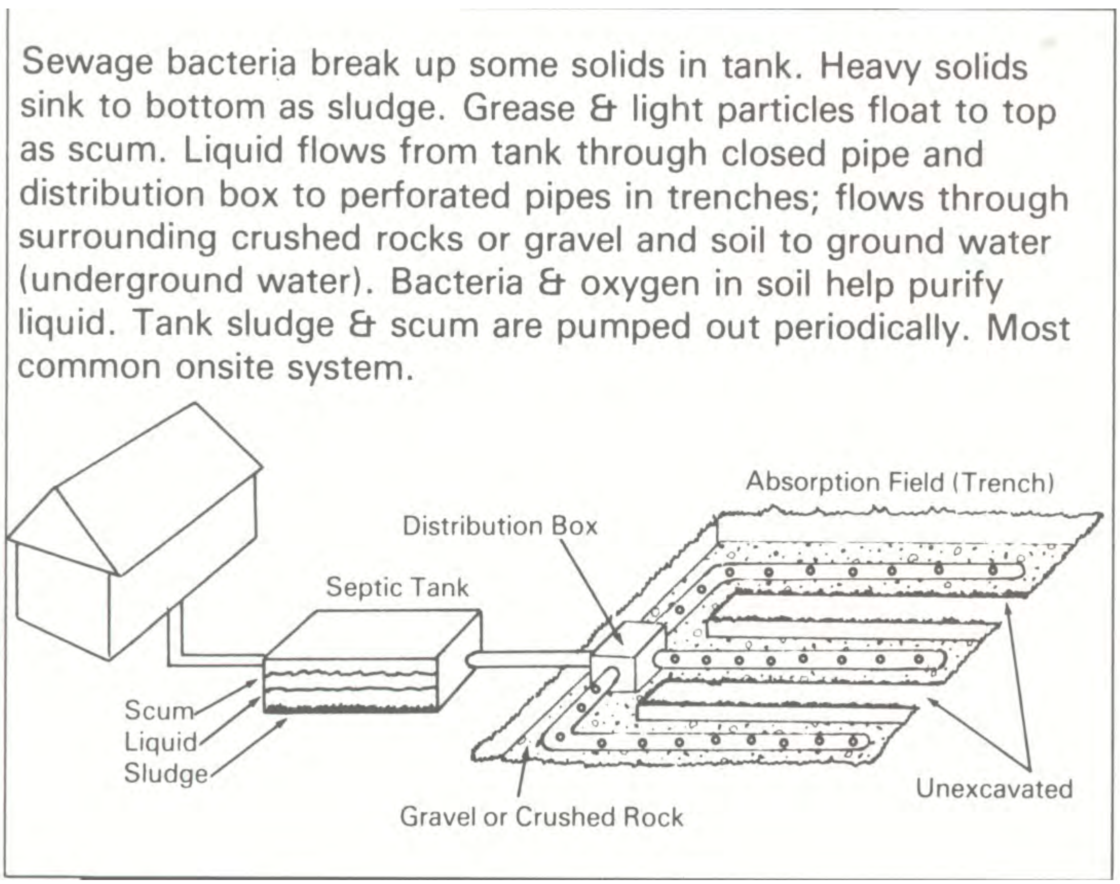


Figure 7. Typical septic tank/drainfield configuration (from McComas 1993. LakeSmarts).

3.6. Watershed Summary

Overview: The watershed area that drains to the Chain of Lakes is in exceptional natural state compared to watersheds in other areas of the state. The land in the watershed is dominated by wilderness areas and is composed primarily of forests and wetlands.

Because most of the watershed is composed of wetlands to the south and within a national forest to the west and north, there is the long term prospect for primarily a natural condition.

However, shorelands around the lake are privately owned and subject to alterations. Shoreland areas are critical to the lake environment. They are in a high natural state at this time (based on shoreline inventory results). The challenge will be to preserve those conditions, which will benefit lake water quality in the long run.

Wetland Influence: Due to higher stream concentrations, streams carried in more phosphorus to Pike, Amik, and Round Lakes in 2010 compared to 2001 (Table 9). In 2010, it appears Pike and Amik's phosphorus concentrations probably reflected the increase from the stream phosphorus inputs, whereas Round and Turner Lakes were not affected (Table 10).

The streams had extra phosphorus in 2010 which was likely due to above average early season rainfall. The rain probably "pushed" phosphorus from the wetlands into Pine, Fould's, and Squaw Creeks. That would also account for the deeper brownish stain in the creek flows in 2010. The brown stain was due to naturally occurring dissolved organic compounds in the wetlands that were flushed out due to the rain.

The higher phosphorus content in the streams is not expected to be a long term trend. Stream phosphorus concentrations should be less in the future and the lake's will respond with lower phosphorus concentrations as well.

The good news is the lakes appear to have stable water quality for the long term with some seasonal variation.

Table 9. Stream phosphorus data (in µg per liter)(May - September Average).

	2001	2010
Pine Creek (flows into Amik)	33	44
Fould's Creek (flows into Pike)	26	49
Squaw Creek (flows into Pike)	39	52
Pike Lake Outlet (flows into Round)	31	44

Table 10. Lake phosphorus data (in µg per liter)(May - September Average).

	2001	2010	2011
Amik Lake	26	36	44
Pike Lake	29	44	44
Round Lake	32	31	33
Turner Lake	27	24	33

4. Lake Features

4.1. Lake Statistics

The chain of lakes is shown in Figure 8 and lake characteristics are shown in Table 11.

Figure 8. Lake maps of Pike, Round, and Amik and Turner Lakes.

Table 11. Lake and watershed characteristics for Pike, Round, and Amik and Turner Lakes.

	Round	Pike	Amik	Turner
Area (ac)	726	806	224	149
Mean depth (ft)	16	11	5	8
Maximum depth (ft)	24	17	8	12
Volume (ac-ft)	11,616	8,866	1,120	1,192
Watershed area (ac) (not including lake)	61,274	58,596	15,023	567
Watershed area:lake ratio	84	73	67	4
Estimated Average Water Residence Time (years)	0.2	0.2	0.1	2.4
Public Access	2	2	0	0
Inlets	3	3	1	1
Outlets	1	1	1	1

4.2. Temperature and Dissolved Oxygen in the Lakes

Dissolved oxygen and temperature measurements reveal several things about a lake. If oxygen is absent in the bottom of the lake, phosphorus can be released from the lake sediments. If the temperature is the same from the top to the bottom of the lake in the open water season, all the water will mix. If oxygen is depleted over the winter, winterkill can occur. Examples of dissolved oxygen and temperature profiles are shown in Figure 9.

Winter oxygen levels can be low in the bottom water of all four lakes. However oxygen is present in the upper water column. In summer, the lakes are well mixed and oxygen is present throughout the summer.

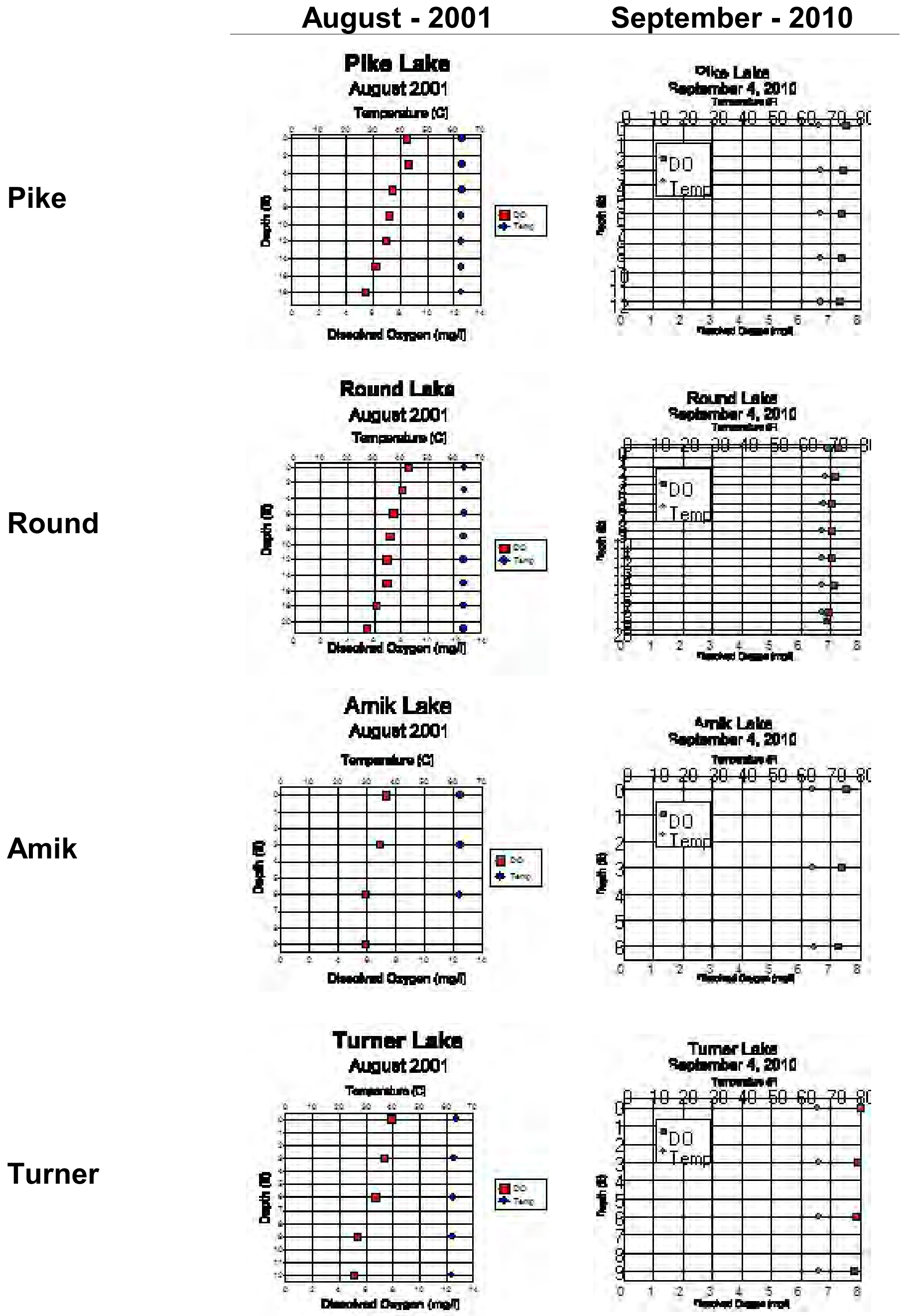
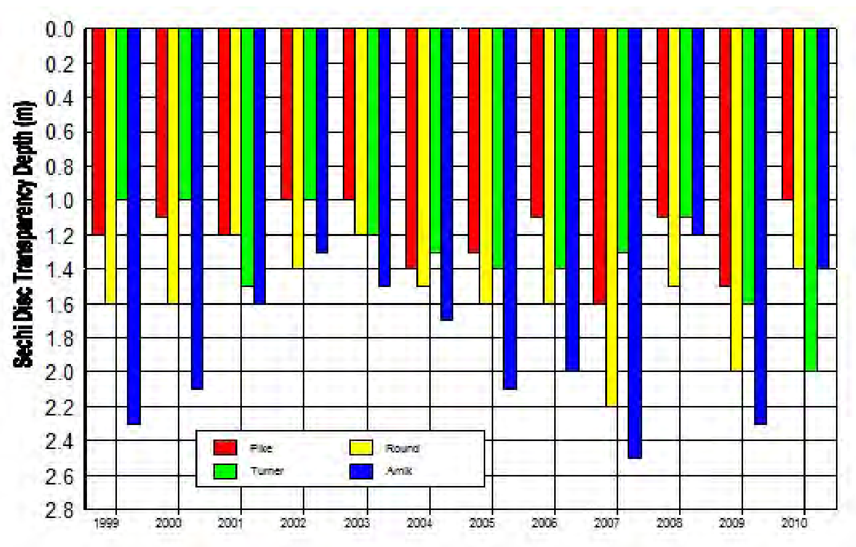


Figure 9. Dissolved oxygen/temperature profiles for Pike, Round, and Amik and Turner Lakes.

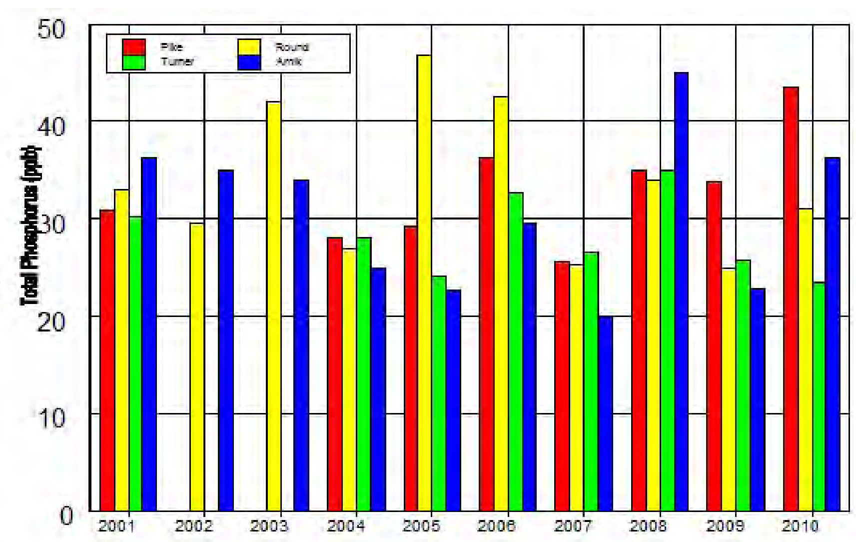
4.3. Water Quality Summary

Water testing was conducted by volunteers for the chain of lakes starting in the 1990s, with intensive efforts occurring from 1998 through 2010. Lake monitoring has characterized lake water quality conditions and helped us to understand factors influencing water quality in all three lakes.

A summary of Secchi disc transparencies and total phosphorus concentrations collected from 1999 through 2010 are shown in Figure 10.



Secchi Disc Transparency



Total Phosphorus Concentration

Figure 10. Secchi disc transparency (meters) and total phosphorus (ppb) from 1999 through 2010.

How does the water quality of the Chain compare to other lakes? The Chain of Lakes water quality parameters are compared to typical values for unimpacted lakes in the Northern Lakes and Forests Ecoregion in Table 12. For the three primary water quality parameters of Secchi disc, phosphorus, and chlorophyll, the Chain of Lakes have values that are outside the ranges of ecoregion lakes. The reasons for the water quality conditions of the Chain of Lakes appear to be due to natural conditions and are related to the large watershed drainage area.

For the most part, all four major lakes have similar water clarity and nutrient levels. When there is a thick growth of aquatic plants, Amik can be slightly clearer (as it was in 2000 and 2007) compared to the other three lakes.

Table 12. Summary of water chemistry for the Pike Chain of Lakes (May - Sept average).

	Total Phosphorus (ppb)				Chlorophyll (ppb)				Secchi Disk (m)			
	Pike	Round	Turner	Amik	Pike	Round	Turner	Amik	Pike	Round	Turner	Amik
1999									1.1	1.6	1.5	2.1
2000	26	30	23	16					1.0	1.6	1.1	1.9
2001	31	33	30	36	21	17	13	13	1.2	1.4	1.2	1.5
2002		29.5		35.0		12.7		10.1	1.0	1.4	1.0	1.2
2003		42.0		34.0		17.3		11.0	1.0	1.2	1.2	1.5
2004	28.1	26.9	28.0	24.9	9.3	14.4	14.0	7.9	1.4	1.5	1.3	1.7
2005	29.2	46.9	24.2	22.7	10.4	11.3	9.3	6.9	1.3	1.6	1.4	2.1
2006	36.2	42.6	32.6	29.6	16.4	13.4	8.9	7.8	1.1	1.6	1.4	2.0
2007	25.6	25.3	26.6	20.0	7.5	51.6	8.5	3.9	1.6	2.2	1.3	2.5
2008	35.0	34.0	35	45.0	9.2	9.5	18.1	14.6	1.1	1.5	1.1	1.2
2009	33.8	25.0	25.8	22.8	13.8	7.2	9.9	3.1	1.5	2.0	1.6	2.3
2010	43.5	31.0	23.5	36.3	13.6	7.9	6.9	18.4	1.0	1.4	2.0	1.4
2011	44	33	33	44	24.9	36.3	10.9	13.6				1.7
Northern Lakes and Forest	14 - 27	14 - 27	14 - 27	14 - 27	<10	<10	<10	<10	2.4 - 4.6	2.4 - 4.6	2.4 - 4.6	2.4 - 4.6

In 1999 and 2000, lake water samples were sent to the University of Wisconsin-Stevens Point lab and a number of parameters were analyzed. Results showed alkalinity is low, but not dangerously low, and that the pH is slightly basic, which is fine. Color results are interesting. All four lakes have relatively high color, with Turner the lowest and Pike the highest. This color is a product of the inflowing streams bringing in dissolved substances from wetland drainage.

Table 13. Water chemistry data summary for the Chain of Lakes from the University of Wisconsin-Stevens Point results for 1999 and 2000 (P=Pike; R=Round; A=Amik; T=Turner).

Stevens Point Data	10.31.99				4.30.00				10.20.00			
	P	**R**	**A**	**T**	**P**	**R**	**A**	**T**	**P**	**R**	**A**	**T**
Total phosphorus (ppb)	29	32	24	32	27	27	29	31	26	30	16	23
Secchi disc (ft)	4.5	5.5	6.5	4.3	5	5.5	5.7	5.8	4.5	5.8	6.5	4.3
Color (SU)	93	83	48	49	107	79	59	39	100	71	66	33
Turbidity (NU)	2.2	1.6	2.2	2.4	1.7	1.9	1.9	2.4	0.6	0.9	0.4	0.6
Kjeldahl N (mg/l)	0.94	0.92	0.59	0.83	0.5	0.45	0.67	0.41	1.19	1.47	0.92	1.1
Nitrate/nitrite (mg/l)	<0.02	0	0.1	<0.02	0.1	0	<0.01	<0.01	0	0	0	0
Ammonia (mg/l)	<0.01	<0.01	0	<0.01	<0.01	<0.01	<0.01	<0.01	0.1	0	<0.01	0
pH	7.5	7.57	7.71	7.52	7.2	7.35	7.38	7.32	6.47	7.22	6.78	7.29
Alkalinity	33	32	44	32	28	31	38	34	24	32	34	36
Conductivity	73	72	89	70	59	67	70	63	77	69	82	69
Chloride (mg/l)	<0.5	<0.1	<0.5	<0.5	1.1	24.8	0.2	0.2	2	0.5	<0.5	<0.5
Sulfate (mg/l)	7.5	6	4	3.5	3.4	3.7	3.3	2.5	6.8	3	4.5	2.8
Sodium (mg/l)	1.9	1.8	1.7	1.5	1.8	1.7	1.4	1.4	1.8	1.7	1.6	1.4
Potassium (mg/l)	0.5	0.5	0.5	0.6	0.7	0.6	0.7	0.6	0.5	0.6	0.7	0.6
Magnesium (mg/l)	8	8	16	8	12	9.4	12.5	14.1	8.4	14.6	8.5	14
Calcium (mg/l)	24	24	28	24	20	22.6	25.5	21.9	23.6	21.4	27.5	22
Reactive phosphorus (ppb)	12	<2	10	<2	6	8	6	4	25	20	10	8
Total nitrogen (mg/l)	0.94	0.94	0.68	0.83	0.51	0.49	0.67	0.41	1.25	1.51	0.95	1.13
Total inorganic nitrogen		0	0.13		0	0			0.13	0.1	0	0.1
Total hardness (mg/l)	32	32	44	32	32	32	38	36	32	36	36	36
N/P ratio	32.4	29.4	28.3	25.9	18.9	18.1	23.1	13.2	48.1	50.3	59.4	49.1

Tucker Lake drains to Amik. It has a small watershed and good water quality. Notice it has a lower color content. That's because a relatively small wetland area drains to the lake.

Table 14. Snapshot of water quality conditions for Tucker Lake, a lake that drains to Amik Lake.

Tucker Lake (for comparison)	Lake size: 118 ac, Max. depth: 32 ft, Mean depth: 14 ft Watershed size (not including lake): 506 acres		
7/20/01	**3 feet**	**6 feet**	**Integrated Sample 0-6 ft**
Total phosphorus	11	15	15
Chlorophyll a	2	2	1.8
color (su)			10
Calcium (mg/l)			13
Alkalinity (mg/l)			47
Conductivity			106
pH			8.26
Magnesium (mg/l)			4.7
Nitrate-nitrogen			<0.01
Kjeldahl nitrogen			0.47
Turbidity			1.0

4.3.1. Secchi Disc Transparency

Transparency in lakes is measured with a white and black disc (Secchi disc) that is lowered over the side of a boat into the water. The depth at which the disc is no longer visible is considered the Secchi disc measurement. The Secchi disc measurement gives some insight into the amount of nutrients in the lake. The deeper the Secchi disc transparency, the clearer the lake is and the less algae present. Because nutrients make algae grow, we suspect good water transparency means low phosphorus concentrations in the lake.

Secchi disc measurements are an easy way to measure the trends of a lake. Measurements made over the years can help determine if the lake is improving or declining. Fluctuation of a couple feet is normal from year to year, but if the growing season average declines for several years, potential nutrient sources should be looked at more closely. Amik Lake's yearly averages are typically the best of the four lakes, although that can vary from year to year (Figure 11).

A summary of readings taken through the growing season are shown in Table 15.

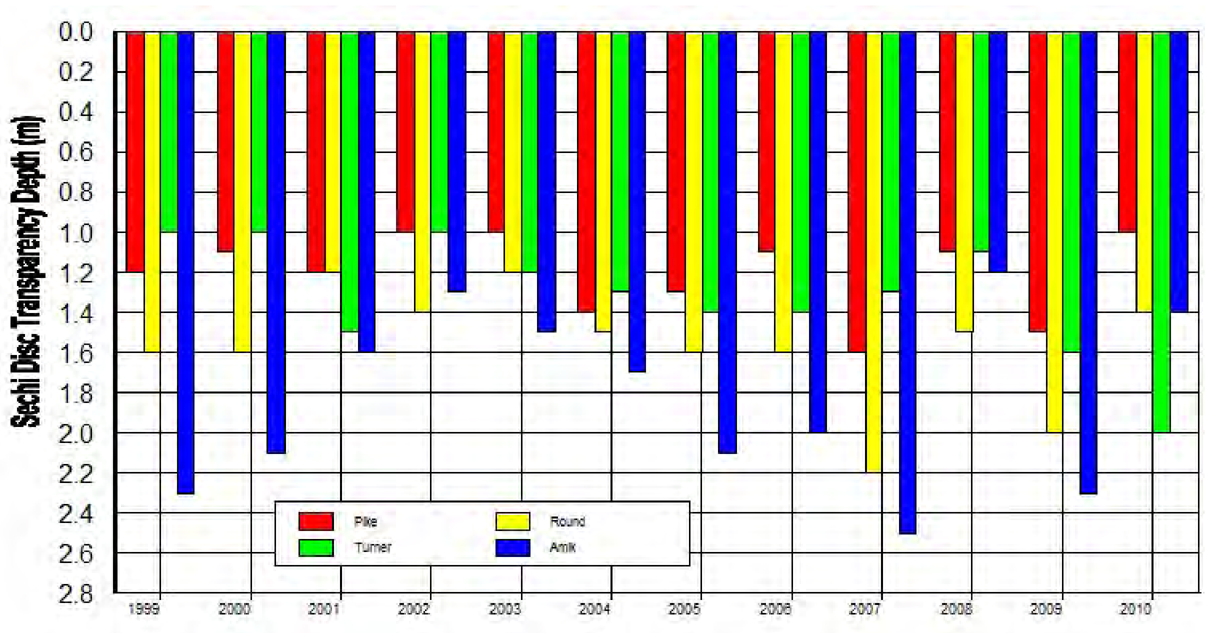


Figure 11. Pike, Round, Amik, and Turner Lakes growing season mean Secchi disc transparency are shown in meters.

Table 15. Secchi disc transparency in meters for all four lakes from 1999 through 2010.

Secchi Disc-m		Pike												Round											
		2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999
May	wk 1		2.0																				3.0		
	wk 2	2.3	1.6					1.5	1.3						2.3								1.5		
	wk 3	2.0	1.4			1.5	1.5	1.4				1.5		2..1			2.9	2.4					1.7	2.0	
	wk 4	2.1	1.4	1.4	1.6		1.2	1.4	1.1	1.1	1.2	1.5			2.3	1.7	2.9		1.8	1.5	1.2	1.7	1.4		
June	wk 1	2.3	1.5	1.1	1.4		1.3	1.4	1.2		1.3	1.5	1.5		2.3		2.7		1.7	1.5		1.5	1.5	1.8	2.0
	wk 2		1.6		1.7	1.3		1.3	1.2	1.3	1.3	1.5	1.5						1.8	1.5	1.4		1.4	1.8	1.7
	wk 3	1.7	1.7			1.3	1.6	1.1	1.4	1.1	1.4		1.2		1.8			1.7		1.3		1.4	1.4	1.8	1.8
	wk 4	1.1	1.6	0.7	1.7		1.4	1.1	1.1	1.1	1.4	1.4	1.4	2.1	1.8	1.3	2.4	1.7	1.8	1.3	1.4	1.4	1.4	1.8	1.8
July	wk 1	0.8	1.4		1.7	1.3	1.4		1.2	1.1	1.3	1.4	1.4		1.8			1.8	1.7	1.5	1.4		1.3	1.7	2.0
	wk 2		1.8		1.7	1.3	1.3	1.4	1.2	1.0	1.3	0.9	1.2		2.0		2.2	2.0	1.5	1.4	1.3	1.4	1.4	1.6	1.7
	wk 3	0.4	1.5	1.1	1.6	1.1	1.2		0.9	1.1	1.4	0.9			2.1	1.1	2.1	1.4	1.4	1.7	1.2	1.4	1.3	1.5	1.6
	wk 4	0.4	1.4		1.7	1.1	1.1	1.1	0.8	1.0	1.0	1.0	1.0	1.1		1.4	1.7	1.4	1.4	1.5	0.9	1.3	1.3	1.5	1.5
Aug	wk 1	0.4	1.6			1.0	1.1	1.4	0.8	0.9	1.0	0.9	0.8		2.1		1.7	1.4	1.3	1.5	1.2	1.3	1.3	1.4	1.5
	wk 2	0.3				1.0		1.3	0.7	0.9	0.9	0.8	0.8		2.0	1.5		1.4			1.1	1.3	1.0	1.4	1.5
	wk 3	0.3	1.3	1.1		1.0	1.4	1.3	0.8	1.0	0.9	0.8	0.9		1.8	1.5		1.1	1.2	1.4	1.1	1.3	1.0	1.3	1.5
	wk 4	0.4	1.2		1.7	0.9	1.1	1.6	0.5	1.1	0.8		0.9		1.8	1.4		1.1	1.5	1.4	1.0	1.2	1.1	1.3	1.5
Sept	wk 1	0.4	1.3				1.2	1.8				0.9	1.1	0.5		1.6		1.5	1.8	1.5	1.1	1.3	1.1	1.3	1.5
	wk 2	0.4	1.1		1.2	0.9	1.2	1.7		1.1	1.1		1.1				1.2		2.0	1.4		1.3	1.2	1.4	1.5
	wk 3		1.1	1.4		1.0	1.3	1.7	0.8		1.0	0.9	1.1		1.5	1.8		1.5	1.7	1.6	1.3	1.3	1.2	1.5	1.5
	wk 4					1.2	1.3	1.5	1.1	0.8	1.1		1.0		1.8	1.9		1.6		1.6	1.4	1.4	1.3	1.6	1.5
May-Sept AVG		1.0	1.5	1.1	1.6	1.1	1.3	1.4	1.0	1.0	1.2	1.0	1.1	1.4	2.0	1.5	2.2	1.6	1.6	1.5	1.2	1.4	1.4	1.6	1.6
June-Sept AVG		0.7	1.4	1.1	1.6	1.1	1.3	1.4	1.0	1.0	1.1	1.1	1.1	1.2	1.9	1.5	2.0	1.5	1.6	1.5	1.2	1.3	1.3	1.5	1.6
July-Aug AVG		0.4	1.5	1.1	1.7	1.1	1.2	1.4	0.9	1.0	1.1	1.0	1.0	0.5	1.9	1.4	1.9	1.5	1.4	1.5	1.2	1.3	1.2	1.5	1.6

Secchi Disc-m		Turner												Amik											
		2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999
May	wk 1											1.4									1.4				
	wk 2		1.6						1.2						1.9				2.0	1.4			1.0		1.6
	wk 3	2.5				1.9						1.4		2.1			2.5	2.1	2.0	1.3	1.2		1.0	1.8	
	wk 4		1.4	1.2		1.8	1.8	1.7	1.1	1.2	1.4	1.5		2.6	2.3	1.3	2.4	1.8	1.8	1.4	1.3	1.1	1.7		2.0
June	wk 1				1.3		1.7	1.2	1.1	1.0		1.5	0.9	2.4			2.4	1.9	1.8	1.3		1.1		1.8	1.8
	wk 2		1.6		1.2	1.2	1.7		1.3		1.4	1.5	1.1			1.1	2.6	1.8	1.8	1.5	1.2			1.8	1.8
	wk 3	2.0	2.1	1.0	1.0	1.3		1.3	1.1	0.9	1.8	1.5	1.1		2.0	1.1	2.6	1.6	1.9	1.2	1.4	1.1	1.2	1.8	1.8
	wk 4	2.1		1.1	1.0	1.3		1.2	1.3	1.4	1.1	1.2	0.9	1.7	2.0	1.0	2.5	1.6	2.0	1.5	1.1	1.3	1.3	2.1	2.1
July	wk 1			0.9		1.2	1.2		1.2	1.1	0.9	1.2	1.1		2.3	1.1			1.8	1.7		0.9	1.5	1.8	2.7
	wk 2	2.4	1.6	0.9	1.4		1.4	1.3	1.2	1.0	1.3	1.2	0.9	2.0	2.3	1.1	2.4		2.0	1.7		1.0	1.2		2.4
	wk 3		1.5	1.5	1.4	1.3			1.2	1.1	1.1	1.1	1.1	1.3	2.2	1.0	2.4	1.5	1.7	1.7	1.3	1.0	1.3	2.0	2.1
	wk 4	1.5			1.4		1.1	1.1	1.1	1.0	1.0	0.9	1.2	1.2	2.3	1.0	2.4	1.6	2.3	1.4	1.6	1.1	1.2	1.8	2.4
Aug	wk 1			1.0	1.3	1.4	1.1	1.1	1.0	0.8	1.1	0.8	1.0	0.8	2.4	1.0	2.6	1.7	2.1	1.7		1.0	1.1	1.8	2.0
	wk 2				1.2	1.4			1.1	0.9	1.3	0.7	0.9		2.4	1.1	2.6	1.9	2.1	1.9	1.9	1.2	0.9	1.8	
	wk 3			1.1	1.1	1.3	1.1	1.7		0.8	1.1	0.7	0.9	0.8	2.6	1.2	2.6	2.2	2.4	1.8		1.5	1.2	1.4	2.1
	wk 4		1.4	1.2			1.1	1.1	1.0	1.1	1.1	0.6	1.0	0.6	2.4	1.4		2.3	2.4	1.7	1.7	1.7	1.7	2.7	2.4
Sept	wk 1	1.2			1.2	1.3	1.3		1.0	0.9		0.7	1.0	0.5	2.7	1.5	2.6	2.4	2.1	2.5		1.7	1.8	2.4	
	wk 2				1.7		1.4		1.2	0.9		0.6		0.5		1.8	2.3	2.7	2.5		2.0	1.5			
	wk 3						1.5	1.4	1.1		1.0	0.7	1.1		2.7	1.9	2.6	2.6	2.4	2.4	1.8		3.8		2.5
	wk 4					1.7		1.4	1.6	1.1	0.8	0.8	0.9		2.7			2.4		2.3	2.1	1.5	2.4		2.4
May-Sept AVG		2.0	1.6	1.1	1.3	1.4	1.4	1.3	1.2	1.0	1.2	1.1	1.5	1.4	2.3	1.2	2.5	2.0	2.1	1.7	1.5	1.2	1.5	1.9	2.1
June-Sept AVG		1.8	1.6	1.1	1.3	1.3	1.3	1.3	1.2	1.0	1.2	1.0	1.5	1.2	2.4	1.2	2.5	2.0	2.1	1.8	1.6	1.3	1.6	1.9	2.2
July-Aug AVG		1.2	1.5	1.1	1.3	1.3	1.2	1.3	1.1	1.0	1.1	0.8	1.0	1.1	2.4	1.1	2.5	1.9	2.1	1.7	1.6	1.2	1.3	1.9	2.3

4.3.2. Phosphorus

Phosphorus is a nutrient that is closely monitored in lakes because it is generally the nutrient that stimulates algae blooms. Phosphorus concentrations for 2010 for all four lakes are shown in Table 16. A graph of phosphorus concentrations for 2001-2010 for the four lakes is shown in Figure 12.

Lakes in the "Northern Lakes and Forests" Ecoregion typically have phosphorus concentrations less than 27 ppb. All four lakes are slightly above this concentration in most years.

Table 16. Total phosphorus data for the four lakes in 2010.

	Pike	Round	Amik	Turner
May 17	24	20	19	23
June 25	26	19	27	21
July 28	46	27	41	22
September 4	78	58	58	28
Average	***44***	***31***	***36***	***24***

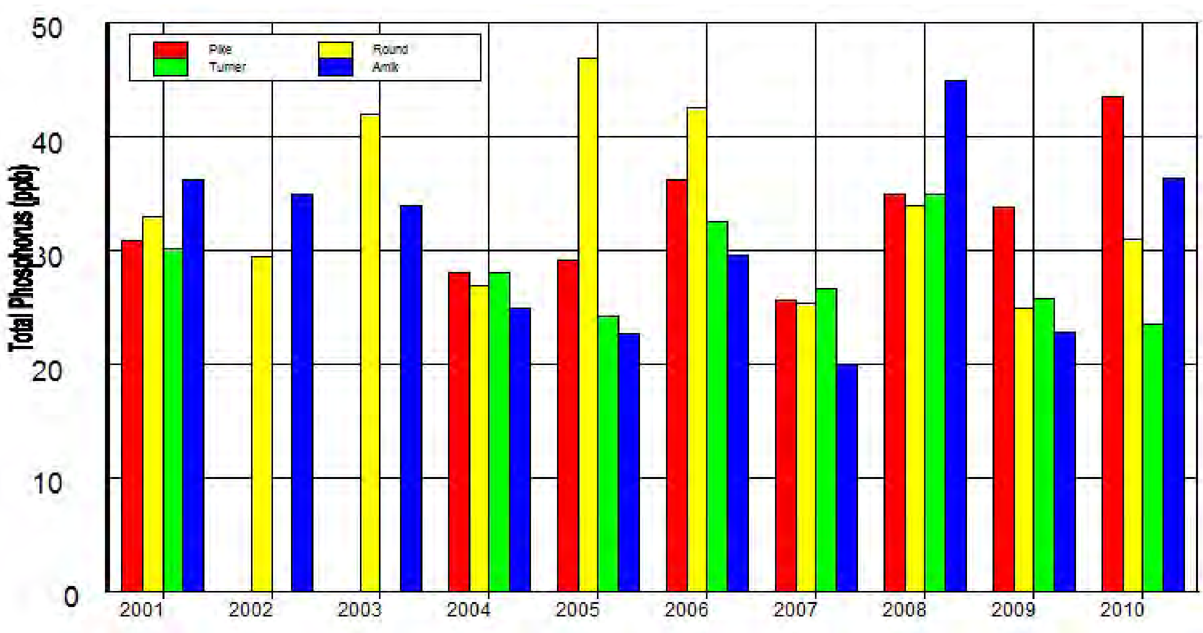


Figure 12. Pike, Round, Amik, and Turner Lakes seasonal average total phosphorus concentrations 2001 through 2010.

Phosphorus in the Top and Bottom Water in 2001: What's interesting about the phosphorus results is that the top and bottom readings are similar. This indicates that there is not very much release of phosphorus from the lake sediments. If there was, the bottom phosphorus readings would be higher.

Table 17. Summer monthly water quality data for the Chain of Lakes in 2001.

Wisconsin State Laboratory of Hygiene	5.30.01				6.25.01				7.11.01				8.20.01				9.18.01			
	P	R	A	T	P	R	A	T	P	R	A	T	P	R	A	T	P	R	A	T
Total phosphorus (ppb)																				
surface	28	26	33	25	27	26	32	27	25	22	35	29	37	39	34	37	37	52	47	33
bottom	33	25	33	31	29	29	33	35	23	32	28	35	32	33	34	45	39	47	45	31

Phosphorus Distribution within Pike Lake in August 2001: The results of stream sampling and the deep water sampling indicated that the main phosphorus source was from the stream inputs. The question was "How does phosphorus vary from one end of the lake to the other?" In August, Pike Lake was sampled in four locations (shown below). The results show Pike Lake is well mixed. The Musky Jack's sample was influenced by the Foulds Creek inflow, but the rest of the lake is influenced by Squaw Creek. A difference in 4 ppb is not much of a difference. For practical purposes, phosphorus levels are similar from the north end to the south end.

	8.3.01
	TP (ppb)
North Pike	24
South Pike	23
Squaw Lake	23
Musky Jacks Bay	20

4.3.3. Chlorophyll and Algae

The normal transition for algae in lakes over the summer months begins with diatoms, which then die back while green algae become dominant. Next, the green algae die back and then blue-green algae become dominant. Typically, algae concentrations increase as the summer goes on. This is the pattern found in all four lakes over the summer of 2001. Algae were not identified in 2010. The amount of algae in a lake is often characterized by the chlorophyll content. So, analyzing for chlorophyll is a typical parameter to test for.

Results of chlorophyll testing for the summer of 2001 and 2010 are shown in Figure 13 and Table 18. There is a fair amount of variability from 2001 to 2010 and from lake to lake.

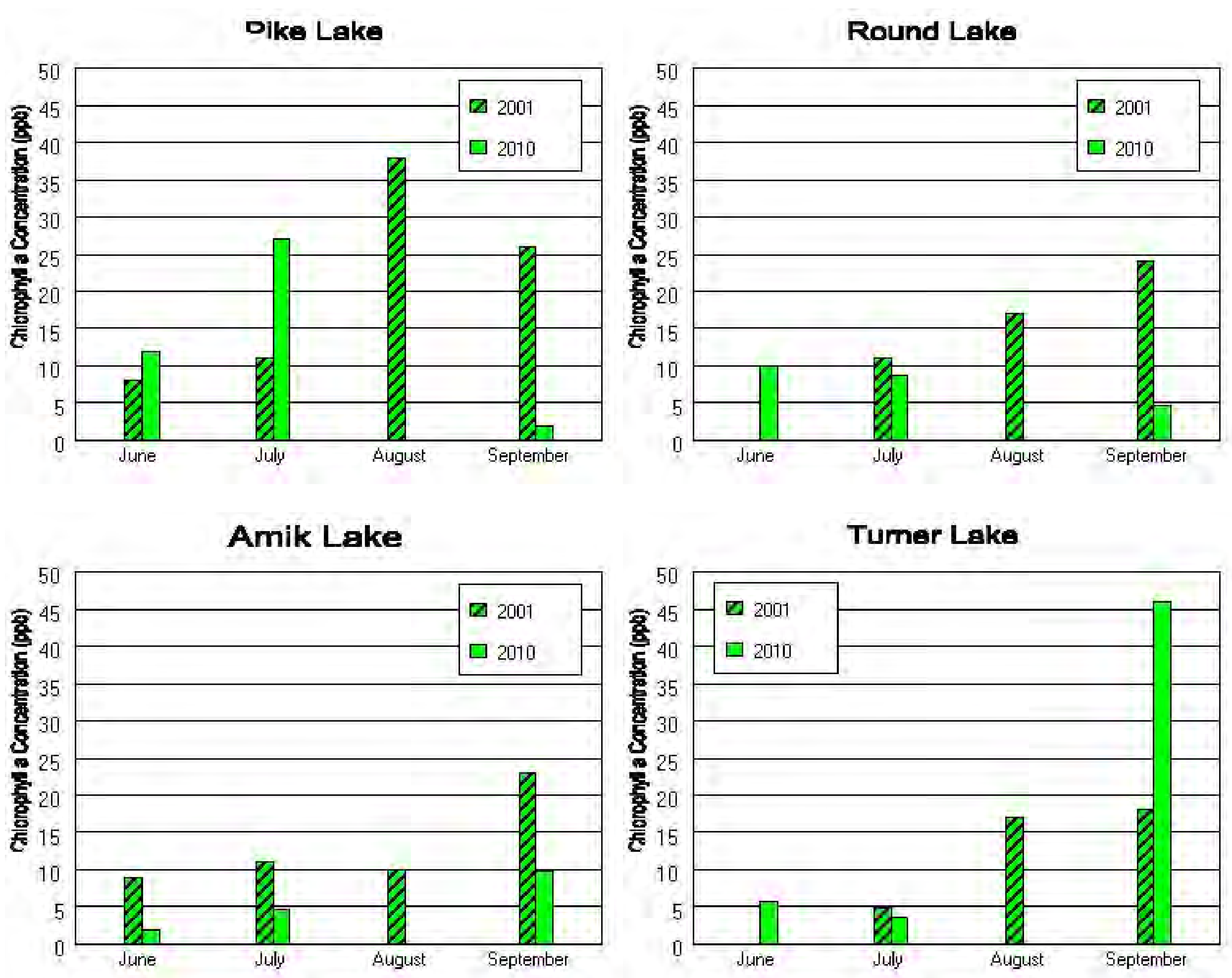


Figure 13. Chlorophyll concentrations for June, July, August, and September 2001 and 2010.

Table 18. Chlorophyll a is a rough measurement of the amount of algae there is in a lake. Concentrations in 2001 and 2010 are shown below.

Date	Pike	Round	Amik	Turner
6.25.01	8	--	9	--
7.11.01	11	11	11	5
8.20.01	38	17	10	17
9.18.01	26	24	23	18
Average	**21**	**17**	**13**	**13**
6.25.10	12	10	3.9	5.7
7.28.10	27	8.8	7.3	3.5
9.4.10	1.9	4.6	9.7	46
Average	**14**	**7.8**	**7.0**	**18**

Algae bloom intensities can be assessed by the concentration of chlorophyll in a lake (Table 19). Pike had the highest algae levels of the four lakes in 2001 and Turner had the highest levels in 2010 primarily because of the high September 4, 2010 reading.

Table 19. Chlorophyll a concentrations related to algae blooms for 2001 (MPCA 1994).

Chlorophyll a concentrations	Degree of algae bloom
0-9 µg/l	No bloom
10 - 20 µg/l	Mild bloom
21 - 29 µg/l	Nuisance bloom
30 µg/l and greater	Severe bloom

4.4. Lake Sediments Characteristics

Lake sediments in four lakes in the Pike Chain were sampled on September 29, 2010 and results are shown in Table 20.

Table 20. Pike Chain soil data. Sample were collected on September 29, 2010. Soil chemistry results are reported as $\mu g/cm^3$-dry which is equivalent to ppm except for organic matter (%) and pH (standard units).

Sample Number	Depth (ft)	Bulk Density (wt/8.51)	Water pH	Bray-P (ppm)	Olsen-P (ppm)	Exch K (ppm)	LOI OM (%)	Zinc (ppm)	Iron (ppm)	Copper (ppm)	Manganese (ppm)	Calcium (ppm)	Mg (ppm)	Boron (ppm)	NH4-N (ppm)	SO4-S (ppm)	Fe/Mn (%)	Fe/P
AMIK																		
A1	7	0.32	5.7	1	1	8	88.1	0	143	0	10	450	63	0	15	1.622	14.3	143
A2	7	0.64	6.4	1.6	0.5	13	30.9	2.8	121.6	1.1	7.1	1520	194	0.7	8.0	42	17.1	76
A3	7.5	0.38	6.6	0.6	0.3	12	47.1	1.3	310.0	0.4	30.7	1120	69	0.2	41.1	4	10.1	516
A4	11	0.33	6.1	2.3	0.6	10	40.7	0.5	169.0	0.2	9.5	370	34	0.3	59.0	5	17.8	73.4
A5	7	0.35	5.9	2.4	0.3	13	35.2	0.6	170.7	0.2	9.1	360	36	0.2	25.9	6	18.8	71.1
A6	6	0.53	5.9	2.7	3.6	37	43.0	5.1	436.0	0.6	10.5	1273	178	0.6	17.8	37	41.4	21.1
PIKE																		
P1	7	1.35	5.9	12.7	3.5	18	1.1	2.2	221.0	0.3	22.5	478	43	0.7	5.0	44	9.8	17.4
P2	7.5	1.30	6.1	6.7	2.2	28	1.7	2.0	245.8	1.4	23.2	760	84	0.4	6.8	38	10.6	36.7
P3	5	1.35	6.1	34.6	11.5	21	1.2	1.7	151.9	0.8	14.4	431	48	0.2	3.7	23	10.6	4.4
P4	4	1.29	6.2	21.9	5.5	14	1.3	1.5	110.7	0.4	5.9	376	42	0.1	4.1	23	18.7	5
P5	5.5	1.29	6.4	12.1	3.3	21	0.7	2.2	103.2	0.2	9.0	282	33	0.2	22.4	24	11.5	8.5
P6	5	1.28	5.8	12.0	3.3	12	1.0	3.3	161.1	0.3	8.8	259	27	0.3	5.2	37	18.2	13.4
P7	7	0.87	5.9	5.9	2.2	10	2.7	2.1	260.1	0.3	20.4	422	45	0.4	6.1	25	12.8	44.1
P8	5	0.56	6.1	3.1	3.3	16	13.4	1.4	401.7	0.4	30.9	594	55	0.1	10.8	8	13.0	121.7
P9	6	1.00	6.2	3.4	0.8	11	2.9	2.0	119.7	0.3	9.3	642	68	0.3	4.5	68	12.9	35.2
P10	7	1.30	6.0	8.8	2.2	17	0.9	2.2	174.4	0.2	14.9	471	43	0.3	6.2	79	11.7	19.8
P10-R	6	1.34	7.0	5.7	1.1	18	1.0	1.0	79.7	1.8	8.5	599	87	0.6	4.2	34	9.3	13.9
P11	7	1.04	6.4	4.4	1.8	11	3.7	2.4	165.2	0.9	9.2	1063	134	0.4	8.9	99	18.0	37.5
P12	4	1.21	6.9	10.3	3.1	14	1.5	2.1	196.0	0.3	19.3	502	61	0.4	7.2	60	10.2	19
P13	4	1.39	6.7	22.4	3.5	20	0.9	0.7	108.0	0.5	9.7	404	45	0.1	4.6	19	11.2	4.8
P14	7	1.38	6.1	19.9	4.7	20	0.8	2.5	191.3	0.5	14.2	280	36	0.2	4.6	52	13.5	9.6
P15	16	0.63	6.1	1.1	4.8	33	31.5	3.1	575.2	0.2	13.5	1306	159	0.7	6.2	32	42.7	119.8
ROUND																		
R1	7	1.36	6.5	8.1	3.5	23	0.7	1.3	171.4	0.3	11.2	314	43	0.2	4.9	49	15.2	21.2
R2	4	1.47	6.3	12.5	3.8	24	0.4	1.1	112.8	0.1	13.0	134	18	0.3	8.5	20	8.6	9
R3	5	0.94	6.7	10.4	4.8	15	4.4	0.5	193.5	0.4	24.5	498	58	0.1	5.4	8	7.9	10.6
R4	4	1.29	7.0	18.7	3.3	14	0.6	1.3	90.9	0.2	7.4	330	23	0.1	6.3	11	12.3	4.9
R5	6	1.05	6.6	13.4	2.7	20	3.8	1.2	225.9	0.4	25.8	471	57	0.3	6.9	14	8.8	16.8
R6	5	1.29	6.8	16.5	4.4	20	1.0	0.7	86.2	0.2	13.4	459	20	0.1	7.3	13	6.4	5.2
R7	5	1.37	6.4	31.6	4.7	33	0.6	1.1	105.3	0.6	15.6	412	60	0.1	6.4	35	6.8	3.3
R8	5	0.95	6.4	11.3	3.2	27	4.1	1.3	216.1	0.9	32.8	562	69	0.1	6.1	26	6.6	19.1
R9	7	1.30	6.6	17.7	4.4	27	1.2	2.4	242.8	0.4	27.5	481	61	0.2	8.3	42	8.8	13.7
R10	6	1.36	6.2	33.6	4.6	17	0.8	1.3	172.3	0.3	18.5	336	42	0.2	5.9	37	9.3	5.1
R11	7.5	1.49	6.2	16.4	3.8	25	0.5	1.4	146.1	0.3	22.8	175	23	0.1	9.7	18	6.4	8.9
R12	7	1.36	6.2	15.0	4.6	28	0.8	1.4	183.2	0.3	35.0	287	37	0.2	5.4	21	5.2	12.2
R13	7.5	1.41	6.3	15.6	4.8	36	0.6	1.2	161.8	0.2	20.6	371	43	0.1	6.0	17	7.9	10.3
R14	7	1.40	6.8	7.1	2.4	17	0.5	1.1	104.2	0.2	7.5	252	29	0.2	7.0	26	13.9	14.6
R14R	7	1.38	6.8	7.1	2.4	19	0.6	1.1	130.2	0.2	10.7	225	29	0.9	4.4	33	12.1	19.5
R15	25	0.72	6.2	1.9	4.9	48	32.4	3.2	598.1	0.4	47.5	1495	212	1.2	27.4	20	12.6	122.1
R16 (Deep)	22	0.68	6.0	1.2	5.2	37	33.3	2.6	588.6	0.3	26.0	1549	215	1.2	29.2	37	22.7	113.2
TURNER																		
T1	7	1.25	6.9	5.3	2.1	21	1.5	1.6	236.9	0.4	12.7	247	31	0.2	5.2	32	18.6	44.6
T2	7.5	1.28	6.9	4.4	1.1	25	1.2	1.1	132.3	1.1	7.6	664	95	0.4	4.0	151	17.3	30.1
T3	6.5	1.04	6.5	7.1	2.7	30	3.5	1.2	268.6	0.4	15.1	443	47	0.4	7.3	18	17.8	37.8
T4	8	1.19	6.3	16.2	5.1	16	2.0	1.4	179.5	0.4	8.9	584	86	0.2	7.2	43	20.1	11.1
T5	13.5	0.48	6.2	3.7	2.5	19	38.6	4.0	404.7	0.6	12.1	614	93	0.4	23.1	25	33.5	109.4

Pike Lake Chain Sediment Phosphorus Release Potential Based on Phosphorus Concentrations and Fe:P Ratios: Sediment phosphorus in the Pike Chain ranges from low to high. A variety of factors contribute to phosphorus release from sediments and resulting internal phosphorus loading in lakes. Research by Jensen et al (1992) found when a total iron to total phosphorus ratio was greater than 15 to 1, phosphorus release from lake sediments was minor. That benchmark has been used to characterize the potential of the Pike Lake Chain lake sediments to release phosphorus. Results show a mix of sediment Fe:P ratios in shallow and deep water. Round Lake has the highest potential for phosphorus release and Amik has the lowest potential.

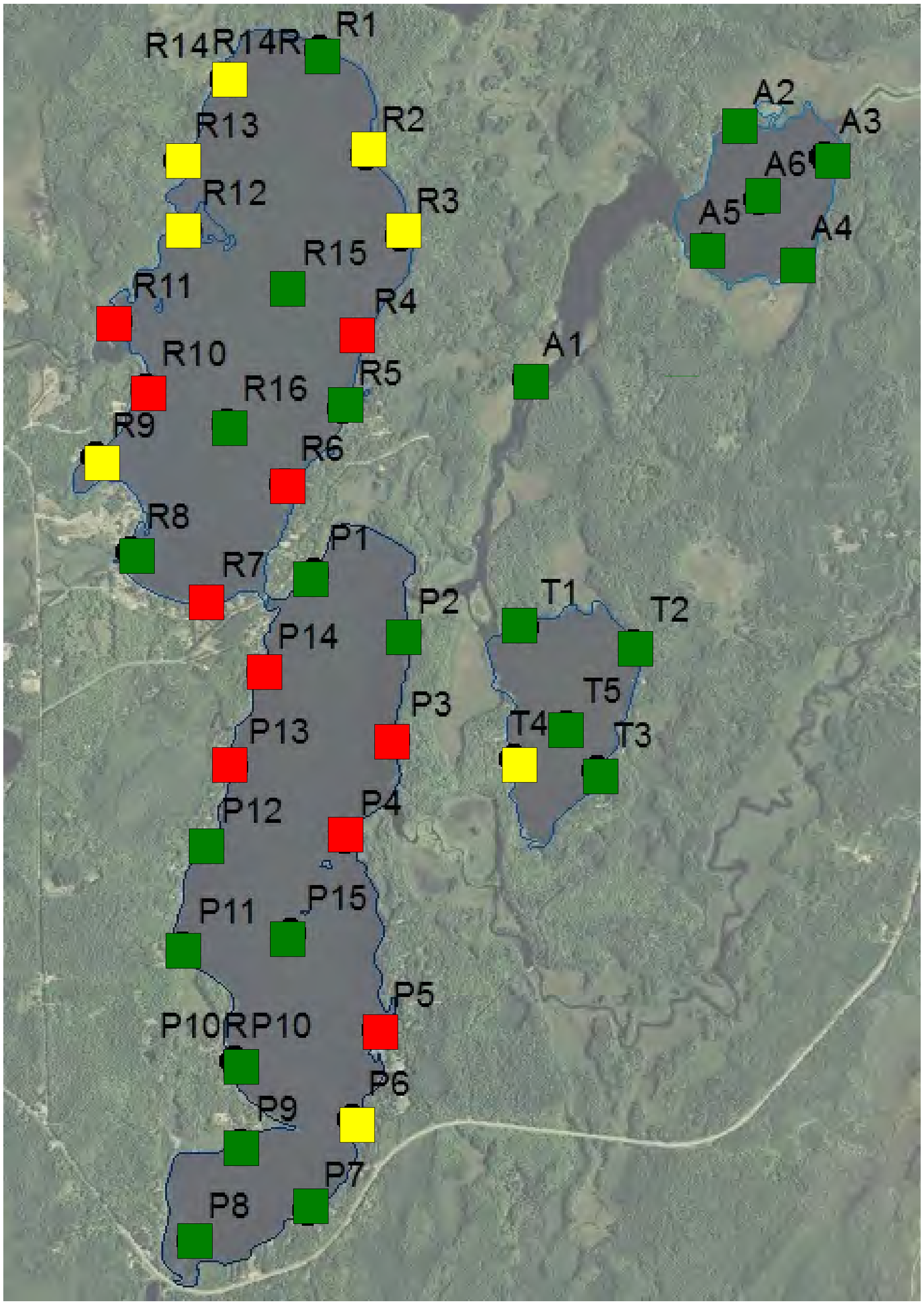


Figure 14. Lake sediment sample locations are shown with color squares. Colored squares represent phosphorus release potential at that site. Key: Green = low; Yellow = moderate; and Red = high.

4.5. Zooplankton and Other Invertebrates

Zooplankton are important in lakes. They graze on algae. If the algae population is composed of small algae cells, these are edible by zooplankton, and this grazing action can actually keep the lake relatively clear. The zooplankton community is composed of species of daphnia and copepods in the four lakes (Figure 15). The zooplankton communities are typical of lakes in this region.

However, there are a couple of invertebrates surprises. In Amik Lake, a colony of bryozoans is present. They are attached to tree branches and can grow to the size of a basketball, but a cantaloupe size is more common in Amik (Figure 16).

There is also a report of rusty crayfish in Pike Lake. They are regional exotics and not desirable for a lake. They can decimate plant beds. They will be monitored in the future as one of the lake management recommendations.

Figure 15. Example of a zooplankton species from Turner Lake, July 2001.

Figure 16. [top] Bryozoan colonies found in Amik Lake, August 4, 2001.
[bottom] Rusty crayfish like the one shown above have been found in Pike Lake.

4.6. Aquatic Plant Status

Aquatic plants are very important to lakes. They act as nurseries for small fish, refuges for larger fish, and they help to keep the water clear. Currently Pike, Round, Amik and Turner Lakes have a wide diversity of aquatic plants, but coverage varies greatly among the four lakes.

The coverage and abundance of aquatic plants for Pike, Round, and Amik and Turner Lakes in 2010 is summarized in Table 21 and is discussed for individual lakes in the next few pages. Specific details on aquatic plant surveys are available in a separate report.

Of the submerged plants, water celery is the most common in Pike and Round Lakes. Fern pondweed is the most abundant plant in Amik Lake and elodea was most abundance in Turner Lake. Nine plant species are found in all four lakes.

All four lakes had between 12 to 14 submerged and floatingleaf plant species.

Figure 17. Coontail, a native, non-rooted plant was found in low densities in Pike Lake, June 2001, but found in high densities in Amik Lake.

Summary of Aquatic Plant Surveys for the Pike Chain in 2010

Table 21. Summary for Pike Chain of Lakes aquatic plant percent occurrences for 2010 (top number). Number in parentheses is the number of sites the plant was found. Green shading represents dominant plant species.

	Percent Occurrence of Aquatic Plants				
	Pike (108 sites)	Round (127 sites)	Amik (241 sites)	Turner (154 sites)	Total Occurrence (630 sites)
Pickerel plant (*Pontederia cordata*)	1 (1)	--	2 (5)	3 (5)	(11)
Swamp loosetrife (*Decodon verticillatus*)	--	--	--	1 (1)	(1)
Bulrush - softstem (*Scirpus validus*)	4 (4)	1 (1)	1 (2)	1 (2)	(9)
Cattails (*Typha sp*)	--	--	--	1 (1)	(1)
Watershield (*Brasenia Schreberi*)	16 (17)	3 (4)	1 (3)	3 (5)	(29)
White waterlily (*Nuphar sp*)	2 (2)	6 (8)	7 (18)	1 (4)	(32)
Spatterdock (*Nuphar variegatum*)	5 (5)	2 (3)	2 (6)	2 (3)	(17)
Floatingleaf burreed (*Sparganium sp*)	8 (9)	--	1 (1)	5 (8)	(18)
Coontail (*Ceratophyllum demersum*)	8 (9)	1 (1)	33 (80)	11 (17)	(107)
Chara (*Chara sp*)	7 (8)	39 (49)	3 (8)	1 (2)	(67)
Moss (*Drepanocladus sp*)	3 (3)	--	1 (1)	--	(4)
Elodea (*Elodea canadensis*)	--	2 (2)	32 (77)	40 (61)	(148)
Northern watermilfoil (*Myriophyllum sibiricum*)	5 (5)	3 (4)	7 (16)	3 (5)	(30)
Naiads (*Najas sp*)	28 (30)	44 (56)	1 (2)	13 (20)	(108)
Nitella (*Nitella sp*)	11 (12)	--	24 (58)	10 (15)	(85)
Cabbage (*Potamogeton amplifolius*)	3 (3)	2 (3)	22 (52)	6 (9)	(67)
Variable pondweed (*P. gramineus*)	6 (6)	17 (22)	--	--	(28)
Floatingleaf pondweed (*P. natans*)	1 (1)	--	--	--	(1)
Stringy pondweed (*P. pusillus*)	2 (2)	--	3 (8)	14 (21)	(31)
Claspingleaf pondweed (*P. richardsonii*)	18 (19)	14 (18)	27 (64)	15 (23)	(124)
Fern pondweed (*P. robbinsii*)	11 (12)	2 (3)	61 (148)	28 (43)	(206)
Flatstem pondweed (*P. zosteriformis*)	1 (1)	1 (1)	20 (47)	13 (20)	(69)
Bladderwort (*Utricularia sp*)	6 (6)	1 (1)	1 (2)	--	(9)
Water celery (*Vallisneria americana*)	81 (87)	79 (100)	7 (17)	13 (20)	(224)
Number of submerged and floatingleaf species	14	12	14	12	

Summary of Aquatic Plant Surveys for Individual Lakes

Pike Lake Aquatic Plants: Pike Lake has a lot of different aquatic plant species; it's just that they only grow in shallow water (in water less than 6 feet deep). Water celery and naiads were the most common species (summarized in Table 21). Floatingleaf species were present and very pretty in the areas that they colonized (Figure 19).

A unique feature of Pike Lake is the bottom covering of wooden slabs in the north shore of the southern bay. They were discarded into the bay during the sawmill operation. No aquatic plants were found in this area (Figure 20), but they offer some habitat for fish and invertebrates.

Figure 18. Discarded wooded slabs from the sawmill operation are still found in a southern bay of Pike Lake.

Figure 19. [top photos] Examples of floatingleaf plants in Pike Lake consisting of watershield and Sparganium on July 26, 2001.
[bottom photos] Aquatic plants on July 15, 2010.

Pike Lake **(806 acres)**

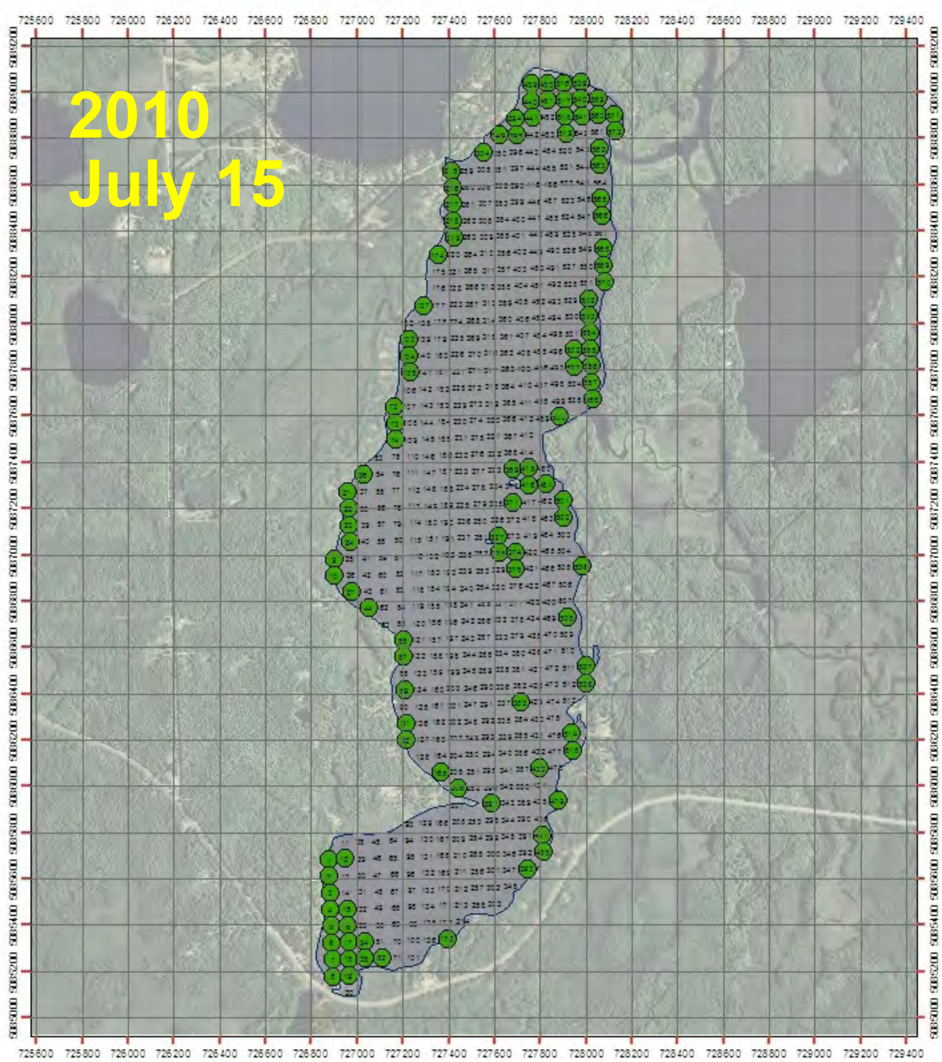


Figure 20. Pike Lake aquatic plant maps based on surveys conducted by Blue Water Science.
[top] Aquatic plant distribution in 2010 is shown with green circles.
[bottom] Aquatic plant distribution in 2001 is shown with red shading.

Round Lake Aquatic Plants: Round Lake had 12 aquatic species in 2010. Water celery (Figure 21) was the most common plant, with naiads and claspingleaf also being common (summarized in Table 21).

Plants only grew out to a depth of six feet. Plant coverage is shown in Figure 22.

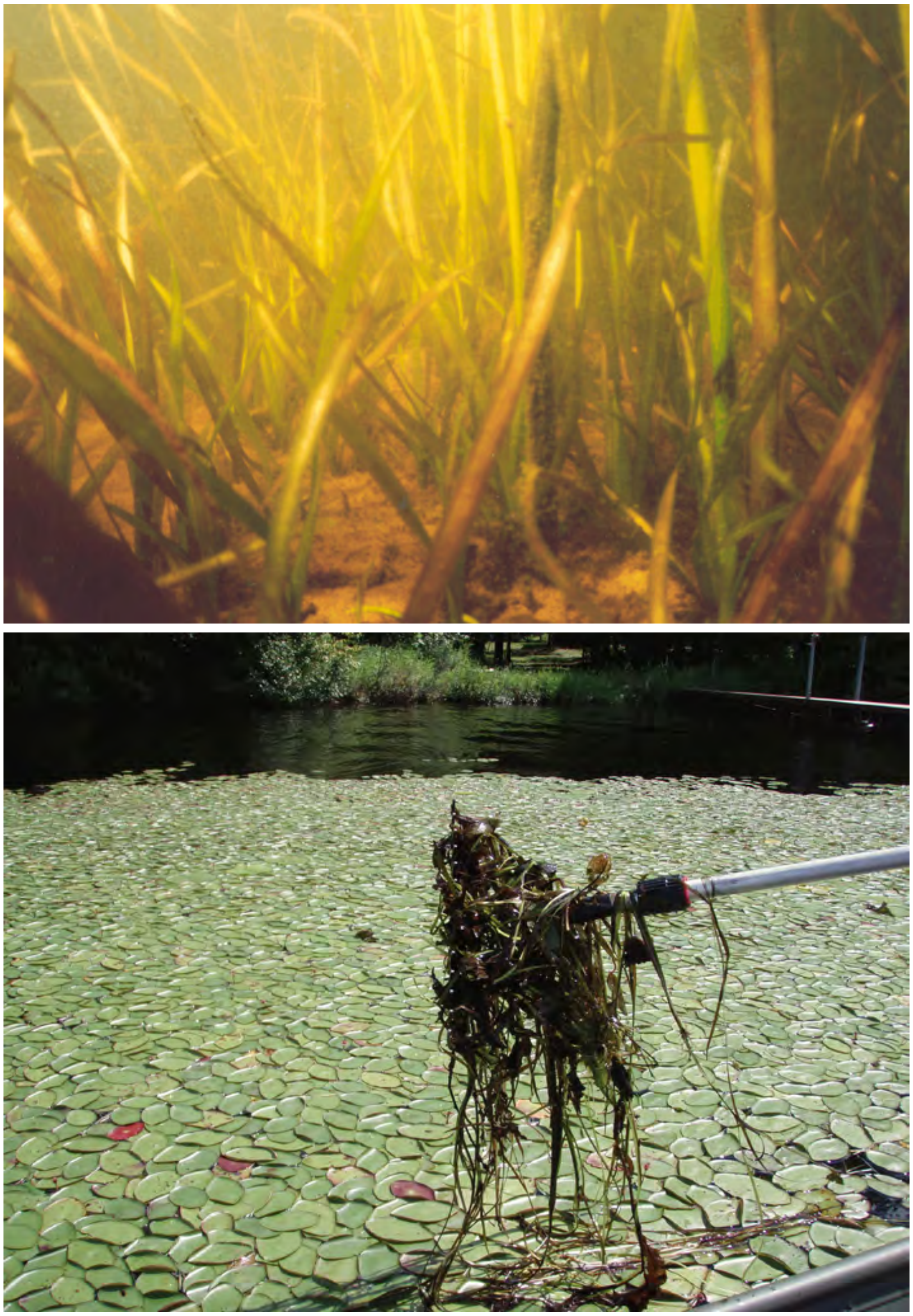
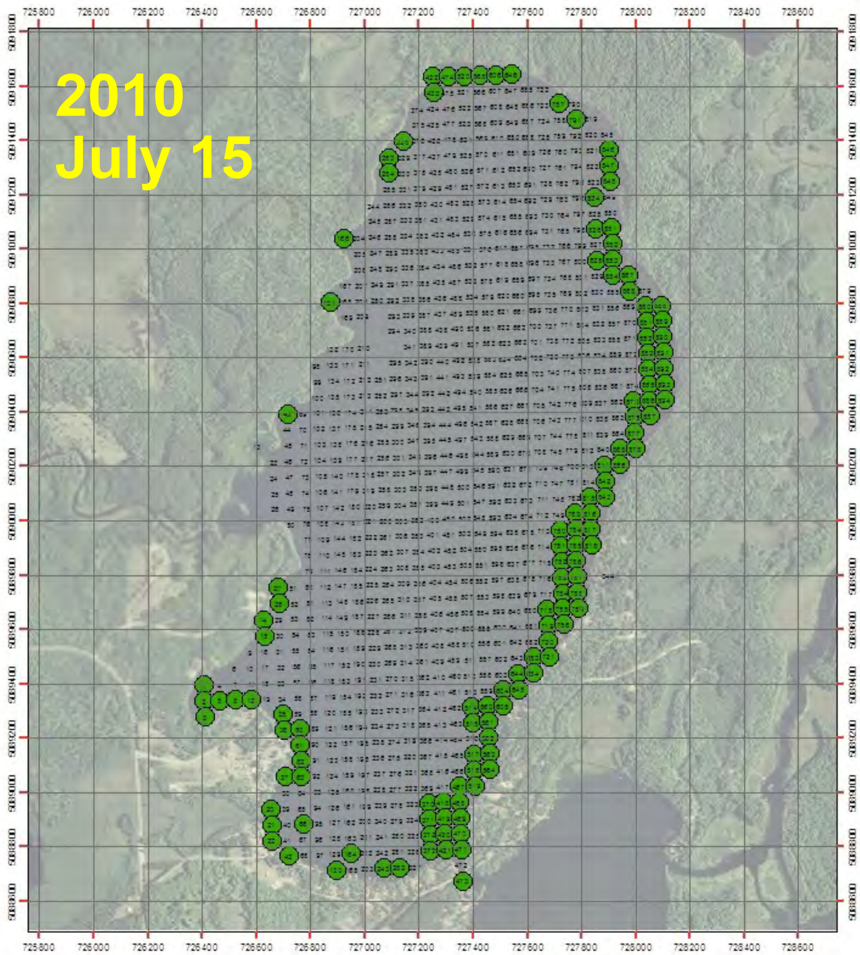


Figure 21. [top] Underwater picture of water celery in Round Lake on July 26, 2001. [bottom] Watershield (floatingleaf plant) and water stargrass (on rakehead) sampled on July 15, 2010.

Round Lake (726 acres)



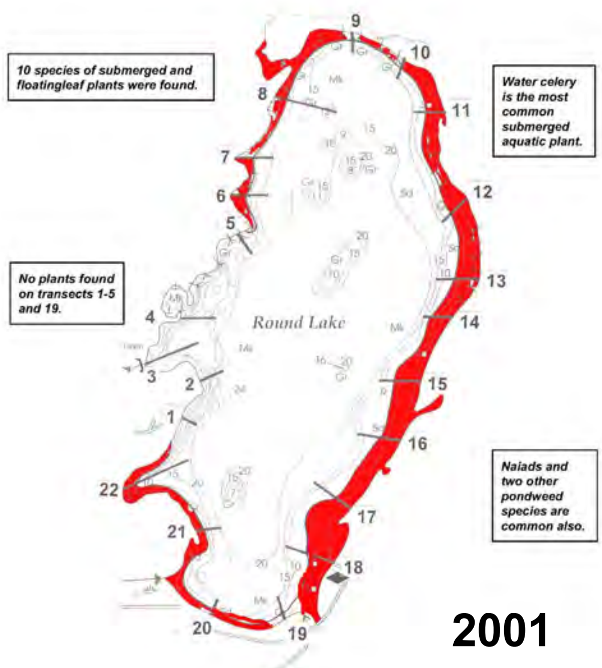


Figure 22. Round Lake aquatic plant map based on surveys conducted by Blue Water Science. [top] Aquatic plant distribution in 2010 is shown with green circles. [bottom] Aquatic plant distribution in 2001 is shown with red shading.

Amik Lake Aquatic Plants: Amik Lake has a diverse plant community with 14 species of floatingleaf and submerged plants. In 2010, fern pondweed was the most common species followed by a half dozen other species. Amik Lake is shallow and plant growth was found throughout most of the lake in 2010, but generally scattered. Plant growth is robust along the nearshore areas (Figure 23).

An interesting plant species in Amik Lake is cabbage (*Potamogeton amplifolius*). In 2000 it was reported to cover almost the entire lake basin. However, in 2001, cabbage was present, but scattered. It had the appearance of a “die-back”. Upon inspection of leaves and stems, we found that aquatic insect larvae were apparently feeding on the leaves and stems of the cabbage probably causing the “die-back”. Its possible this insect could be responsible for controlling the excessive growth of cabbage (Figure 24).

It appears cabbage will not be a long-term problem in Amik. The good news is that the abundant vegetation will help keep water quality good. The only downside is that a couple of residences have a slight problem getting to open water.

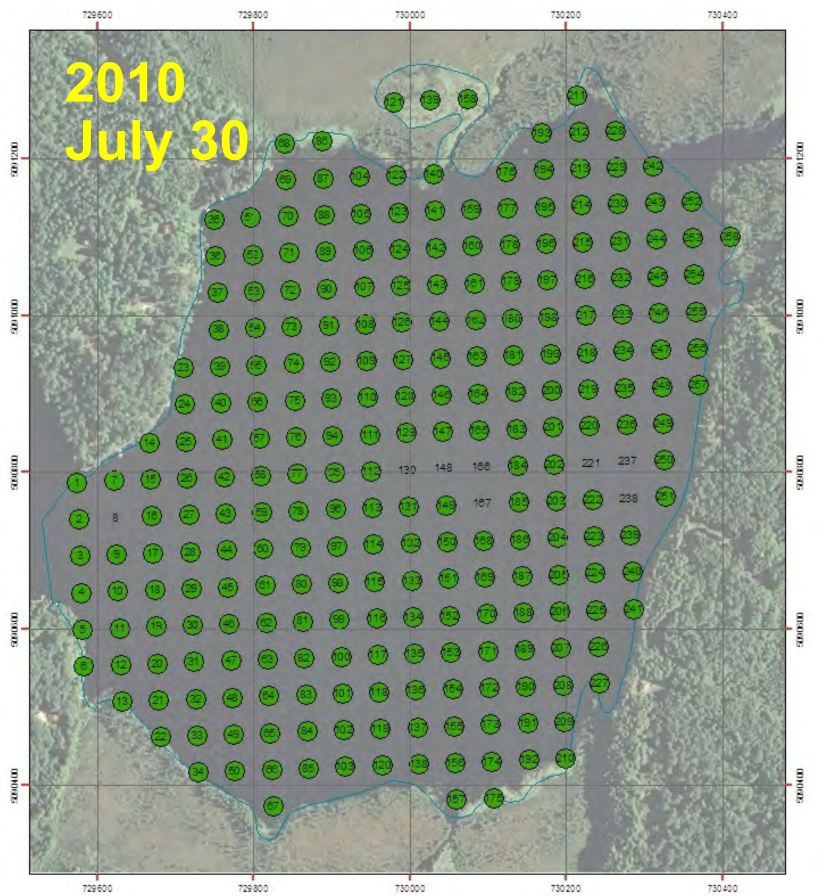
In 2010, cabbage was common, but the dominant plant was fern pondweed (Figure 24).

Aquatic plant coverage may have been greater in 2010 compared to 2001 (Figure 25).

Figure 23. Nearshore growth of aquatic vegetation in Amik Lake, July 2001.

Figure 24. [top-left] This chironomid species was found on the underside of cabbage leaves in Amik Lake in 2001.
[top-left] At the time of the plant survey on July 26, 2001, much of the cabbage community was found scattered and not at nuisance densities.
[bottom-left] Watershield in Amik Lake on July 15, 2010.
[bottom-right] Fern pondweed in Amik Lake on July 15, 2010.

Amik Lake (224 acres)



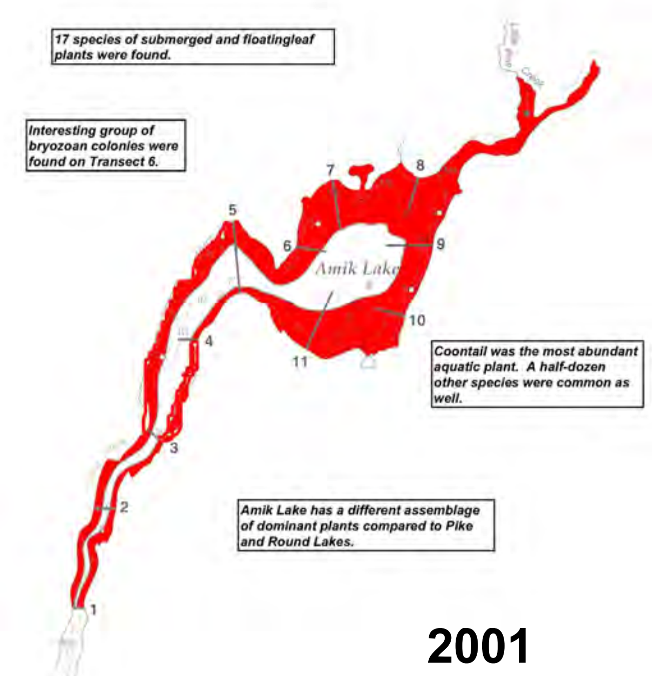
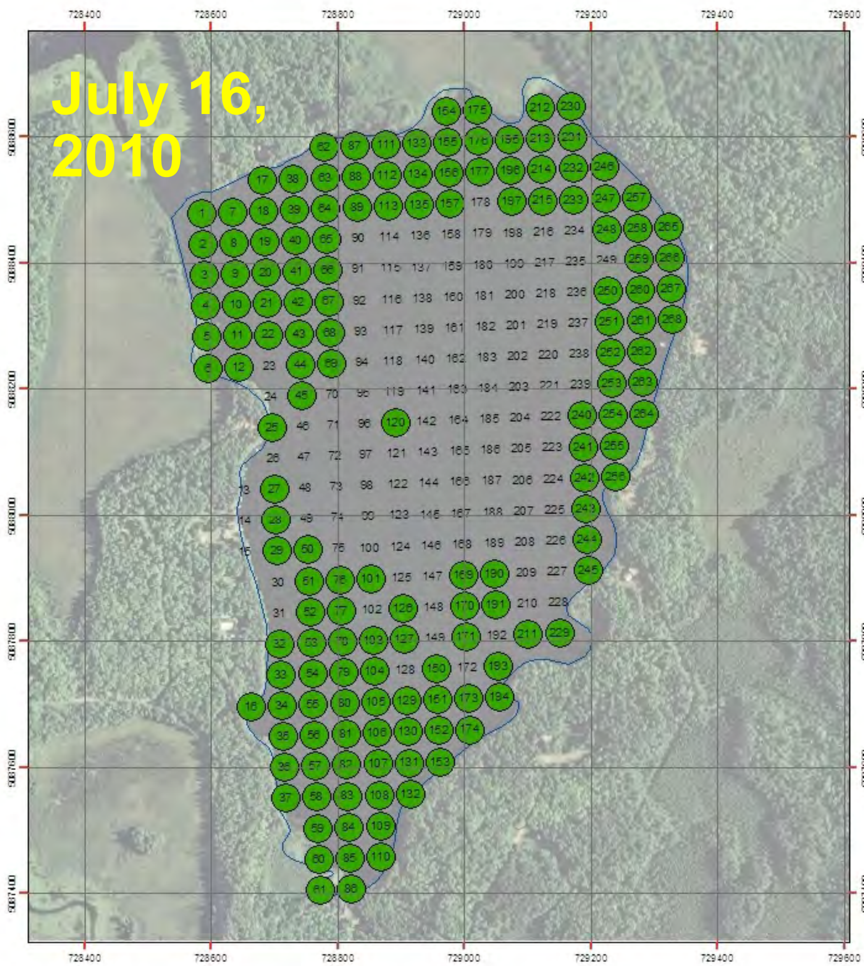


Figure 25. Amik Lake aquatic plant map based on surveys conducted by Blue Water Science.
[top] Aquatic plant distribution in 2010 is shown with green circles.
[bottom] Aquatic plant distribution is shown with red shading.

Turner Lake Aquatic Plants: Turner Lake has a diverse aquatic plant community dominated by elodea in 2010 followed by fern pondweed (Table 21 and Figure 26). Plant growth may have expanded in 2010 compared to 2001 survey (Figure 27).

Figure 26. [top-left] Nearshore vegetation in Turner, on August 4, 2001.
[top-right] Water celery and elodea collected during the plant survey on Turner Lake in 2001.
[bottom-left] Arrowhead plants in Turner Lake on July 16, 2010.
[bottom-right] Fern pondweed found in Turner Lake on July 16, 2010.

Turner Lake (149 acres)



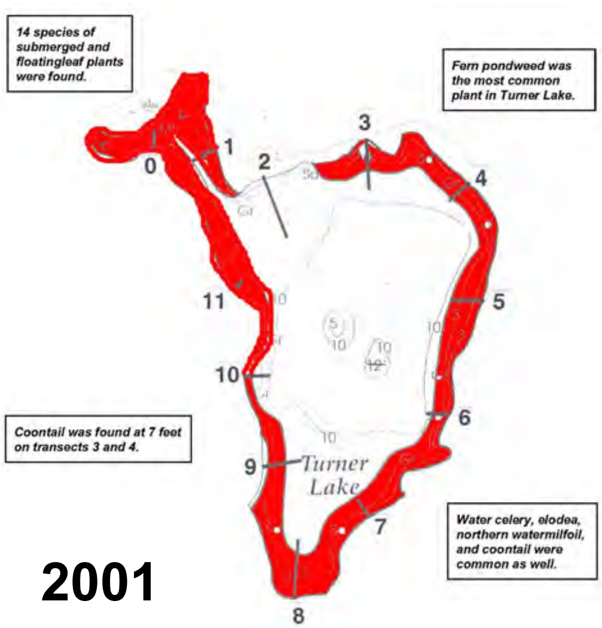


Figure 27. Turner Lake aquatic plant map based on surveys conducted by Blue Water Science. [top] Aquatic plant distribution in 2010 is shown with green circles. [bottom] Aquatic plant distribution is shown with red shading.

4.7. Fishery Status

Fishing is an important recreational activity of the Pike Lake Chain. Within the sport fishery, muskies and walleyes are important species but crappies are important as well.

This type of information was collected by talking to anglers on the lake. In 1999 and 2000, over an 18-month time span, the WDNR conducted a creel survey on the Pike Lake Chain. Interviews were conducted over summer and through winter. Results are shown in Figure 28 and 29 and in Table 22.

Some of the findings included the following:

- Anglers spent the most time pursuing muskies and walleyes on Pike and Round Lakes (Figure 28).
- Panfish were the most frequently caught fish and Turner Lake produced the most panfish on a per acre basis (Figure 29).
- Muskies were the most difficult fish to catch, taking over 20 hours to catch a fish. Largemouth bass were easier to catch, except in Pike Lake (Figure 29).

A number of other "fish facts" regarding fish lengths of species caught, how many fish caught and released, and hours of fishing are found in Table 22.

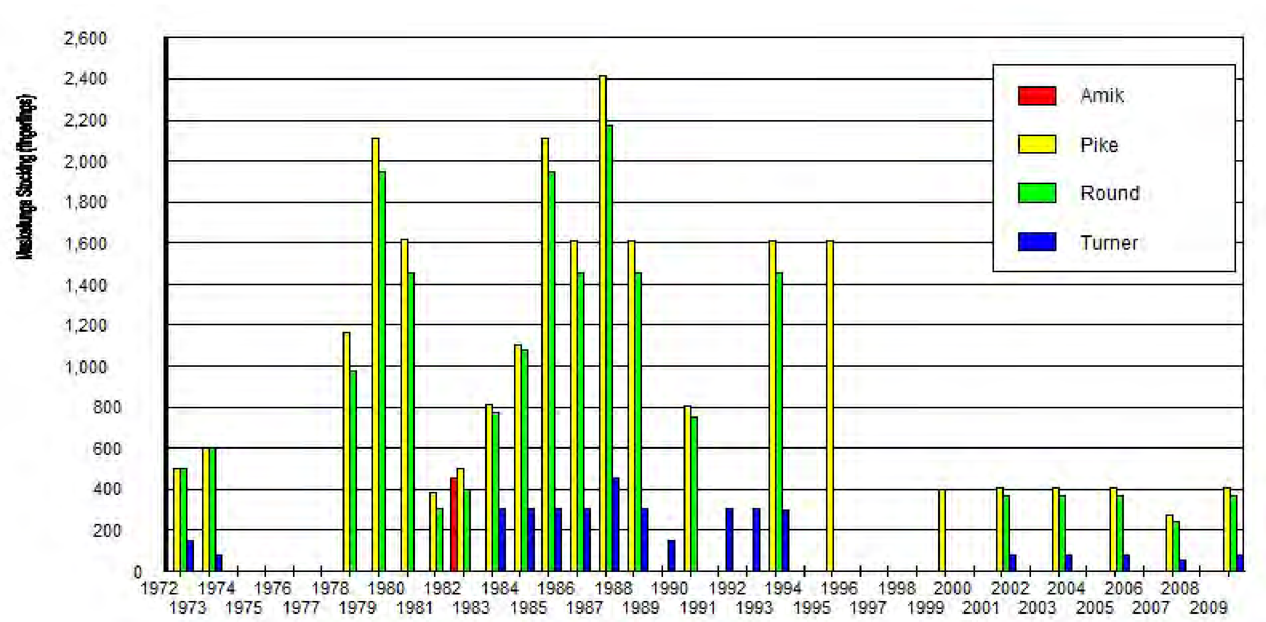


Figure 28. Hours of fishing for various species in the Chain based on creel survey results.

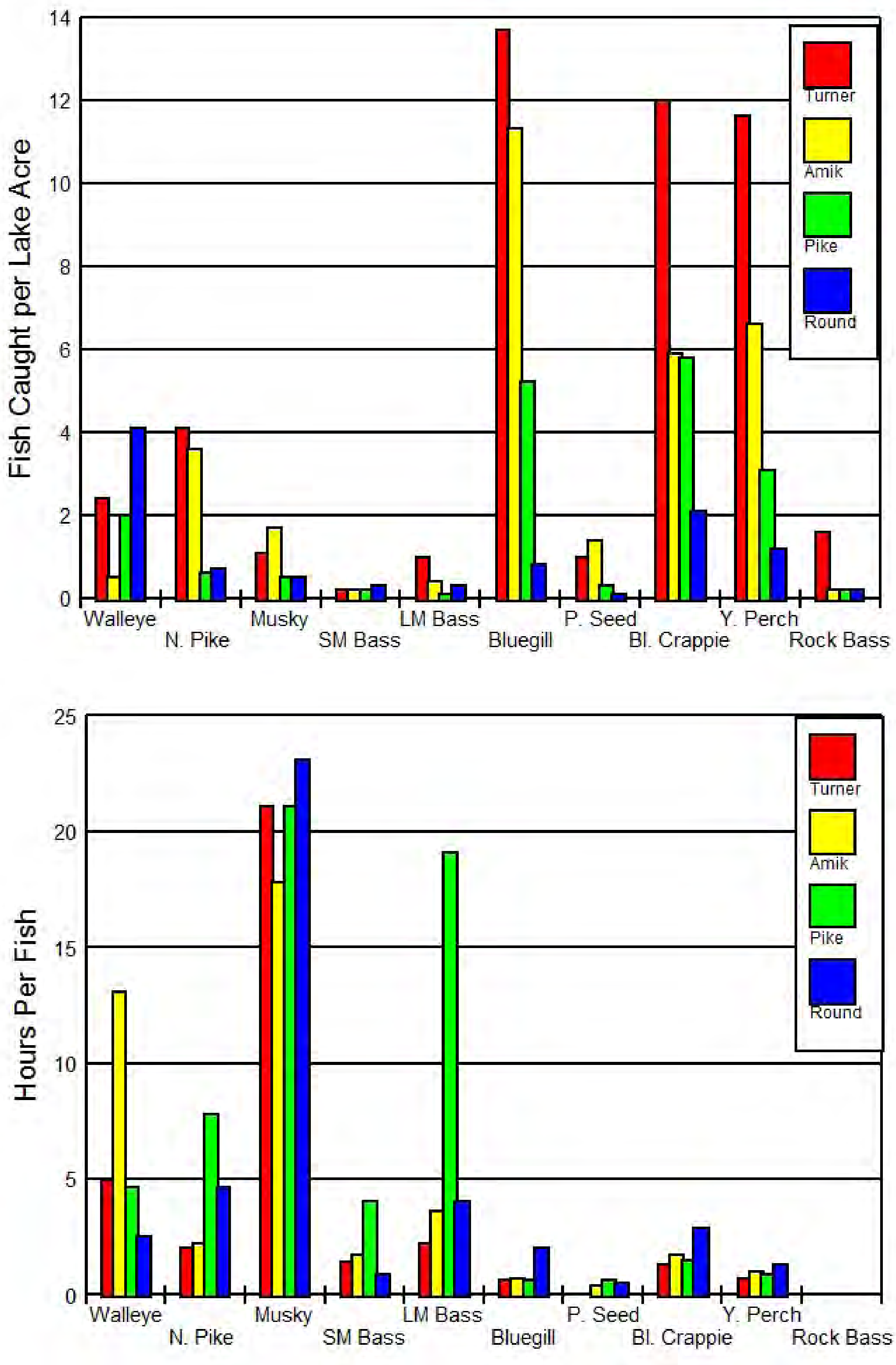


Figure 29. [top] Fish caught per acre based on the creel survey.
[bottom] The average number of hours it took to catch a fish of the targeted species that anglers were pursuing.

Table 22. Summary of creel census data collected on the Pike Lake Chain over 1999 and 2000.

Species	Lake	Hours of Fishing	Percent Hours for that Species	Catch	Fish Caught per Acre	Hours Per Fish	Percent Harvested	Mean Length of Harvested Fish
Walleye	Turner	1766	15	358	2.4	4.9	36	14.8
	Amik	1520	10	116	0.5	13.1	66	11.9
	Pike	7530	23	1621	2	4.6	23	12.9
	Round	7459	30	2981	4.1	2.5	23	12.6
N. Pike	Turner	1239	11	610	4.1	2	10	20.7
	Amik	1770	11	801	3.6	2.2	7	21.4
	Pike	3625	11	465	0.6	7.8	20	22.9
	Round	2394	10	521	0.7	4.6	3	25.1
Musky	Turner	3561	31	169	1.1	21.1	0	--
	Amik	6678	42	375	1.7	17.8	0	--
	Pike	8111	25	384	0.5	21.1	0	--
	Round	8207	33	354	0.5	23.1	0	--
SM Bass	Turner	37	0.3	27	0.2	1.4	0	--
	Amik	85	0.5	50	0.2	1.7	0	16.6
	Pike	598	2	149	0.2	4	3	14.3
	Round	190	0.8	223	0.3	0.9	9	15
LM Bass	Turner	340	3	155	1	2.2	0	--
	Amik	326	2	90	0.4	3.6	0	--
	Pike	669	2	35	0.1	19.1	0	--
	Round	188	0.8	47	0.3	4	0	--
Bluegill	Turner	1223	11	2040	13.7	0.6	26	7.6
	Amik	1755	11	2542	11.3	0.7	39	7
	Pike	2515	8	4172	5.2	0.6	54	6.6
	Round	1141	5	580	0.8	2	42	7
P. Seed	Turner	0	0	152	1	BC	9	6
	Amik	138	1	318	1.4	0.4	40	6.1
	Pike	115	0.4	207	0.3	0.6	20	6.7
	Round	14	0.1	31	0.1	0.5	81	6.5
Bl. Crappie	Turner	2304	20	1790	12	1.3	50	10
	Amik	2212	14	1315	5.9	1.7	52	9.5
	Pike	6816	21	4698	5.8	1.5	70	9.6
	Round	4330	17	1510	2.1	2.9	48	10
Y. Perch	Turner	1179	10	1723	11.6	0.7	8	8.2
	Amik	1404	9	1469	6.6	1	27	7.3
	Pike	2250	7	2460	3.1	0.9	32	7.6
	Round	1111	4	837	1.2	1.3	24	7.9
Rock Bass	Turner	33	0.3	236	1.6	BC	6	6.1
	Amik	0	0	39	0.2	BC	0	--
	Pike	0	0	385	0.2	BC	13	7.4
	Round	0	0	131	0.2	BC	3	7.9

*Lake Sturgeon: 11 hours of fishing pressure in Round Lake, no catches.
** BC = By-catch

A more recent fish survey was conducted by the WDNR in 2005 on Pike, Round, and Turner Lakes. Results are shown over the next 6 pages.

WISCONSIN DNR
FISHERIES INFORMATION SHEET
PIKE LAKE, PRICE COUNTY, 2005

The Department of Natural Resources conducted a fisheries assesment of Pike Lake, Price County, from April 13, 2005 to May 10, 2005.

Pike Lake is a drainage lake that is part of the Pike Lake Chain of lakes.

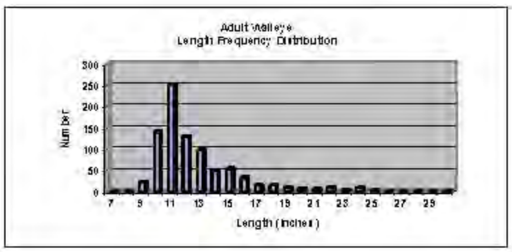


Figure 1. Length frequency distribution of adult walleye captured in Pike Lake, Price County during a spring 2005 survey.

Walleye

We conducted a mark-recapture survey of Pike Lake's adult walleye population from 04/13/05-04/18/05. We captured and marked (fin clipped) 431 adult walleye in 4 days of fyke netting. During electrofishing sampling on 04/18/05, 429 adult walleye were captured. The largest walleye captured was 27 inches.

	Male	Female	Unknown
7.0 - 11.9	414	1	85
12.0 - 14.9	262	15	21
15.0 - 19.9	45	72	10
20.0 +	0	41	0
TOTAL	721	129	116

Table 1. Length frequency distribution of walleye by gender captured in Pike Lake, Price County during a spring 2005 survey.

Largemouth and Smallmouth Bass

We also surveyed the largemouth and smallmouth bass populations of Pike Lake from 04/13/05 to 05/10/05.

We captured and marked (fin clipped) 44 largemouth bass, 8 inches or larger, during our fyke netting and electrofishing sampling. Of those largemouth bass, 24 were 14 inches long or larger. The largest largemouth bass captured was 19 inches long.

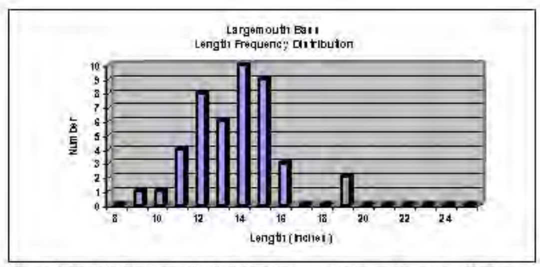


Figure 2. Length frequency distribution of largemouth bass 8"+ captured in Pike Lake, Price County during a spring 2005 survey.

We captured and marked (fin clipped) 65 smallmouth bass. Of those smallmouth, 26 were 14 inches long or larger, and 0 were 18 inches long or larger. The largest smallmouth bass captured was 17 inches long.

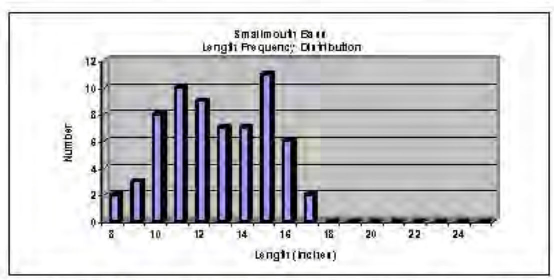


Figure 3. Length frequency distribution of smallmouth bass 8"+ captured in Pike Lake, Price County during a spring 2005 survey.

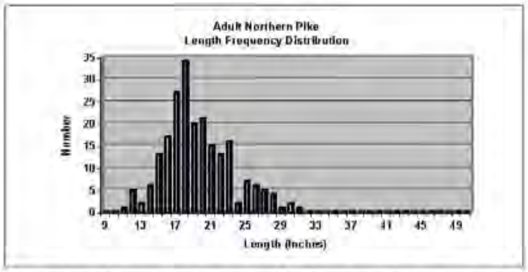


Figure 4. Length frequency distribution of adult northern pike captured in Pike Lake, Price County during a spring 2005 survey.

Northern Pike
From 04/13/05 to 04/17/05 218 adult northern pike were captured in fyke nets. The largest northern pike captured was 31 inches.

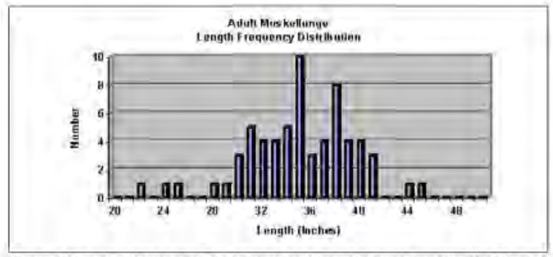


Figure 5. Length frequency distribution of adult muskellunge captured in Pike Lake, Price County during a spring 0 survey.

Muskellunge
We captured 64 adult muskellunge during our fyke netting and electrofishing sampling of Pike Lake. Of the adult muskellunge captured, 43 were 34 inches long or larger. The largest muskellunge captured was a 45-inch female.

This report is interim only; data and findings should not be considered final. Results of creel surveys should be available by June of the year following the survey. If you are interested in a summary of the creel survey or want an update on this year's fyke netting and electrofishing survey results contact:

Jamison Wendel, Treaty Fisheries Biologist
Wisconsin Department of Natural Resources
810 W. Maple St.
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(715) 635-4095
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For answers to questions about fisheries management activities and plans for Pike Lake, Price County contact.

Jeff Scheirer, Fisheries Biologist
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WISCONSIN DNR
FISHERIES INFORMATION SHEET
ROUND LAKE, PRICE COUNTY, 2005

The Department of Natural Resources conducted a fisheries assesment of Round Lake, Price County, from April 13, 2005 to May 10, 2005.

Round Lake is a drainage lake that is part of the Pike Lake Chain of lakes.

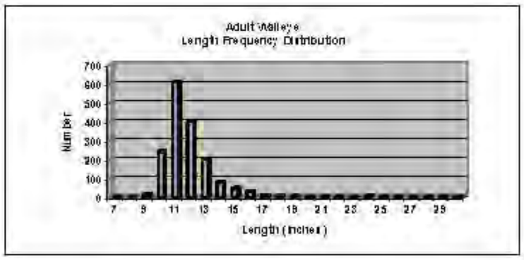

Figure 1. Length frequency distribution of adult walleye captured in Round Lake, Price County during a spring 2005 survey.

Walleye

We conducted a mark-recapture survey of Round Lake's adult walleye population from 04/13/05-04/18/05. We captured and marked (fin clipped) 1245 adult walleye in 5 days of fyke netting. During electrofishing sampling on 04/18/05, 433 adult walleye were captured. The largest walleye captured was 28 inches.

	Male	Female	Unknown
7.0 - 11.9	865	1	21
12.0 - 14.9	617	67	7
15.0 - 19.9	17	83	3
20.0 +	0	25	0
TOTAL	1499	176	31

Table 1. Length frequency distribution of walleye by gender captured in Round Lake, Price County during a spring 2005 survey.

Largemouth and Smallmouth Bass

We also surveyed the largemouth and smallmouth bass populations of Round Lake from 04/13/05 to 05/10/05.

We captured and marked (fin clipped) 19 largemouth bass, 8 inches or larger, during our fyke netting and electrofishing sampling. Of those largemouth bass, 17 were 14 inches long or larger. The largest largemouth bass captured was 16 inches long.

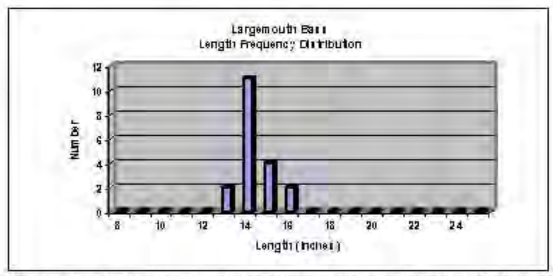

Figure 2. Length frequency distribution of largemouth bass 8"+ captured in Round Lake, Price County during a spring 2005 survey.

We captured and marked (fin clipped) 46 smallmouth bass. Of those smallmouth, 17 were 14 inches long or larger, and 0 were 18 inches long or larger. The largest smallmouth bass captured was 17 inches long.

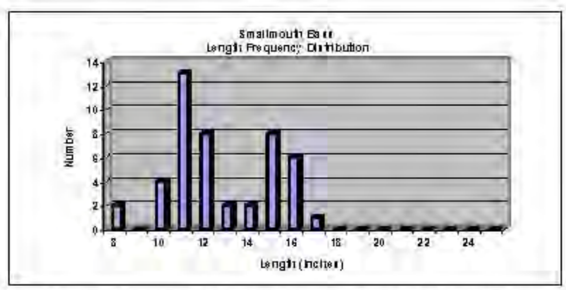

Figure 3. Length frequency distribution of smallmouth bass 8"+ captured in Round Lake, Price County during a spring 2005 survey.

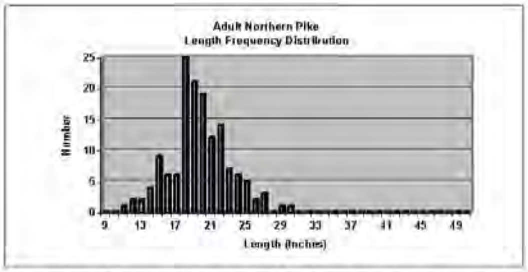

Figure 4. Length frequency distribution of adult northern pike captured in Round Lake, Price County during a spring 2005 survey.

Northern Pike

From 04/13/05 to 04/18/05 146 adult northern pike were captured in fyke nets. The largest northern pike captured was 30 inches.

Muskellunge

We captured 83 adult muskellunge during our fyke netting and electrofishing sampling of Round Lake. Of the adult muskellunge captured, 47 were 34 inches long or larger. The largest muskellunge captured was a 46-inch female.

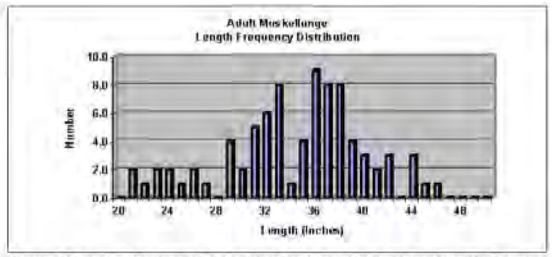

Figure 5. Length frequency distribution of adult muskellunge captured in Round Lake, Price County during a spring 0 survey.

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WISCONSIN DNR
FISHERIES INFORMATION SHEET
TURNER LAKE, PRICE COUNTY, 2005

The Department of Natural Resources conducted a fisheries assesment of Turner Lake, Price County, from April 13, 2005 to May 10, 2005.

Turner Lake is a drainage lake that is part of the Pike Lake Chain of lakes.

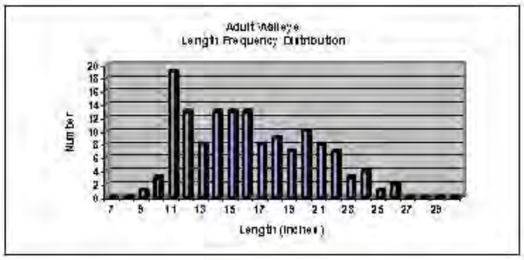

Figure 1. Length frequency distribution of adult walleye captured in Turner Lake, Price County during a spring 2005 survey.

Walleye

We conducted a mark-recapture survey of Turner Lake's adult walleye population from 04/13/05-04/16/05. We captured and marked (fin clipped) 75 adult walleye in 3 days of fyke netting. During electrofishing sampling on 04/16/05, 67 adult walleye were captured. The largest walleye captured was 26 inches.

	Male	Female	Unknown
7.0 - 11.9	23	0	30
12.0 - 14.9	31	3	20
15.0 - 19.9	18	21	11
20.0 +	1	32	2
TOTAL	73	56	63

Table 1. Length frequency distribution of walleye by gender captured in Turner Lake, Price County during a spring 2005 survey.

Largemouth and Smallmouth Bass

We also surveyed the largemouth and smallmouth bass populations of Turner Lake from 04/13/05 to 05/10/05.

We captured and marked (fin clipped) 67 largemouth bass, 8 inches or larger, during our fyke netting and electrofishing sampling. Of those largemouth bass, 26 were 14 inches long or larger. The largest largemouth bass captured was 18 inches long.

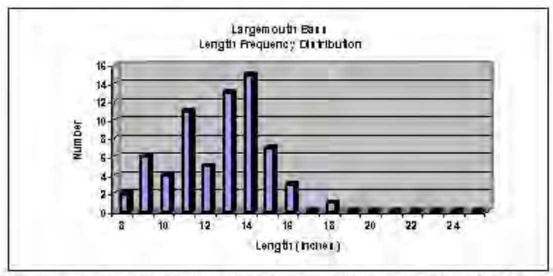

Figure 2. Length frequency distribution of largemouth bass 8"+ captured in Turner Lake, Price County during a spring 2005 survey.

We captured and marked (fin clipped) 4 smallmouth bass. Of those smallmouth, 0 were 14 inches long or larger, and 0 were 18 inches long or larger. The largest smallmouth bass captured was 13 inches long.

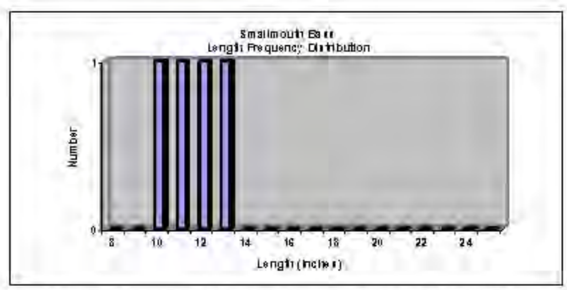

Figure 3. Length frequency distribution of smallmouth bass 8"+ captured in Turner Lake, Price County during a spring 2005 survey.

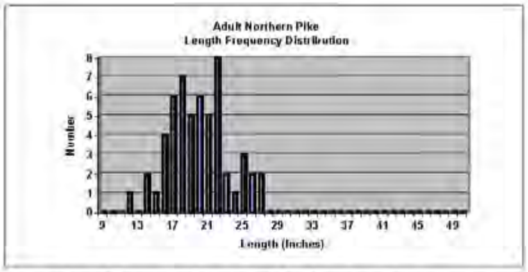

Figure 4. Length frequency distribution of adult northern pike captured in Turner Lake, Price County during a spring 2005 survey.

Northern Pike
From 04/13/05 to 04/16/05 55 adult northern pike were captured in fyke nets. The largest northern pike captured was 27 inches.

Muskellunge
We captured 28 adult muskellunge during our fyke netting and electrofishing sampling of Turner Lake. Of the adult muskellunge captured, 15 were 34 inches long or larger. The largest muskellunge captured was a 44-inch female.

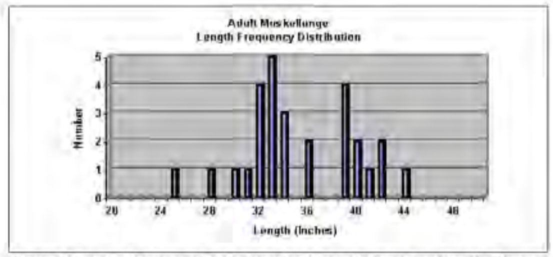

Figure 5. Length frequency distribution of adult muskellunge captured in Turner Lake, Price County during a spring 2005 survey.

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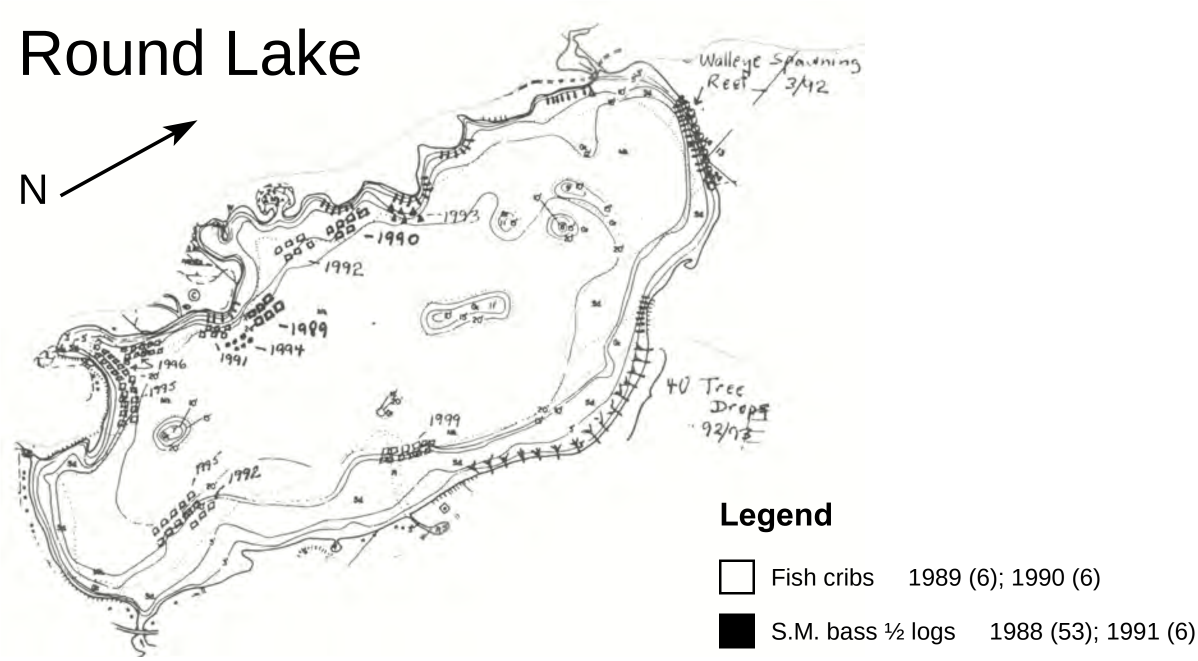
Fish Cribs in the Pike Lake Chain: Because of a lack of aquatic plants in Round and Pike Lakes past 8 feet of water depth, fish cribs and other artificial structures have been installed in an attempt to increase fish habitat. Fish crib locations are shown in Figure 30.



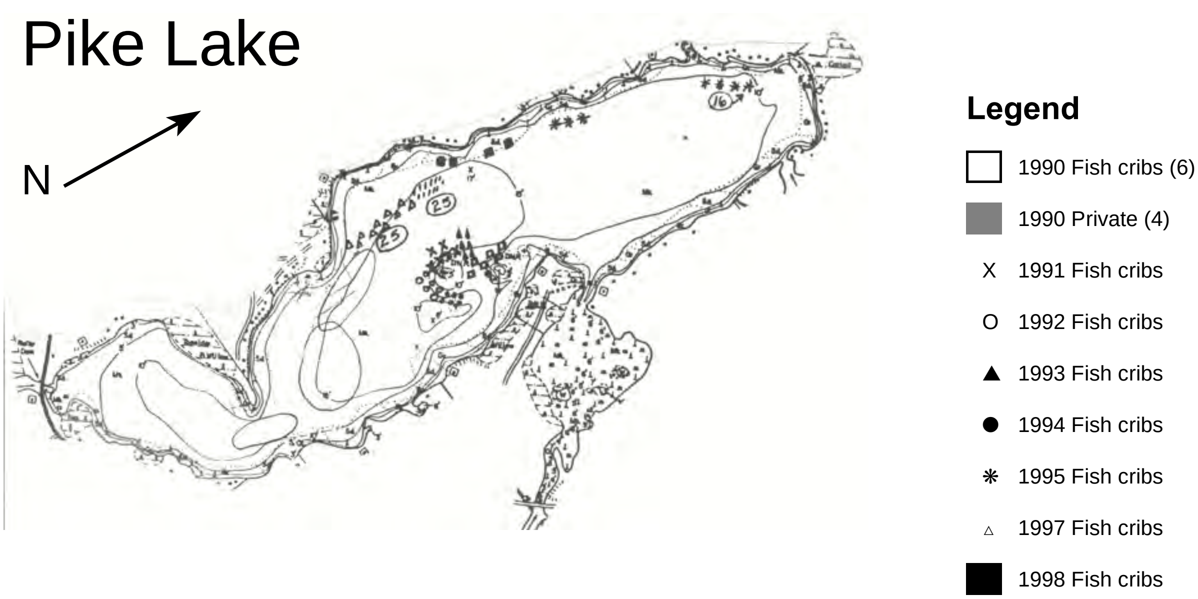


Figure 30. Fish crib placement as along with other structures in Round Lake (top) and Pike Lake (bottom).

The Status of Fish Cribs in Round Lake

In 2001, fish cribs were observed by scuba diving. The two cribs observed in Round Lake were mostly intact (Figure 31) and in fact, a bluegill was observed using the crib (Figure 31, bottom).

Because of the brownish water color due to the wetland or "bog" stain, cribs are hard to see, although fish will find them and use them for protection.

Figure 31. Underwater views of a fish crib in Round Lake in July, 2001.

5. Lake and Watershed Assessment

5.1. How Do the Lakes Rate?

One way to evaluate the conditions of the Pike Lake Chain of Lakes is to compare their water quality to other lakes within the same ecoregion. An ecoregion is an area that has similar geology, plants, and soils. There are 84 ecoregions in the continental United States. The Pike Lake Chain is within the Northern Lakes and Forests Ecoregion.

The Pike Lake Chain water quality parameters are not quite within the water quality ranges for lakes in the Northern Lakes and Forests Ecoregion (Table 23). Although clarity, chlorophyll, and phosphorus levels are out of range for Pike, Round, Amik and Turner, there are several unique factors at play. One of the factors is the large watershed. It doesn't appear there are significant sources of pollution to the lakes. In fact, this was reinforced with a historical lake analysis using lake sediments and conducted by Paul Garrison, WDNR.

When the lake condition from 100 years ago was compared to today's condition, Paul Garrison concluded that the nutrients in Round Lake have probably increased slightly, and not dramatically. This was probably due to logging impacts as well as shoreline development.

Table 23. Range of summer water quality characteristics for lakes in the Northern Lakes and Forest ecoregion (from Descriptive Characteristics of the Seven Ecoregions in Minnesota, by G. Fandrei, S. Heiskary, and S. McCollar. 1988. Minnesota Pollution Control Agency).

Parameter	Northern Lakes & Forests	Pike Lake		Round Lake		Amik Lake		Turner Lake	
		2001	2010	2001	2010	2001	2010	2001	2010
Total Phosphorus (µg/l) (top water summer average)	14-27	31	44	33	31	36	36	30	24
Algae (chlorophyll mean (µg/l))	<10	21	14	17	7.8	13	7.0	13	18
Algae (chlorophyll maximum (µg/l))	<15	38	27	24	10	23	9.7	18	46
Secchi disc (feet)	8-15	3.8	3.3	3.9	4.6	5.1	4.6	4.9	6.6
Total Kjeldahl Nitrogen (µg/l)	<750	930		840		760		800	
TN:TP Ratio	25:1-35:1	30:1		25:1		21:1		27:1	

Summary of Phosphorus Loading to Lakes: There are various sources of phosphorus to the lakes. The estimated amounts of phosphorus carried into the lakes on an annual basis are shown in Table 24.

Table 24. Summary of phosphorus loading to lakes (in pounds).

	Phosphorus (pounds/year)	How the Phosphorus Load was Calculated
Turner		
Direct drainage	127	567 ac x 80 ppb-P
Rainfall	40	149 ac x 0.27 pounds/ac
Septic systems*	3	20 systems x 0.15 lbs/system
PHOSPHORUS LOAD	170	
Amik		
Pine Creek	1,100	13,408 ac x 33 ppb-P
Tucker Lake watershed	24	624 ac x 15 ppb-P
Direct drainage	157	991 ac x 70 ppb-P
Rainfall	61	224 ac x 0.27 lbs/ac
Septic systems	2	14 x 0.15 lbs/systems
PHOSPHORUS LOAD	1,344	
Pike		
Foulds Creek	700	10,704 ac x 26 ppb-P
Squaw Creek	2,900	29,792 ac x 39 ppb-P
Amik Lake watershed	1,000	15,247 ac x 26 ppb-P
Turner Lake watershed	48	716 ac x 27 ppb-P
Direct drainage	480	2,137 ac x 90 ppb-P
Rainfall	218	806 ac x 0.27 lbs/ac
Septic systems	26	170 x 0.15 lbs/system
PHOSPHORUS LOAD	5,372	
Round Lake		
Pike Lake watershed	4,600	59,402 ac x 31 ppb-P
Direct drainage	327	1,872 ac x 70 ppb-P
Rainfall	196	726 ac x 0.27 lbs/ac
Septic systems	12	80 x 0.15 lbs/system
PHOSPHORUS LOAD	5,135	

* Septic system loading was calculated as follows: Assume 1 system is used by 3 people for half the year. Phosphorus generated by 1 person/yr = 0.5 kg = 1 pound. An estimated 90% of the phosphorus is removed by the soil absorption field. Phosphorus from one system = 3 people x 0.5 yr x 1 pound/person x 0.10 that goes to lake = 0.15 pounds/system.

Phosphorus Inputs to Amik, Turner, Pike, and Round

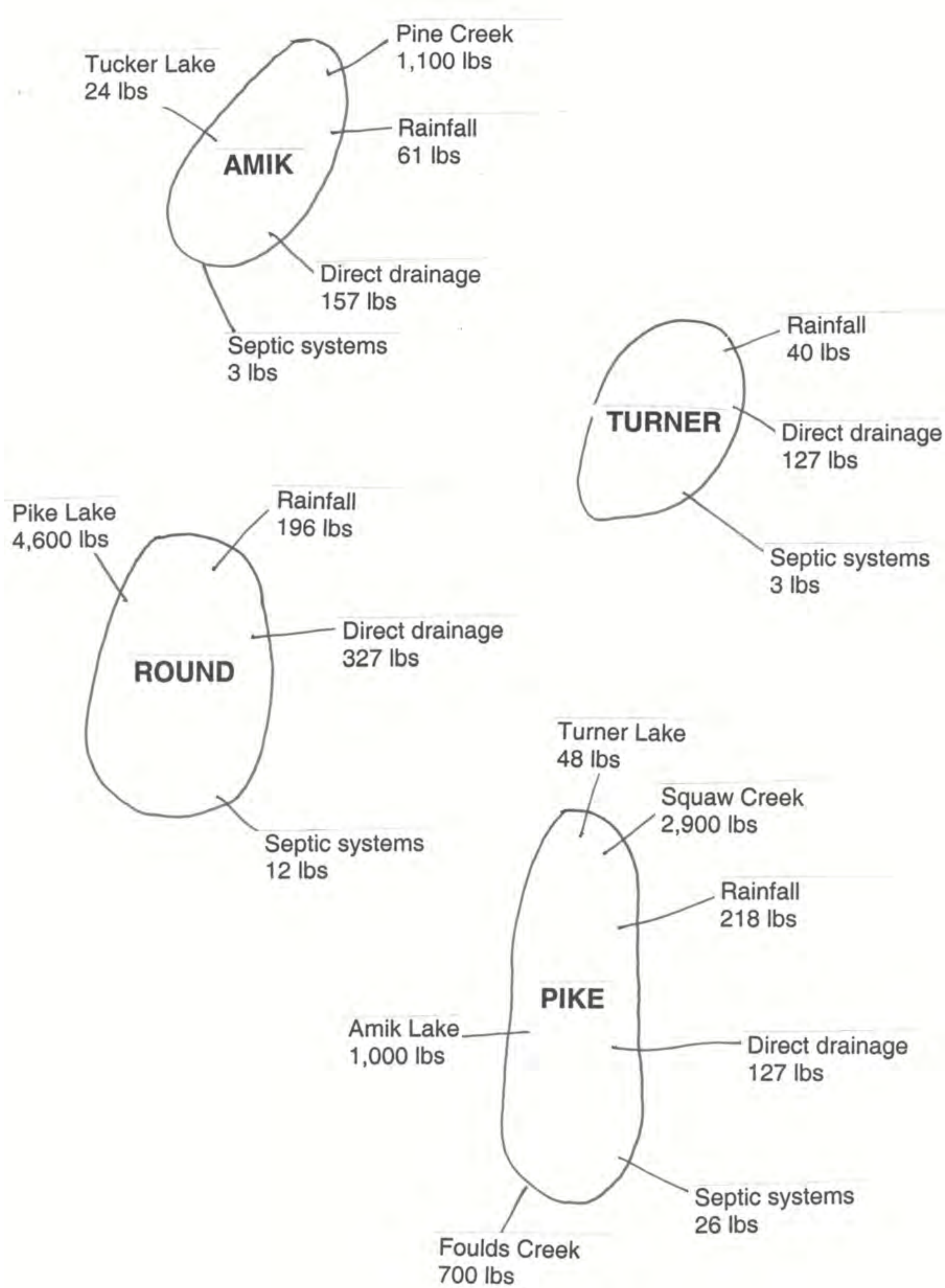


Figure 32. Summary of phosphorus sources to the Pike Chain of Lakes.

5.2. Wetland Influences on Lake Water Quality

Water quality in the Pike Lake Chain of Lakes is good, but different than many other glacial lakes in the Ecoregion. Water is not as clear in the Pike Chain as in other area lakes. However, there are special circumstances that account for the water quality conditions. The size of the watershed, land use, and the lake volume are all contributing factors.

One way to check the status of the Pike Lake Chain lakes was to insert existing data into equations to see if the answers matched what the observed water quality conditions are. These equations are referred to as lake models.

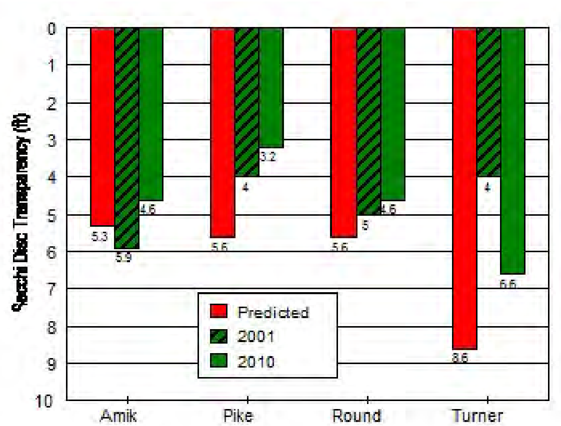
Lake models were run using watershed size and the known phosphorus concentrations in the incoming streams. Another lake model was run using an ecoregion stream phosphorus value of 52 ppb. Results are shown in Table 25 and Figure 33. In 2001, there is fair agreement between the predicted lake phosphorus concentration and the observed phosphorus concentration for Turner, Amik, Pike and Round lakes when the stream phosphorus input of 52 ppb is used.

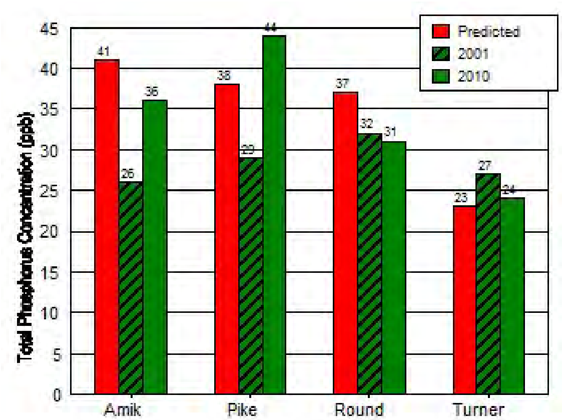
In 2010, lake phosphorus concentrations in Pike Lake were higher than predicted using an Ecoregion stream inflow phosphorus concentration of 52 ppb (Table 25).

In addition, the primary reasons for Pike and Round water clarity predictions being slightly “off” in 2001 and 2010 is due to the “bog stain” of the lakes which originates from the large wetland areas.

Table 25. Observed lake water quality conditions and predicted lake water quality conditions based on measured stream phosphorus concentrations of around 30 ppb and Ecoregion phosphorus runoff of 52 ppb.

	Turner	Amik	Pike	Round
Water Clarity [in feet (meters)]				
Predicted lake values based on measured stream phosphorus concentration of around 30 ppb.	10.9 (3.3)	7.3 (2.2)	7.3 (2.2)	8.3 (2.5)
Predicted lake values based on theoretical stream concentration of 52 ppb.	8.6 (2.6)	5.3 (1.6)	5.6 (1.7)	5.6 (1.7)
Observed in 2001	4.3 (1.3)	5.9 (1.8)	4.0 (1.2)	5.0 (1.5)
Observed in 2010	6.6 (2.0)	4.6 (1.4)	3.2 (1.0)	4.6 (1.4)
Total Phosphorus (in ppb)				
Predicted lake values based on measured stream phosphorus concentration of around 30 ppb.	17	27	27	24
Predicted lake values based on theoretical stream concentration of 52 ppb.	23	41	38	37
Observed in 2001	27	26	29	32
Observed in 2010	24	36	44	31
Chlorophyll a (in ppb)				
Predicted lake values based on measured stream phosphorus concentration of around 30 ppb.	4	8	8	7
Predicted lake values based on theoretical stream concentration of 52 ppb.	7	15	14	13
Observed in 2001	13	13	21	17
Observed in 2010	7	18	14	8





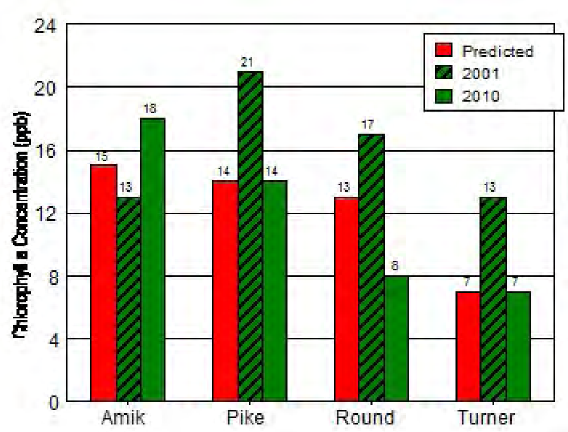


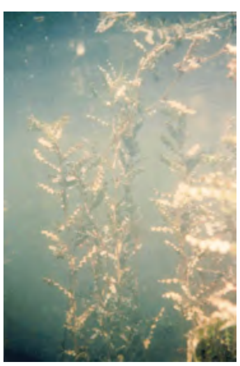
Figure 33. Predicted water quality values, based on an Ecoregion stream phosphorus concentration of 52 ppb and actual water quality results for 2001 and 2010.

5.3. Aquatic Invasive Species Assessment

The potential for aquatic invasive species (AIS) to grow in the Pike Lake Chain was assessed in 2010. Based on the existing conditions of the lakes, there is generally a low to moderate potential for nuisance growth of the AIS species that were evaluated (Table 26). The main AIS of concern is the VHS virus which is not found in the Pike Lake Chain but could harm the fish population if it was introduced.

Table 26. Overview of seven aquatic invasive species that could impact The Pike Lake Chain are listed below. As of 2010, curlyleaf pondweed, Eurasian watermilfoil, and zebra mussels have not been observed in the Pike Lake Chain.

Species	Pike Lake Chain Status	Potential for Nuisance Colonization in the Pike Lake Chain	Management Action	
			Short Term	Long Term
Plants				
1. Curlyleaf pondweed	not in the Pike Lake Chain of Lakes	low to moderate	annual surveys by consultant or residents	selective treatment for nuisance growth conditions
2. Eurasian watermilfoil	not in the Pike Lake Chain of Lakes	low	annual surveys by consultant or residents	selective treatment for nuisance growth conditions
3. Purple loosestrife	in the area	moderate	annual surveys by residents	spot control and use of beetles for large area control
Invertebrate				
4. Zebra mussels	absent, but in Price County	moderate	mussel monitoring devices for early detection	contingency funds for aggressive rapid response
5. Rusty crayfish	present in Turner Lake	low to moderate	crayfish traps for early detection	use fish to control rusty crayfish
6. Chinese mystery snail	present in Pike Lake	moderate	no action needed	no action needed
Species to Watch				
7. VHS	absent	moderate to high	inform and educ	
8. Hydrilla	absent	low to moderate	inform and educ	


Curlyleaf Pondweed


Eurasian Watermilfoil


Zebra Mussel

Zebra Mussel Growth Potential

Zebra mussels are not found in the Pike Lake Chain as of 2010. A review of water column characteristics for the Pike Chain was compared to characteristics suited for zebra mussels (blue shading) and is shown in Table 27. Low calcium concentrations determined in 2010 in all four lakes indicate zebra mussel shell production would be limited and therefore growth would be limited. If zebra mussels invade, zebra mussel growth is expected to be light to moderate in the Pike Chain of Lakes. Ongoing scouting activities are recommended through the growing season. A zebra mussel coordinator from the Pike Lake Chain should be appointed and this person would coordinate control activities between the WDNR, the Pike Lake Chain, and contractors. An action plan should be formulated in the future with procedures outlined for actions.

Discussions with the WDNR should be held prior to zebra mussel detection in the Pike Lake Chain to outline control activities and the need for potential permits.

Figure 34. Underwater view of Round Lake, July 2001. These rocks would provide suitable habitat for zebra mussel attachment, but low calcium concentrations would likely limit zebra mussel growth.

Table 27. Water column zebra mussel suitability criteria and the Pike Lake Chain water column conditions. Conditions for low to moderate growth seem to dominate. Heavy growth of zebra mussels would not be expected in the Pike Chain of Lakes.

		Little Potential for Adult Survival	Little Potential for Larval Development	Moderate (survivable, but will not flourish)	High (favorable for optimal growth)
Calcium (mg/l)	Pike		9.5		
	Round		9.0		
	Turner		9.2		
	Amik		12.2		
	Mackie and Claudi 2010	<8	8 - 15	15 - 30	>30
Dissolved oxygen (depth of colonization in meters)	Pike		4-6 m (water depth)	4 m	0-3 m
	Round			2-7 m	0-2 m
	Turner			1-4 m	0-1 m
	Amik		1-3 m	0-1 m	
	Mackie and Claudi 2010	<3 mg/l	3 - 7 mg/l	7 - 8 mg/l	>8 mg/l
Temperature (°C) (depth of colonization in meters)	Pike			4-5 m	0-4 m
	Round			5-6 m	0-5 m
	Turner				0-4 m
	Amik				0-3 m
	Mackie and Claudi 2010	<10 or >32 °C	26 - 32 °C	10 - 20 °C	20 - 26 °C
pH	Pike	6.7			
	Round	6.6			
	Turner		7.0		
	Amik				
	Mackie and Claudi 2010	<7.0 or >9.5	7.0 - 7.8 or 9.0 - 9.5	7.8 - 8.2 or 8.8 - 9.0	8.2 - 8.8
Alkalinity* (as mg $CaCO_3$/l)	Pike		30		
	Round	28			
	Turner		36		
	Amik		44		
	Mackie and Claudi 2010	<30	30 - 55	55 - 100	100 - 280
Conductivity* (umhos)	Pike		50		
	Round		40		
	Turner		45		
	Amik				
	Mackie and Claudi 2010	<30	30 - 60	60 - 110	>110
Secchi depth (m)	Pike		1.1		
	Round		1.5		
	Turner		1.5		
(3 year avg.	Amik		1.6		
2008-2010)	Mackie and Claudi 2010	<1 or >8	1 - 2 or 6 - 8	4 - 6	2 - 4
Chlorophyll a (ug/l)(food source)	Pike			12.2	
	Round			8.2	
	Turner			11.7	
(3 year avg.	Amik			12.0	
2008-2010)	Mackie and Claudi 2010	<2.5 or >25	2.0 - 2.5 or 20 - 25	8 - 20	2.5 - 8
Total phosphorus (ppb)	Pike		39.6		
	Round				32.5
	Turner				28.2
(3 year avg.	Amik		36.9		
2008-2010)	Mackie and Claudi 2010	<5 or >50	5 - 10 or 35 - 50	10 - 25	25 - 35

* not tested at this time

Curlyleaf Pondweed Growth Potential
Curlyleaf pondweed is not currently found in the Pike Lake Chain. Research has found curlyleaf growth is limited or enhanced based on lake sediment characteristics. Curlyleaf does best in sediments with a high pH and low iron content (McComas, unpublished). If lake sediments are conducive to curlyleaf growth, curlyleaf will sprout and grow annually. Unless the conducive sediment conditions change, curlyleaf will continue to grow on and annual basis.

It is predicted that curlyleaf can grow in the Pike Lake Chain, but will not grow to produce heavy growth. Most of the Pike lake Chain lake sediments have a low pH. If treatment is considered in the future, the latest research indicates the use of herbicides produce annual control, but long-term control (where treatments could be discontinued in the future) has not been observed (personal communication with John Skogerboe, U.S. Army Corp of Engineers).

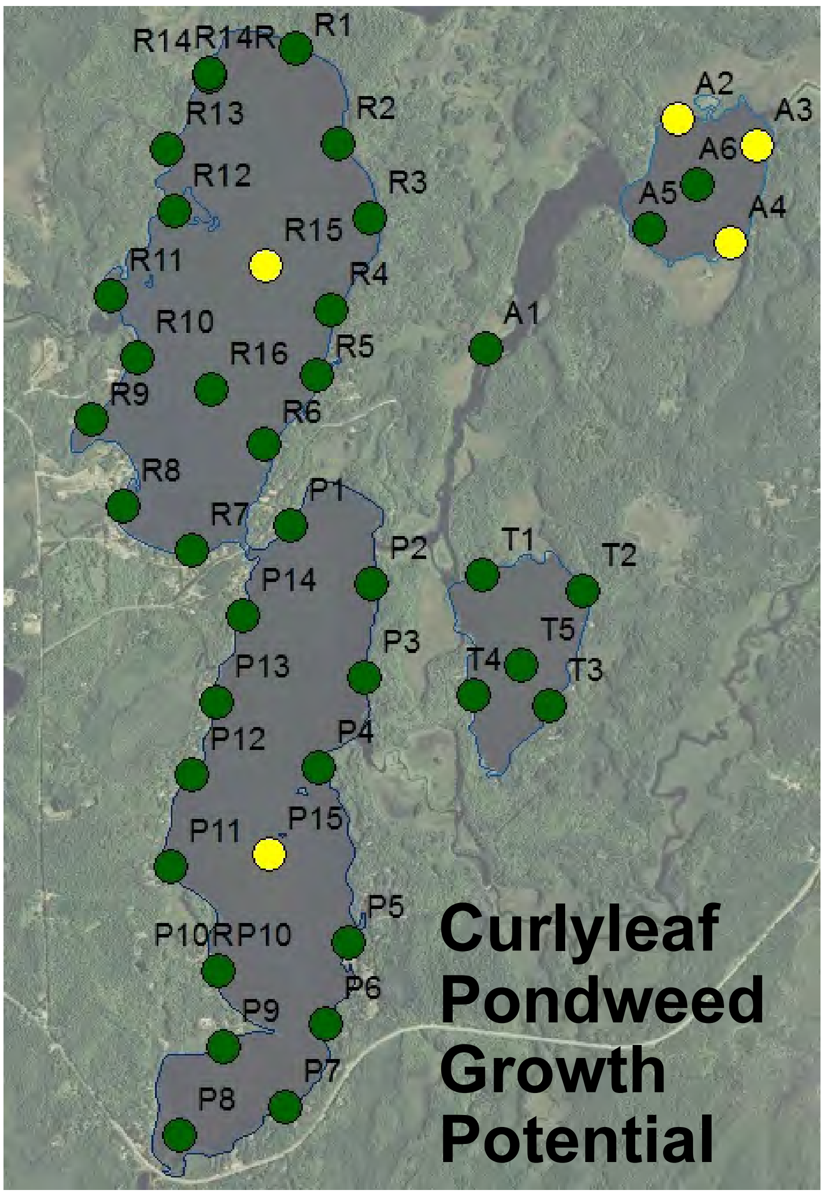


Figure 35. The circle color indicates the type of curlyleaf pondweed growth predicted to occur at that site. Key: green = light; yellow = moderate; red = heavy.

Eurasian Watermilfoil Growth Potential
Eurasian watermilfoil has not been reported in the Pike Lake Chain. However, if milfoil was to invade the Pike Chain, lake sediment analyses indicate potential milfoil growth would be light to moderate with the potential for heavy growth at only the south end of Pike Lake. Heavy milfoil growth has been correlated with high sediment nitrogen conditions and the Pike Lake Chain has mostly low to moderate nitrogen conditions.

For the Pike Lake Chain, it is estimated plants have the potential to grow down to at least 8 feet of water depth. For The Pike Lake Chain, there is the potential for Eurasian watermilfoil to cover an area of several hundred acres. However, results of the lake sediment survey show a much smaller lake area has sediment conditions conducive to heavy milfoil growth. It is estimated less than 10 acres of lake area has the potential to support heavy milfoil growth. Ongoing annual scouting activities are recommended.

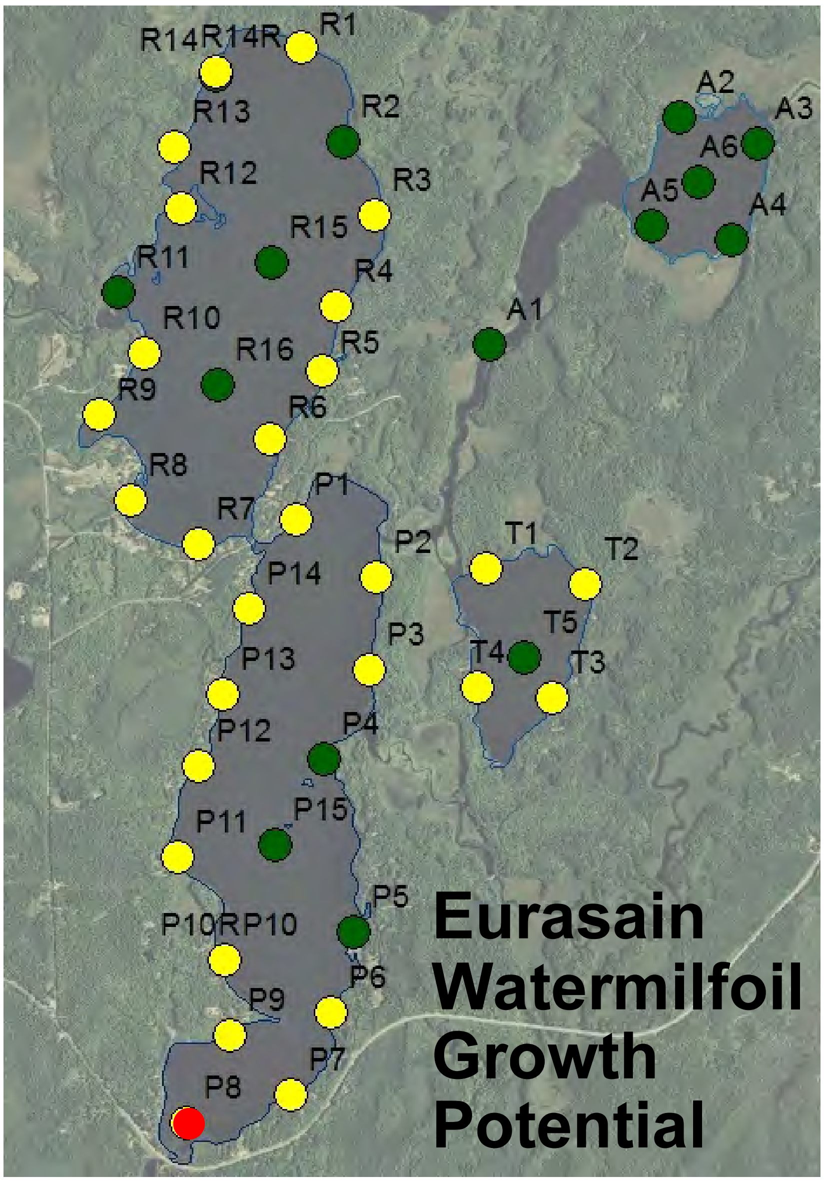


Figure 36. Indicates the type of Eurasian watermilfoil growth predicted to occur at that site. Key: green = light; yellow = moderate; red = heavy.

6. Lake Project Ideas for Protecting Water Quality and Wildlife

6.1. Ongoing Programs and New Project Ideas

1. Ongoing watershed stewardship.
2. Wetland nutrient management.
3. Aquatic invasive species management.
4. Aquatic plant management.
5. Fish management recommendations.
6. Water quality monitoring program.

6.1.1. Ongoing Watershed Stewardship

Protecting the natural character of the watershed helps maintain good runoff water quality and maintains the northwoods aesthetics.

Two important areas to address are:

1. Working with Price and Vilas Counties shoreland ordinances.
2. Educating new waterfront property owners on the value of shoreline habitat and good landscaping practice.

Figure 37. Map produced by a Lake Association board member showing no-wake and shallow areas.

Shoreland Development: Controls are in place at the county level to guide new shoreland development and redevelopment. Shoreland development guidelines are available from the county offices or even on-line. Price County has a progressive approach to protecting its natural resource assets. Existing shoreland ordinances if enforced, should project the lake environment in the future. Pike, Round, and Turner Lakes are in Price County. Amik Lake is in Vilas County.

Shoreland Buffers: The Pike Lake Chain has a high degree of natural vegetative buffers along the shoreline already in place. The challenge ahead will be to maintain those and even improve low quality buffers.

A shoreland inventory consisting of photographs of the Pike Lake Chain shorelands was conducted by the Association in 2001. This serves as reference for volunteers who may be interested in improving the natural conditions of their shoreland buffer. The shoreland inventory is available from the Lake Association secretary or president.

6.1.2. Wetland Nutrient Management

The wetland acreage in the Pike Chain of Lakes watershed is significant. The exact acreage was not determined in this study but wetland and forest acreage is the dominant land use category. Agricultural and residential development are minor land use components. The wetlands in the watershed are relatively unimpacted and in a natural condition. However, in some years they may contribute an above average phosphorus load to the lakes. The condition where extra nutrients are exported from wetlands occurs in a "wet" year (above average precipitation) following a "dry" year (below average precipitation). Extra phosphorus is flushed out of the wetlands and into the streams and eventually into the lakes. This is what occurred in 2010 and lake phosphorus levels were above average. This is basically a natural occurrence. No special wetland nutrient management projects are recommended at this time.

Figure 38. Extensive wetland acreage is present in the watershed. In a wet year coming off a dry year, extra nutrients will be flushed out of the wetlands.

6.1.3. Aquatic Invasive Species Management

Although the Pike Chain of Lakes has a couple of aquatic invasive species (AIS) and is surrounded by lakes with other AIS, the Pike Chain of Lakes are not adversely impacted with them at this time. An AIS assessment has been conducted and results indicate that the major AIS are not likely to create lake problems (Table 28). Because rusty crayfish are present in Turner Lake and may expand to other lakes, additional information on management approaches is given on the next page.

Table 28. Overview of seven aquatic invasive species that could impact The Pike Lake Chain are listed below. As of 2010, curlyleaf pondweed, Eurasian watermilfoil, and zebra mussels have not been observed in the Pike Lake Chain.

Species	Pike Lake Chain Status	Potential for Nuisance Colonization in the Pike Lake Chain	Management Action	
			Short Term	Long Term
Plants				
1. Curlyleaf pondweed	not in the Pike Lake Chain of Lakes	low to moderate	annual surveys by consultant or residents	selective treatment for nuisance growth conditions
2. Eurasian watermilfoil	not in the Pike Lake Chain of Lakes	low	annual surveys by consultant or residents	selective treatment for nuisance growth conditions
3. Purple loosestrife	in the area	moderate	annual surveys by residents	spot control and use of beetles for large area control
Invertebrate				
4. Zebra mussels	absent, but in Price County	moderate	mussel monitoring devices for early detection	contingency funds for aggressive rapid response
5. Rusty crayfish	present in Turner Lake	low to moderate	crayfish traps for early detection	use fish to control rusty crayfish
6. Chinese mystery snail	present in Pike Lake	moderate	no action needed	no action needed
Species to Watch				
7. VHS	absent	moderate to high	inform and educ	
8. Hydrilla	absent	low to moderate	inform and educ	

Rusty Crayfish Management: The rusty crayfish situation has been evaluated from a number of angles. The most cost-effective management approach is to "let nature take its course." A variety of control measures have been tried over the last 15 years. None have produced satisfactory control. What seems to happen over time are two naturally occurring controls. First, the crayfish actually eat themselves out of house and home. With a decline of weed beds, their food source is diminished, and this will limit their population. Secondly, fish learn how to attack and eat the feisty crayfish. Once the fish community learns how to overcome the threatening posture and slightly oversized pinchers, they will be dining on crayfish.

You can tell when fish are starting to have an impact because small crayfish will be eaten first, leaving only larger crayfish in the population. Pike Lake Chain is not at this stage yet.

Rusty crayfish could be a problem in the Pike Chain for 5 to 10 years with the possibility their population would decline after that. Then their population probably would resemble a native crayfish population . . . they would be present but not much of a problem.

There are two crayfish projects the Pike Lake Chain Association could consider. The first is to use fish to control the smaller crayfish. Yellow perch can be good crayfish predators. Catch and release tactics would be helpful. Signs and information materials could be distributed to lake residents and at public landings to encourage catch and release fishing. The idea is to maximize the impact of fish predation on crayfish.

The second project area is to set traps and remove crayfish. An example of a trap is shown in Figure 39. It would take a substantial effort for several years to have a significant impact.

For Pike Lake, initial trapping would indicate the severity of the problem. If it is a big problem, at least 200 traps should probably be set for 5 to 6 years. This may be a project area that Lake Association volunteers could participate in.

Figure 39. [left] Rusty crayfish can devastate plant beds. The Pike Lake Chain needs all the aquatic plants it can get.
[right] A funnel-shaped net fitted over a bucket with bait is an effective crayfish trapping device and could be used in the Pike Lake Chain.

6.1.4. Aquatic Plant Management

A high priority lake protection recommendation is to maintain healthy native aquatic plant communities in all four lakes, and increase plants in Pike and Round, if possible. Currently, all four lakes have a variety of emergent aquatic plant growth, but submerged plants are scattered in Pike and Round Lakes. In all four lakes, the aquatic plants are vital for helping sustain clear water conditions and contribute to fish habitat.

Emergent plants in the Pike Lake Chain are fairly common, and submerged plants in Amik are adequate. However, the challenge is to increase submerged aquatic plants in Round and Pike Lakes. Several plant improvement ideas are given below:

- determine if rusty crayfish are limiting aquatic plants.
- conduct a lake soil fertility survey to determine if soils can support plant growth. Sample areas with plants and areas without plants. If soil fertility is similar, then something other than nutrients are inhibiting plant growth.
- maintaining good shoreland conditions can promote improved plant distribution.

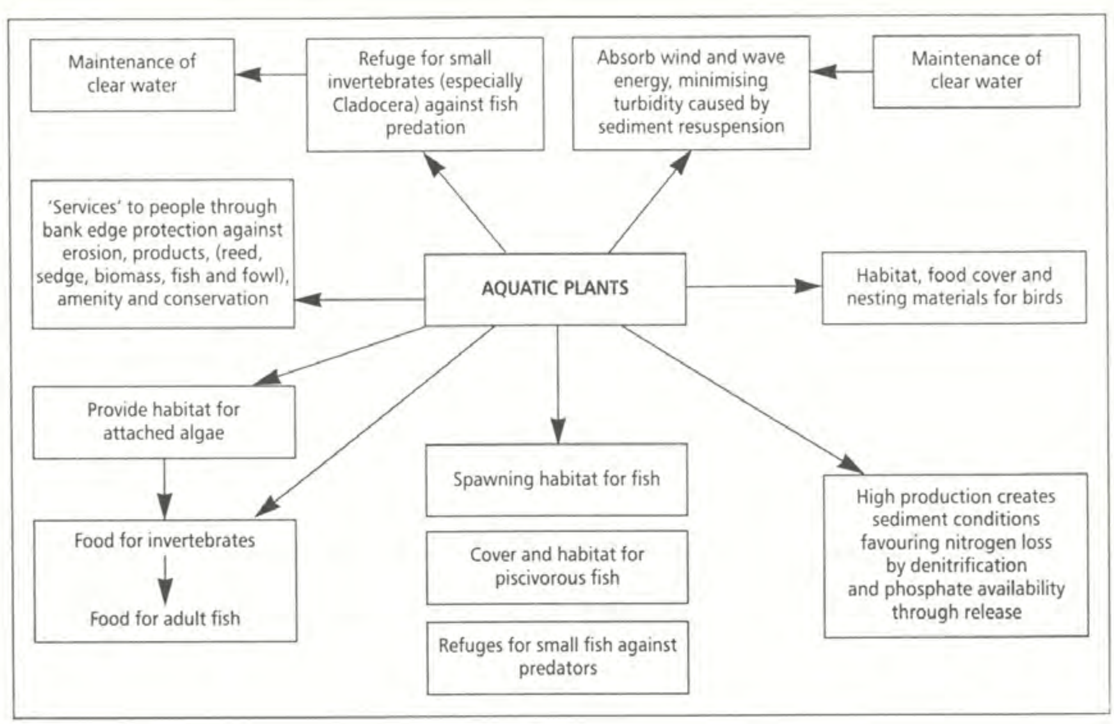


Figure 40. Links between aquatic plants and other organisms, including ourselves (source: Moss and others. 1996. A guide to the restoration of nutrient-enriched shallow lakes. Broads Authority Norwich, England).

6.1.5. Fish Management Recommendations

prepared by: Fisheries and Water Quality Committee, Dallas Helm, Chair, with comments in italics by Steve McComas

Planning program:

1. Continue Lake Programs as listed below for water quality sampling and analysis to increase the data base for the Pike Lake Chain. Program sampling as appropriate each year and implement using volunteers from the Pike Lake Chain.
   a. Continue Secchi disc clarity readings on all four lakes and incoming streams. This to include any satellite monitoring programs.
   b. Continue weekly lake level readings at the Thoroughfare Bridge.
   c. Expand monitoring programs to include creek mouths and checking for variations with in the lake system.
   d. Continue some program for checking dissolved oxygen, esp., winter months.
   e. Continue monthly temperature profile readings. (*this is optional and would be good if the labor is available*)
   f. Do phosphorus and chlorophyll readings as funding is available.
2. Continue working with the DNR and U.S. Forest Service to place fish cribs in the Price Co. lakes. Investigate the use of partial height cribs in Turner Lake as max. depth is 13'. My conversation with the DNR indicated we need 4' over the top of the crib after placement. Obtain crib materials as required to assist the U.S. Forest Service, i.e. blocks, brush, property permission for building cribs. Continue monitoring cribs for content, ie., brush, integrity, etc. (*cribs are not a high priority for Turner. Panfish catch rates are the highest on the Chain. Rather, work to improve aquatic plant conditions*)
3. Be on the lookout for studies on stirring and mixing of sediment by outboard motors or other watercraft. This relates to shallow water running of boats in lakes, channels, and weed beds (motor trolling) that might be detrimental. (*Information in Lake and Pond Management Guidebook indicates Turner is susceptible to sediment resuspension by boats*)
4. Keep abreast of DNR fish and forage stockings programs in area lakes, esp., our lakes. Assist DNR with the scatter placement of stocked fish as agreeable with the DNR. Obtain fish surveys, stocking and shocking reports from the DNR. Record all data and send to file. Be aware of any fish tracking programs that are implemented.
5. Maintain and improve DNR and Forest Service relationships and continue sharing of information between us and the appropriate departments. This includes sending copies of all data collected on our lake system. This is the responsibility of the Chair of the Committee.
6. Continue to share committee obtained data with the membership of the Lake Association and put all data in central file for future reference. At the current time all data is given to the Secretary file.
7. Continue program of monitoring loon nesting and chick hatch for the Loon Watch Association in Ashland, Wisconsin. Investigate enhancing and implementing Loon nesting sights on all four lakes and incoming streams. Continue the protection of the osprey nest on Pike Lake, if applicable. Monitor all birds, sea gulls, ducks, geese, eagles, cormorants, etc., and notify appropriate DNR Dept's of any problems.
8. Keep abreast of local and professional fishing tournaments in the lakes.
9. Implement a program for monitoring incoming streams for beaver dams. Establish a procedure for communicating this information to appropriate local departments of DNR.
10. Investigate the replacement or restoration of roller dams on the Flambeau River. Not sure this falls within our committee responsibility, but put in for record.
11. We have a situation where decayed weeds are occurring on rock bars, mostly on Pike Lake. Why are the weeds dying? *It could be that natural, aquatic plant beds expand and contract, depending on many factors including lake levels and water clarity. I am hoping it's not rusty crayfish doing the damage. Generally, when water clarity improves for a year or two, aquatic plants respond with*

better growth.

12. Keep abreast of DNR fish size and limits on the Pike Lake chain.
13. There used to be lots of schools of small catfish or willow cats in the shallow water and a large population of crabs in the lake system, both of which seem to have diminished. Why? *Catfish year classes may not be as successful as they once were. These waters are marginal for catfish. (Fortunately . . . it looks like there are plenty of other options for anglers.)*

6.1.6. Water Quality Monitoring Program

A lake monitoring program is outlined in Table 29. It is designed to be flexible to accommodate the volunteer work force and a fluctuating budget.

Table 29. BIWB Water Quality Monitoring Program

Category	Level	Alternative	Labor Needed	Cost/Year
A. Dissolved oxygen	1	Check dissolved oxygen at Amik, Turner, Pike, and Round every two weeks in December, January, February, and March depending on winter conditions.	Moderate	$0
	2	Check dissolved oxygen at Amik and Turner outlet and Pike outlet every one to two weeks in December, January, February, and March, depending on winter conditions.	Moderate	$0
	3	Collect dissolved oxygen and temperature profiles in all three lakes, once or twice a month from May-September.	Moderate	$0
B. Water clarity	1	Secchi disc taken at spring and fall turnover.	Low	$0
	2	Secchi disc monitoring once per month May - October for all four lakes.	Low-moderate	$0
	3	Secchi disc monitoring twice per month, May - October for all four lakes.	Moderate	$0
C. Water chemistry	1	Sample all four lakes for phosphorus and chlorophyll once per month from May - September (surface water only).	Low-moderate	$800
	2	Sample all four lakes for phosphorus and chlorophyll twice per month from May - October.	Moderate	$1,600
	3	Sample all four lakes for phosphorus, chlorophyll, Kjeldahl-N, nitrate-nitrite-N, and ammonia-N once per month (May-October)	Moderate	$960
	4	Sample all four lakes for phosphorus, chlorophyll, Kjeldahl-N, nitrate-nitrite-N, and ammonia-N twice per month (May-October).	Moderate	$1,920
D. Special samples	1	Special samples: suspended solids, BOD, chloride, turbidity, sampling bottom water, and other parameters as appropriate.	--	$50+

A recommended program consists of Levels A1, B3, and C2 or C3 depending on the available budget.

TECHNICAL APPENDIX

1. Summary of Available Lake Information
   1.1. Dissolved oxygen and temperature profiles
   1.2. Citizen questionnaire survey results

Other reports that have been completed but are not in the appendix include the following:

- 2003. Lake Management Plan
- 2003. Pike Chain Shoreland Inventory
- 2012. AIS Assessment
- 2012. Sediment Survey
- 2012. Lake Management Plan Updated
- 2012. Aquatic Plant Survey for 2010

1. Summary of Available Lake Information

Historical Highlights

Glaciers and Soils: The Pike Lake Chain of Lakes was formed approximately 10,000 years ago during the last glacial retreat of the Chippewa glacial lobe (Figure A-1). The soils deposited by the Chippewa Lobe glacier were primarily sands and loamy-sands. Beneath these soils, at depths of about 50-350 feet, is Precambrian bedrock that is over one billion years old. The bedrock is referred to as the North American shield.

In glacial outwash areas, it is hard to predict what kind of material will be deposited. Apparently, in Round Lake a variety of rock sizes were left behind including small and large boulders. Many of these were of glacial origin.

These rocks are not to be confused with the rock pile used to anchor the log booms during the logging era.

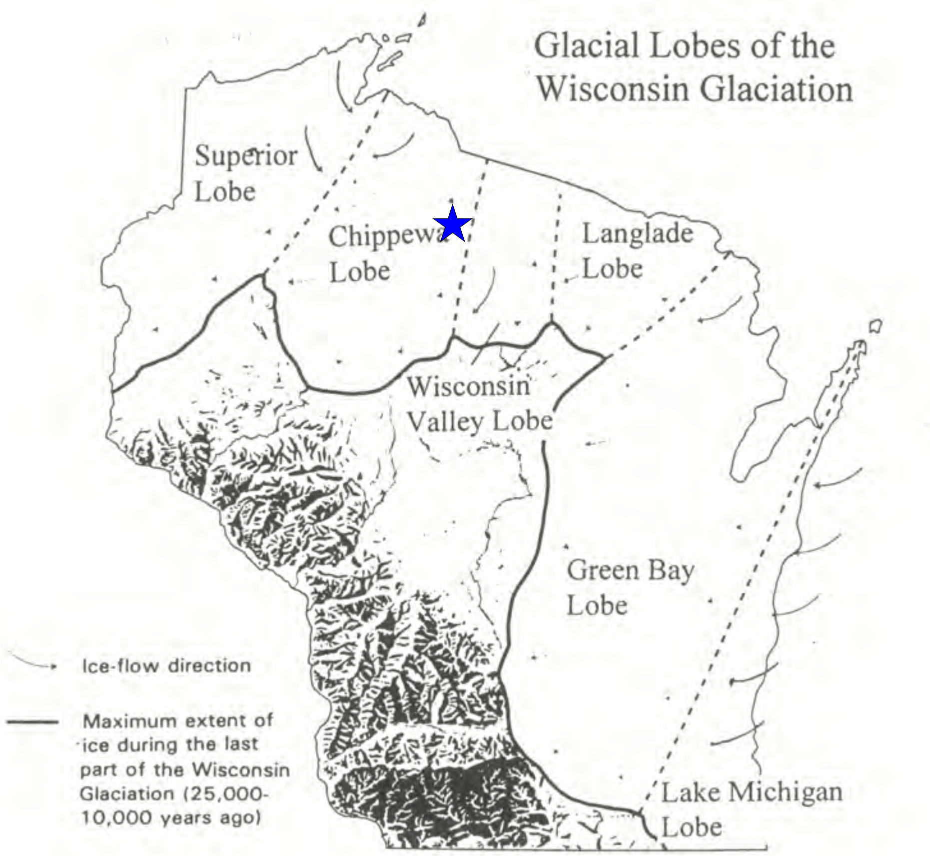


Figure A-1 . Glacial lobes of the Wisconsin glaciation. The Pike Lake Chain of Lakes is located in the Chippewa lobe.

The soils in the Pike Lake Chain sit on top of glacial sands and are some of the most acid (pH 5.5) and have some of the highest available phosphorus (138 lbs/acre) of any soil in Wisconsin. The Pike Lake Chain of Lakes rests in Soils Group (21) referred to as the Vilas, Omega, Pence group. A soil regions map of Wisconsin is shown in Figure A-2.

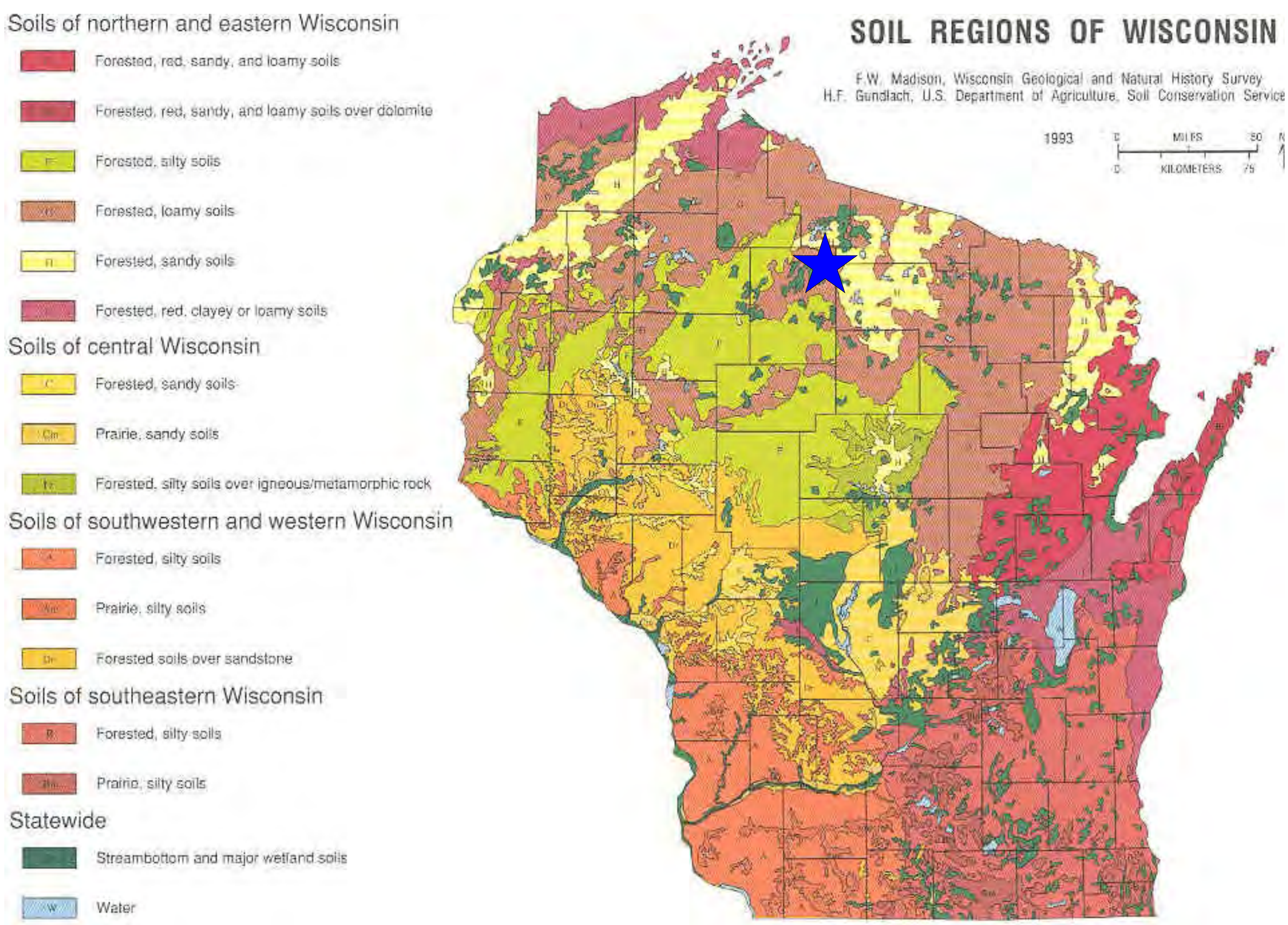


Figure A-2. Pike Lake Chain of Lakes is located in a depression in soil groups that is categorized as forested loamy soils.

Streams that Flow into the Pike Lake Chain

Figure A-3. Foulds Creek - April 2001. The creek flows north into Pike Lake with a relatively high flow in spring.

Figure A-4. Fould's Creek - September 2001. In the fall, the flow in Foulds Creek is low. The average flow annual flow is estimated at 14 cubic feet per second.

Figure A-5. Squaw Creek is a major inflow to Pike Lake.

1.1. Dissolved oxygen and temperature profiles

Dissolved oxygen and temperature measurements reveal several things about a lake. If oxygen is absent in the bottom of the lake, phosphorus can be released from the lake sediments. If the temperature is the same from the top to the bottom of the lake in the open water season, all the water will mix. If oxygen is depleted over the winter, winterkill can occur. Examples of dissolved oxygen and temperature profiles are shown in Figure A-6.

Winter oxygen levels can be low in the bottom water of all four lakes. However oxygen is present in the upper water column. In summer, the lakes are well mixed and oxygen is present throughout the summer.

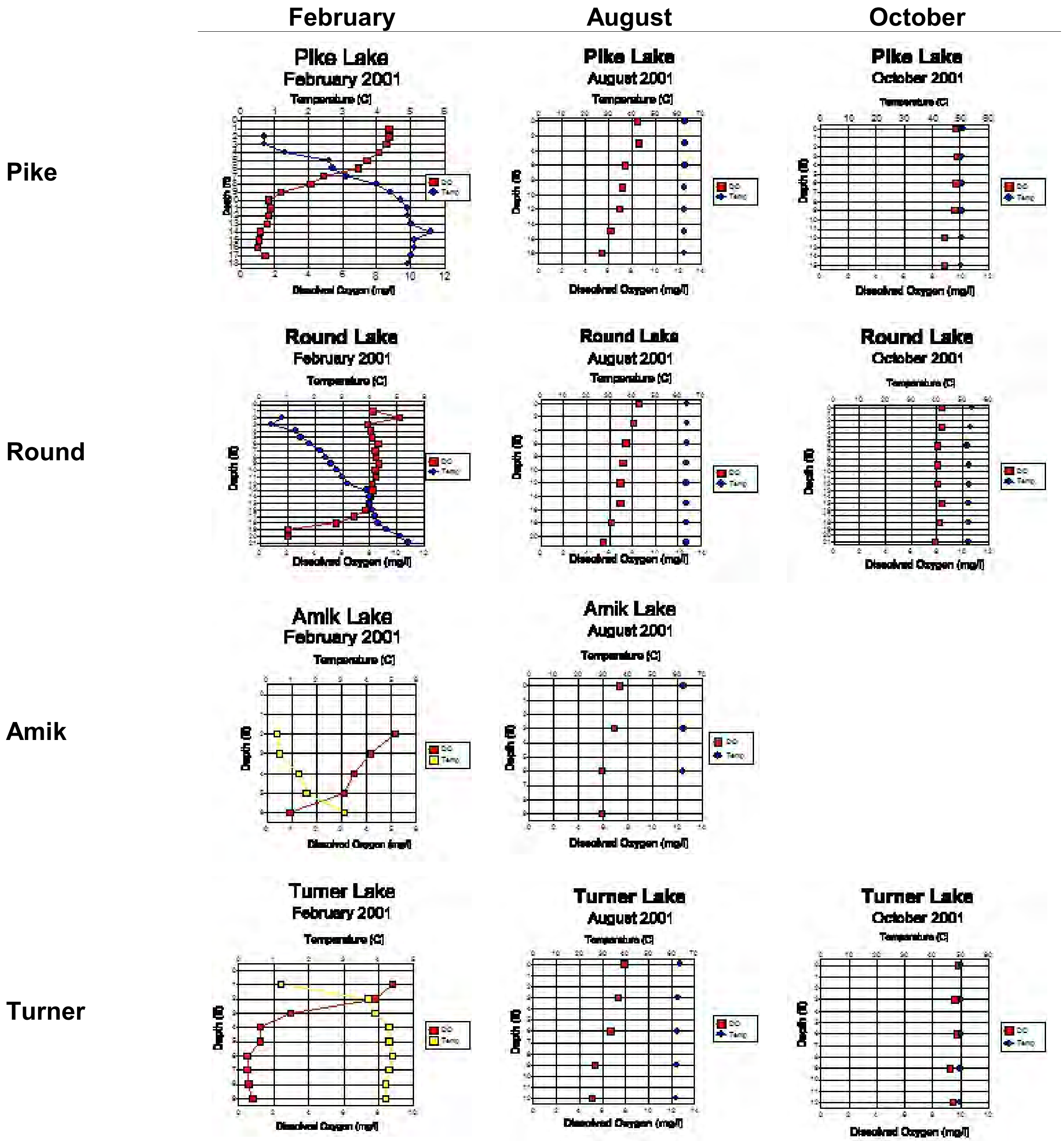


Figure A-6. Dissolved oxygen/temperature profiles for Pike, Round, and Amik and Turner Lakes.

1.2. Citizen questionnaire survey results

(prepared by Pike Lake Chain of Lakes Association, 1/15/02)

Introduction

In 2001 the Pike Lake Chain Lakes Association, Inc. received a Lakes Planning Grant from the Wisconsin Department of Natural Resources. The planning grant's primary goal was to establish, for the chain, a comprehensive set of base line data. This comprehensive data would allow the association to measure future changes to the chain of lakes. One of the specified requirements of the planning grant was to obtain a survey of riparian landowners, concerning their feelings on general areas of interest, fishing and boating activities, and activities of the association.

The survey was developed by the association board and mailed to 285 riparian landowners of the Pike Lake chain, as well as members of the association that did not own land on water. The survey was mailed in the summer of 2001. Responses were requested to be returned by September 15th of 2001. Of the 285 surveys mailed we had a return of 175 surveys, or a 61.4% response. With this high rate of return, we believe we have an excellent participation for surveys of this type, which shows an interest in the information requested. Where applicable, the results of this survey will be compared to the survey that was made by the Land Conservation Department of Price County in 2000. We believe that the results of the survey also indicate that the riparian landowners of the chain have a real concern for the water quality and well-being of our chain for today and the future.

The results of the survey will also be helpful in directing the board of the Pike Lake Chain, in addressing the feelings, perceptions and wishes of the riparian landowners. The survey results, along with all the other activities provided for by the grant, will help the association develop short and long range plans for the continued preservation of the quality of our lake chain.

Summary of Responses

Of the 175 survey results obtained, 97 or 55.3% were received from residents of Pike Lake. Of the remaining surveys, 36 or 20.6% came from Round Lake, 19 or 10.6% from Turner Lake, 12 or 6.7% from Amik Lake, 7 or 4% from residents of creeks and rivers, and 4 or 2.3% from residents located off water. The results are consistent with the number of riparian properties owned on each lake in the chain.

Respondents indicated that the two top reasons for purchase of their property were for the appreciation, peace and tranquillity of the area and for hunting and fishing. These results are consistent with the data received in the Price County survey, as well as most other lakes and rivers in the state. The respondents of our survey differed slightly from the Price County survey, in that they placed “water sports” and “entertaining friends and relatives” as their third and fourth reasons for property purchase. The Price County survey placed “observing wildlife” as the third selection and “entertaining friends and relatives” along with holding property for appreciation in value as a tie for fourth choice. The choice of “water sports” was well down the list of choices in the Price County survey.

As was expected most respondents did not feel that, as of today, we were experiencing heavy use of the lake chain , or that we were experiencing major problems with conflicts of use. The respondents also feel that the present placement of “no wake” buoys are correct and adequate for our lake system. They also feel that our present “water skiing” hours are acceptable, and they would like to have a town ordinance established to require the use of PWCs (personal water craft) to conform to the same restrictions as water skiing.

Our respondents also feel that our fish stocking activities by the DNR are adequate, and that we should continue the placement of cribs in Pike and Round lakes. If there is no liability to the association, they would like the placement of cribs to be extended to Turner and Amik lakes. Our respondents also do not favor the use of our chain by any major fishing tournaments. On the issue of local fishing tournaments, the results indicate about a 50 - 50 split in the support of this tournament activity.

Results also indicate that the riparian landowners on the chain are only somewhat familiar with existing regulations relating to shoreland property ownership. This is also supported by a request of the majority of respondents to have the association provide timely information on water related issues. As to other association activities, a majority of respondents want us to keep the association annual meeting as the Sunday in the Memorial Day weekend. There is about a 50 - 50 split on whether the annual meeting should also include a social gathering.

*(**Note:** Since not all questions were answered by all respondents, we have elected to use percentages in reporting results, rather than number totals.)*

Question IA. How do you rank these factors in order of importance as reasons for purchasing your property ?

A. Appreciating peace and quiet.
B. Hunting and fishing.
C. Entertaining friends and relations.
D. Holding property for appreciation.
E. Water sports.
F. Other.

1st Choice.

	Total Chain	Pike Lake	Round Lake	Turner Lake	Amik Lake	Other
A.	60.9%	61.3%	59.3%	65.0%	63.6%	55.6%
B.	25.4%	29.0%	19.5%	25.0%	27.3%	11.1%
C.	3.0%	2.2%	8.3%			
D.	2.4%	3.2%			9.1%	
E.	5.9%	4.3%	11.1%	10.0%		
F.	2.4%		2.8%			33.3%

Question IB. How would you rate boat traffic on your lake?

NORMAL USE.

Total chain.	
Light use	73.2%
Moderate use	26.8%
Heavy use	0.0%

Question ID - 1. Do you believe that Price County should require all septic systems to be pumped every three years regardless of age?

	Total chain	Pike Lake	Round Lake	Turner Lake	Amik Lake	Other
Yes	55.6%	61.4%	46.3%	47.4%	45.5%	70.0%
No	44.4%	38.6%	53.7%	52.6%	54.5%	30.0%

Comments: If used year round; If new every 5 years, if old every 3 years.

Question ID - 2. If the association could obtain a special price for septic tank pumping, through a formal bid process, would you subscribe to the service?

	Total Chain	Pike Lake	Round Lake	Turner Lake	Amik Lake	Other
Yes	75.2%	76.2%	79.3%	73.7%	63.6%	60.0%
No	24.8%	23.8%	20.7%	26.3%	36.4%	40.0%

Comments: If it was the most reasonable.

Question ID - 3. Are you aware of existing regulations relating to shoreland ownership?

A. Shoreland Zoning

	Total chain	Pike Lake	Round Lake	Turner Lake	Amik Lake	Other
Familiar	33.6%	29.7%	26.9%	47.4%	45.5%	50.0%
Somewhat	46.8%	50.5%	46.2%	42.1%	54.5%	10.0%
Not Familiar	19.6%	19.8%	26.9%	10.5%	0.0%	40.0%

B. Sanitary Ordinances

	Total chain	Pike Lake	Round Lake	Turner Lake	Amik Lake	Other
Familiar	36.4%	33.7%	25.0%	52.6%	63.6%	40.0%
Somewhat	46.9%	49.4%	59.4%	31.6%	27.3%	30.0%
Not Familiar	16.7%	16.9%	15.6%	15.8%	9.1%	

F. Boating Regulations and Ordinances.

	Total chain	Pike Lake	Round Lake	Turner Lake	Amik Lake	Other
Familiar	72.1%	72.6%	77.4%	84.2%	40.0%	60.0%
Somewhat	24.0%	25.0%	19.4%	15.8%	60.0%	10.0%
Not Familiar	3.9%	2.4%	3.2%	0.0%	0.0%	30.0%

SECTION II FISHING & BOATING

Question IIA. The DNR provides stocking of fish in our lake system, with approximately 85,000 walleye fry being stocked on even years and approximately 2,000 musky fingerlings being stocked on odd years.

1. Do you believe this is an adequate stocking program ?

Total chain.
Yes - 65.5%
No - 34.5%

	Pike lake.	Round lake.	Turner lake.	Amik lake.	Other.
Yes. -	59.3%	79.1%	20.0%	90.9%	80.0%
No. -	40.7%	20.9%	80.0%	9.1%	20.0%

2. Do you believe walleye stocking should ?

Total chain.
Stay the same. - 45.4%
Increase. - 50.9%
Decrease. - 3.7%

3. Do you believe that musky stocking should?

Total chain.
Stay the same. - 60.3%
Increase. - 21.7%
Decrease. - 18.0%

4. Do you believe that all stocking should stop and the system revert to natural reproduction?

Total chain.
Yes. - 7.7%
No. - 92.3%

Question II B. Do you believe that the 34 in. limit on musky is adequate to manage the system?

Total chain.
Yes. - 54.5%
No. - 7.3%
No opinion. - 24.7%
Go to Trophy
Size. - 13.5%

Question II C. Fish cribs have been used by the DNR to improve fishing opportunities and to enhance deep water habitat. Fish cribs have been placed in Round and Pike lakes only.

1. Do you believe this should continue ?

	Total chain.
Yes. -	87.6%
No. -	12.4%

2. If there is no liability to the association, should cribs be placed in Turner & Amik lakes as well ?

	Total chain.
Yes. -	72.9%
No. -	27.1%

Question II D. Our lake chain has not been used very much for big fishing tournaments. In recent years we have had local fishing tournaments only.

1. Do you favor encouraging major fishing tournaments for the future ?

	Total chain.
Yes. -	5.9%
No. -	94.1%

2. Do you favor encouraging local fishing tournaments for the future ?

	Total chain.
Yes. -	52.0%
No. -	48.0%

	Pike lake.	Round lake.	Turner lake.	Amik lake.	Other.
Yes. -	52.7%	56.8%	45.0%	41.7%	50.0%
No. -	47.3%	43.2%	55.0%	58.3%	50.0%

Comments. As long as catch & release; Keep it no more than present.

Question II E. "No wake" zones have been established by town ordinance at the entrance to Squaw creek, at the passage between Round & Pike lakes, and a portion of Rice creek as it enters Pike lake.

1. Do you believe these are adequate markings ?

	Total chain.
Yes. -	85.8%
No. -	14.2%

2. Do you believe these "no wake" zones should be expanded ?

	Total chain.
Yes. -	18.5%
No. -	81.5%

	Pike lake.	Round lake.	Tuner lake.	Amik lake.	Other.
Yes. -	11.6%	18.4%	28.6%	33.3%	40.0%
No. -	88.4%	81.6%	71.4%	66.7%	60.0%

2a. If you believe that "no wake" zones should be expanded, where should this expansion occur ?

All of Squaw creek. Boat landings.
More of Rice creek. All the way up Rice creek.
Further into Pike from Thorofare bridge. Further into lakes at all locations.
Add more buoys. Major weed beds.
Along all lake shores. Further out from dam.
Sensitive lake front areas. Wherever shoreline damaged.

Question II G. Do you believe that Personal Watercraft (PWC's) should be included in restricted hours, rather than as allowed by State regulations from sunrise to sunset?

	Total chain.
Yes. -	82.5%
No. -	17.5%

a. If you believe that restricted hours should be established, what should they be ?

Ban PWC's from the chain. 6.6%

Question II H. Do you believe that we have adequate enforcement of State and Town fishing and boating regulation and ordinances?

	Entire chain.
Very good. -	12.3%
Good. -	40.3%
Fair. -	16.4%
Poor. -	21.6%
Non existent. -	9.4%

SECTION III - EDUCATION

Question III A. I would like the association to provide timely information on state and county issues that may affect our lakes and streams?

	Entire chain.
Yes. -	92.4%
No. -	7.6%

Comment. I think you are doing a fine job; The county has always notified us in the past; Information perhaps once in awhile.

Question III B. I would like educational materials / information to be provided in the form of - (List in order of preference).

	1st. place vote.	2nd. place vote.	3rd. place vote.
Pamphlets. -	77.9%	11.1%	13.3%
Speakers. -	13.8%	62.2%	33.3%
Seminars. -	8.3%	26.7%	53.4%

Comment. Speakers or seminars are equal in value.