Smith Lake 18-0028-00 CROW WING COUNTY

Lake Water Quality

Summary

Smith Lake is located 4 miles south of Garrison, MN in Crow Wing County. It is less than a mile from the western shore of Lake Mille Lacs.

Smith Lake has three inlets and one outlet, which classify it as a drainage lake. The inlets enter the lake from the west, north and east. The outlet drains south and goes through Holt Lake before draining into Lake Mille Lacs.

Water quality data have been collected on Smith Lake since 1990 (Tables 2 & 3). These data show that the lake is mesotrophic, which is characteristic of moderately clear water throughout the summer and excellent recreational opportunities.

Table 1. Smith Lake location and key physical characteristics.

Location Data		Physical Characteristics	
MN Lake ID:	18-0028-00	Surface area (acres):	480 acres
County:	CROW WING	Littoral area (acres):	181 acres
Ecoregion:	Northern Lakes & Forests	% Littoral area:	37%
Major Drainage Basin:		Max depth (ft), (m):	54, 16.4
Latitude/Longitude:		Inlets:	3
Invasive Species:	None	Outlets:	1
		Public Accesses:	None

Table 2. Availability of primary data types for Smith Lake.

Data Availability

Transparency data		Good data set through the Citizen Lake Monitoring Program.
Chemical data		Sufficient phosphorus and chlorophyll a data from MPCA assessment (2 years), but not enough for trend analysis.
Inlet/Outlet data		No inlet data exist for Smith Lake. There are three data points for the outlet taken in 2010.

Recommendations **For recommendations refer to page 19.**

Lake Map

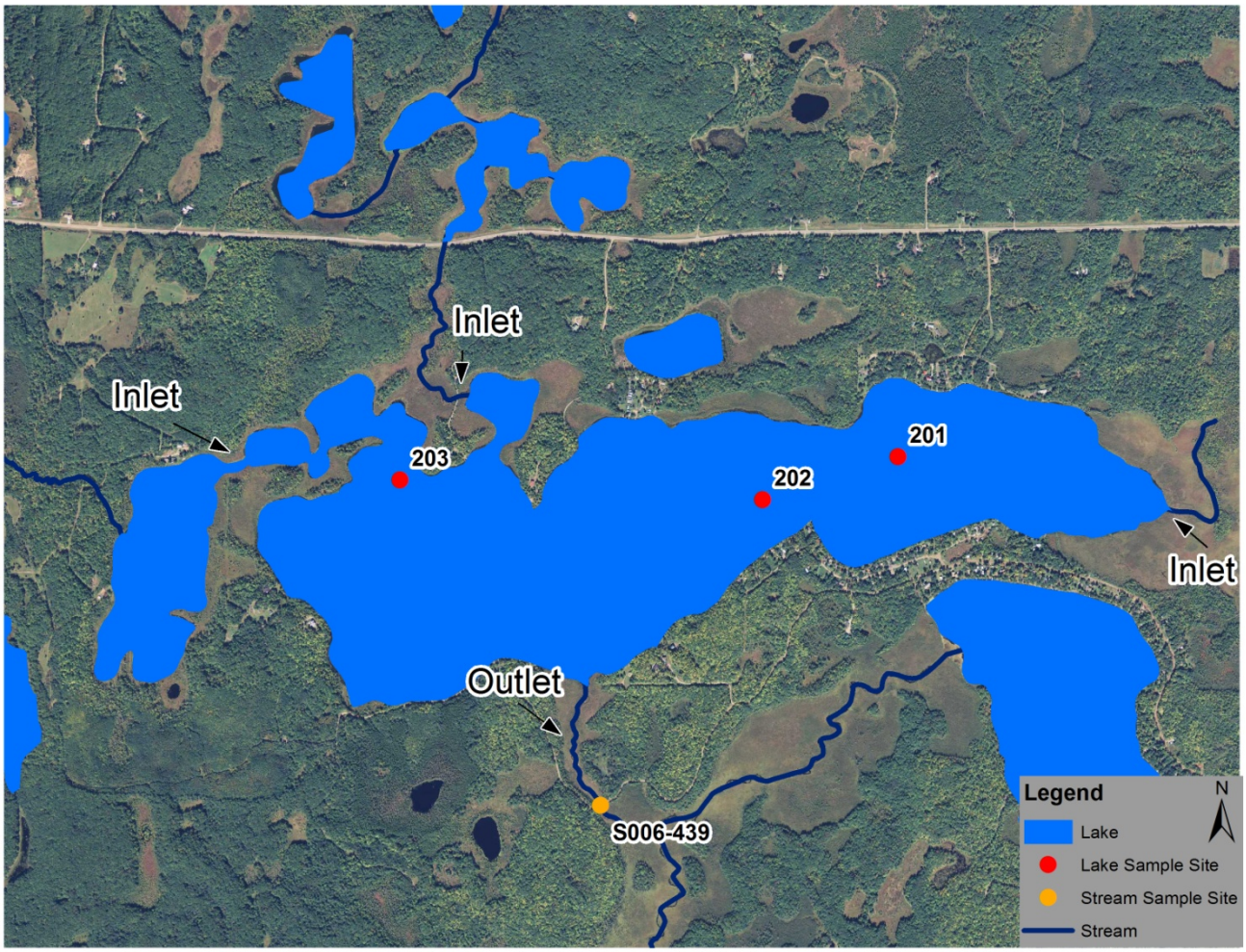


Figure 1. Map of Smith Lake illustrating lake sample site locations, stream inlets and outlets and 2010 aerial land use.

Table 3. Monitoring programs and associated monitoring sites. (CLMP: Citizens Lake Monitoring Program; OCLM: Outdoor Corps Lake Monitoring; MPCA: Minnesota Pollution Control Agency)

Lake Site	Depth (ft)	Monitoring Programs
201	18	CLMP: 1990-1999, 2002-2009; OCLM: 2004
202*primary	40	CLMP: 2000-2011; OCLM: 2001; MPCA: 2002
203	30	CLMP: 2002-2009

Average Water Quality Statistics

The information below describes available chemical data for the primary site (202) of Smith Lake through 2002 (Table 4). The data set is limited, and all parameters with the exception of total phosphorus, chlorophyll *a* and secchi depth, are means for just 2002 data.

Minnesota is divided into 7 ecoregions based on land use, vegetation, precipitation and geology. The MPCA has developed a way to determine the "average range" of water quality expected for lakes in each ecoregion. For more information on ecoregions and expected water quality ranges, see page 11.

Table 4. Water quality means compared to ecoregion ranges and impaired waters standard.

Parameter	Mean	Ecoregion Range[1]	Impaired Waters Standard[2]	Interpretation
Total phosphorus (ug/L)	18	14 - 27	> 30	Results are within the expected range for the ecoregion.
[3]Chlorophyll *a* (ug/L)	6	4 - 10	> 9	
Chlorophyll *a* max (ug/L)	10	<15		
Secchi depth (ft)	10.8	7.5 - 15	< 6.5	
Dissolved oxygen	Dimictic *See page 8*			Dissolved oxygen depth profiles show that the deep areas of the lake are anoxic in late summer.
Total Kjeldahl Nitrogen (mg/L)	0.53	0.4 - 0.75		Indicates insufficient nitrogen to support summer nitrogen-induced algae blooms.
Alkalinity (mg/L)	120	40 - 140		Indicates a low sensitivity to acid rain and a good buffering capacity.
Color (Pt-Co Units)	10	10 - 35		Indicates clear water with little to no tannins (brown stain).
pH	8.4	7.2 - 8.3		Indicates a hardwater lake. Lake water pH less than 6.5 can affect fish spawning and the solubility of metals in the water.
Chloride (mg/L)	2.0	0.6 - 1.2		Slightly higher than the expected range for the ecoregion, but still considered low level.
Total Suspended Solids (mg/L)	2	<1 - 2		Indicates low suspended solids and clear water.
Specific Conductance (umhos/cm)	224	50 - 250		Within the expected range for the ecoregion.
Total Nitrogen :Total Phosphorus	29:1	25:1 – 35:1		Indicates the lake is phosphorus limited, which means that algae growth is limited by the amount of phosphorus in the lake.

[1]The ecoregion range is the 25th-75th percentile of summer means from ecoregion reference lakes
[2]For further information regarding the Impaired Waters Assessment program, refer to http://www.pca.state.mn.us/water/tmdl/index.html
[3]Chlorophyll *a* measurements have been corrected for pheophytin
Units: 1 mg/L (ppm) = 1,000 ug/L (ppb)

Water Quality Characteristics - Historical Means and Ranges

Table 5. Water quality means and ranges for primary sites.

Parameters	Primary Site 202	Site 201	Site 203
Total Phosphorus Mean (ug/L):	**18**		
Total Phosphorus Min:	12		
Total Phosphorus Max:	40		
Number of Observations:	15		
Chlorophyll *a* Mean (ug/L):	**6**		
Chlorophyll-a Min:	3		
Chlorophyll-a Max:	10		
Number of Observations:	15		
Secchi Depth Mean (ft):	**10.8**	**10.6**	**10.7**
Secchi Depth Min:	7.0	7.0	6.0
Secchi Depth Max:	16.1	16.1	15.0
Number of Observations:	244	191	92

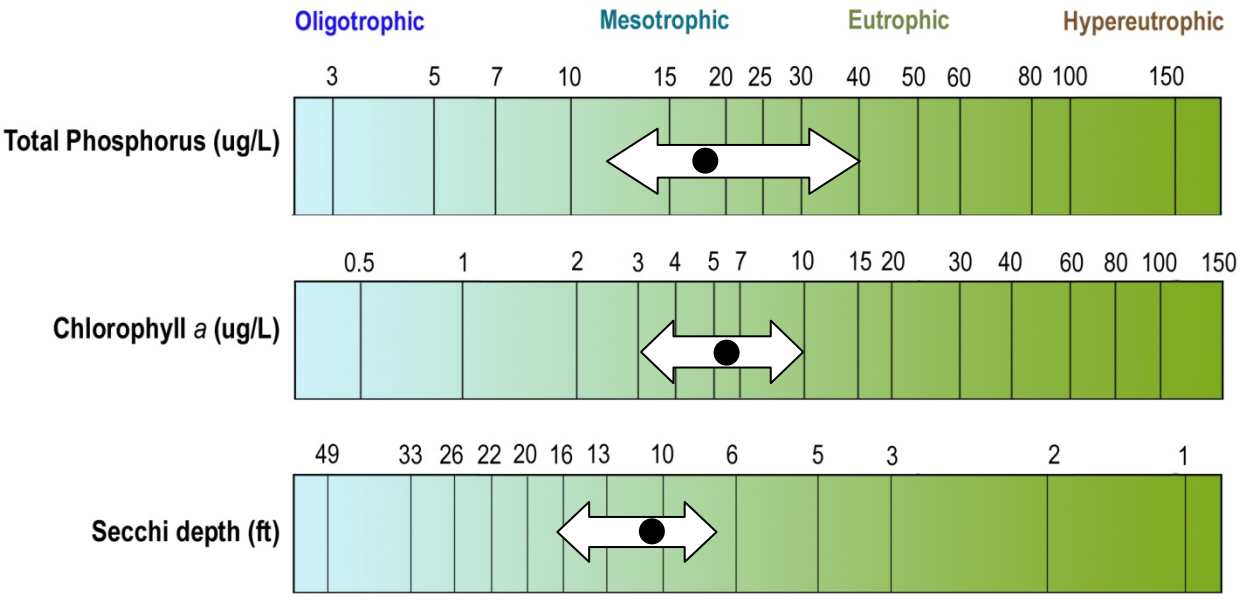


Figure 2. Smith Lake total phosphorus, chlorophyll *a* and transparency historical ranges. The arrow represents the range and the black dot represents the historical mean (Primary Site 202). Figure adapted after Moore and Thornton, [Ed.]. 1988. Lake and Reservoir Restoration Guidance Manual. (Doc. No. EPA 440/5-88-002)

Transparency (Secchi Depth)

Transparency is how easily light can pass through a substance. In lakes it is how deep sunlight penetrates through the water. Plants and algae need sunlight to grow, so they are only able to grow in areas of lakes where the sun penetrates. Water transparency depends on the amount of particles in the water. An increase in particulates results in a decrease in transparency. The transparency varies year to year due to changes in weather, precipitation, lake use, flooding, temperature, lake levels, etc.

The annual mean transparency for Smith Lake ranges from 8 to 12.2 feet. The transparency throughout the lake appears to be relatively uniform, with the best transparency occurring at the deeper sites in the lake (sites 202 and 203).

Transparency monitoring should be continued annually in order to track water quality changes.

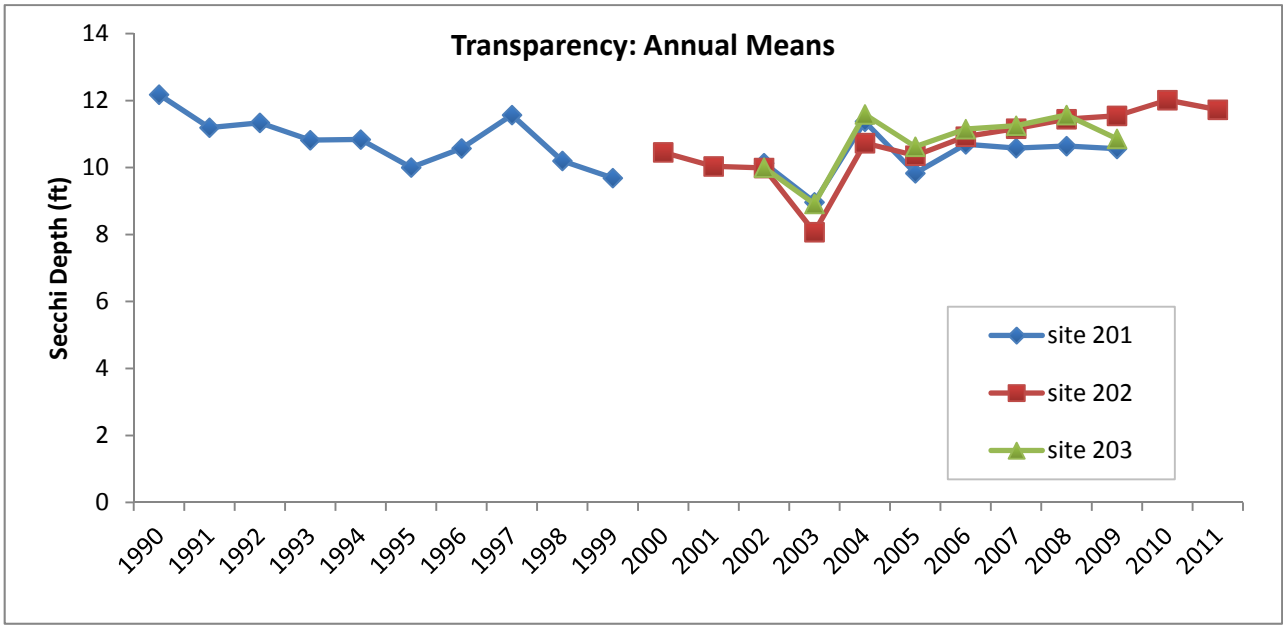


Figure 3. Annual mean transparency comparing all three sites.

Smith Lake transparency ranges from 7 to 16 ft at the primary site (202). Figure 4 shows the seasonal transparency dynamics. The transparency in Smith Lake stays relatively steady all summer. Some lakes vary a lot in the summer and some do not. The dynamics have to do with algae and zooplankton population dynamics, and lake turnover.

It is important for lake residents to understand the seasonal transparency dynamics in their lake so that they are not worried about why their transparency is lower in August than it is in June. It is typical for a lake to vary in transparency throughout the summer.

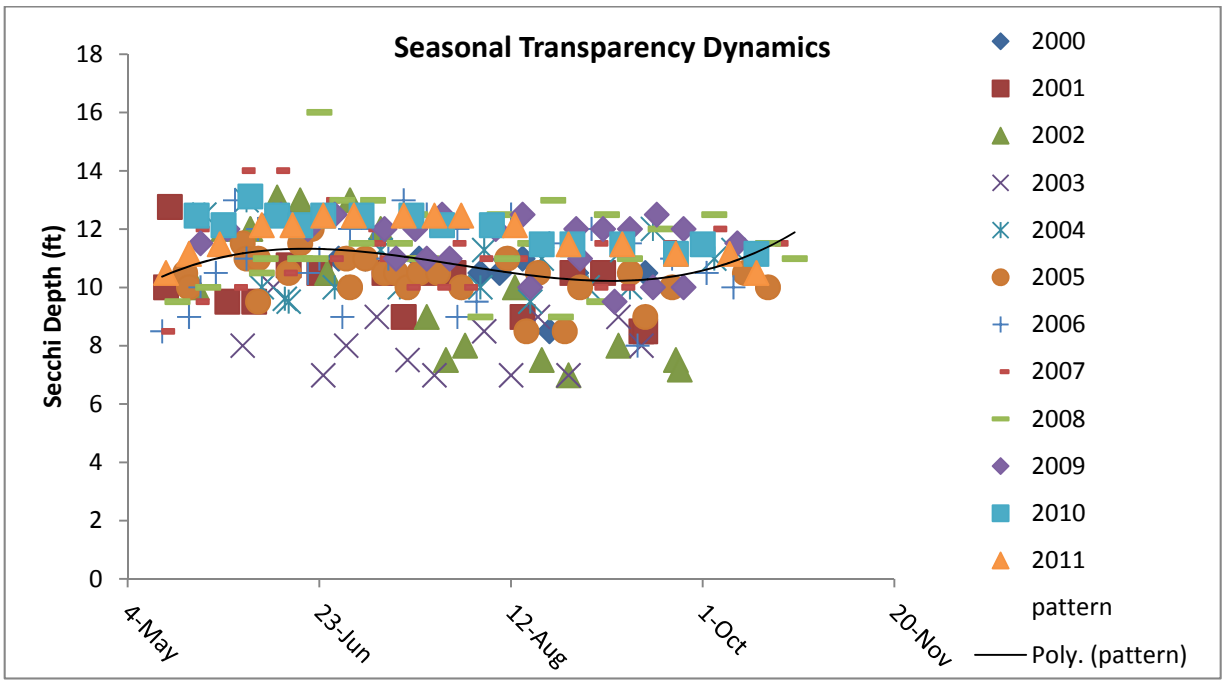


Figure 4. Seasonal transparency dynamics and year to year comparison (Primary Site 205). The black line represents the pattern in the data.

User Perceptions

When volunteers collect secchi depth readings, they record their perceptions of the water based on the physical appearance and the recreational suitability. These perceptions can be compared to water quality parameters to see how the lake "user" would experience the lake at that time. Looking at transparency data, as the secchi depth decreases the perception of the lake's physical appearance rating decreases. Smith Lake was rated as being "crystal clear" 74% of the time between 2000-2011.

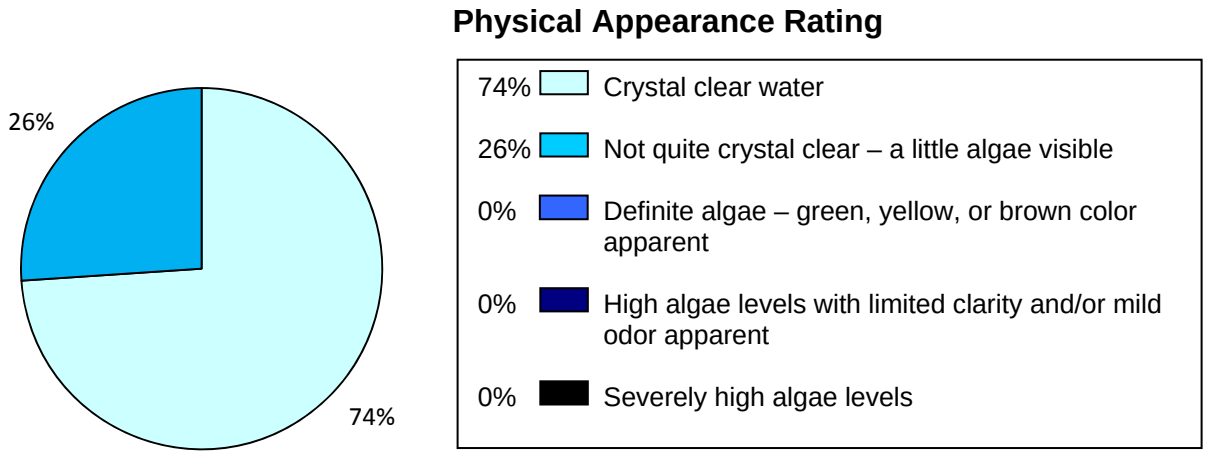
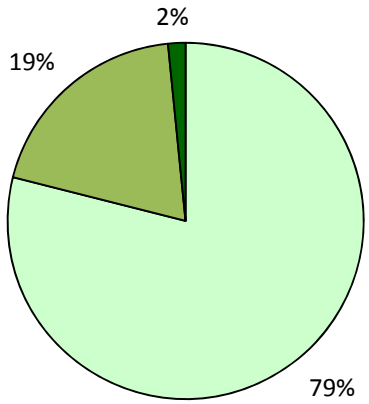


Figure 5. Physical appearance rating, as rated by the volunteer monitor (2000-2011).

As the secchi depth decreases, the perception of recreational suitability of the lake decreases. Smith Lake was rated as being "beautiful" 79% of the time from 2000-2011.



Recreational Suitability Rating

79%	Beautiful, could not be better
19%	Very minor aesthetic problems; excellent for swimming, boating
2%	Swimming and aesthetic enjoyment of the lake slightly impaired because of algae levels
0%	Desire to swim and level of enjoyment of the lake substantially reduced because of algae levels
0%	Swimming and aesthetic enjoyment of the lake nearly impossible because of algae levels

Figure 6. Recreational suitability rating, as rated by the volunteer monitor (2000-2011).

Total Phosphorus

Smith Lake is phosphorus limited, which means that algae and aquatic plant growth is dependent upon available phosphorus.

Total phosphorus was evaluated in Smith Lake in 2001-2002, 2004. The data show that phosphorus concentrations increase slightly as the summer goes on (Figure 7). Both sites have similar concentrations. The majority of the data points fall into the mesotrophic range.

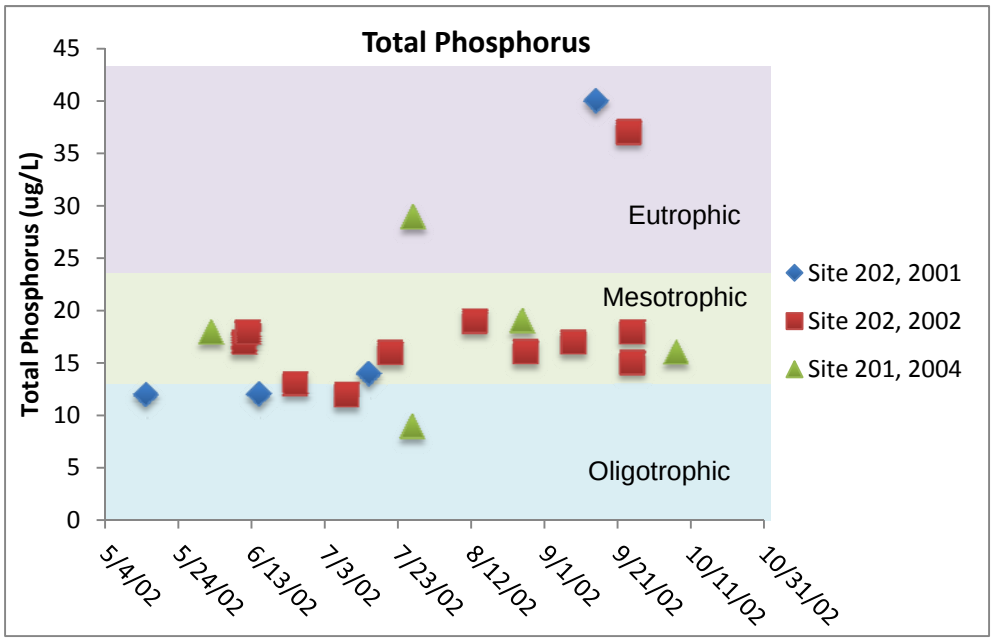


Figure 7. Historical total phosphorus concentrations (ug/L) for Smith Lake.

Phosphorus should continue to be monitored to track any future changes in water quality.

Chlorophyll *a*

Chlorophyll *a* is the pigment that makes plants and algae green. Chlorophyll *a* is tested in lakes to determine the algae concentration or how "green" the water is.

Chlorophyll *a* concentrations greater than 10 ug/L are perceived as a mild algae bloom, while concentrations greater than 20 ug/L are perceived as a nuisance.

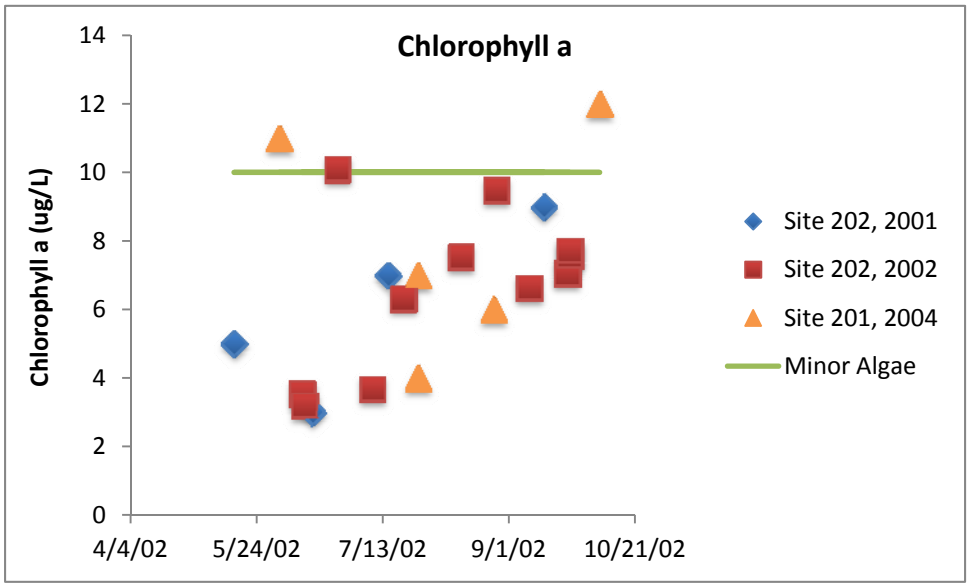
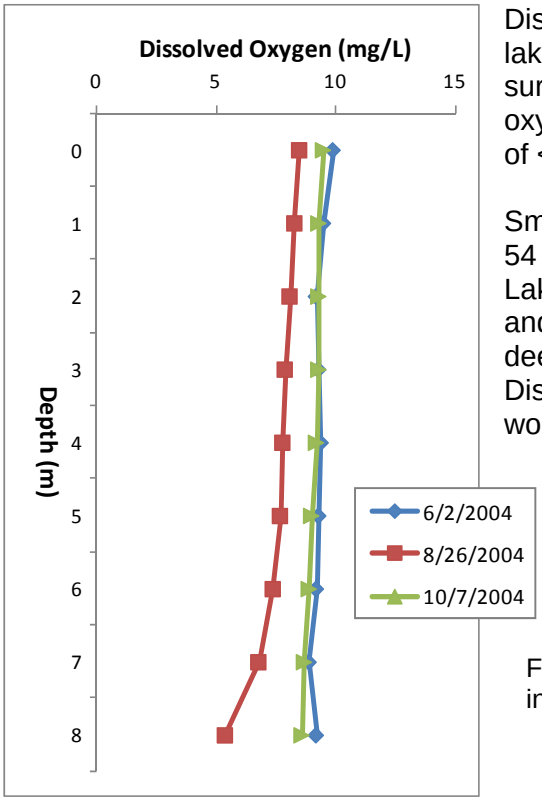


Figure 8. Chlorophyll *a* concentrations (ug/L) for Smith Lake.

Chlorophyll *a* was evaluated in Smith Lake in 2001-2002, 2004. Chlorophyll *a* concentrations reached 10 ug/L in 2002 and 2004, indicating minor algae blooms (Figure 8). There was not much variation between sites over the years monitored, and chlorophyll *a* concentrations remained relatively steady over the summer. These results are consistent with the transparency results in that it does not vary much over the course of the summer.

Dissolved Oxygen



Dissolved Oxygen (DO) is the amount of oxygen dissolved in lake water. Oxygen is necessary for all living organisms to survive except for some bacteria. Living organisms breathe in oxygen that is dissolved in the water. Dissolved oxygen levels of <5 mg/L are typically avoided by game fisheries.

Smith Lake is a relatively deep lake, with a maximum depth of 54 ft. The only dissolved oxygen data that exists for Smith Lake is at site 201 in 2004. This lake site is only 18 feet deep, and it shows that this area of the lake mixes all summer. The deeper areas of the lake most likely stratify in mid-summer. Dissolved oxygen profile monitoring for a year at site 202 would better explain the lake's mixing patterns.

Figure 9. Dissolved oxygen profile for Smith Lake in 2004 at site 201.

Trophic State Index

Phosphorus (nutrients), chlorophyll *a* (algae concentration) and Secchi depth (transparency) are related. As phosphorus increases, there is more food available for algae, resulting in increased algal concentrations. When algal concentrations increase, the water becomes less transparent and the Secchi depth decreases.

The results from these three measurements cover different units and ranges and thus cannot be directly compared to each other or averaged. In order to standardize these three measurements to make them directly comparable, we convert them to a trophic state index (TSI).

The mean TSI for Smith Lake falls into the mesotrophic range (Figure 10). There is good agreement between the TSI for phosphorus, chlorophyll *a* and transparency, indicating that these variables are strongly related (Table 6).

Mesotrophic lakes (TSI 40-50) are characterized by moderately clear water most of the summer (Table 7). "Meso" means middle or mid; therefore, mesotrophic means a medium amount of productivity. Mesotrophic lakes are commonly found in central Minnesota and have clear water with algal blooms in late summer. They are also good for walleye fishing.

Table 6. Trophic State Index.

Trophic State Index	Site 202
TSI Total Phosphorus	46
TSI Chlorophyll-a	48
TSI Secchi	43
TSI Mean	43
Trophic State:	Mesotrophic

Numbers represent the mean TSI for each parameter.

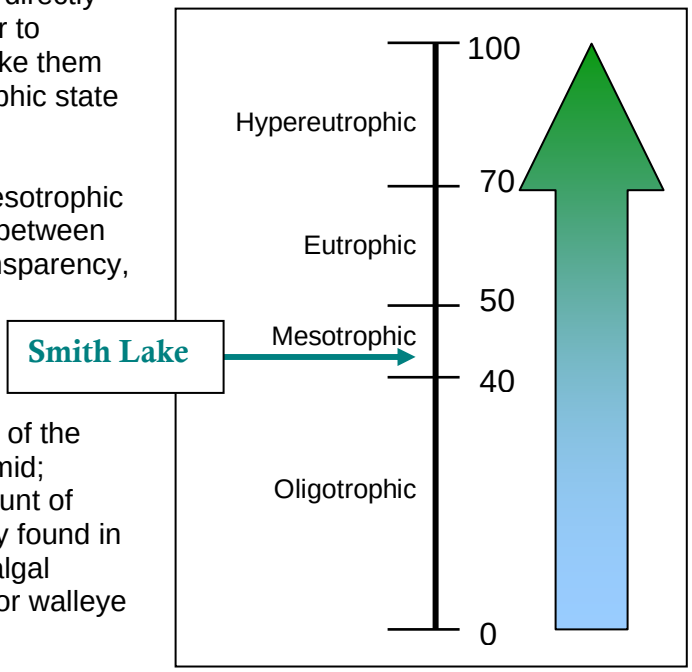


Figure 10. Trophic state index chart with corresponding trophic status.

Table 7. Trophic State Index categories and corresponding lake conditions.

TSI	Attributes	Fisheries & Recreation
<30	**Oligotrophy:** Clear water, oxygen throughout the year at the bottom of the lake, very deep cold water.	Trout fisheries dominate
30-40	Bottom of shallower lakes may become anoxic (no oxygen).	Trout fisheries in deep lakes only. Walleye, Cisco present.
40-50	**Mesotrophy:** Water moderately clear most of the summer. May be "greener" in late summer.	No oxygen at the bottom of the lake results in loss of trout. Walleye may predominate.
50-60	**Eutrophy:** Algae and aquatic plant problems possible. "Green" water most of the year.	Warm-water fisheries only. Bass may dominate.
60-70	Blue-green algae dominate, algal scums and aquatic plant problems.	Dense algae and aquatic plants. Low water clarity may discourage swimming and boating.
70-80	**Hypereutrophy:** Dense algae and aquatic plants.	Water is not suitable for recreation.
>80	Algal scums, few aquatic plants	Rough fish (carp) dominate; summer fish kills possible

Source: Carlson, R.E. 1997. A trophic state index for lakes. *Limnology and Oceanography*. 22:361-369.

Trend Analysis

For detecting trends, a minimum of 8-10 years of data with 4 or more readings per season are recommended. Minimum confidence accepted by the MPCA is 90%. This means that there is a 90% chance that the data are showing a true trend and a 10% chance that the trend is a random result of the data. Only short-term trends can be determined with just a few years of data, because there can be different wet years and dry years, water levels, weather, etc, that affect the water quality naturally.

There is not enough historical data to perform trend analysis for total phosphorus or chlorophyll *a* on Smith Lake. Site 202 had over 8 years of transparency data, which was enough data to perform a long-term trend analysis (Table 8). The data was analyzed using the Mann Kendall Trend Analysis.

Table 8. Trend analysis for Smith Lake.

Lake Site	Parameter	Date Range	Trend	Probability
202*primary	Transparency	2000-2011	Improving	95%
202*primary	Total Phosphorus	2001-2002	Insufficient data	--
202*primary	Chlorophyll a	2001-2002	Insufficient data	--

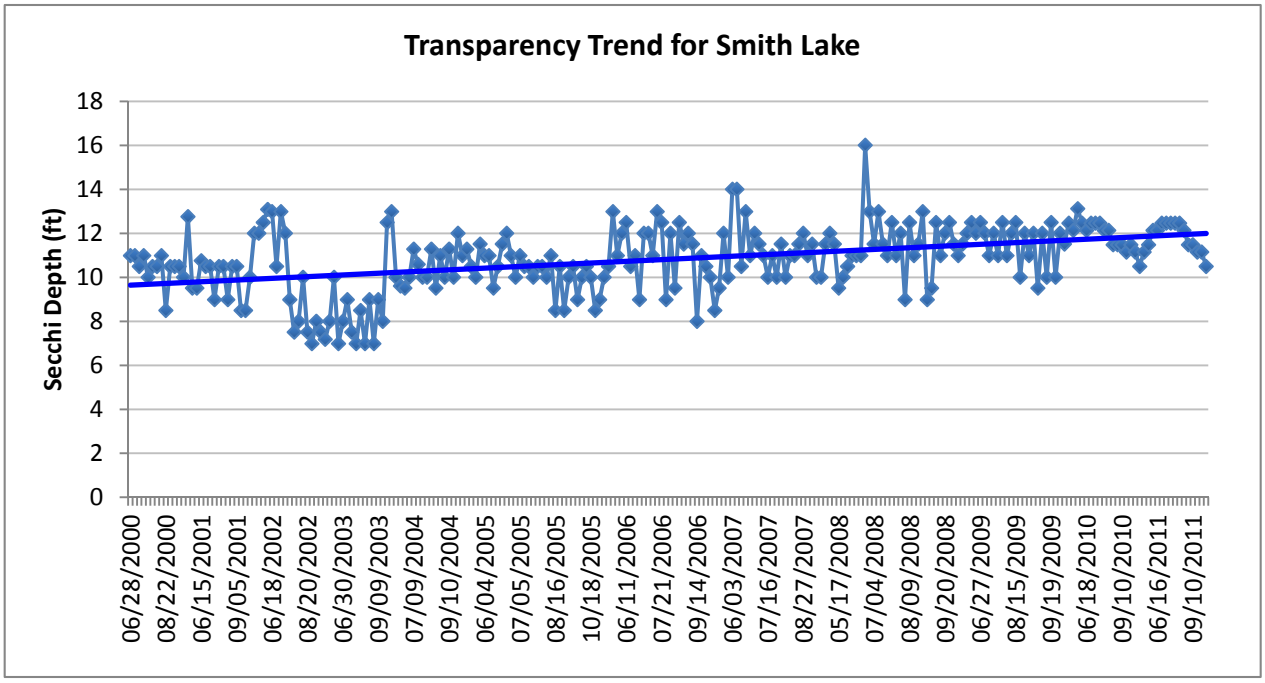


Figure 11. Transparency (ft) trend for site 202.

Smith Lake shows a significant improving trend in transparency from 2000-2011. The transparency has improved an average of approximately 2 feet over this time period. Transparency monitoring should continue at both sites so that this trend can be tracked in future years.

Ecoregion Comparisons

Minnesota is divided into 7 ecoregions based on land use, vegetation, precipitation and geology (Figure 12). The MPCA has developed a way to determine the "average range" of water quality expected for lakes in each ecoregion. From 1985-1988, the MPCA evaluated the lake water quality for reference lakes. These reference lakes are not considered pristine, but are considered to have little human impact and therefore are representative of the typical lakes within the ecoregion. The "average range" refers to the 25th - 75th percentile range for data within each ecoregion. For the purpose of this graphical representation, the means of the reference lake data sets were used.

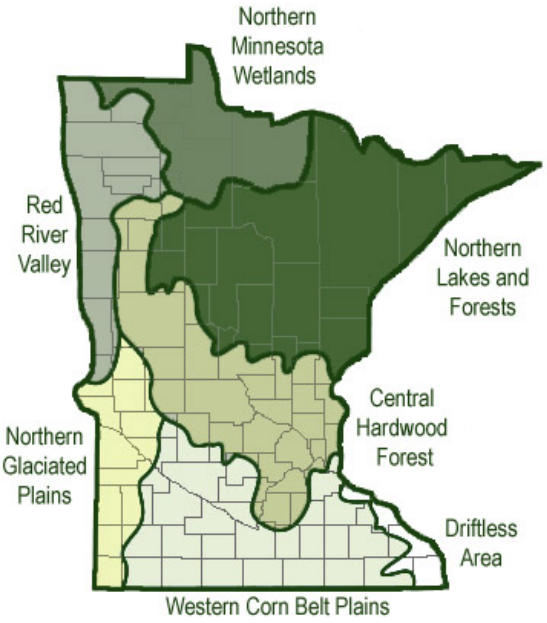
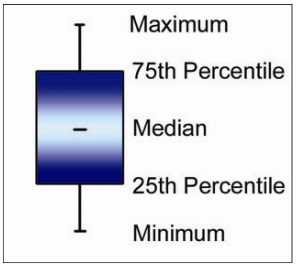
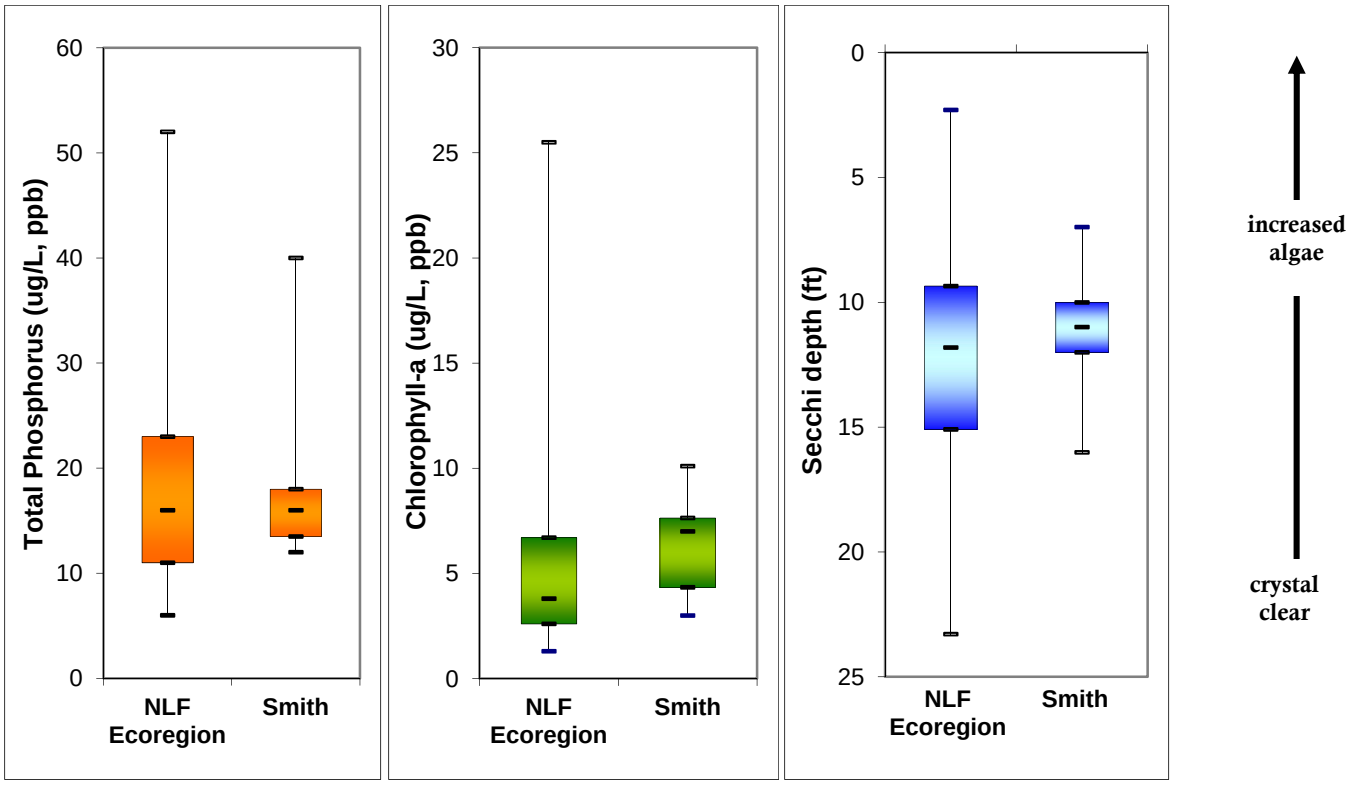


Figure 12. Map of Minnesota with the seven ecoregions.

Smith Lake is in the Northern Lakes and Forests Ecoregion. The mean total phosphorus, chlorophyll a and transparency (secchi depth) for Smith are all within the expected ecoregion ranges (Figure 13).





Figures 13a-c. Smith Lake ranges compared to Northern Lakes and Forest Ecoregion ranges. The Smith Lake total phosphorus and chlorophyll *a* ranges are from 15 data points collected in May-September of 2001-2002. The Smith Lake secchi depth range is from 244 data points collected in May-September from 2000-2011.

Lakeshed Data and Interpretations

Lakeshed

Understanding a lakeshed requires an understanding of basic hydrology. A watershed is defined as all land and water surface area that contribute excess water to a defined point. The MN DNR has delineated three basic scales of watersheds (from large to small): 1) basins, 2) major watersheds, and 3) minor watersheds.

The **Rum River Major Watershed** is one of the watersheds that make up the Upper Mississippi River Basin, which drains south to the Gulf of Mexico (Figure 14). This major watershed is made up of 101 minor watersheds. Smith Lake is located in **minor watershed 21059** (Figure 15).

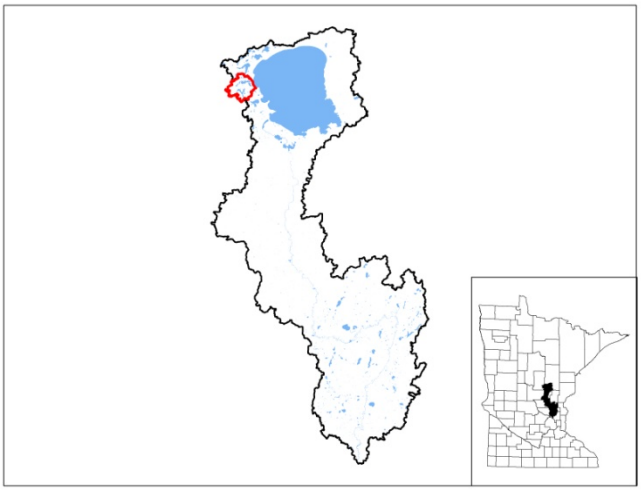


Figure 14. Rum River Major Watershed.

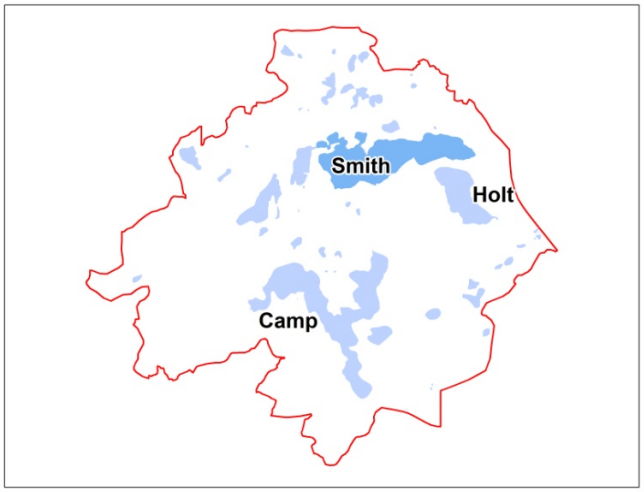


Figure 15. Minor Watershed 21059 contributes water to Smith Lake.

The MN DNR also has evaluated catchments for each individual lake with greater than 100 acres surface area. These lakesheds (catchments) are the "building blocks" for the larger scale watersheds. Smith Lake falls within the **Smith (2105901) lakeshed** (Figure 16). Though very useful for displaying the land and water that contribute directly to a lake, lakesheds are not true watersheds because they do not show the water flowing into a lake from upstream streams or rivers. While some lakes may have only one or two upstream lakesheds draining into them, others may be connected to a large number of lakesheds, reflecting a larger drainage area via stream or river networks. For further

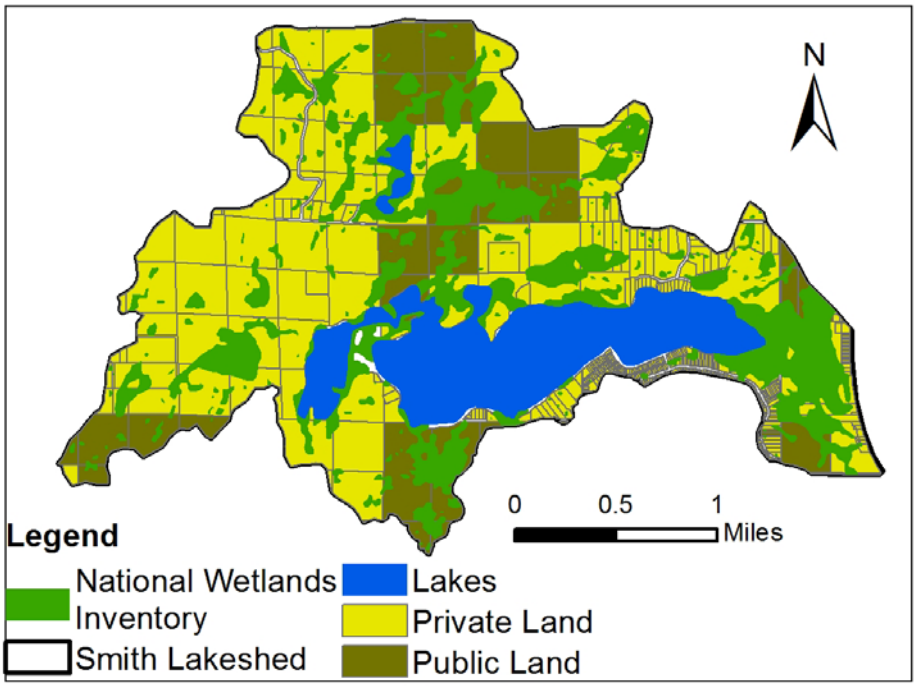


Figure 16. The Smith (2105901) Lakeshed. This area is the land and water surface that flow directly into Smith Lake.

discussion of Smith Lake's full watershed, containing all the upstream, see page 17. The data interpretation of the Smith Lake lakeshed is only the immediate lakeshed, as this area is the land surface that flows directly into Smith Lake.

The lakeshed vitals table identifies where to focus organizational and management efforts for each lake (Table 9). Criteria were developed using limnological concepts to determine the effect to lake water quality.

KEY
Possibly detrimental to the lake
Warrants attention
Beneficial to the lake

Table 9. Lakeshed vitals for Smith Lake.

Lakeshed Vitals		Rating
Lake Area	480 acres	descriptive
Littoral Zone Area	181 acres	descriptive
Lake Max Depth	54 ft.	descriptive
Lake Mean Depth	NA	NA
Water Residence Time	NA	NA
Miles of Stream	1.9	descriptive
Inlets	3	
Outlets	1	
Major Watershed	21 – Rum River	descriptive
Minor Watershed	21059	descriptive
Lakeshed	2105901	descriptive
Ecoregion	Northern Lakes and Forest	descriptive
Total Lakeshed to Lake Area Ratio (total lakeshed includes lake area)	6:1	
Standard Watershed to Lake Basin Ratio (standard watershed includes lake areas)	6:1	
Wetland Coverage	23.6%	
Aquatic Invasive Species	None	
Public Drainage Ditches	None	
Public Lake Accesses	None	
Miles of Shoreline	6.8	descriptive
Shoreline Development Index	2.2	
Public Land to Private Land Ratio	0.4:1	
Development Classification	Recreational Development	
Miles of Road	11.2	descriptive
Municipalities in lakeshed	None	
Forestry Practices	County Forest Management: http://www.co.crow-wing.mn.us/index.aspx?NID=261	
Feedlots	None	
Sewage Management	Individual Subsurface Sewage Treatment Systems (Inspection and assessment required for all permits and property transfers within the Shoreland Protection Zone)	
Lake Management Plan	Healthy Lakes & Rivers Partnership program	
Lake Vegetation Survey/Plan	None	

Land Cover / Land Use

The activities that occur on the land within the lakeshed can greatly impact a lake. Land use planning helps ensure the use of land resources in an organized fashion so that the needs of the present and future generations can be best addressed. The basic purpose of land use planning is to ensure that each area of land will be used in a manner that provides maximum social benefits without degradation of the land resource.

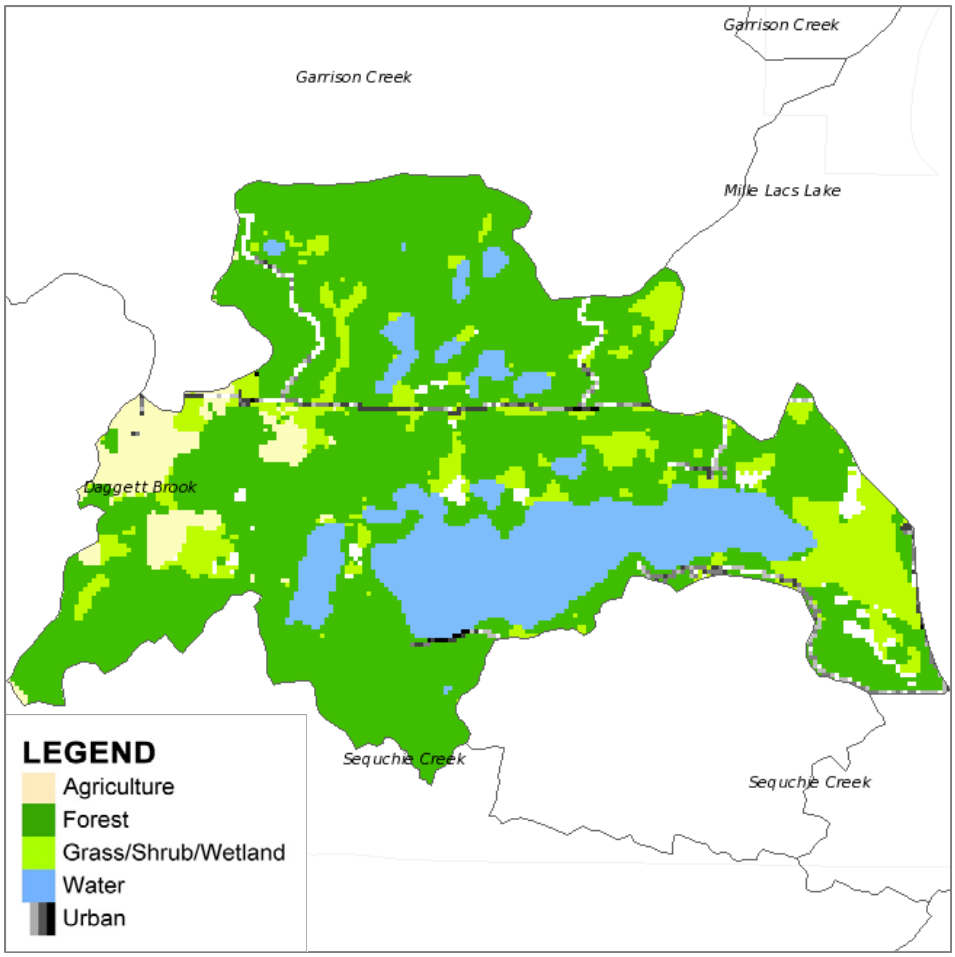


Figure 17. The Smith (2105901) lakeshed land cover (http://land.umn.edu).

Changes in land use, and ultimately land cover, impact the hydrology of a lakeshed. Land cover is also directly related to the lands ability to absorb and store water rather than cause it to flow overland (gathering nutrients and sediment as it moves) towards the lowest point, typically the lake. Impervious intensity describes the lands inability to absorb water, the higher the % impervious intensity the more area that water cannot penetrate in to the soils. Monitoring the changes in land use can assist in future planning procedures to address the needs of future generations.

Phosphorus export, which is the main cause of lake eutrophication, depends on the type of land cover occurring in the lakeshed. Figure 17 depicts the land cover in Smith Lake's lakeshed.

The University of Minnesota has online records of land cover statistics from years 1990 and 2000 (http://land.umn.edu). Although this data is 12 years old, it is the only data set available to compare over a decade of time. Table 10 describes Smith Lake's lakeshed land cover statistics and percent change from 1990 to 2000. Due to the many factors that influence demographics, one cannot determine with certainty the projected statistics over the next 10, 20, 30+ years, but one can see the transition within the lakeshed from agriculture, grass/shrub/wetland, and water acreages to forest and urban acreages. The largest change in percentage is the decrease in agriculture cover (46%); however, in acreage, forest cover has increased the most (293 acres). In addition, the impervious intensity has increased, which has implications for storm water runoff into the lake. The increase in impervious intensity is consistent with the increase in urban acreage.

Table 1. Smith Lake's lakeshed land cover statistics and % change from 1990 to 2000 (http://land.umn.edu).

	1990		2000		% Change
Land Cover	**Acres**	**Percent**	**Acres**	**Percent**	**1990 to 2000**
Agriculture	264	7.74	141	4.13	46.6% Decrease
Grass/Shrub/Wetland	516	15.12	444	13.01	14% Decrease
Forest	1863	54.59	2156	63.17	15.7% Increase
Water	673	19.72	571	16.73	15.2% Decrease
Urban	105	3.08	107	3.14	1.9% Increase
Impervious Intensity %					
0	3348	98.21	3333	97.77	0.4% Decrease
1-10	23	0.67	24	0.7	4.3% Increase
11-25	21	0.62	26	0.76	23.8% Increase
26-40	10	0.29	14	0.41	40% Increase
41-60	4	0.12	9	0.26	125% Increase
61-80	1	0.03	3	0.09	200% Increase
81-100	1	0.03	0	0	100% Decrease
Total Area	3413		3413		
Total Impervious Area (Percent Impervious Area Excludes Water Area)	12	0.44	17	0.6	41.7% Increase

Demographics

Smith Lake is classified as a recreational development lake. Recreational development lakes usually have between 60 and 225 acres of water per mile of shoreline, between 3 and 25 dwellings per mile of shoreline, and are more than 15 feet deep.

The Minnesota Department of Administration Geographic and Demographic Analysis Division extrapolated future population in 5-year increments out to 2035. Compared to Crow Wing County as a whole, Garrison Township has a higher extrapolated growth projection (Figure 18).

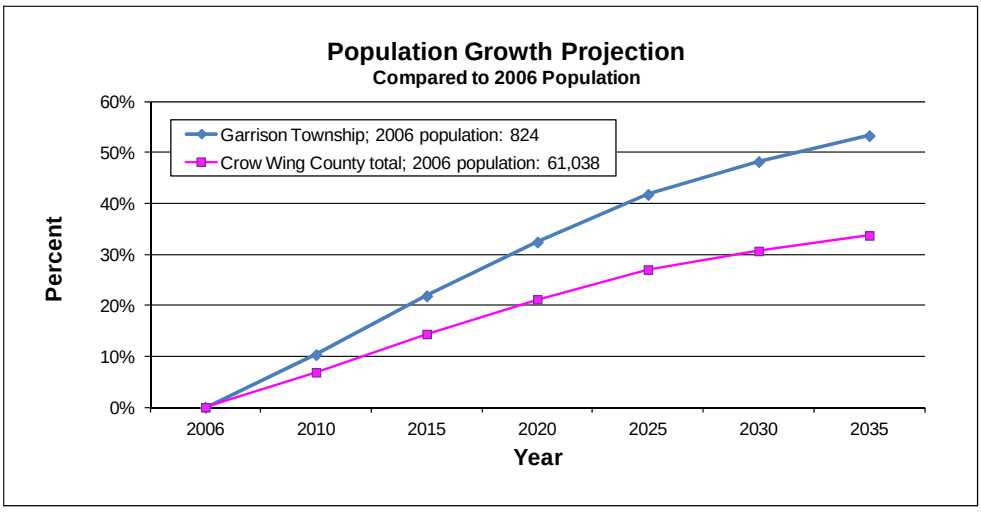


Figure 18. Population growth projection for Ponto Lake Township and Cass County. (source: http://www.demography.state.mn.us/resource.html?Id=19332)

Smith Lake Lakeshed Water Quality Protection Strategy

Each lakeshed has a different makeup of public and private lands. Looking in more detail at the makeup of these lands can give insight on where to focus protection efforts. The protected lands (easements, wetlands, public land) are the future water quality infrastructure for the lake. Developed land and agriculture have the highest phosphorus runoff coefficients, so this land should be minimized for water quality protection.

The majority of the land within Smith Lake's lakeshed is made up of private forested uplands (Table 11). This land can be the focus of development and protection efforts in the lakeshed. Compared to other lakes, the public ownership is relatively high.

Table 11. Land ownership, land use/land cover, estimated phosphorus loading, and ideas for protection and restoration in the lakeshed (Sources: Crow Wing County parcel data, National Wetlands Inventory, and the 2006 National Land Cover Dataset).

	Private (61%)					16%	Public (23%)		
	Developed	**Agriculture**	**Forested Uplands**	**Other**	**Wetlands**	**Open Water**	**County**	**State**	**Federal**
Land Use (%)	2.7%	4.7%	26.2%	12.1%	15.3%	16%	13.3%	9.7%	0%
Runoff Coefficient Lbs of phosphorus/acre/ year	0.45 - 1.5	0.26 - 0.9	0.09		0.09		0.09	0.09	0.09
Estimated Phosphorus Loading Acerage x runoff coefficient	41–137	41–143	81		47		40	30	0
Description	Focused on Shoreland	Cropland	Focus of develop-ment and protection efforts	Open, pasture, grass-land, shrub-land	Protected				
Potential Phase 3 Discussion Items	Shoreline restoration	Restore wetlands; CRP	Forest stewardship planning, 3rd party certification, SFIA, local woodland cooperatives		Protected by Wetland Conservation Act		County Tax Forfeit Lands	State Forest	National Forest

DNR Fisheries approach for lake protection and restoration

Credit: Peter Jacobson and Michael Duval, Minnesota DNR Fisheries

In an effort to prioritize protection and restoration efforts of fishery lakes, the MN DNR has developed a ranking system by separating lakes into two categories, those needing protection and those needing restoration. Modeling by the DNR Fisheries Research Unit suggests that total phosphorus concentrations increase significantly over natural concentrations in lakes that have watershed with disturbance greater than 25%. Therefore, lakes with watersheds that have less than 25% disturbance need protection and lakes with more than 25% disturbance need restoration (Table 12). Watershed disturbance was defined as having urban, agricultural and mining land uses. Watershed protection is defined as publicly owned land or conservation easement.

Table 12. Suggested approaches for watershed protection and restoration of DNR-managed fish lakes in Minnesota.

Watershed Disturbance (%)	Watershed Protected (%)	Management Type	Comments
< 25%	> 75%	Vigilance	Sufficiently protected -- Water quality supports healthy and diverse native fish communities. Keep public lands protected.
	< 75%	Protection	Excellent candidates for protection -- Water quality can be maintained in a range that supports healthy and diverse native fish communities. Disturbed lands should be limited to less than 25%.
25-60%	n/a	Full Restoration	Realistic chance for full restoration of water quality and improve quality of fish communities. Disturbed land percentage should be reduced and BMPs implemented.
> 60%	n/a	Partial Restoration	Restoration will be very expensive and probably will not achieve water quality conditions necessary to sustain healthy fish communities. Restoration opportunities must be critically evaluated to assure feasible positive outcomes.

The next step was to prioritize lakes within each of these management categories. DNR Fisheries identified high value fishery lakes, such as cisco refuge lakes. Ciscos (*Coregonus artedi)* can be an early indicator of eutrophication in a lake because they require cold hypolimnetic temperatures and high dissolved oxygen levels. These watersheds with low disturbance and high value fishery lakes are excellent candidates for priority protection measures, especially those that are related to forestry and minimizing the effects of landscape disturbance. Forest stewardship planning, harvest coordination to reduce hydrology impacts and forest conservation easements are some potential tools that can protect these high value resources for the long term.

Smith Lake is classified with having 37.5% of the watershed protected and 8.9% of the watershed disturbed (Figure 19). Therefore, Smith Lake should have a protection focus. Goals for the lake should be to limit any increase in disturbed land use.

Figure 20 displays the upstream lakesheds that contribute water to the lakeshed of interest; however, this particular lakeshed is a headwaters catchment. No additional lakesheds should drain into this area. The area highlighted in light green has the potential to contribute water to Smith Lake, whether through direct overland flow or through a creek or river.

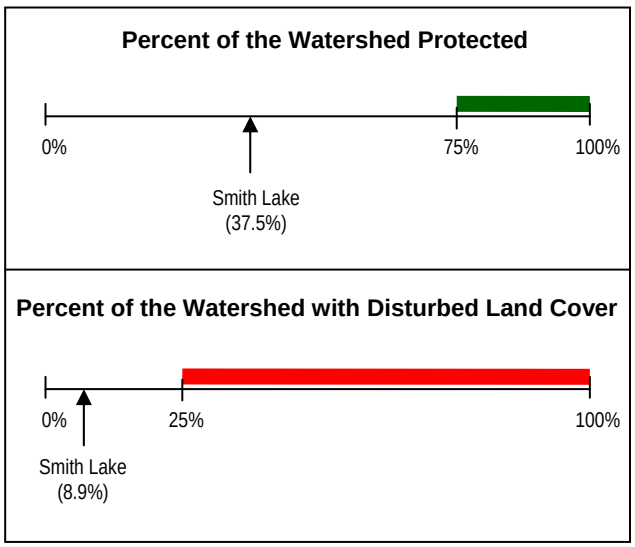


Figure 19. Smith Lake lakeshed's percentage of watershed protected and disturbed.

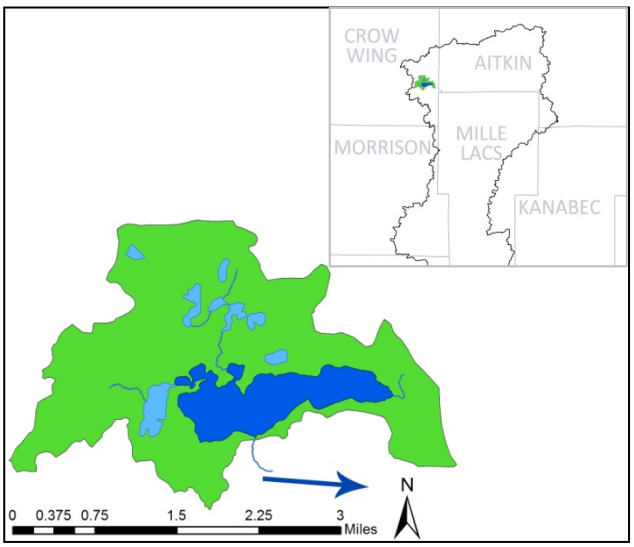


Figure 20. Upstream lakesheds that contribute water to the Smith lakeshed. Color-coded based on management focus (Table 12).

Smith, Status of the Fishery (as of 08/11/1997)

Smith Lake is 441 acres in size and is located just south of Garrison in eastern Crow Wing County. It is within the boundaries of the 1837 treaty area. There were about 72 homes/cabins and one resort along 6 miles of shoreline in 1997. There was no designated public access present. The lake is 54 feet deep and about 41% of the surface area is less than 15 feet deep. It is a hardwater lake with good phosphorus fertility. Water clarity was about typical for the area. Bottom soils in water less than four feet deep were a mix of sand, gravel, marl and muck. The aquatic plant community was reasonably diverse. Emergent aquatic species help cycle nutrients and provide some shore protection from erosion. Species like bulrush improve the quality of spawning habitat for bass and panfish. Species like wild rice often provide spawning habitat for northern pike. Submergent and floating leafed plants provide important cover and food sources for a wide variety of aquatic life.

The netting done in 1997 showed results fairly similar to those seen in previous surveys. Northern pike were caught in "low" numbers compared to similar type lakes. The catch was similar to previous catches in Smith Lake. Three age classes were sampled and growth was good. Average size was 24 inches and 4.7 lbs..

The walleye catch was also typical for the lake and "low" when compared to similar type lakes. Only three fish were caught and averaged 20 inches and 3.2 lbs..

Largemouth bass numbers were in the "high" category. The 1994 year class was the strongest of the three sampled and bass growth was slow. Bluegills were caught in "average" numbers and ranged from 3.3-8.2 inches long in the trap net catch. About 14% were at least 7.0 inches long. Bluegill growth was slow until about age six. The crappie catch was also in the "average" category and had good growth. As is common, one age class made up the majority of the crappie catch. Other panfish species sampled included pumpkinseed and rock bass, both caught in "average" numbers.

Forage species sampled included yellow perch, tullibees and white suckers. Perch catch was typical for Smith Lake but "low" in comparison with similar type lakes. White suckers were also found in "low" numbers, also typical for the lake. The tullibee catch was in the "average" category and similar to past catches for the lake.

Other species sampled included bowfin (dogfish), golden shiner and yellow bullhead. Common carp were sampled in 1985 but not in 1997.

See the link below for specific information on gillnet surveys, stocking information, and fish consumption guidelines. http://www.dnr.state.mn.us/lakefind/showreport.html?downum=18002800

Key Findings / Recommendations

Monitoring Recommendations
Transparency monitoring at sites 202 and 203 should be continued annually. It is important to continue transparency monitoring weekly or at least bimonthly every year to enable year-to-year comparisons and trend analyses. Phosphorus and chlorophyll a monitoring should continue at site 202, as the budget allows, to track future water quality trends.

Overall Conclusions
Overall, Smith Lake has good water quality, and is in fairly good shape for lakeshed protection. It is a mesotrophic lake (TSI=43) with an improving trend in transparency in the past decade. Twenty-three percent (23%) of the lakeshed is in public ownership, and 37% of the lakeshed is protected, while 9% of the lakeshed is disturbed (Figure 19).

Smith Lake is at an advantage in that it is a headwaters catchment, which means that no other lakesheds flow into it. This means the land practices around the lake are the main impact to the lake's water quality.

Priority Impacts to the lake
The priority impact to Smith Lake is current and additional development. There is an area of heavy development on the southeast shore between Smith and Holt Lakes. There wasn't any change in urban or impervious acreage around the lake from 1990-2000, so there doesn't appear to be a lot of development pressure for the non-developed areas of this lake. Much of the shoreline is ringed with wetlands and is therefore undevelopable. Agriculture makes up 4.7% of the lakeshed (Table 11). The agricultural land use appears to be mostly pasture/hay land.

Wetlands are present throughout the watershed. These areas potentially receive local runoff and filter nutrients and sediment before it enters the lake. Some of the wetland complexes to the north and side of the lake are on public land.

Best Management Practices Recommendations
The management focus for Smith Lake should be to protect the current water quality and the lakeshed on managing and/or decreasing the impact caused by current and additional development, including second tier development, and impervious surface area. Project ideas include protecting land with conservation easements, enforcing county shoreline ordinances, smart development, shoreline restoration, rain gardens, and septic system maintenance.

County-wide Recommendation
In order to better manage the impact of septic systems on lake water quality, it is recommended that the county implement a lake-wide septic inspection program. In a program such as this, the county would focus on one to three lakes a year, pull septic system records on those lakes, and require old systems to be inspected. This program can rotate through the county doing a few lakes each year.

Organizational contacts and reference sites

Smith lake Association	No website available.
DNR Fisheries Office	1601 Minnesota Drive, Brainerd, MN 56401 218-828-2550 brainerd.fisheries@state.mn.us
Regional Minnesota Pollution Control Agency Office	7678 College Road, Suite 105, Baxter, MN 56425 218-828-2492, 800-657-3864 http://www.pca.state.mn.us/pyri3df
Crow Wing Soil and Water Conservation District	322 Laurel St. Suite 13, Brainerd, MN 56401 218-828-6197 http://www.co.crow-wing.mn.us/swcd/
Crow Wing County Environmental Services Department	322 Laurel St. Suite 14, Brainerd, MN 56401 218-824-1125 http://www.co.crow-wing.mn.us/index.aspx?nid=211

Funding

This project was funded in part by the Board of Water & Soil Resources and the Initiative Foundation, a regional foundation.