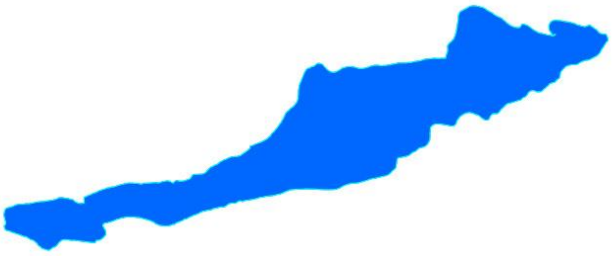
Pike Lake 16-0252-00 COOK COUNTY

Lake Water Quality

Summary



Pike Lake is located 9 miles west of Grand Marais, MN in Cook County. It is a long and narrow lake covering 814 acres (Table 1).

Pike Lake has two inlets and one outlet, which classify it as a drainage lake. The two perennial stream inlets enter Pike Lake from the far eastern and western corners of the lake. Water exits Pike Lake through Murmur Creek on its way to Caribou Lake and eventually Lake Superior.

A good water quality dataset exists for Pike Lake which ranges from 1980–2011 (Tables 2–3). These data show that the lake is oligotrophic (TSI = 36) with clear water conditions most of the summer and excellent recreational opportunities.

Pike Lake Association is a member of the Cook County Coalition of Lake Associations and has been active in water quality monitoring and education.

Table 1. Pike Lake location and key physical characteristics.

Location Data		Physical Characteristics	
MN Lake ID:	16-0252-00	Surface area (acres):	814
County:	Cook	Littoral area (acres):	328
Ecoregion:	Northern Lakes and Forests	% Littoral area:	40%
Major Drainage Basin:	Lake Superior - North	Max depth (ft), (m):	40, 12.1
Latitude/Longitude:	47.76549911/-90.59580231	Inlets:	2
Invasive Species:	None	Outlets:	1
		Public Accesses:	2

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

Data Availability

Transparency data		Excellent data source from 1998-2010.
Chemical data		Good amount of data, but not enough for a trend analysis.
Inlet/Outlet data		Not available.

Recommendations **For recommendations refer to page 18.**

Lake Map

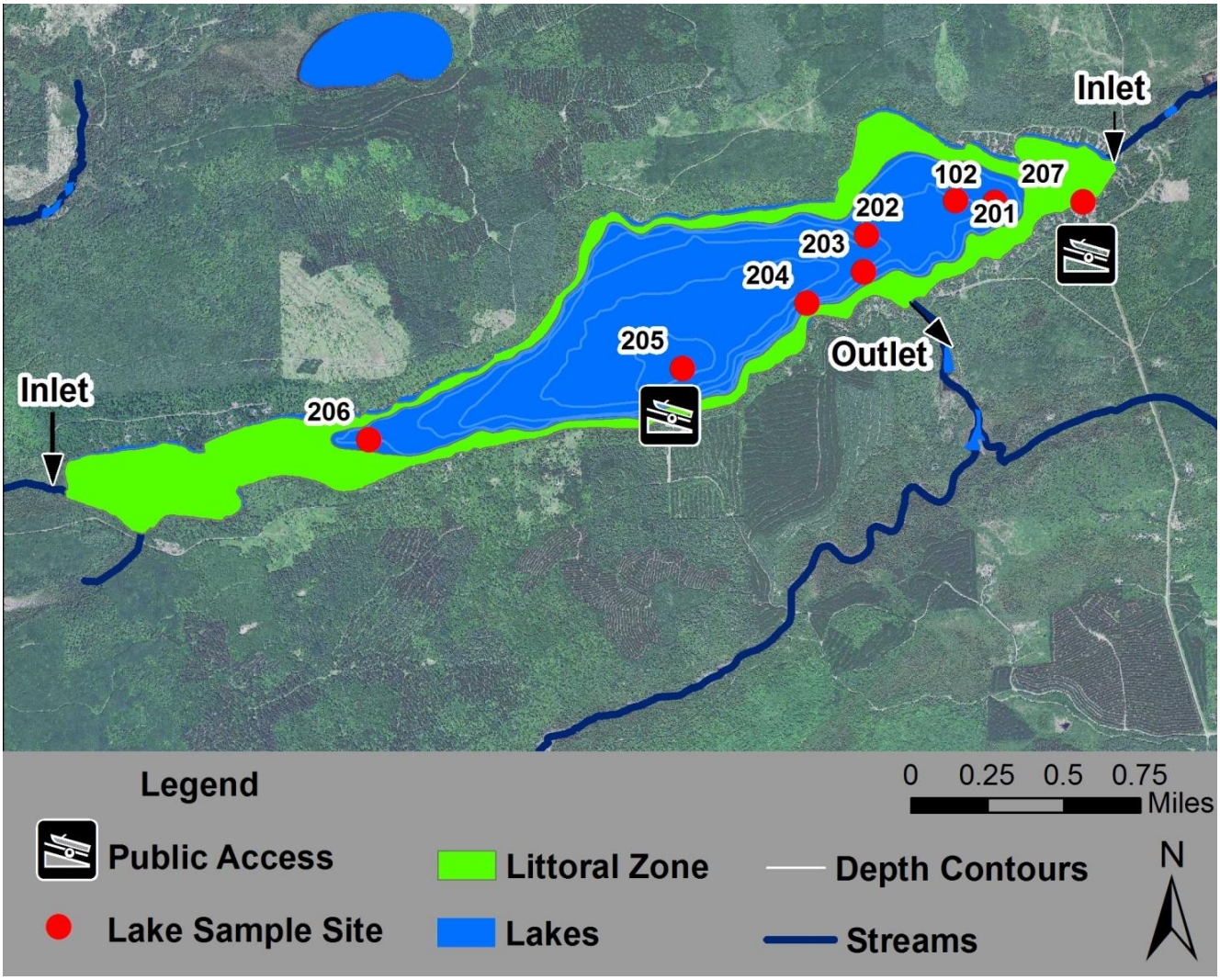


Figure 1. Map of Pike Lake with 2010 aerial imagery and illustrations of lake depth contour lines, sample site locations, inlets and outlets, and public access points. The light green areas in the lake illustrate the littoral zone, where the sunlight can usually reach the lake bottom allowing aquatic plants to grow.

Table 3. Monitoring programs and associated monitoring sites. Monitoring programs include the Minnesota Pollution Control Agency Lake Monitoring Program (MPCA), Citizen Lake Monitoring Program (CLMP), and Cook County Water Plan Initiative (CCWPI).

Lake Site	Depth (ft)	Monitoring Programs
102	22	MPCA: 1998
201	25	CLMP: 1989–1992, 1994–1995; CCWPI: 2007; CLMP+: 2010
202	27	CLMP: 1992, 2000–2003, 2005–2011
203	30	CLMP: 1993
204	25	CLMP: 1993
205* Primary site	40	MPCA: 1980, 1998; CCWPI: 2007; CLMP: 1998–2011
206	20	CLMP: 2000–2003, 2005–2011
207	NA	MPCA Mercury Trends: 2011

Average Water Quality Statistics

The information below describes available chemical data for Pike Lake through 2011 (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 1980 and 1998 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)	9	14–27	> 30	Results are better than the expected range for the ecoregion.
[3]Chlorophyll *a* (ug/L)	2	4–10	> 9	
Chlorophyll *a* max (ug/L)	4	<15		
Secchi depth (ft)	19.0	8–15	< 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)	0.37	0.40–0.75		Indicates insufficient nitrogen to support summer nitrogen-induced algae blooms.
Alkalinity (mg/L)	26	40–140		Indicates sensitivity to acid rain and low buffering capacity.
Color (Pt-Co Units)	8	10–35		Indicates clear water with little to no tannins (brown stain).
pH	7.0	7.2–8.3		Below the expected range for the ecoregion. Lake water pH less than 6.5 can affect fish spawning and the solubility of metals in the water.
Chloride (mg/L)	1.0	0.6–1.2		Within the expected range for the ecoregion.
Total Suspended Solids (mg/L)	2	<1–2		Within the expected range for the ecoregion. Indicates low suspended solids and clear water.
Conductivity (umhos/cm)	52	50–250		Within the expected range for the ecoregion.
Total Nitrogen : Total Phosphorus	41:1	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 lake monitoring sites.

Parameters	Primary Site 205	Site 201	Site 202	Site 206
Total Phosphorus Mean (ug/L):	**9**	**9**		
Total Phosphorus Min:	6	6		
Total Phosphorus Max:	15	10		
Number of Observations:	11	9		
Chlorophyll *a* Mean (ug/L):	**2**	**2**		
Chlorophyll-a Min:	1	1		
Chlorophyll-a Max:	4	3		
Number of Observations:	10	9		
Secchi Depth Mean (ft):	**19.0**	**18.2**	**18.5**	**17.8**
Secchi Depth Min:	12.9	12.5	13.4	12.9
Secchi Depth Max:	26.5	25.0	27.0	20.0
Number of Observations:	87	38	79	76

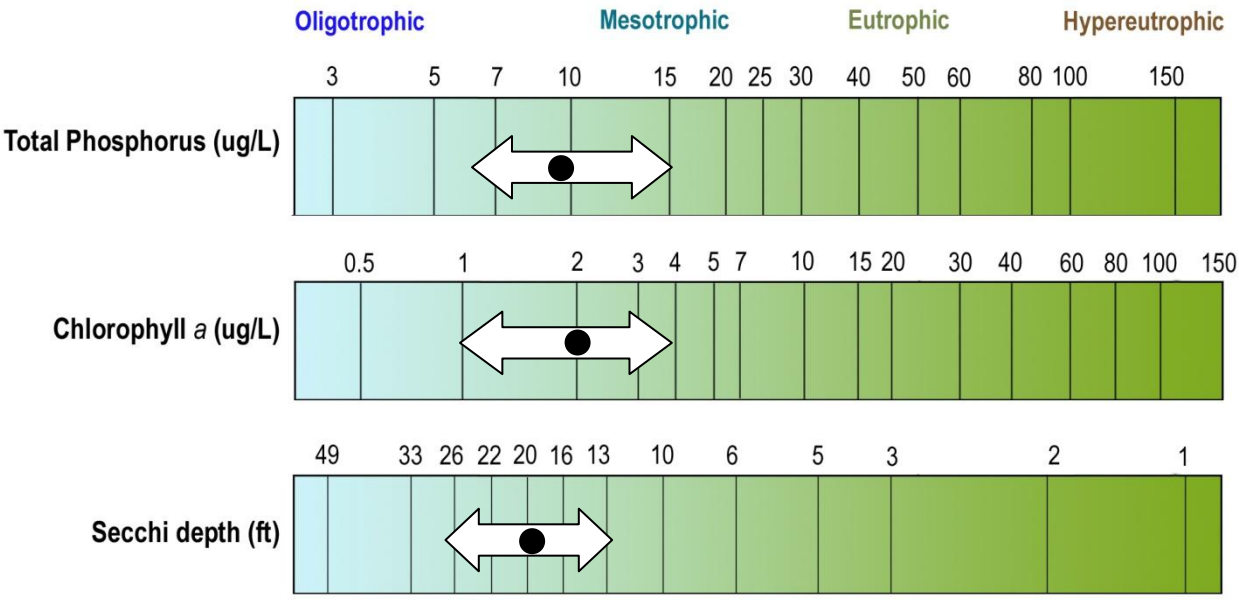


Figure 2. Pike Lake total phosphorus, chlorophyll *a* and transparency historical ranges. The arrow represents the range and the black dot represents the historical mean (Primary Site 205). Figure adapted after Moore and Thornton, [Ed.]. 1988. Lake and Reservoir Restoration Guidance Manual. (Doc. No. 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 mean transparency in Pike Lake ranges from 16 to 21 feet (Figure 3). The transparency throughout the lake appears to be relatively uniform, with the best transparency occurring at the deepest spot in the large main basin (site 205).

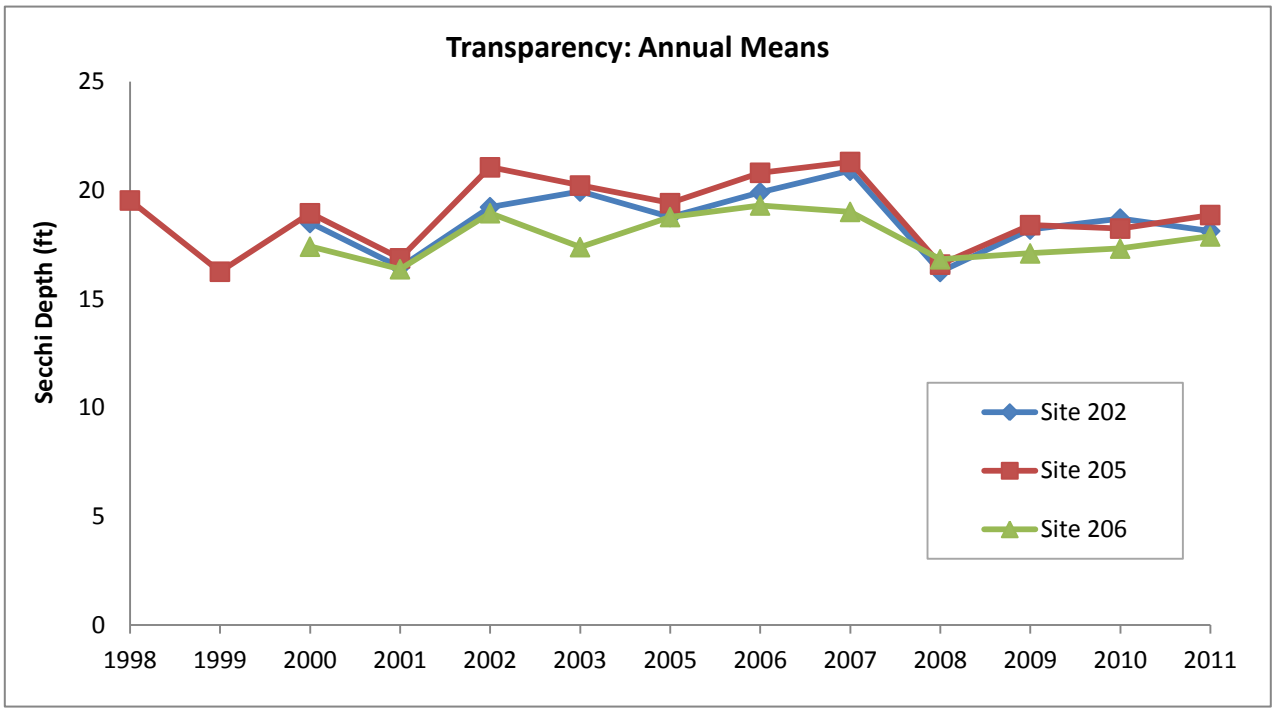


Figure 3. Annual mean transparency comparison between sites.

Pike Lake transparency ranges from 12.9 to 26.5 ft at the primary site (205). Figure 4 shows the seasonal transparency dynamics. The transparency remains fairly even all summer in Pike Lake. This pattern is typical for a clear lake with good transparency. 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.

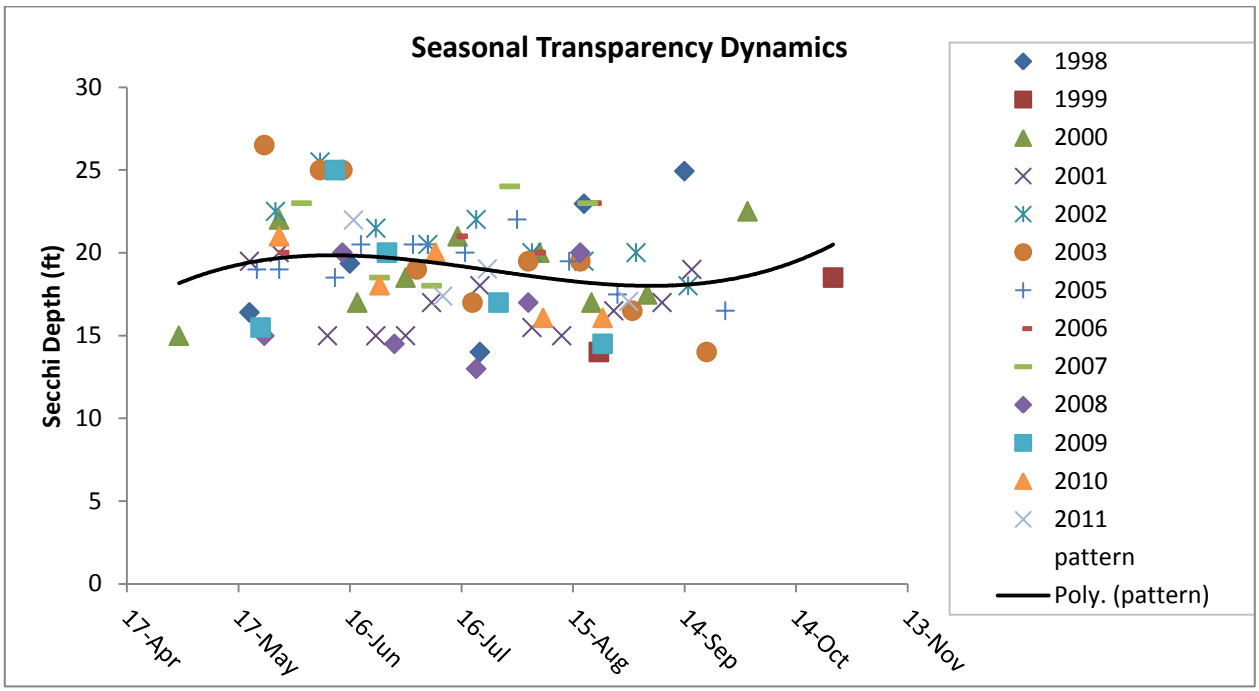


Figure 4. Seasonal transparency dynamics and year to year comparison (Primary Site 205). The black line represents the pattern in the data.

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. Pike Lake was rated as being "crystal clear" 61% of the time by samplers at site 205 between 1998 and 2011 (Figure 5).

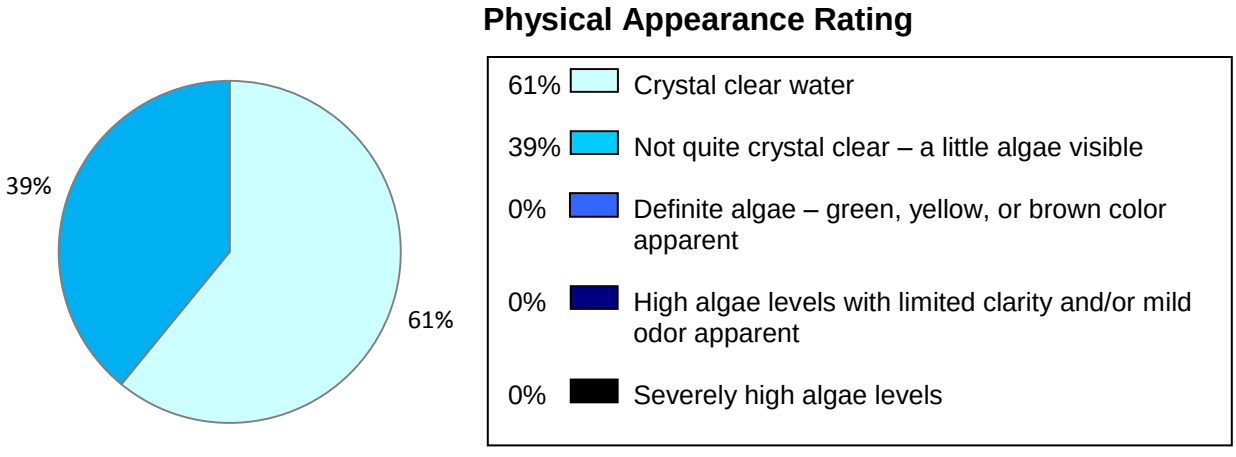


Figure 5. Pike Lake physical appearance ratings by samplers at site 205.

As the secchi depth decreases, the perception of recreational suitability of the lake decreases. Pike Lake was rated as being "beautiful" 42% of the time from 1998-2011 (Figure 6).

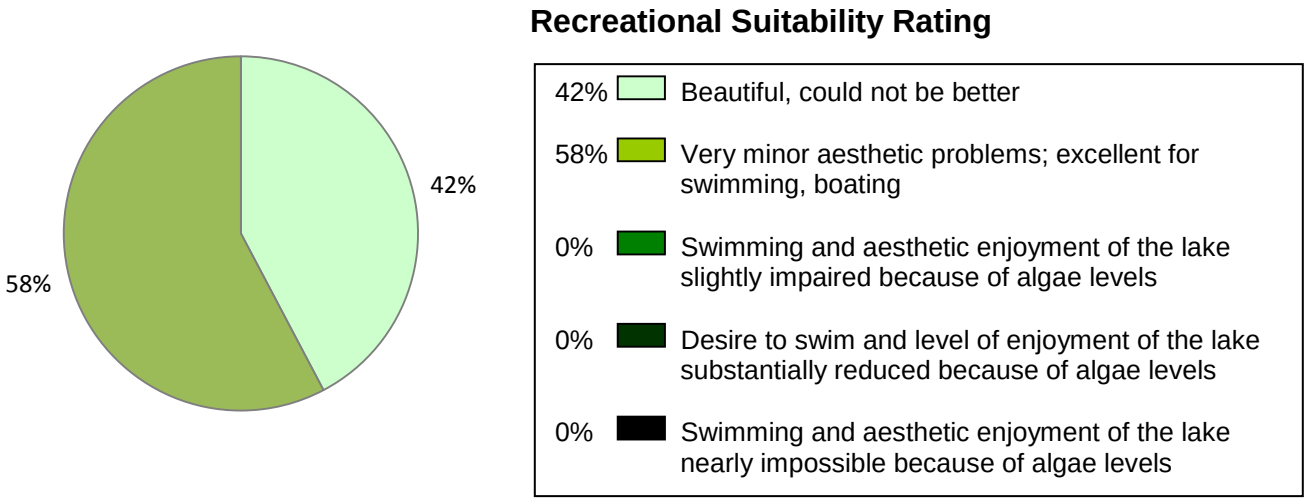


Figure 6. Recreational suitability rating, as rated by the volunteer monitor at site 205.

Total Phosphorus

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

Total phosphorus was evaluated in Pike Lake in 1980, 1998, 2007, and 2010. The data do not indicate much seasonal variability, except for that the highest phosphorus readings occur late in the summer. The majority of the data points and the mean fall into the oligotrophic range (Figure 7).

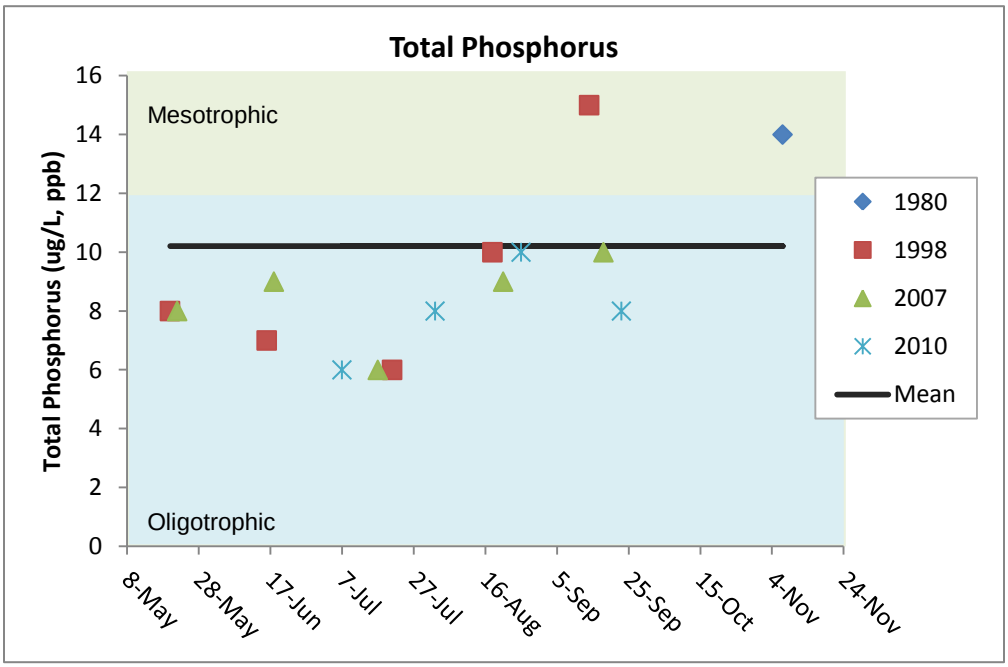


Figure 7. Historical total phosphorus concentrations (ug/L) for Pike Lake site 205.

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 deter mine 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.

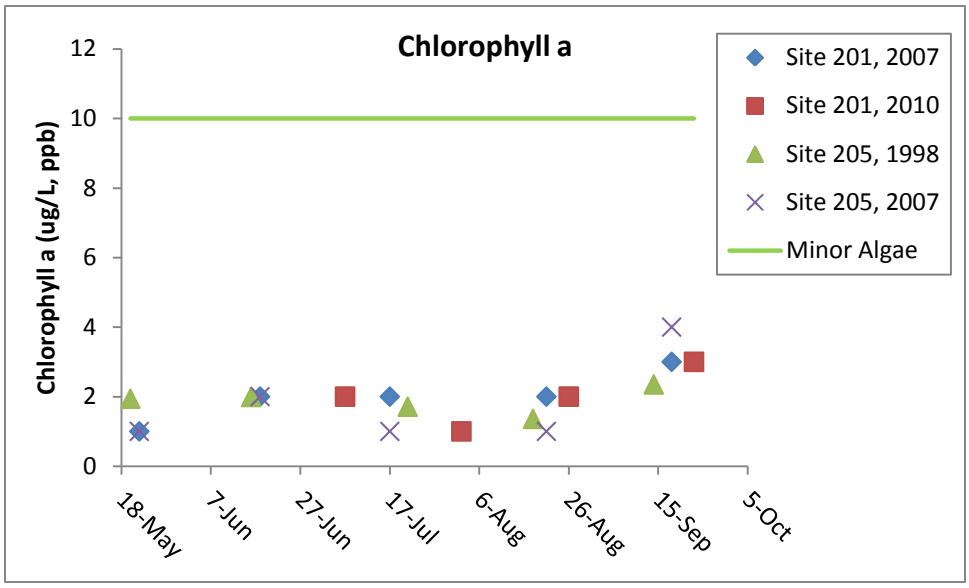


Figure 8. Chlorophyll *a* concentrations (ug/L) for Pike Lake.

Chlorophyll *a* was evaluated in Pike Lake in 1998, 2007 and 2010 (Figure 8). Chlorophyll *a* concentrations remained well below 10 ug/L on all sample dates, indicating clear water most of the summer. There was not much variation over the years monitored and chlorophyll *a* concentrations remained relatively steady over the summer.

Dissolved Oxygen

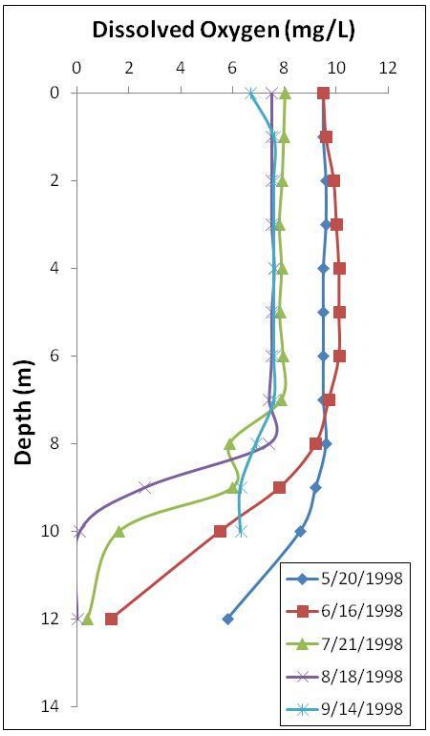


Figure 9. Dissolved oxygen profile for Pike Lake in 2010 at site 205.

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.

Pike Lake has a 40 ft deep section in the middle. Dissolved oxygen profiles from data collected in 1998 at site 205 show stratification developing mid-summer. The thermocline occurs at approximately 8 meters (26 ft.), which means that gamefish will be scarce below this depth. Figure 9 is a representative DO profile for Pike Lake.

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 Pike Lake falls into the oligotrophic 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).

Oligotrophic lakes (TSI 0-39) typically have clear water throughout the summer and are excellent for recreation (Table 7). Some very deep oligotrophic lakes are able to support a trout fishery.

Table 6. Trophic State Index.

Trophic State Index	Site 205
TSI Total Phosphorus	36
TSI Chlorophyll-a	37
TSI Secchi	35
TSI Mean	36
Trophic State:	Oligotrophic

Numbers represent the mean TSI for each parameter.

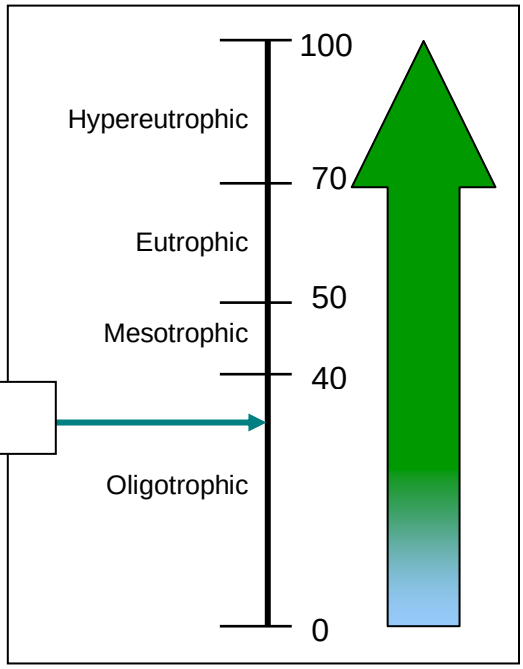


Figure 10. Trophic state index chart with corresponding trophic status.

Table 7. Trophic state index attributes and their corresponding fisheries and recreation characteristics.

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.

Pike Lake had enough data to perform a trend analysis for transparency, but not chlorophyll a or phosphorus (Table 8). The data was analyzed using the Mann Kendall Trend Analysis.

Table 8. Trend analysis for site 205.

Lake Site	Parameter	Date Range	Trend
205	Total Phosphorus	1980, 1998, 2007	Insufficient data
205	Chlorophyll a	1980, 1998, 2007	Insufficient data
205	Transparency	1998-2011	No trend

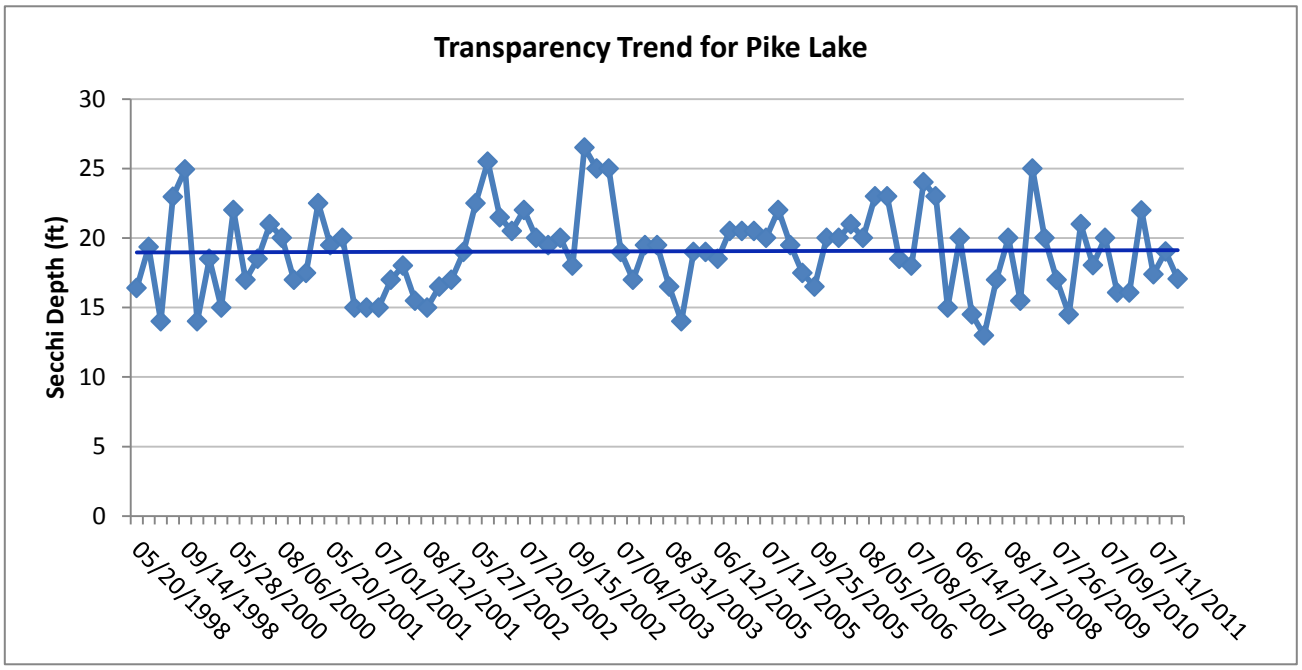


Figure 11. Transparency (ft) trend for site 205 from 1998-2011.

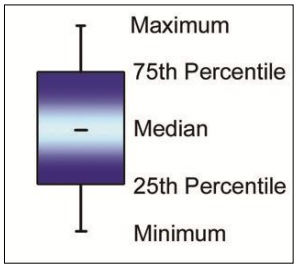
Pike Lake shows no evidence of water quality trends (Figure 11). That means that the water quality is stable. Transparency monitoring should continue so that this trend can be tracked in future years.

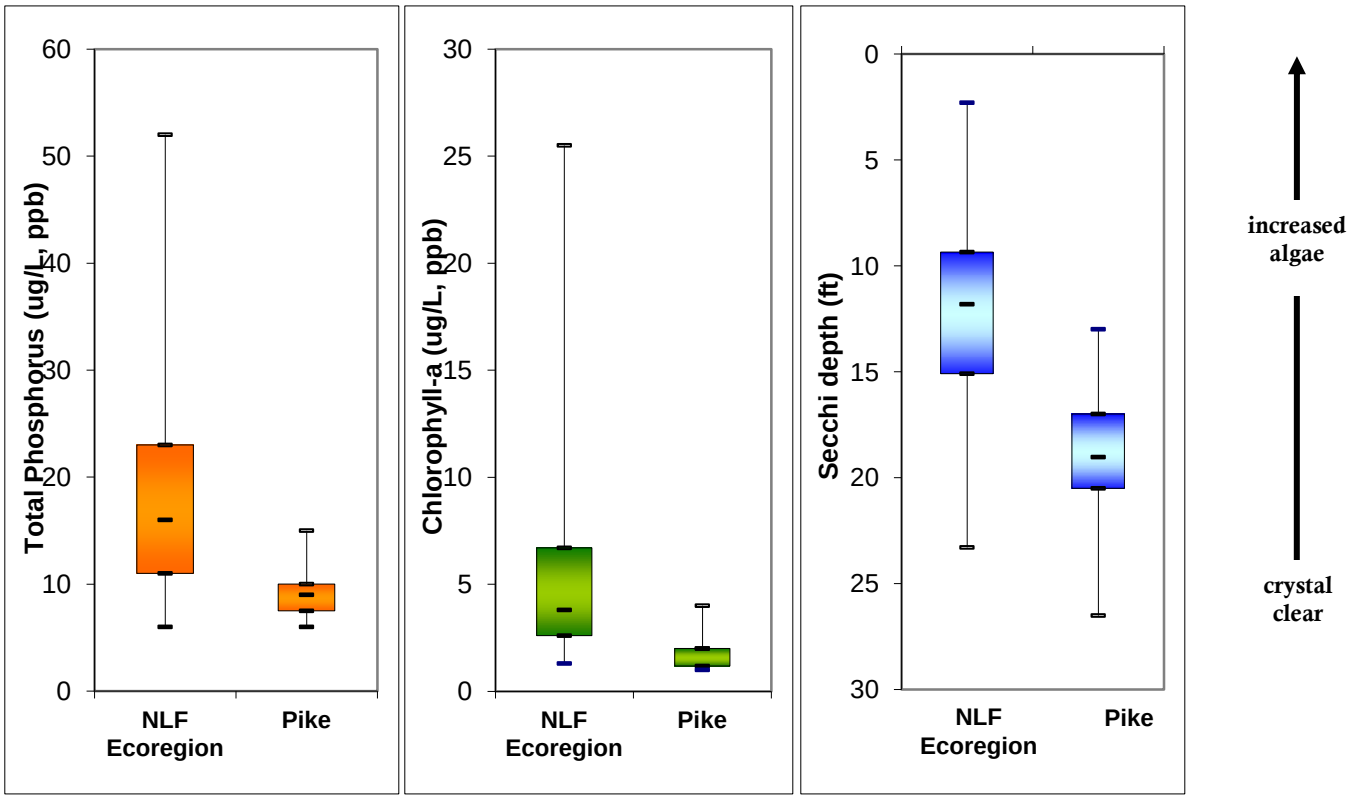
Ecoregion Comparisons

Minnesota is divided into 7 ecoregions based on land use, vegetation, precipitation and geology. 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. Minnesota Ecoregions.

Lake Pike is in the Northern Lakes and Forests Ecoregion (Figure 12). The mean total phosphorus, chlorophyll a and transparency (secchi depth) for Pike are slightly better than the ecoregion ranges (Figure 13).





Figures 13a-c. Pike Lake ranges compared to Northern Lakes and Forest Ecoregion ranges. The Pike Lake total phosphorus and chlorophyll *a* ranges are from 11 data points collected in May-September of 1998, 2007 and 2010. The Pike Lake secchi depth range is from 87 data points collected in May-September from 1998-2011.

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 **Lake Superior - North Major Watershed** is one of the watersheds that make up the Great Lakes Basin (Figure 14). This major watershed is made up of 119 minor watersheds. Pike Lake is located in **minor watershed** 1061 (Figure 15).

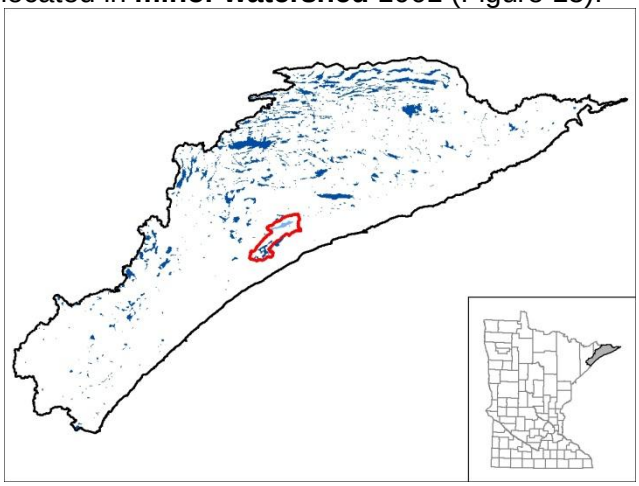


Figure 14. Lake Superior - North Major Watershed.

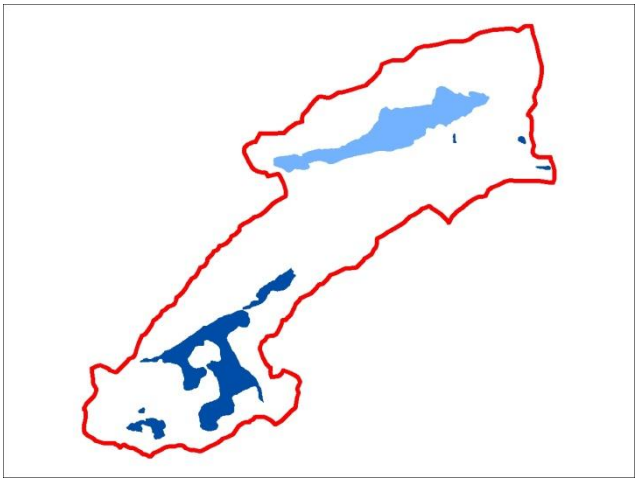


Figure 15. Minor Watershed 1061

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. Pike Lake falls within **lakeshed 0106102** (Figure 16). Though very useful for displaying the land and water that contribute directly to a lake, lakesheds are not always true watersheds because they may 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 discussion of Pike Lake's full watershed, containing all the lakesheds upstream of the Pike Lake lakeshed, see page 17. The data interpretation of the Pike Lake lakeshed includes only the immediate lakeshed as this area is the land surface that flows directly into Pike Lake.

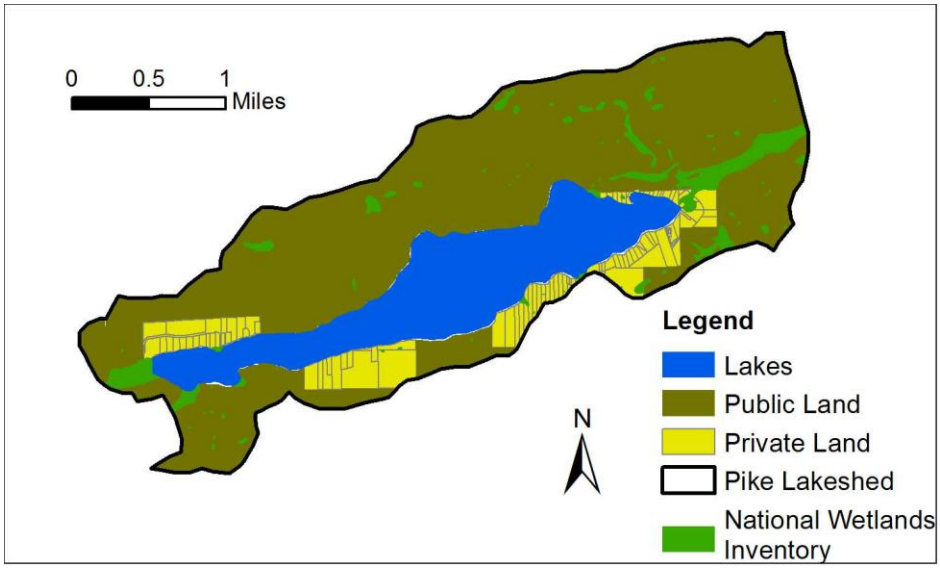


Figure 16. Pike Lake lakeshed (0106102) with land ownership, lakes, and wetlands illustrated.

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. Pike Lake lakeshed vitals table.

Lakeshed Vitals		Rating
Lake Area	814 acres	descriptive
Littoral Zone Area	328 acres	descriptive
Lake Max Depth	40 ft.	descriptive
Lake Mean Depth	21 ft.	
Water Residence Time	NA	NA
Miles of Stream	0.4	descriptive
Inlets	2	
Outlets	1	
Major Watershed	1 - Lake Superior (North)	descriptive
Minor Watershed	1061	descriptive
Lakeshed	0106102	descriptive
Ecoregion	Northern Lakes and Forests	descriptive
Total Lakeshed to Lake Area Ratio (total lakeshed includes lake area)	5:1	
Standard Watershed to Lake Basin Ratio (standard watershed includes lake areas)	5:1	
Wetland Coverage	5%	
Aquatic Invasive Species	None	
Public Drainage Ditches	None	
Public Lake Accesses	2	
Miles of Shoreline	8.6	descriptive
Shoreline Development Index	2.15	
Public Land to Private Land Ratio	6.6:1	
Development Classification	Recreational Development	
Miles of Road	7.5	descriptive
Municipalities in lakeshed	None	
Forestry Practices	Active logging on public land	
Feedlots	None	
Sewage Management	Individual Waste Treatment Systems, 2001–2003 inspections	
Lake Management Plan	None	
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.

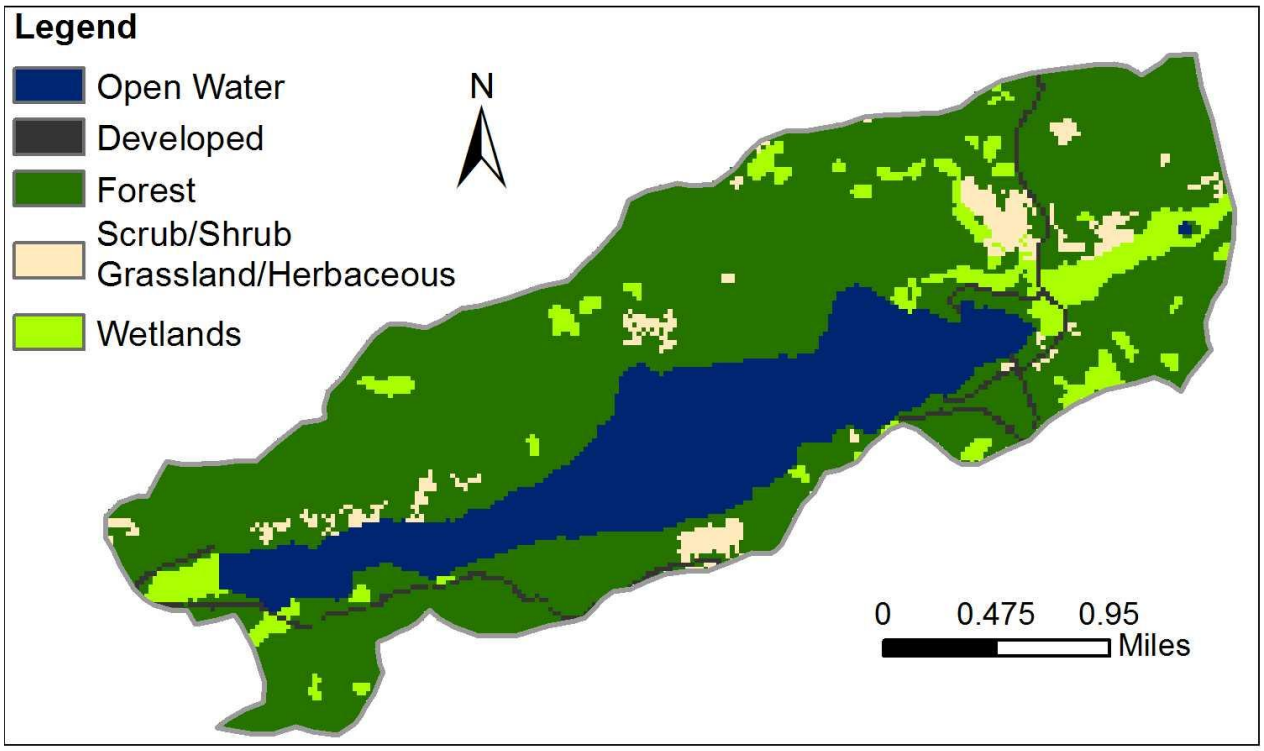


Figure 17. Land cover for Pike Lake lakeshed (0106102). Data Source: National Land Cover Dataset 2006.

Changes in land use, and ultimately land cover, impact the hydrology of a lakeshed. Land cover is also directly related to the land's 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. 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 Pike Lake's lakeshed. Acreage estimates for the major land use types are listed in Table 10. Evergreen and deciduous forests are the main cover class, followed by open water and wetlands. The developed land use class is a small percentage of the total land area and consists mainly of roads. Roughly 872 acres within the lakeshed have been logged since the late 1980s (Figure 18). This encompasses 32% of the public land area.

Table 10. Pike Lake's lakeshed land cover statistics (NLCD 2006).

Land Cover	Acres	Percent
Forest	2672	67.6
Water	806	20.3
Wetland	269	6.8
Grass/Shrub	137	3.5
Developed	72	1.8

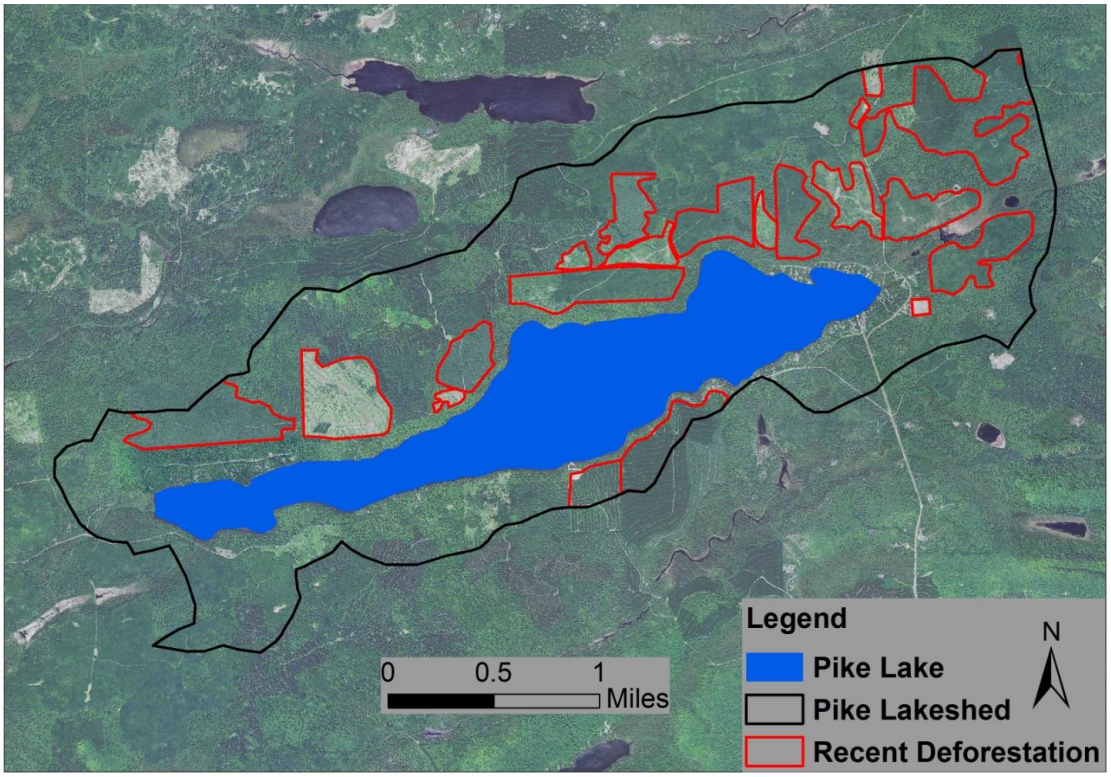


Figure 18. Areas within Pike Lake lakeshed with evidence of deforestation within the past 25 years.

Demographics

Pike 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 Cook County as a whole, the unorganized territories within Cook County have a higher extrapolated growth projection (Figure 19).
(source:http://www.demography.state.mn.us/resource.html?Id=19332)

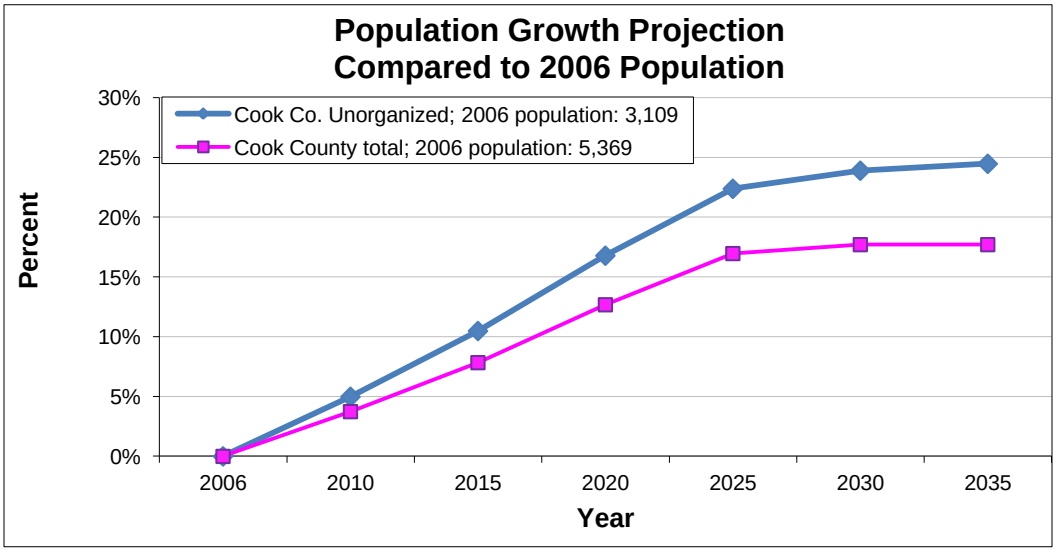


Figure 19. Population growth projection for Cook County, MN and unorganized territories within Cook County, MN.

Pike 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 Pike Lake's lakeshed is publicly owned and forested (Table 11). This land can be the focus of development and protection efforts in the lakeshed. Forested upland is also the primary land use/land cover type on private lands.

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

	Private (11%)					20%	Public (69%)		
	Developed	**Agriculture**	**Forested Uplands**	**Other**	**Wetlands**	**Open Water**	**County**	**State**	**Federal**
Land Use (%)	0.6	0	8.5	1.5	0.4	20	0	4.5	64.5
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 Acreage x runoff coefficient	11–36	0	30		1		0	16	230
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.

Pike Lake's lakeshed is classified with having 83.3% of the watershed protected and 0.16% of the watershed disturbed (Figure 20). Therefore, this lakeshed should have a vigilance focus. Goals for the lake should be to maintain the protected status. Figure 21 displays the surface area that contributes water to the lakeshed of interest. All of the land and water area in this figure has the potential to contribute water to Pike Lake. This particular lakeshed is a headwaters watershed, which means no additional lakesheds drain to the Pike Lake lakeshed.

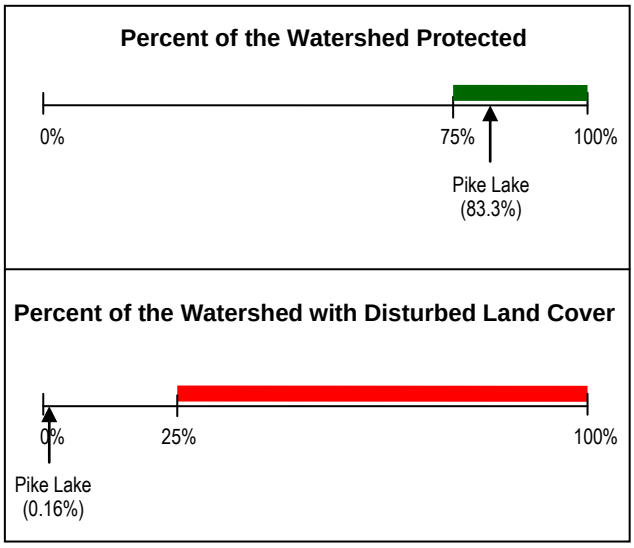


Figure 20. Pike Lake's lakeshed percentage of watershed protected and disturbed.

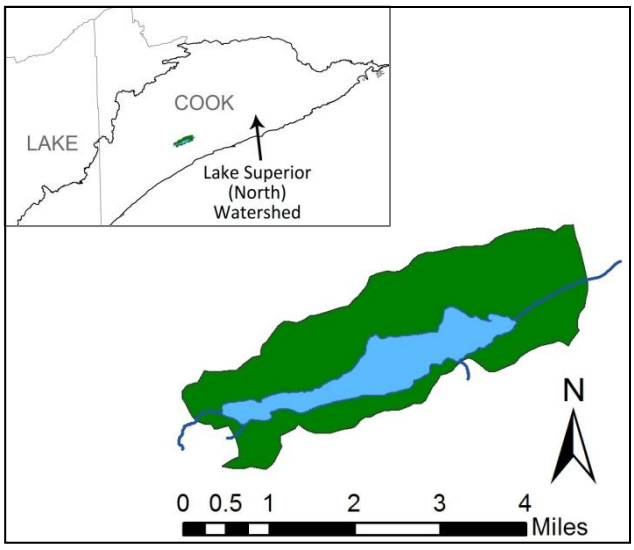


Figure 21. Upstream lakesheds that contribute water to the Pike lakeshed. Color-coded based on management focus (table 12).

Status of the Fishery (DNR, as of 07/20/2009)

Walleye were abundant in Pike Lake in 2009. Although walleye sampled were small on average, that was typical of what has been seen in this lake historically. All walleye collected in 2009 had been produced naturally, since the lake had not been stocked since 1977. Several good year classes were present, including a strong one produced in 2006. Walleye growth rates had been average for the area; three-year-old fish reached an average length of 11.9 inches at the end of their third year.

Pike Lake supported a high-quality smallmouth bass population in 2009. Fish were abundant, and were larger than usual for a lake of this type. A high percentage of the smallmouth bass collected were over 12 inches in length. Several year classes were included in the catch, including strong 2007 and 2005 year classes. Smallmouth bass growth rates had been fairly fast (for this area). Four-year-old fish reached an average length of 10.9 inches at the end of their fourth year.

Northern pike were abundant, but small. The lack of larger fish was unusual for this lake. No northern pike older than four years were taken. Growth rates had been close to average for the area. This lake has the potential to produce some trophy northern pike, due to the availability of cool-water refuge areas, large numbers of yellow perch, and lake whitefish to provide high-quality forage.

Yellow perch were abundant, although their numbers did not match historic levels in this lake. Yellow perch taken in 2009 were also large, with over half the fish taken in gill nets exceeding nine inches in length. Yellow perch provided some excellent angling opportunity, as well as serving as the primary forage for walleye and northern pike.

The lake whitefish gill net catch was within the normal range for the lake class, while the mean weight for lake whitefish taken in gill nets was higher than normal. From the lengths of the fish collected, it appeared that at least four year classes were included in the catch. The smaller lake whitefish present would have provided high-quality forage for larger northern pike. The lake whitefish population appears to have recovered completely from its low in the 1980s, when none were taken in two consecutive assessments.

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=16025200

Key Findings / Recommendations

Monitoring Recommendations

Monitoring for Pike Lake hasn't been done consistently at a primary site. The data is much more useful for determining water quality trends when it is focused on one site that best represents the lake. The primary site for Pike Lake should be site 205 (Figure 1). Transparency monitoring at site 205 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. Total Phosphorus and chlorophyll a monitoring should continue, as the budget allows, to track trends in water quality.

Overall Summary
Pike Lake is in great shape for water quality, and the watershed is very well protected and forested. Pike is an oligotrophic lake (TSI=36) with no detectable trends in water quality. Sixty-nine percent (69%) of the lakeshed is in public ownership, and 83% of the lakeshed is protected, while 0.2% of the lakeshed is disturbed (Figure 19). Only about 3% of the lakeshed is not covered by forest, when excluding the lake's surface area.

Pike Lake is at an advantage in that it is a headwaters catchment. This means that no other lakes flow into it, and the main impact to the lake is the land use occurring in the lakeshed.

Priority Impacts to the lake
A potential priority impact to Pike Lake is land disturbance from deforestation in the lakeshed. Close to 28% of the total land area within the lakeshed appears to have been logged within the last 25 years. Clearing forest cover and extending roads networks into forested areas changes the hydrology within a lakeshed. When forests are cleared near the shoreline of a lake, increased runoff from rain may impact lake water quality.

A secondary impact to Pike Lake would be an increase in development. While less than half of the shoreline area is in private ownership, undeveloped private parcels remain near the lake. In the future there may be significant pressure to sell and develop these properties.

Best Management Practices Recommendations
The management focus for Pike Lake should be to protect the current water quality and limit the effect of additional development within the lakeshed. Strategies include adopting forestry stewardship practices on private lands, enforcing shoreland ordinances, restoring lake shoreline, adopting smart development techniques, and continuing septic system checks and maintenance. The Minnesota Forest Resource Council has produced guidelines for protecting riparian areas at: http://www.frc.state.mn.us/initiatives_sitelevel_management.html.

Organizational contacts and reference sites

Cook County Soil and Water Conservation District	Cook County Courthouse, 411 W. 2nd Street, Grand Marais, MN 55604 218-387-3647 http://www.co.cook.mn.us/index.php/government/departments/soil-and-water
DNR Fisheries Office	1356 Highway 61 East, Grand Marais, MN 55604 218-387-3056 grandmarais.fisheries@state.mn.us
Regional Minnesota Pollution Control Agency Office	525 Lake Avenue South, Suite 400, Duluth, MN 55802 218-723-4660, 1-800-657-3864 http://www.pca.state.mn.us/index.php/about-mpca/mpca-overview/agency-structure/mpca-offices/duluth-office.html