Pine Lake 15-0149-00 CLEARWATER COUNTY

Lake Water Quality

Summary

Pine Lake is located 3 miles west of Clearbrook, MN in Clearwater County. It is a large shallow lake, with a surface area of 1,238 acres with a maximum depth of 15 ft.

Pine Lake has three inlets and one outlet, which classifies it as a drainage lake (Figure 1). One stream inlet, located along the southeast shore, flows from the outlet of Little Pine Lake. A second inlet, the Lost River, flows into Pine Lake along the southwest shore and a small, intermittent creek inlet is located along the northwest shore. The outlet (Lost River) is located near the middle of the north shore. The river takes a northern path out of the lake, eventually turning west before it meets up with the Clearwater River 9 miles east of Red Lake Falls.

Water quality data have been collected on Pine Lake in 1989, 1990-1992, 2007-2010 (Tables 2-3). These data show that the lake is at the mesotrophic/eutrophic border (TSI 49-51), which characteristically has moderately clear water most of the summer and abundant aquatic plant growth (page 9).

The Property Owners of Pine Lake Association are active in many activities, including walleye stocking, mosquito pest management, maintaining recreational areas (i.e. boat landing) and a Labor Day celebration.

Table 1. Pine Lake location and key physical characteristics.

Location Data		Physical Characteristics	
MN Lake ID:	15-0149-00	Surface area (acres):	1,238
County:	Clearwater	Littoral area (acres):	1,188
Ecoregion:	Central Hardwood Forests	% Littoral area:	96%
Major Drainage Basin:	Red River	Max depth (ft), (m):	15, 4.5
Latitude/Longitude:	47.695825,-95.521402	Inlets:	3
Invasive Species:	None as of 2011	Outlets:	1
		Public Accesses:	2

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

Data Availability

Transparency data		There is not enough transparency data for trend analysis. Taking Secchi disk readings consistently is a great way to track water quality.
Chemical data		There are two years (2008-2009) of total phosphorus and chlorophyll a data. This is sufficient for assessment of the current lake water quality.
Inlet/Outlet data		Inlet and outlet data have been collected in the 1990s and 2000s.

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

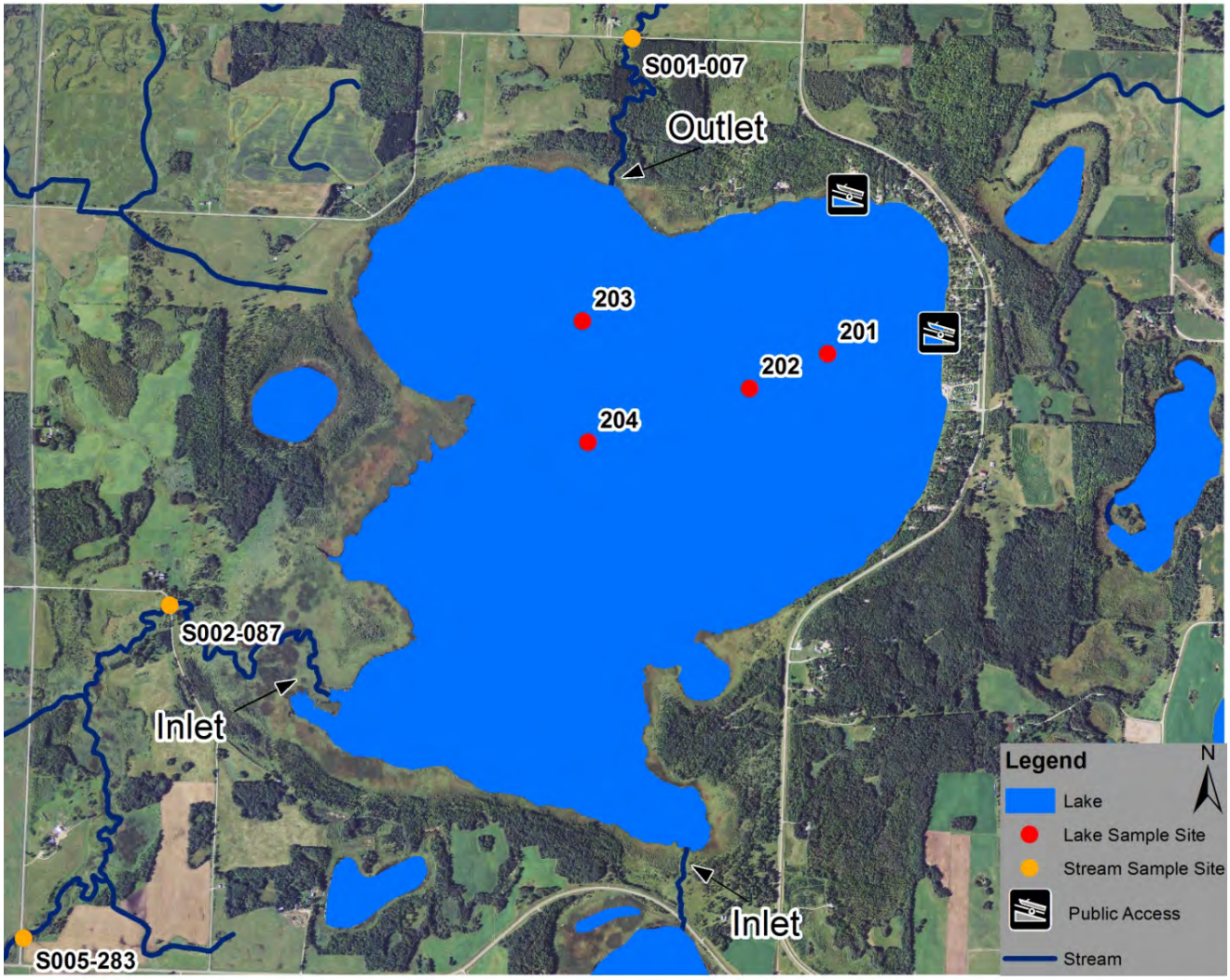

Figure 1. Map of Pine Lake with 2010 aerial imagery and illustrations of lake areas, sample site locations, inlets and outlets, and public access points.

Table 3. Monitoring programs and associated monitoring sites.

Lake Site	Depth (ft)	Monitoring Programs
201	10	CLMP: 1989
202	10	CLMP: 1990-1992, 2007-2010
203	12	CLMP: 2007-2009; County Monitoring: 2008, 2009
204	15	CLMP: 2007

Acronyms
Minnesota Pollution Control Agency (MPCA)
Citizen Lake Monitoring Program (CLMP)
Clean Water Partnership (CWP)

Water Quality Characteristics - Historical Means and Ranges

Table 4. Water quality means and ranges for primary sites. Site 203 was monitored in 2007 and 2008 (2010 secchi depth only). Site 202 secchi depth monitored 1990-1992, 2007-2010.

Parameters	Primary Site 203	Site 202
Total Phosphorus Mean (ug/L):	**25**	
Total Phosphorus Min:	17	
Total Phosphorus Max:	42	
Number of Observations:	12	
Chlorophyll *a* Mean (ug/L):	**6**	
Chlorophyll-a Min:	3	
Chlorophyll-a Max:	9	
Number of Observations:	12	
Secchi Depth Mean (ft):	**7.2**	**8.2**
Secchi Depth Min:	3	5
Secchi Depth Max:	11	10
Number of Observations:	34	55

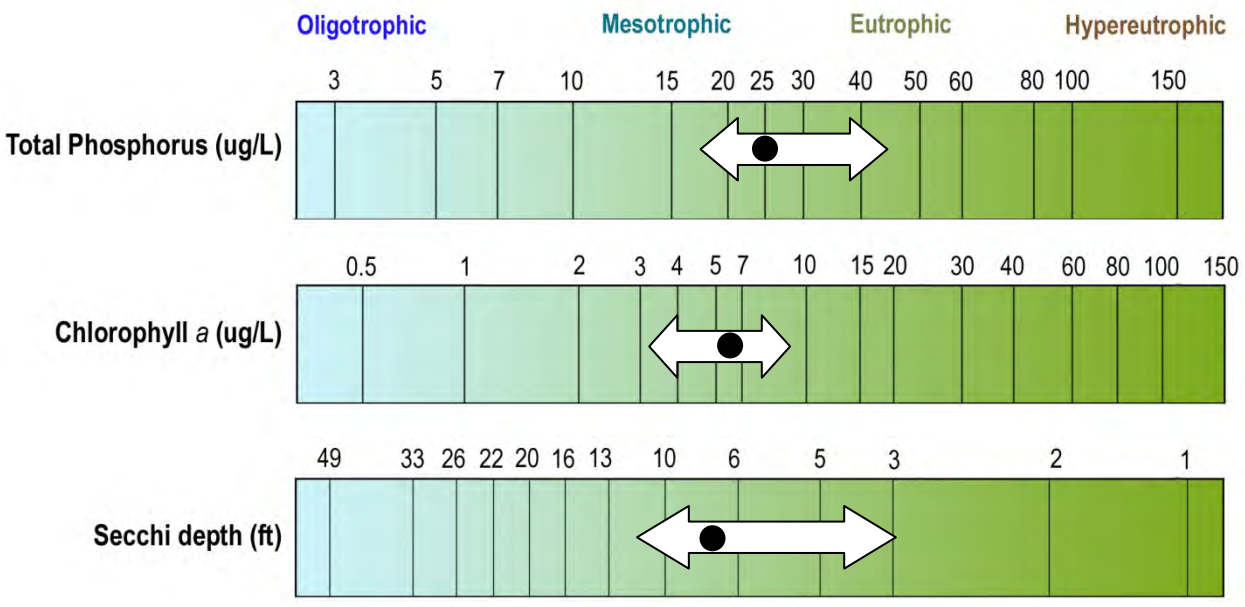

Figure 2. Pine Lake total phosphorus, chlorophyll *a* and transparency historical ranges. The arrow represents the range and the black dot represents the historical mean (Primary Site 203). Figure adapted after Moore and Thornton, [Ed.]. 1988. Lake and Reservoir Restoration Guidance Manual. (Doc. No. 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 ranges from 5.8 to 9.3 feet in Pine Lake. The transparency throughout the lake appears to be relatively uniform (Figure 3).

With only 3 years of secchi data at the primary site (site 203), a trend analysis could not be completed. Site 202 has 7 years of data, but it spans a range of 20 years. Transparency monitoring should be continued annually at sites 203 and 202 in order to track water quality changes.

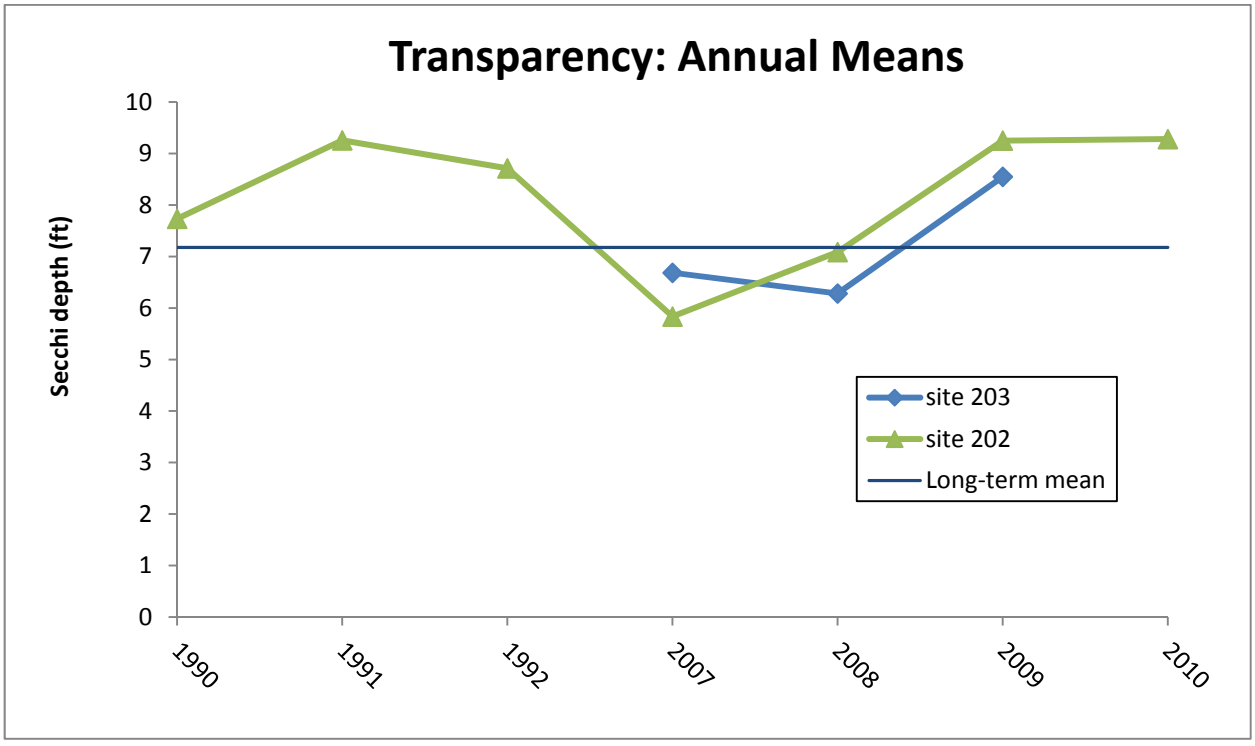

Figure 3. Annual mean transparency compared to long-term mean (site 203) for sites 203 and 202.

Pine Lake transparency ranges from 5 to 10 ft at site 202. Figure 4 shows the seasonal transparency dynamics. Pine Lake transparency remains fairly consistent throughout the summer. There appears to be more variation between years than within years. The lack of variation within years may be due to the depth of Pine Lake. It is likely that Pine Lake mixes several times throughout the summer because it is a shallow lake.

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.

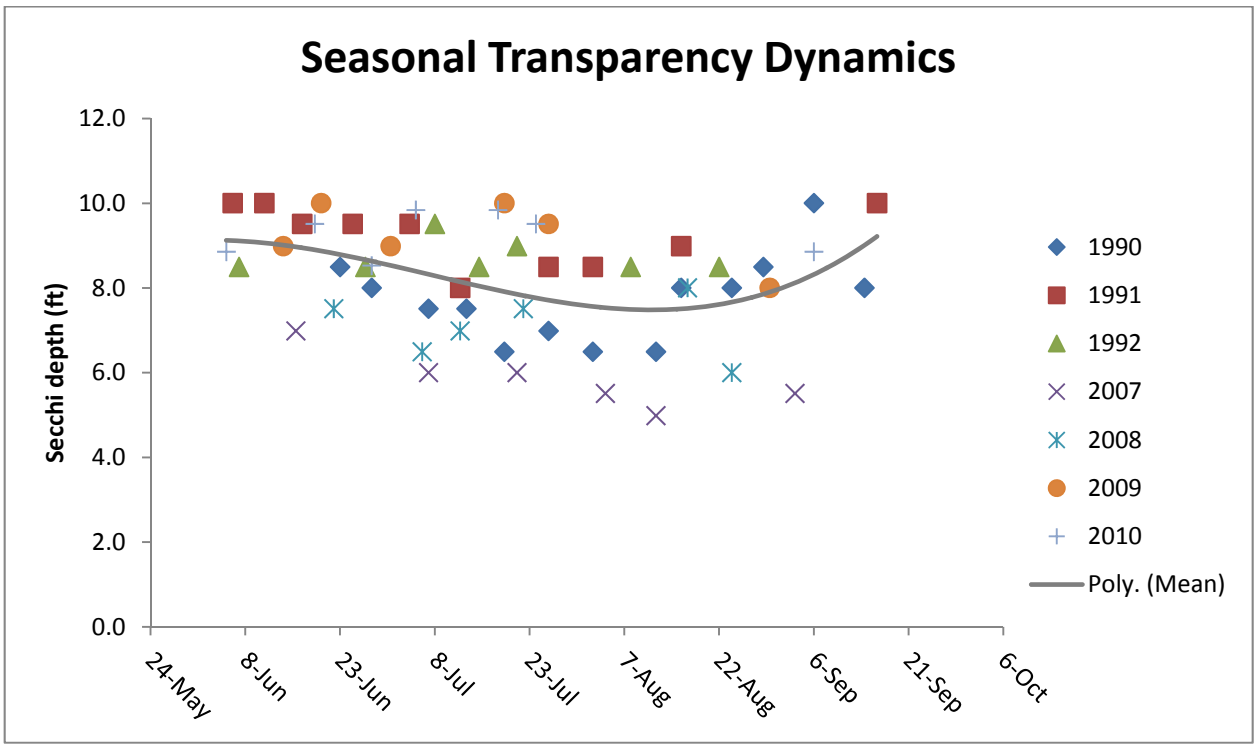

Figure 4. Seasonal transparency dynamics and year to year comparison (site 202). The grey line represents the pattern in the data.

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. Pine Lake was rated as being "crystal clear" 4% of the time between 1990-1992 and 2007-2010.

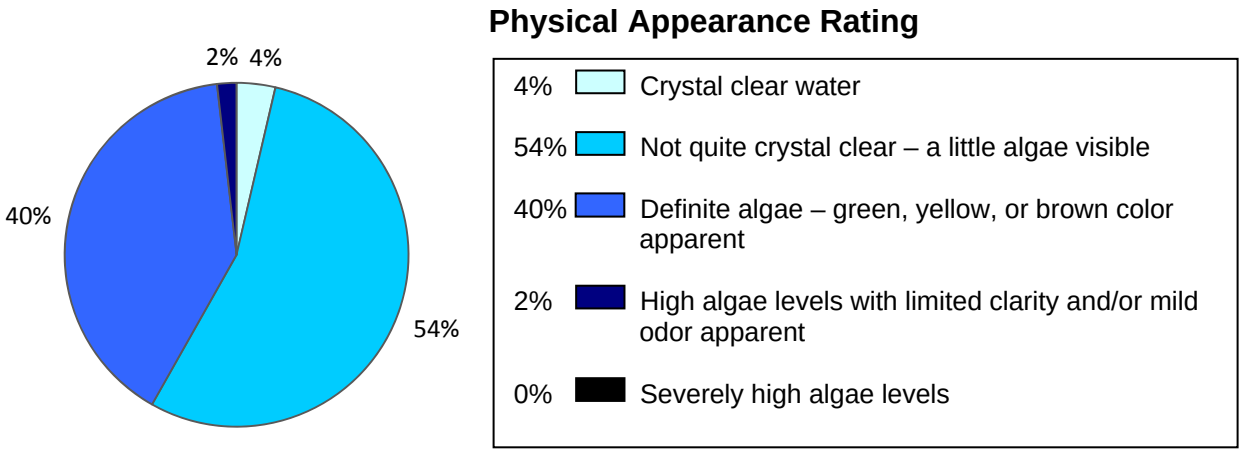

Figure 5. Physical appearance rating at site 202, as rated by the volunteer monitor (1990-1992 and 2007-2010).

As the secchi depth decreases, the perception of recreational suitability of the lake decreases. Pine Lake was rated as having “very minor aesthetic problems" 58% of the time from 1990-1992 and 2007-2010.

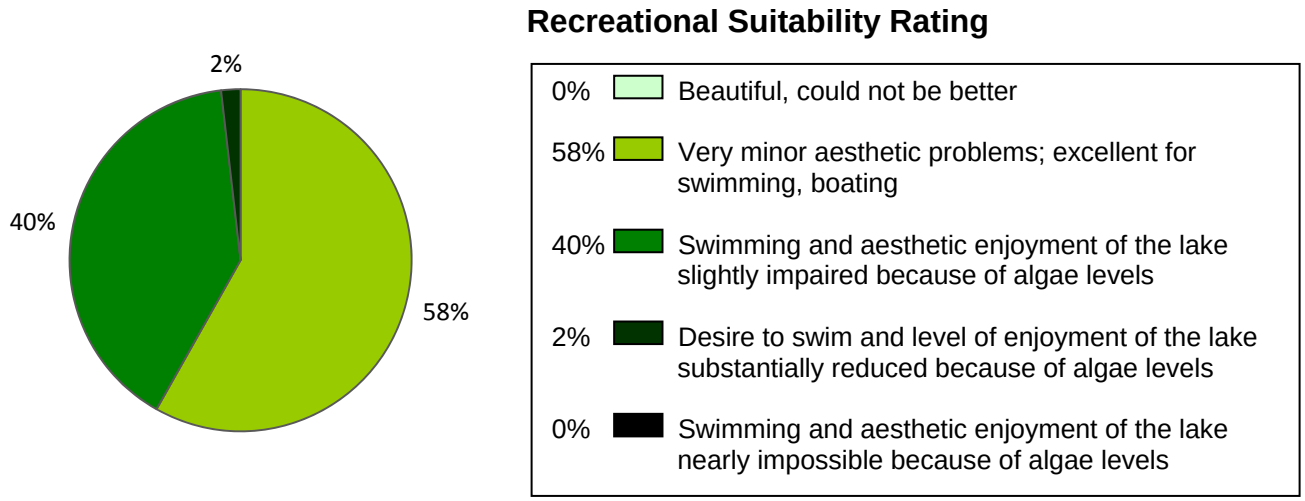

Figure 6. Recreational suitability rating at site 202, as rated by the volunteer monitor (1990-1992 and 2007-2010).

Total Phosphorus

Most lakes in Minnesota are phosphorus limited. Pine Lake does not have nitrogen data, so a nitrogren to phosphorus ratio cannot be calculated.

Total phosphorus was evaluated in Pine Lake June through September in 2008 and 2009 (site 203) and May through September in 2007 (site 204). The data do not indicate much seasonal variability (Figure 7). Most results are near that mesotrophic/eutrophic boundary, with a few results higher.

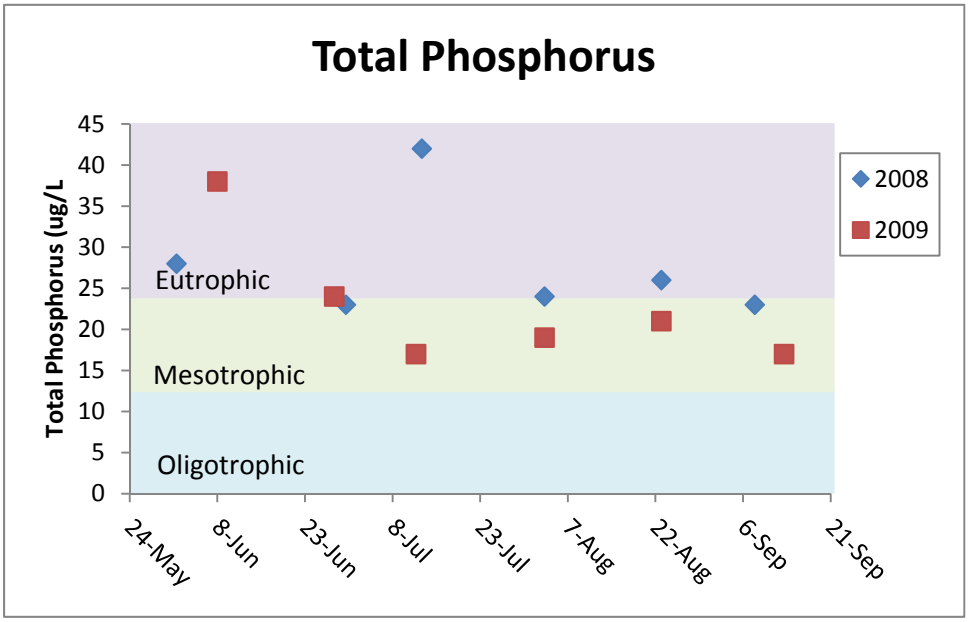

Figure 7. Historical total phosphorus concentrations (ug/L) for Pine Lake at site 203.

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.

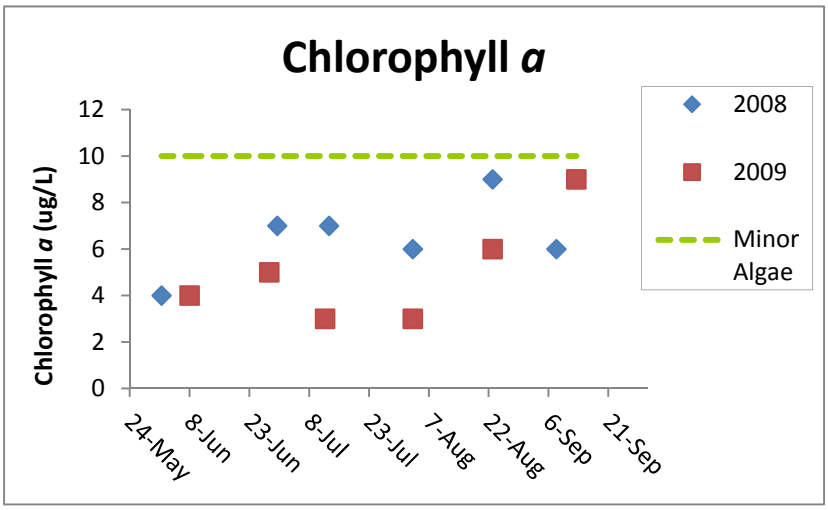

Figure 8. Chlorophyll *a* concentrations (ug/L) for Pine Lake at site 203.
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Chlorophyll *a* was evaluated in Pine Lake June through September in 2008 and 2009 (site 203) and May through September in 2007 (site 204). Chlorophyll *a* concentrations for all dates at site 203 remained below 10 ug/L, indicating clear water most of the summer (Figure 8). There was not much variation within site 203; however, site 204 was monitored in 2007 and 3 of the 5 results were over 10 ug/L. The highest result at this site was 20 ug/L on 9/25/07. There is a line of submergent vegetation from north to south near the indent on the north shore. There is the potential to get increased chlorophyll readings if an individual sample is too close to this submergent vegetation.

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.

No dissolved oxygen data was available for Pine Lake. It is not uncommon for shallow lakes to mix throughout the season, due to wind. If the lake did stratify due to differences in temperature, it is more difficult for the entire profile to mix.

One year of dissolved oxygen data would be helpful for understanding the lake's mixing dynamics and fisheries depths.

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 the main site of Pine Lake is on the border between mesotrophic and eutrophic (49-51) (Figure 9). There is good agreement between the TSI for phosphorus, chlorophyll *a* and transparency, indicating that these variables are strongly related.

Mesotrophic lakes (TSI 40-50) are characterized by moderately clear water most of the summer. "Meso" means middle or mid; therefore, mesotrophic means a medium amount of productivity (Table 6). Mesotrophic lakes have clear water with algal blooms in late summer. They are also good for walleye fishing. Eutrophic lakes are usually shallow, and are found where the soils are fertile. Eutrophic lakes usually have abundant aquatic plants and algae.

Table 5. Trophic State Index for site 203.

Trophic State Index	Site 203
TSI Total Phosphorus	50
TSI Chlorophyll-a	47
TSI Secchi	50
TSI Mean	49
Trophic State:	Mesotrophic/eutrophic

Numbers represent the mean TSI for each parameter.

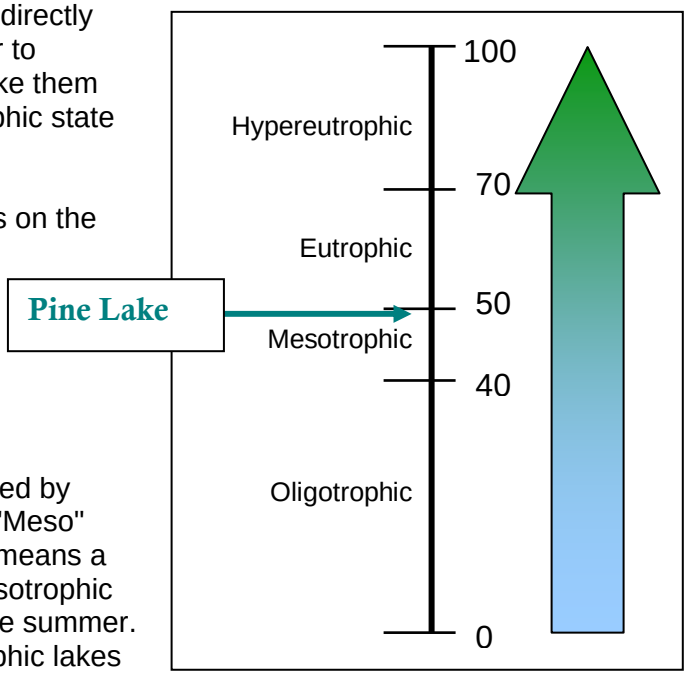


Figure 9. Trophic state index chart with corresponding trophic status.

Table 6. Trophic state ranges and attributes.

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

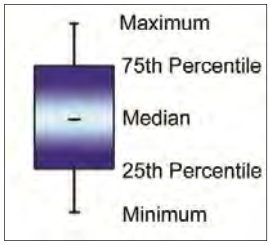
Source: Carlson, R.E. 1997. A trophic state index for lakes. *Limnology and Oceanography*. 22:361-369.

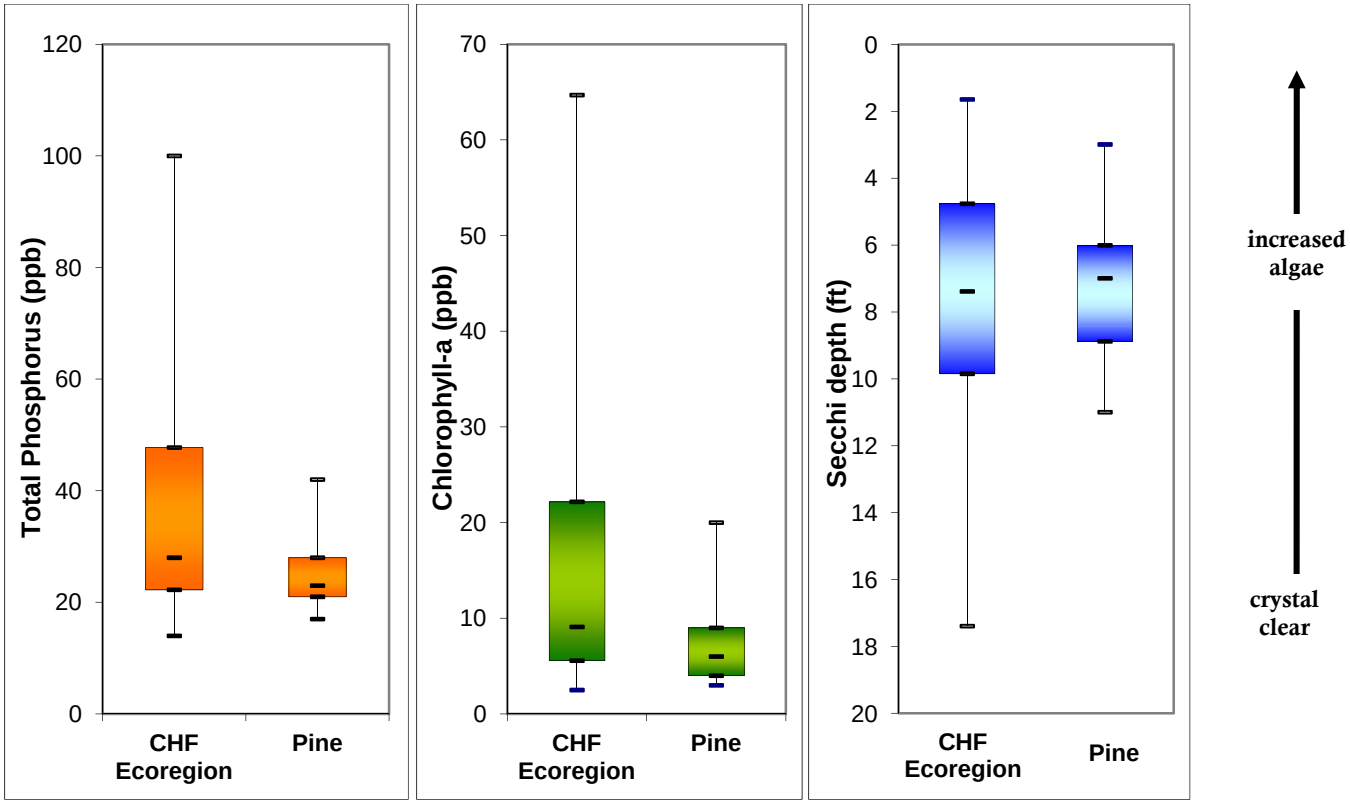
Ecoregion Comparisons

Minnesota is divided into 7 ecoregions based on land use, vegetation, precipitation and geology (Figure 10). 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 10. Map of Minnesota with the seven ecoregions.

Pine Lake is in the Central Hardwoods Forests (CHF) Ecoregion. The mean total phosphorus, chlorophyll a and transparency (Secchi depth) for Pine are all within the expected ecoregion ranges (Figure 11). Pine Lake is located on the border of the narrow, northern sliver of the CHF ecoregion and the Red River Valley Ecoregion. It is unique that Pine Lake is located within 4 miles of 4 different ecoregions.





Figures 11a-c. Pine Lake ranges compared to Central Hardwood Forests Ecoregion. The Pine Lake total phosphorus and chlorophyll *a* ranges are from 12 data points collected in May-September of 2008-2009. The Pine Lake secchi depth range is from 34 data points collected in May-September from 2007-2009.

Inlet/Outlet Assessment

Pine Lake has three inlets and one outlet (Figure 12). The main inlet (Lost River, S002-087) and the outlet (Lost River, S001-007) have been monitored in the 1990s and 2000s.

When compared to the ecoregion ranges for streams, the data fit very well (Table 7). The phosphorus concentration and pH at the outlet is similar to the in-lake concentration, which is typical (Figure 13).

The total phosphorus concentration at the inlet is slighly higher than the ecoregion range. This could be due to disturbance in the watershed (see page 16). A large proportion of the total phosphorus concentration at the inlet is soluable reactive phosphorus (ortho-phosphate), which is another indicator of disturbance. Watershed disturbance could include agriculture and urban development.

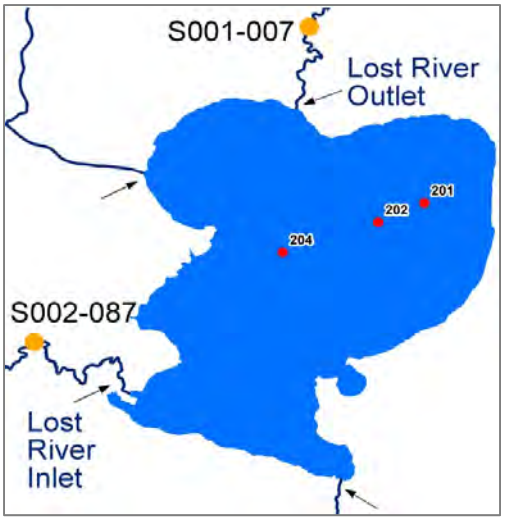


Figure 12. Map of Pine Lake and its inlets and outlets.

Table 7. Monitoring results (1990-2009 means) for Pine Lake stream sites compared to the Ecoregion range.

Site Description	**N+N** (mg/L)	**TP** (ug/L)	**OP** (ug/L)	**TSS** (mg/L)	**Turbidity** (NTU)	**Field pH**
Inlet (S002-087)	0.08	78	50	3.6	3.5	7.7
Outlet (S001-007)	0.05	29	10	3.9	4.0	8.3
Ecoregion Range	0.01 - 0.09	20 - 50	NA	1.8 - 6	1.7 - 4.3	7.6 - 7.9

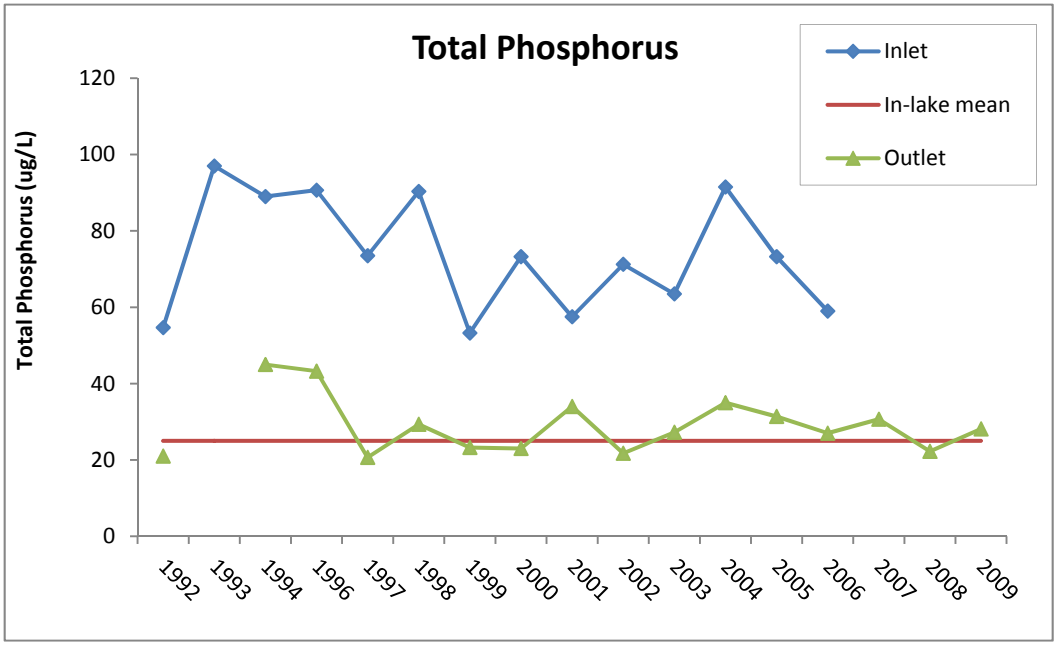


Figure 13. Total Phosphorus annual means for the inlet, outlet and lake.

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 **Clearwater River Major Watershed** is one of the watersheds that make up the Red River Basin, which drains north to Lake Winnipeg (Figure 14). This major watershed is made up of 88 minor watersheds. Pine Lake is located in **minor watershed** 66026 (Figure 15).

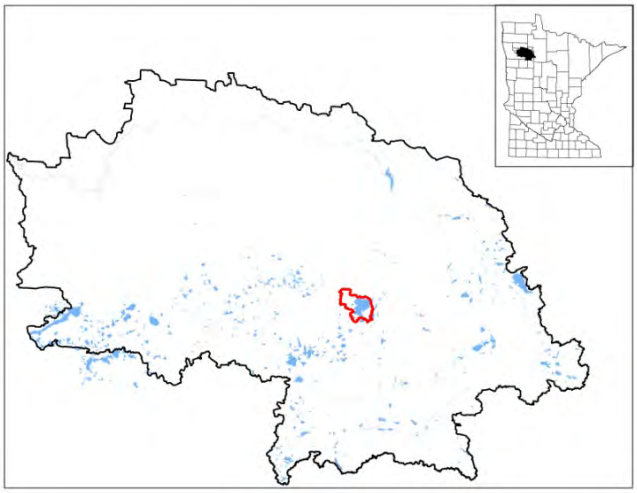


Figure 14. Clearwater River Watershed.

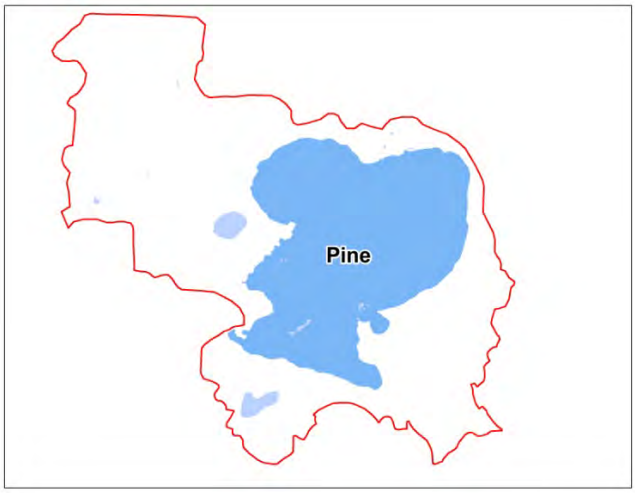


Figure 15. Minor Watershed 66026 contributes water to Pine Lake.

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. Pine Lake falls within the **6602600 lakeshed** (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 Pine Lake's full watershed, containing all the lakesheds upstream of Pine Lake lakeshed, see page 16. The data interpretation of the Pine Lake lakeshed includes only the immediate lakeshed, as this area is the land surface that flows directly into Pine Lake.

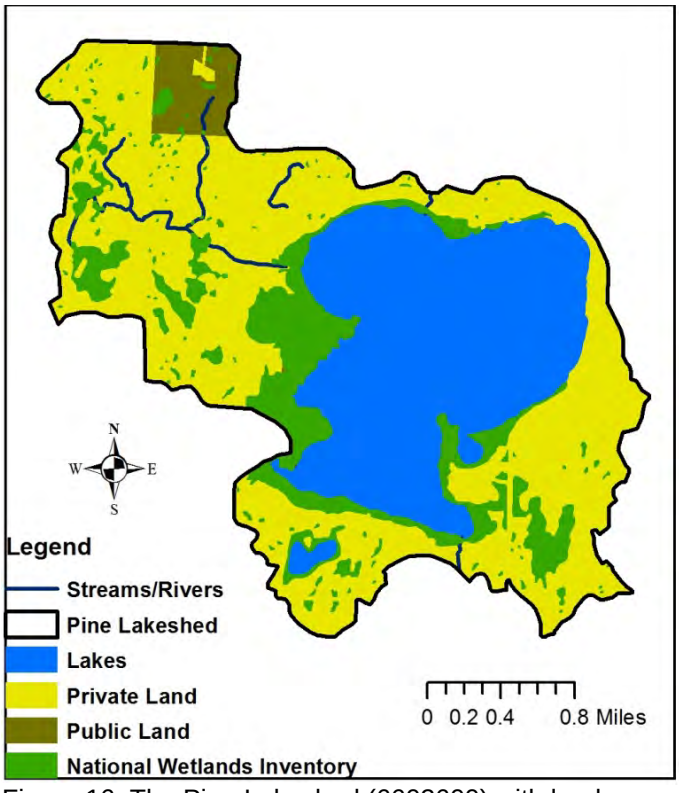


Figure 16. The Pine Lakeshed (6602600) with land ownership, lakes, wetlands, and rivers illustrated.

The lakeshed vitals table (Table 8) identifies where to focus organizational and management efforts for each lake. 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 8. Important characteristics of the land and lake area within a lakeshed, including management activities.

Lakeshed Vitals		Rating
Lake Area	1238 acres	descriptive
Littoral Zone Area	1188 acres	descriptive
Lake Max Depth	15 ft.	descriptive
Lake Mean Depth	NA	NA
Water Residence Time	NA	NA
Miles of Stream	3.8	descriptive
Inlets	3	
Outlets	1	
Major Watershed	66 – Clearwater River	descriptive
Minor Watershed	66026	descriptive
Lakeshed	6602600	descriptive
Ecoregion	Central Hardwood Forests	descriptive
Total Lakeshed to Lake Area Ratio (total lakeshed includes lake area)	3:1	
Standard Watershed to Lake Basin Ratio (standard watershed includes lake areas)	23:1	
Wetland Coverage	14%	
Aquatic Invasive Species	None	
Public Drainage Ditches	Present	
Public Lake Accesses	2	
Miles of Shoreline	10.8	
Shoreline Development Index	NA	NA
Public Land to Private Land Ratio	0.1:1	
Development Classification	Recreational Development	
Miles of Road	10.7	
Municipalities in lakeshed	None	
Forestry Practices	Resource Management Plan – July 2008	
Feedlots	None	
Sewage Management	Land use permits required septic systems to be up to state code; septic system compliance inventory completed in 1999	
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.

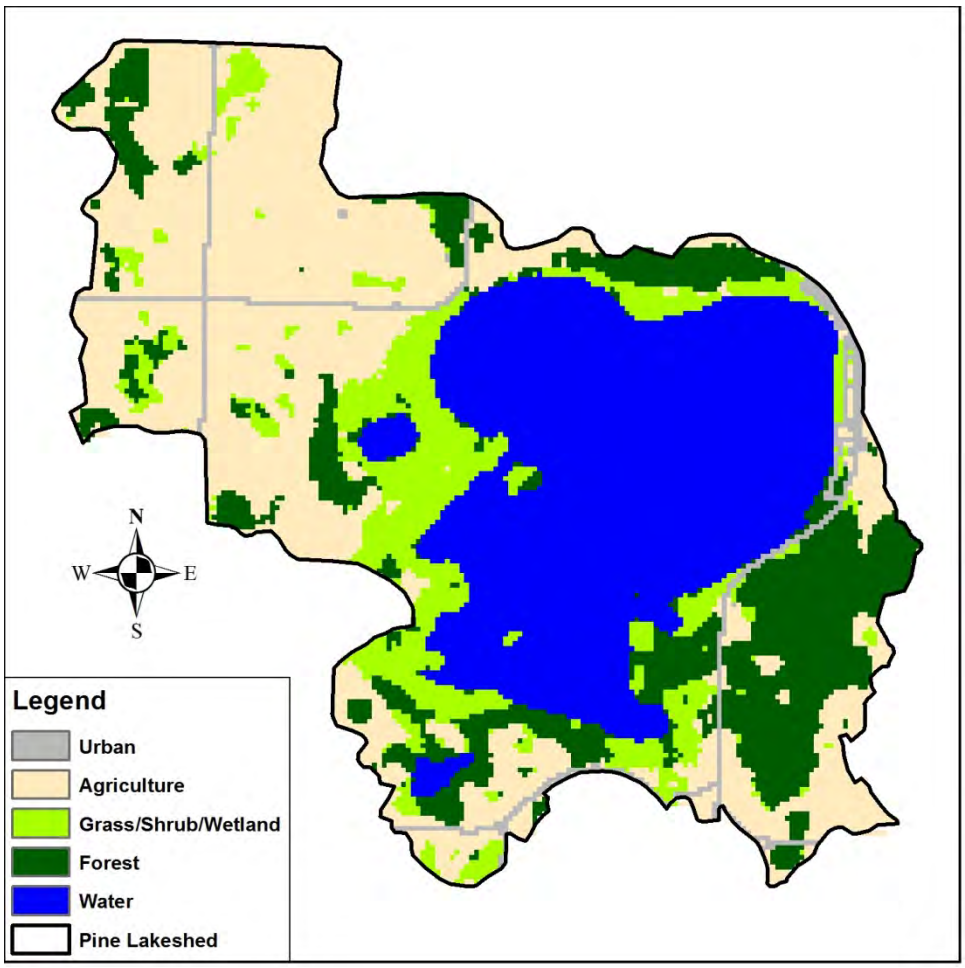


Figure 17. Pine (6602600) lakeshed land cover (http://land.umn.edu).

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 Pine 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 11 years old, it is the only data set that is comparable over a decade's time. Table 9 describes Pine 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 increase in forest cover (27.8%). In addition, the urban acreage has increased (4.9%), which has implications for storm water runoff into the lake.

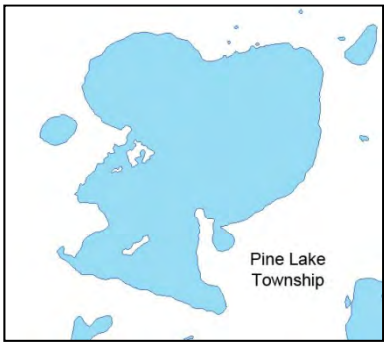
Table 9. Pine Lake's lakeshed land cover statistics and % change from 1990 to 2000 (http://land.umn.edu).

	1990		2000		% Change
Land Cover	**Acres**	**Percent**	**Acres**	**Percent**	**1990 to 2000**
Agriculture	1537	38.75	1363	34.37	11.3% Decrease
Grass/Shrub/Wetland	500	12.61	508	12.81	1.6% Increase
Forest	551	13.89	704	17.75	27.8% Increase
Water	1254	31.62	1261	31.8	0.6% Increase
Urban	122	3.08	128	3.23	4.9% Increase
Impervious Intensity %					
0	3876	97.78	3876	97.78	The impervious surface data did not have a high enough resolution to capture any changes from 1990-2000. The increase in urban acreage can be used as a surrogate for the increase in impervious intensity.
1-10	15	0.38	15	0.38	
11-25	24	0.61	24	0.61	
26-40	22	0.55	22	0.55	
41-60	18	0.45	18	0.45	
61-80	9	0.23	9	0.23	
81-100	0	0	0	0	
Total Area	3966		3966		
Total Impervious Area (Percent Impervious Area Excludes Water Area)	27	1	27	1	

Demographics

Pine 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. These projections are shown in Figure 18 below. Compared to Clearwater County as a whole, Pine Lake Township has a lower extrapolated growth projection.



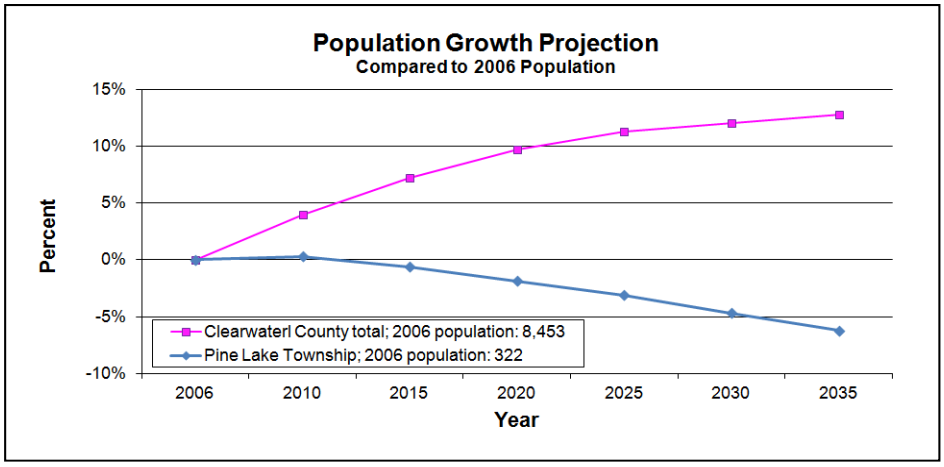


Figure 18. Population growth projection for Pine Lake Township and Clearwater County. (source: http://www.demography.state.mn.us/resource.html?Id=19332)

Pine 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 Pine Lake's lakeshed is made up of private agriculture (Table 10). This land can be the focus of protection efforts in the lakeshed such as restoring wetlands and implementing conservation practices.

Table 10. Land ownership, land use/land cover, estimated phosphorus loading, and ideas for protection and restoration in Pine lakeshed (Sources: Minnesota DNR GAP Stewardship data, National Wetlands Inventory, and the 2006 National Land Cover Dataset).

	Private (60%)					33%	Public (7%)		
	Developed	**Agriculture**	**Forested Uplands**	**Other**	**Wetlands**	**Open Water**	**County**	**State**	**Federal**
Land Use (%)	3.3%	18.8%	15.6%	8.5%	13.8%	33%	3.5%	3.5%	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 Acreage x runoff coefficient	60 – 201	199 – 689	57		54		13	13	
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 11). Watershed disturbance was defined as having urban, agricultural and mining land uses. Watershed protection is defined as publicly owned land or conservation easement.

Table 11. 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.

Pine Lake lakeshed is classified with having 45.7% of the watershed protected and 26.9% of the watershed disturbed (Figure 19). Therefore, Pine Lake should have a full restoration focus. This lake is just over the 25% disturbed threshold, so it is almost ranked in the light green (protection) category. Goals for the lake should be to reduce disturbed land use and install best management practices.

Figure 20 displays the upstream lakesheds that contribute water to the lakeshed of interest. All of the land and water area in this figure has the potential to contribute water to Pine Lake, whether through direct overland flow or through a creek or river. All of the upstream lakesheds to Pine Lake also have a full restoration focus.

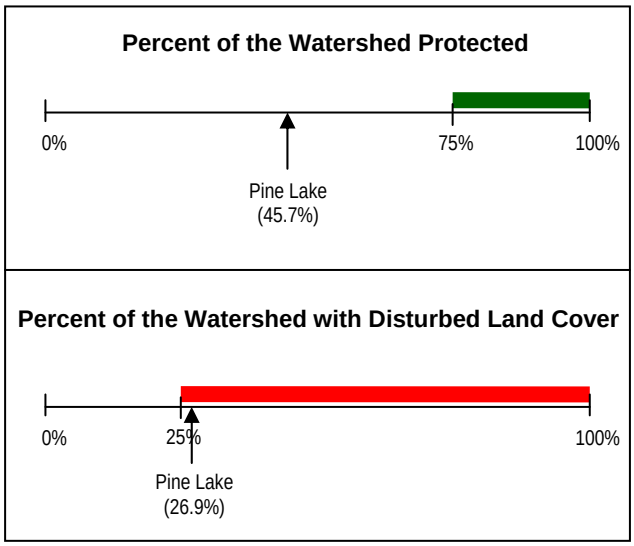


Figure 19. Pine Lake lakeshed's percentage of watershed protected and disturbed.

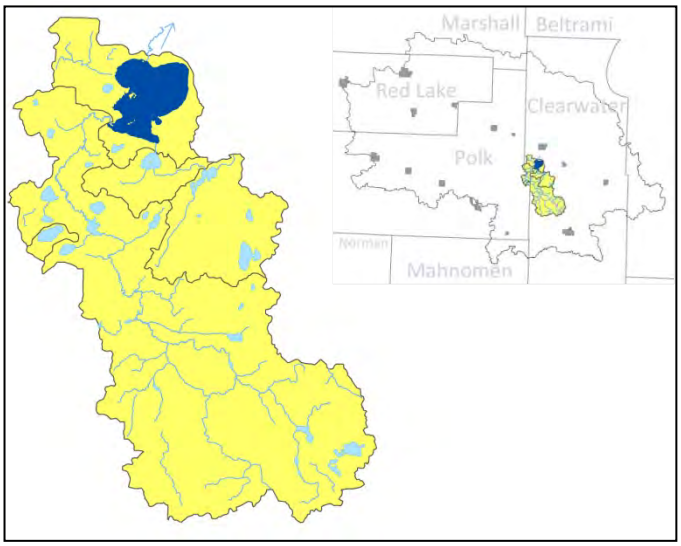


Figure 20. Upstream lakesheds that contribute water to the Pine Lake lakeshed. Color-coded based on management focus (table 11).

Status of the Fishery (as of 07/01/2008)

Pine Lake is a 1,188 acre lake located two miles south of Gonvick in west-central Clearwater County. It is a large, shallow (maximum depth of 15 feet) lake of moderate fertility and clarity with an abundance of aquatic vegetation. There is a public access in the northeast corner of the lake off of County Road 7. Pine Lake is one of the more popular fishing lakes in Clearwater County. In December of 2008, Pine Lake had more fish houses on the ice than any other lake in the county.

The Department of Natural Resources has categorized Minnesota's lakes into 43 different lake classes based on physical and chemical characteristics. Pine Lake is categorized as lake class 39, along with eight other Bemidji area lakes including Three Island, Irving, Minerva and Rogstad. Lakes in this class are typically shallow, characterized by large amounts of littoral area (area less than 15 feet deep), poor water clarity, and a regular shaped shoreline. Pine Lake is managed for walleye, northern pike and bluegill.

In the past, fisheries management on Pine Lake has been centered around winterkill management. Between 1977 and 1992, pump and baffle aeration was attempted with limited success. Walleye fry have been stocked annually since 1977, and other desirable species were frequently reintroduced following winterkill events. Walleye fry stockings were successful but the frequency of winterkill prevented population stability. Other introduced species had little time for reproduction and growth between winterkill events. In 1994, a blower/diffuser type aeration system was installed and has been successful in preventing winterkill.

From 1994 through 2005, walleye fry stocking continued to be successful and since year-classes persisted longer, walleye abundance improved. However, the trend of consistent walleye recruitment has faltered recently. This was evident during the past several fall electrofishing assessments (2006-2008), which have yielded a total of only one juvenile walleye. The recent decline in annual walleye recruitment was also evident in the summer population assessment with just one walleye caught that was younger than age three, and a considerably lower walleye catch rate.

Other shifts in fish community structure have occurred since successful aeration has stabilized the fish community. Many northern pike were captured in both the 2003 and 2008 assessments, with abundance well above average for lake class 39. Despite a higher density, northern pike also had greater average size than in earlier assessments. Pike grow fast in these productive waters and apparently successful aeration is allowing pike to live longer and reach larger sizes.

Sunfish species have also expanded their populations; these species include bluegill, pumpkinseed, black crappie, and largemouth bass. In the past two assessments (2003 and 2008), bluegill abundance ratings exceeded the historical range and were above average for lake class 39. Bluegill was the most common species captured in the 2008 assessment, comprising 38% of all fish in the sample.

Due to the gradual shift in species composition, walleye fry stocking may no longer be as effective as it once was. Panfish abundance has increased and the shallow lake basin does not provide walleye fry much open-water refuge from those species. However, a more diverse species composition appears to be an overall gain for the fishery.

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=15014900

Key Findings / Recommendations

Monitoring Recommendations
The transparency data for Pine Lake is very inconsistent. Transparency monitoring at site 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 monitoring in the lake and at the inlet will show the effectiveness of upstream restoration/protection projects in the watershed.

Priority Impacts to the lake
There is not enough data to perform a trend analysis on Pine Lake, so it is unknown if the lake is improving, steady, or declining. The main disturbance in Pine Lake's watershed is agriculture, which makes up the largest percentage (18.8%) of land cover in privately-owned land (page 15). Agricultural lands are concentrated in the northeast portion of the lakeshed and runoff from this section drains into Pine Lake through a network of public drainage ditches. In addition, because Pine Lake is a shallow lake, it is very important to protect native aquatic plant beds to preserve fish habitat and water clarity.

Best Management Practices Recommendations
Projects that would have the best chance of improving the water quality of Pine Lake include assisting area farmers with best management practices such as restoring wetlands, preserving their land through conservation easements, and education about protecting native aquatic plant beds.

Native aquatic plants stabilize the lake's sediments and tie up phosphorus in their tissues. When aquatic plants are uprooted from a shallow lake, the lake bottom is disturbed, and the phosphorus in the water column gets used by algae instead of plants. This contributes to "greener" water and more algae blooms.

Organizational contacts and reference sites

Property Owners of Pine Lake Association	www.pinelakepoopla.com
DNR Fisheries Office	2114 Bemidji Avenue, Bemidji, MN 56601 218-308-2339 http://www.dnr.state.mn.us/areas/fisheries/bemidji/index.html
Regional Minnesota Pollution Control Agency Office	714 Lake Ave., Suite 220, Detroit Lakes, MN 56501 Phone: 218-847-1519 Toll Free: 1-800-657-3864 http://www.pca.state.mn.us
Clearwater Soil and Water Conservation District	312 Main Avenue North, Suite 3, Bagley, MN 56621 Phone: 218-694-6845 http://www.clearwaterswcd.org/