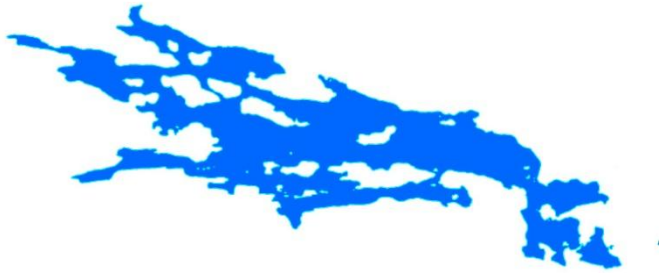
# Poplar Lake 16-0239-00 COOK COUNTY

## Lake Water Quality

## Summary



Poplar Lake is located 20 mile northwest of Grand Marais, MN in Cook County. It is a long and narrow lake covering 764 acres with numerous islands (Table 1).

Poplar Lake has seven inlets and one outlet, which classify it as a drainage lake. Several perennial streams drain into the western half of Poplar Lake including a connection from Skipper Lake. The outlet, Poplar Creek, drains from the southeastern bay towards Lake Superior.

An exceptional transparency dataset exists for Poplar Lake which ranges from 1989–2011; however, chemical data is limited (Tables 2–3). Data from the primary site show that the lake is oligotrophic (TSI = 39) with clear water conditions most of the summer and excellent recreational opportunities (page 9).

The Poplar Lake Association is involved in many activities including water quality monitoring, education, and is a member of the Cook County Coalition of Lake Associations which has pushed for updates in septic system management and advocated for changes to lakeshore zoning rules.

Table 1. Poplar Lake location and key physical characteristics.

| Location Data | | Physical Characteristics | |
|---|---|---|---|
| MN Lake ID: | 16-0239-00 | Surface area (acres): | 764 |
| County: | Cook | Littoral area (acres): | 343 |
| Ecoregion: | Northern Lakes and Forests | % Littoral area: | 45% |
| Major Drainage Basin: | Lake Superior - North | Max depth (ft), (m): | 73, 21 |
| Latitude/Longitude: | 48.04539871/-90.51010132 | Inlets: | 7 |
| Invasive Species: | None | Outlets: | 1 |
| | | Public Accesses: | 1 |

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

## Data Availability

| | | |
|---|---|---|
| Transparency data |  | Excellent data source from 1989–2011. |
| Chemical data |  | Limited data source from 2007–2011. |
| Inlet/Outlet data |  | Not available. |
| **Recommendations** | | **For recommendations refer to page 18.** |

# Lake Map

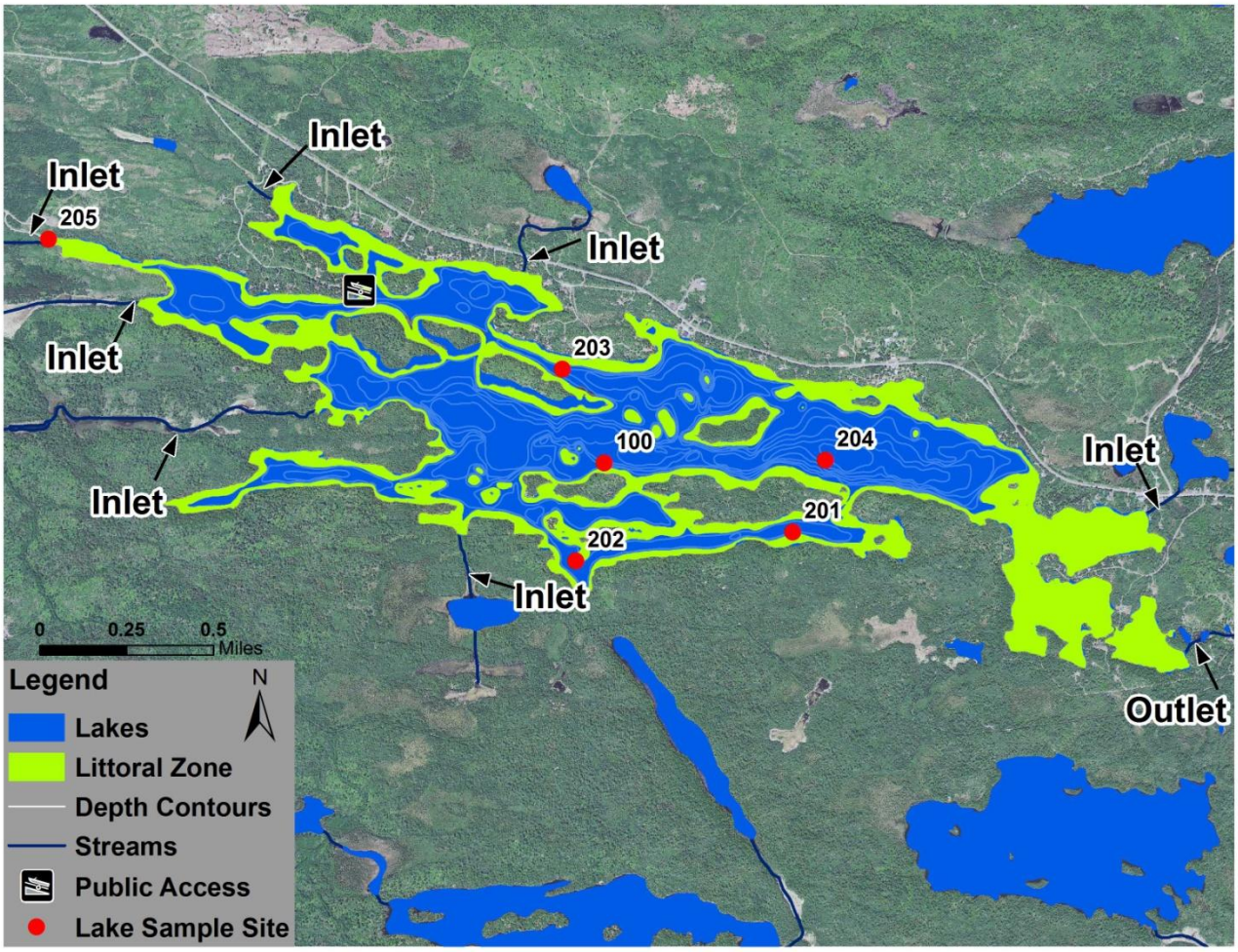



Figure 1. Map of Poplar Lake with 2010 aerial imagery and illustrations of lake depth contour lines, sample site locations, inlets and outlets, and public access points. The light green areas in the lake illustrate the littoral zone, where the sunlight can usually reach the lake bottom allowing aquatic 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 RMB Environmental Laboratories Lakes Program (RMBEL).

| Lake Site | Depth (ft) | Monitoring Programs |
|---|---|---|
| 100 | 30 | MPCA: 1980 |
| 202 | 20 | CLMP: 1989, 2009–2010 |
| 203 | 25 | CLMP:1989–2007 |
| 204 *Primary Site | 65 | CLMP: 2003, 2005–2006. RMBEL: 2007–2011 |
| 205 | NA | MPCA Mercury Monitoring: 2011 |

# Average Water Quality Statistics

The information below describes available chemical data for Poplar Lake through 2011 (Table 4). Data for all parameters is from the primary site 204 and reflects mean values from 2003 and 2005–2011.

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) | 10 | 14–27 | > 30 | Results are better than or within the expected range for the ecoregion. |
| [3]Chlorophyll *a* (ug/L) | 4 | 4–10 | > 9 | |
| Chlorophyll *a* max (ug/L) | 6 | <15 | | |
| Secchi depth (ft) | 10.3 | 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) | 0.44 | 0.40–0.75 | | Indicates insufficient nitrogen to support summer nitrogen-induced algae blooms. |
| Alkalinity (mg/L) | 13 | 40–140 | | Indicates high sensitivity to acid rain and poor buffering capacity. |
| Color (Pt-Co Units) | 30 | 10–35 | | Indicates moderate coloration, which is most likely brown stain from tannins. |
| pH | 7.8 | 7.2–8.3 | | Within 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) | 1.2 | 0.6–1.2 | | Within the expected range for the ecoregion. |
| Total Suspended Solids (mg/L) | 1.9 | <1–2 | | Within the expected range for the ecoregion. Indicates low suspended solids and clear water. |
| Conductivity (umhos/cm) | 23 | 50–250 | | Below the expected range for the ecoregion. |
| Total Nitrogen : Total Phosphorus | 44:1 | 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. Years monitored for chemical data: 2003, 2005–2011. Years monitored for secchi data: 1989–2011.

| Parameters | Primary Site 204 | Site 203 | Site 202 |
|---|---|---|---|
| **Total Phosphorus Mean (ug/L):** | **10** | | |
| Total Phosphorus Min: | 5 | | |
| Total Phosphorus Max: | 15 | | |
| Number of Observations: | 28 | | |
| **Chlorophyll *a* Mean (ug/L):** | **3** | | |
| Chlorophyll-a Min: | 1 | | |
| Chlorophyll-a Max: | 6 | | |
| Number of Observations: | 28 | | |
| **Secchi Depth Mean (ft):** | **10.3** | **13.3** | **9.8** |
| Secchi Depth Min: | 6.5 | 9.5 | 7.0 |
| Secchi Depth Max: | 14.0 | 18.5 | 13.5 |
| Number of Observations: | 42 | 113 | 26 |

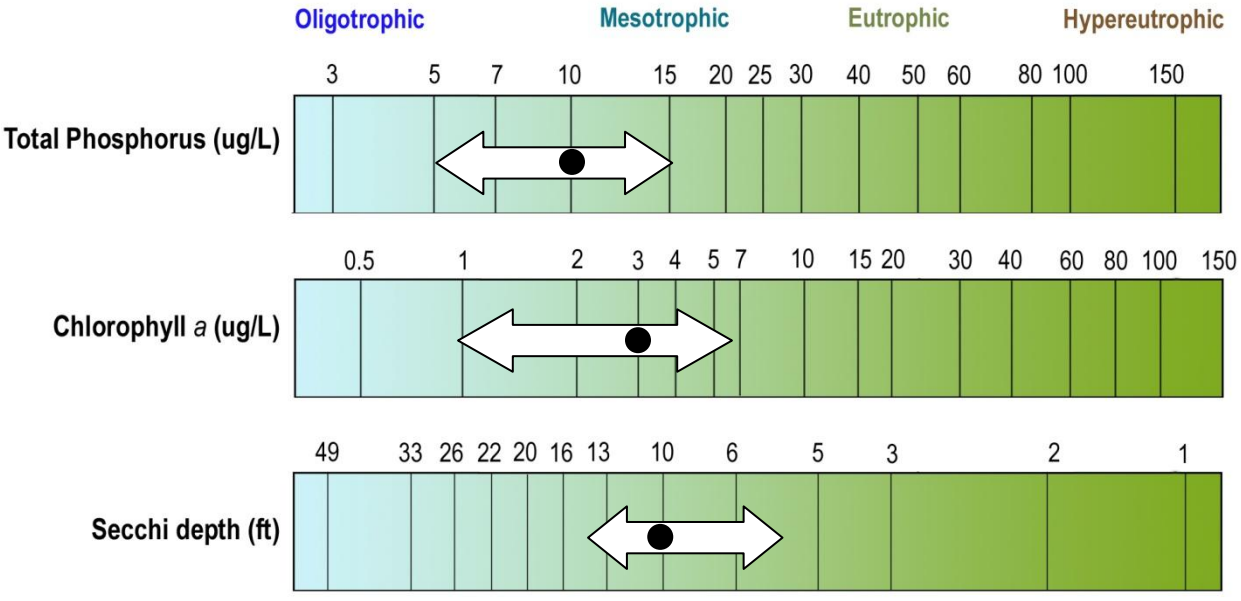



Figure 2. Poplar Lake total phosphorus, chlorophyll *a* and transparency historical ranges. The arrow represents the range and the black dot represents the historical mean (Primary Site 204). Figure adapted after Moore and Thornton, [Ed.]. 1988. Lake and Reservoir Restoration Guidance Manual. (Doc. No. 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 in Poplar Lake ranges from 8.0 to 15.6 feet (Figure 3). The transparency throughout the lake appears to be relatively uniform. The highest average transparency was at site 203 which has 19 years of historical secchi data. Transparency monitoring should be continued annually at site 204 in order to track water quality changes, and continuation of secchi readings at site 203 would be useful considering the long-term dataset that exists at this location.

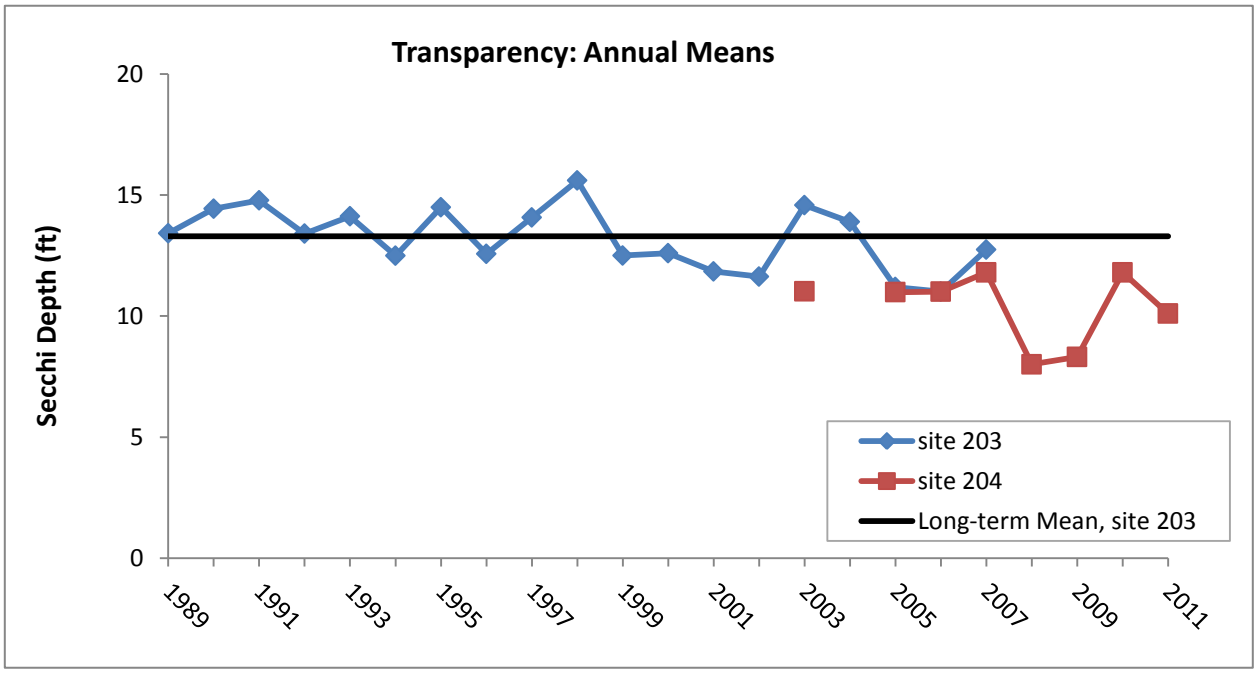



Figure 3. Annual mean transparency compared to long-term mean transparency, sites 203 and 204.

Poplar Lake transparency ranges from 6.5 to 14.0 ft at the primary site (Table 5). Figure 4 shows the seasonal transparency dynamics. The transparency remains fairly even all summer in Poplar 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.

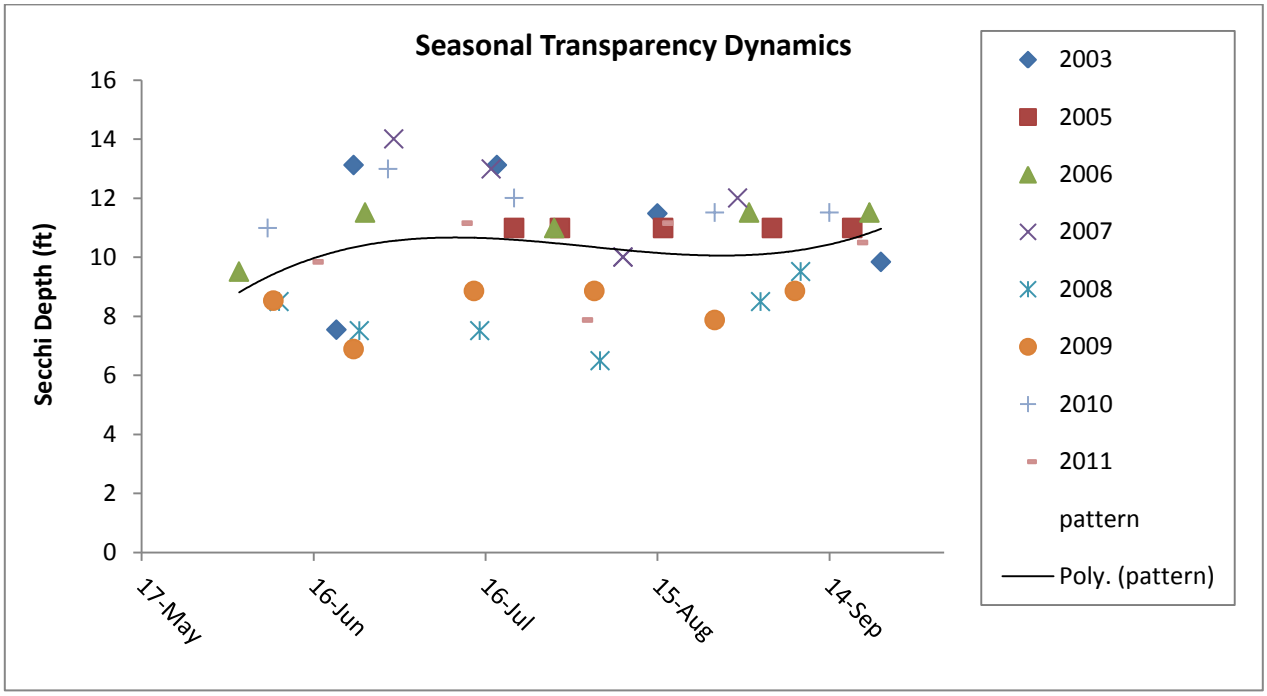



Figure 4. Seasonal transparency dynamics and year to year comparison (Primary Site 204). The black line represents the pattern in the data.

## 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. Poplar Lake was rated as being "not quite crystal clear" 56% of the time by samplers at site 204 between 2003 and 2011 (Figure 5).

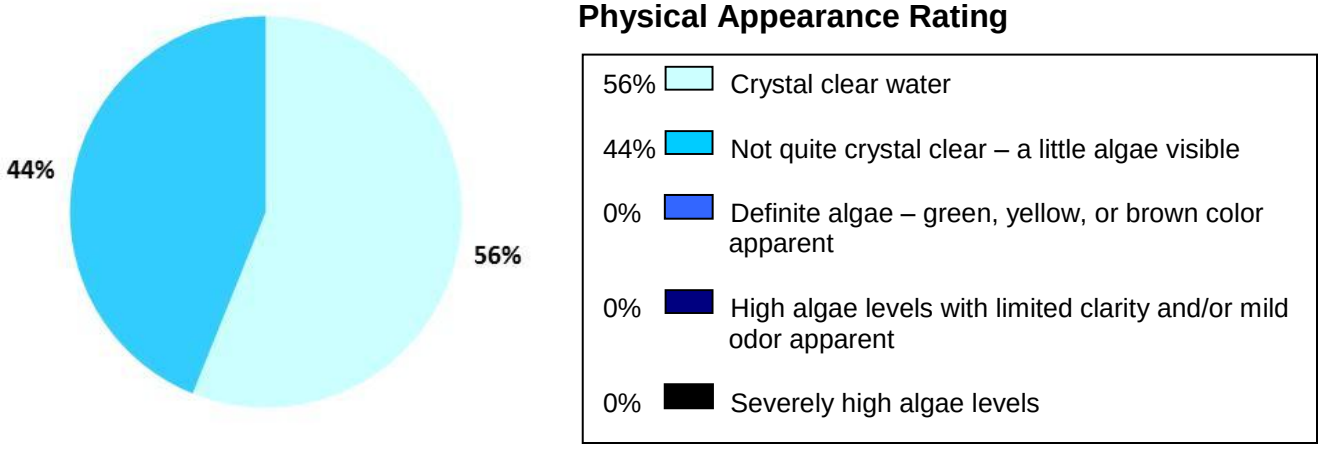



Figure 5. Poplar Lake physical appearance ratings by samplers at site 204.

As the secchi depth decreases, the perception of recreational suitability of the lake decreases. Poplar Lake was rated as being "beautiful" 71% of the time between 2003 and 2011 (Figure 6).

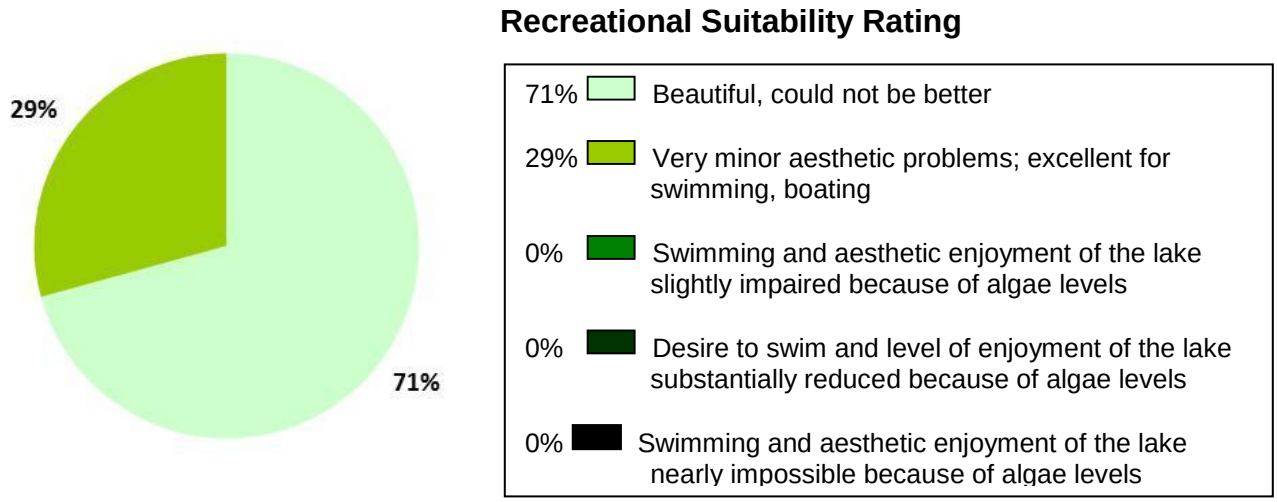



Figure 6. Recreational suitability rating, as rated by the volunteer monitor at site 204.

## Total Phosphorus

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

Total phosphorus was evaluated in Poplar Lake in 2003 and 2005–2011. The data do not indicate much seasonal variability. The majority of the data points fall in the oligotrophic range (Figure 7).

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

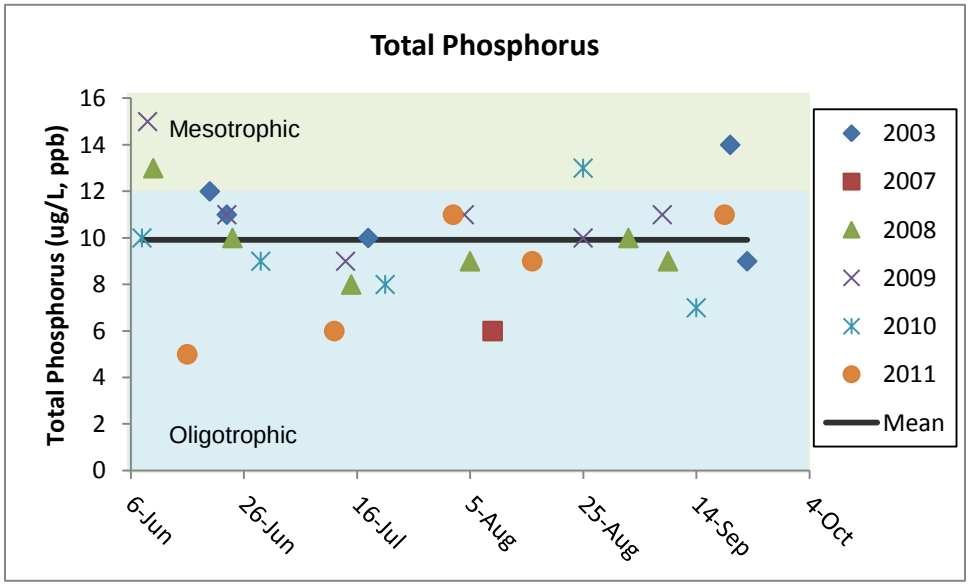



Figure 7. Historical total phosphorus concentrations (ug/L) for Poplar Lake site 204.

# 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.

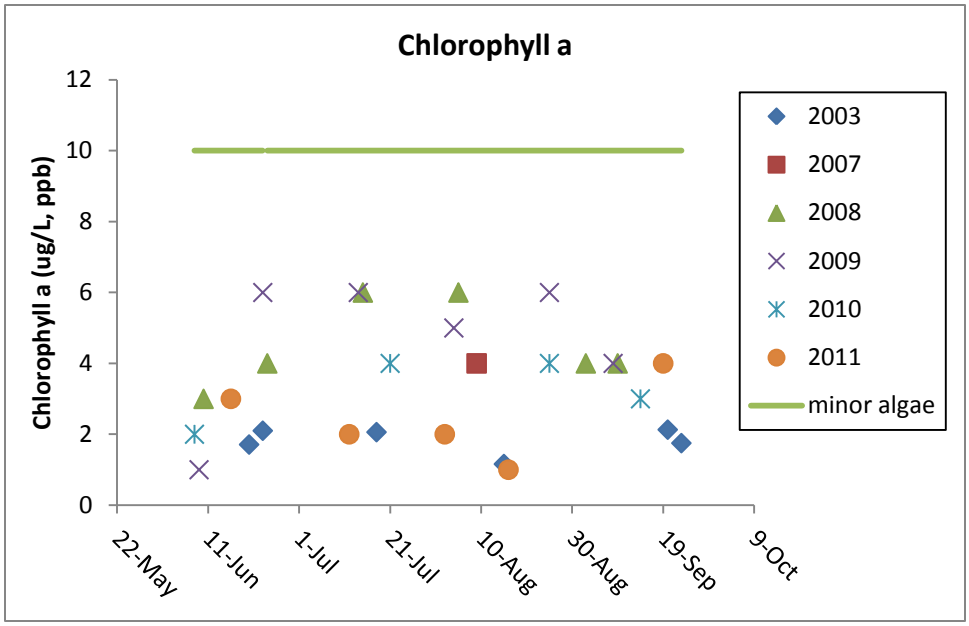



Figure 8. Chlorophyll *a* concentrations (ug/L) for Poplar Lake at site 204.

Chlorophyll *a* was evaluated in Poplar Lake at site 204 in 2003 and from 2007-2011 (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

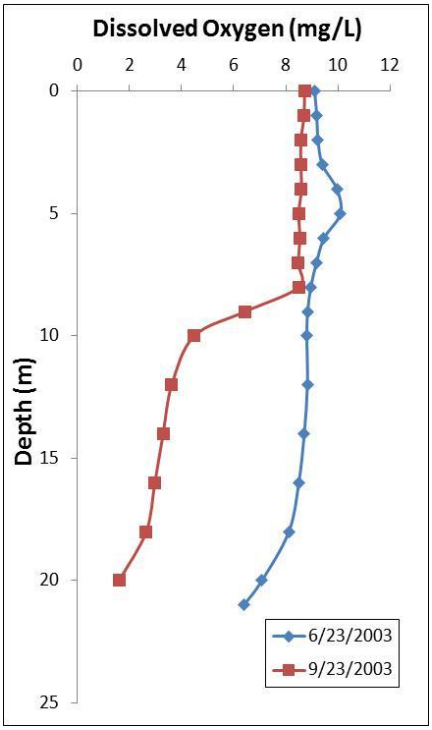



Figure 9. Dissolved oxygen profiles for Poplar Lake in 2003 at site 204.

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.

Dissolved oxygen data is limited to June and September of 2003 for Poplar Lake; however, temperature profiles were collected monthly from June to September that year (Figure 9). The profiles show stratification developing mid-summer. The thermocline on 6/23/2003 occurred at roughly 4 meters (13 ft) while dissolved oxygen was relatively uniform throughout the water column. On 9/23/2003 the thermocline occurred at approximately 8 meters (26 feet) and dissolved oxygen measurements began decreasing at the same depth.

# 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 Poplar Lake falls in the oligotrophic range (Figure 10). The TSI for transparency is higher than the other two parameters due to the brown tannin stain in the water; therefore, it wasn't included in the TSI mean calculation (Table 6). Because of the brown stain, transparency is not a good indicator of nutrient levels and productivity of Poplar Lake.

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 for site 204.

| Trophic State Index | Site 204 |
|---|---|
| TSI Total Phosphorus | 37 |
| TSI Chlorophyll-a | 41 |
| TSI Secchi | 44 |
| TSI Mean | 39 |
| Trophic State: | Oligotrophic |

*Numbers represent the mean TSI for each parameter.*

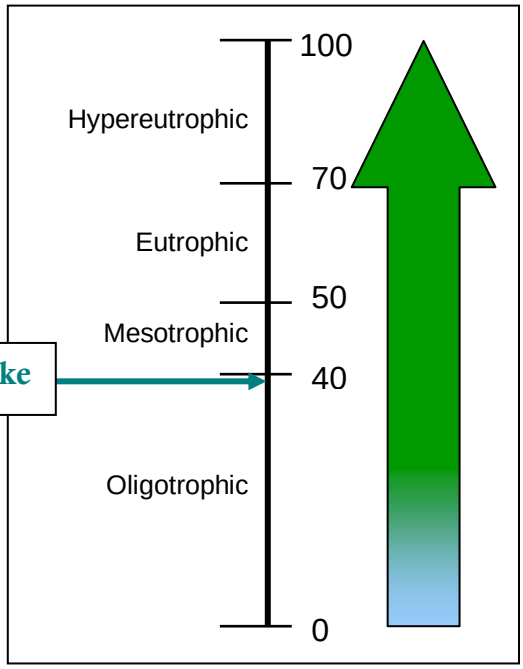



Figure 10. Trophic state index chart with corresponding trophic status.

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.

There is not enough historical data to perform trend analysis for total phosphorus or chlorophyll *a*, at site 204 on Poplar Lake (Table 8); however, transparency could be analyzed at sites 203 and 204. The data was analyzed using the Mann Kendall Trend Analysis.

Table 8. Trend analysis for Poplar Lake.

| Lake Site | Parameter | Date Range | Trend | Probability |
|---|---|---|---|---|
| 204 | Total Phosphorus | 2003, 2007-2011 | Insufficient data | -- |
| 204 | Chlorophyll a | 2003, 2007-2011 | Insufficient data | -- |
| 203 | Transparency | 1989–2007 | Decreasing | 95% |
| 204 | Transparency | 2003, 2005-2011 | No trend | -- |

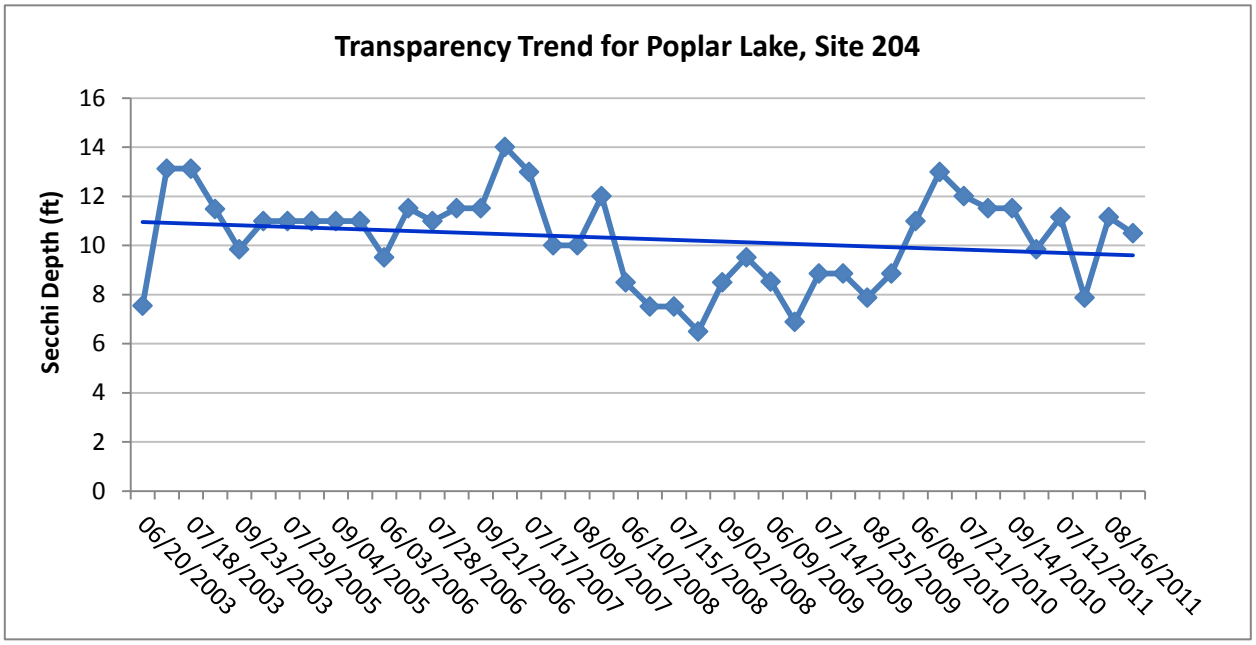



Figure 11. Transparency (ft) trend for site 204.

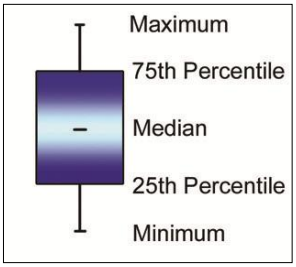
Poplar Lake shows no significant trend in transparency at the primary site (204) in the deepest area of the lake. The data indicate a declining trend in transparency at site 203; however, this site is not at a good location to represent the water quality of the lake. It is in a narrow channel that is approximately 25 feet deep. Due to the irregular shape of Poplar Lake, it is difficult to find a lake site that can represent the water quality of the whole lake. Keeping this in mind, site 204 is the best location for continued monitoring and trend analysis. Transparency monitoring should continue at site 204 so that trends can be tracked in future years.

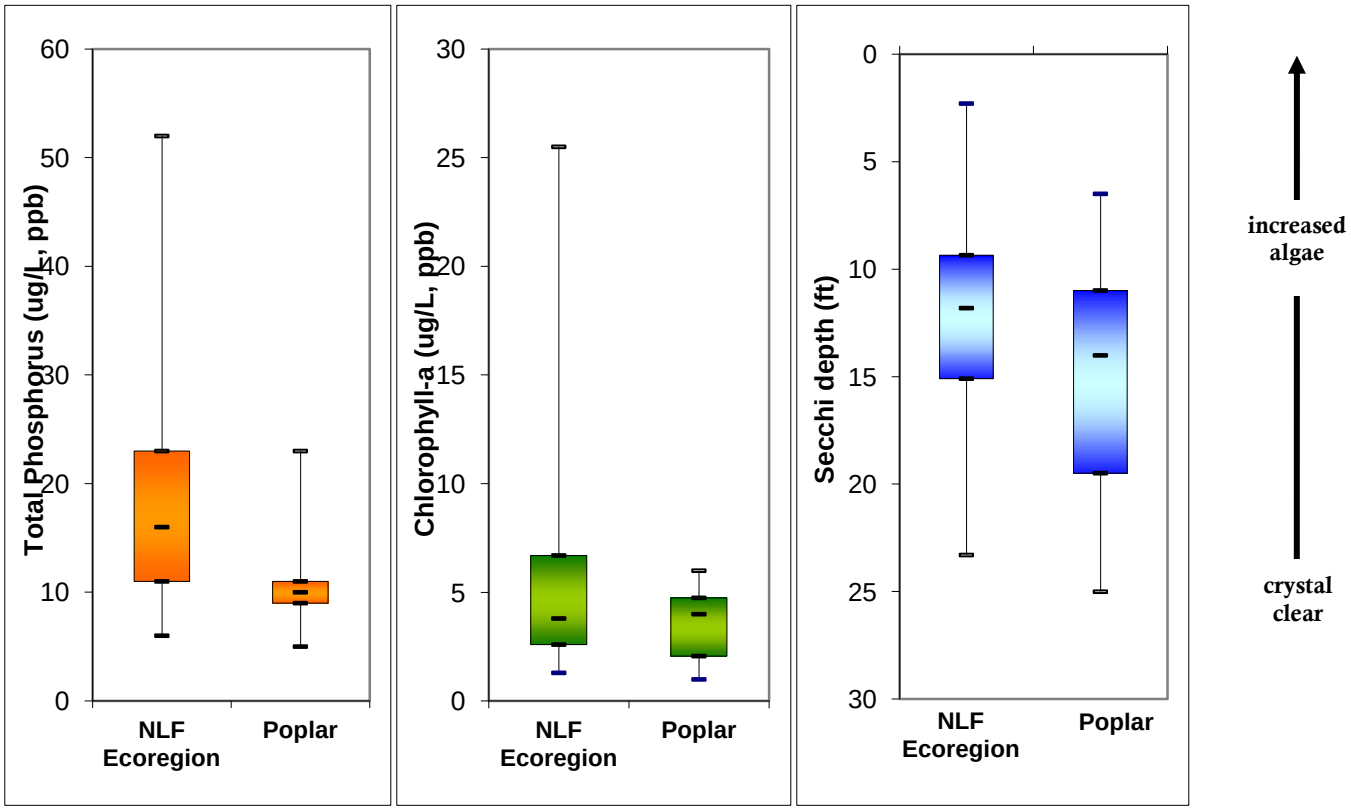
# Ecoregion Comparisons

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 25$^{th}$ - 75$^{th}$ 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.

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




Figures 13a-c. Poplar Lake ranges compared to the Northern Lakes and Forest Ecoregion ranges. The Poplar Lake total phosphorus and chlorophyll *a* ranges are from 28 data points collected in May-September of 2007-2011. The Poplar Lake secchi depth range is from 42 data points collected in May-September from 2003, 2005-2011.

# 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 consists of 119 minor watersheds. Poplar Lake is located in **minor watershed** 1043 (Figure 15).

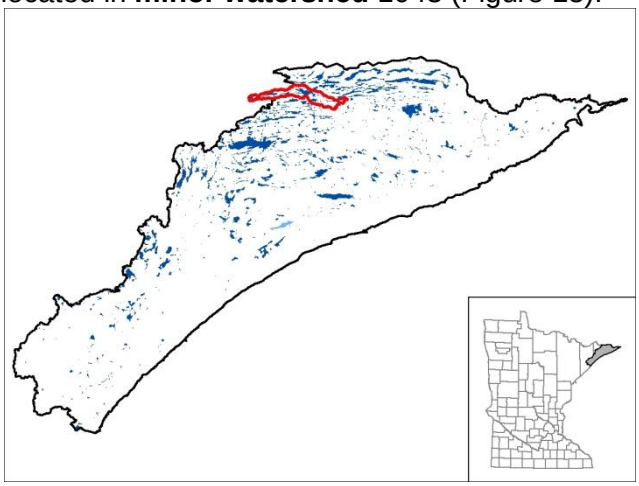


Figure 14. Lake Superior - North Major Watershed.

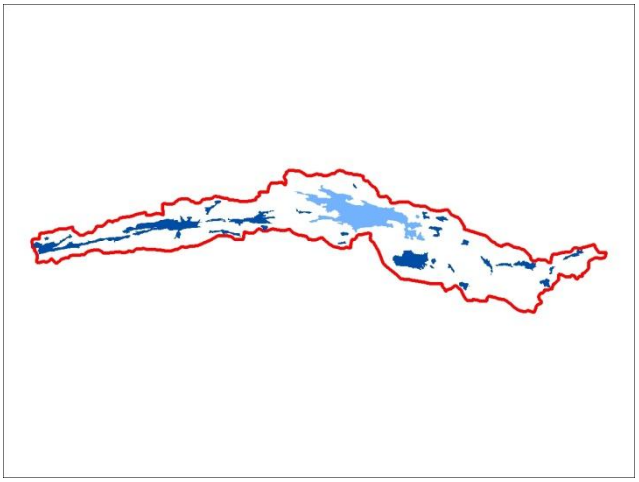


Figure 15. Minor Watershed 1043

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. Poplar Lake falls within **lakeshed 0104301** (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 Poplar Lake's full watershed, containing all the lakesheds upstream of the Poplar Lake lakeshed, see page 16. The data interpretation of the Poplar Lake lakeshed includes only the immediate lakeshed as this area is the land surface that flows directly into Poplar Lake.

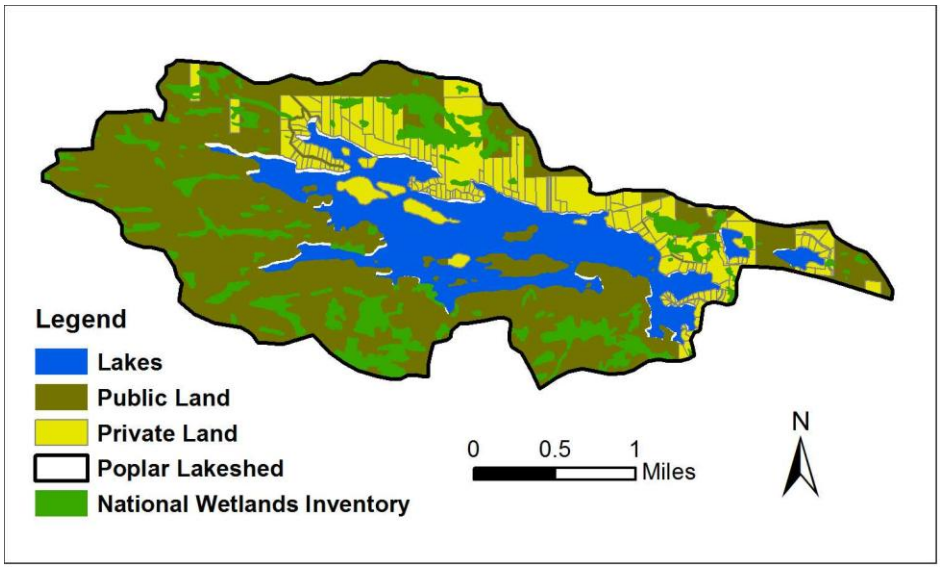



Figure 16. Poplar Lake lakeshed (0104301) with land ownership, lakes, and wetlands illustrated.

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. Poplar Lake lakeshed vitals table.

| Lakeshed Vitals | | Rating |
|---|---|---|
| **Lake Area** | 764 acres | descriptive |
| **Littoral Zone Area** | 343 acres | descriptive |
| **Lake Max Depth** | 73 ft. | descriptive |
| **Lake Mean Depth** | 21 ft. | |
| **Water Residence Time** | NA | NA |
| **Miles of Stream** | 3.1 | descriptive |
| **Inlets** | 7 | |
| **Outlets** | 1 | |
| **Major Watershed** | 1 – Lake Superior - North | descriptive |
| **Minor Watershed** | 1043 | descriptive |
| **Lakeshed** | 0104301 | descriptive |
| **Ecoregion** | Northern Lakes and Forests | descriptive |
| **Total Lakeshed to Lake Area Ratio** (total lakeshed includes lake area) | 4:1 | |
| **Standard Watershed to Lake Basin Ratio** (standard watershed includes lake areas) | 8:1 | |
| **Wetland Coverage** | 14% | |
| **Aquatic Invasive Species** | None | |
| **Public Drainage Ditches** | None | |
| **Public Lake Accesses** | 1 | |
| **Miles of Shoreline** | 6 | descriptive |
| **Shoreline Development Index** | 15.8 | |
| **Public Land to Private Land Ratio** | 2.9:1 | |
| **Development Classification** | Recreational Development | |
| **Miles of Road** | 10.6 | descriptive |
| **Municipalities in lakeshed** | None | |
| **Forestry Practices** | Active logging | |
| **Feedlots** | None | |
| **Sewage Management** | Septic Systems, inspected lake-wide | |
| **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.

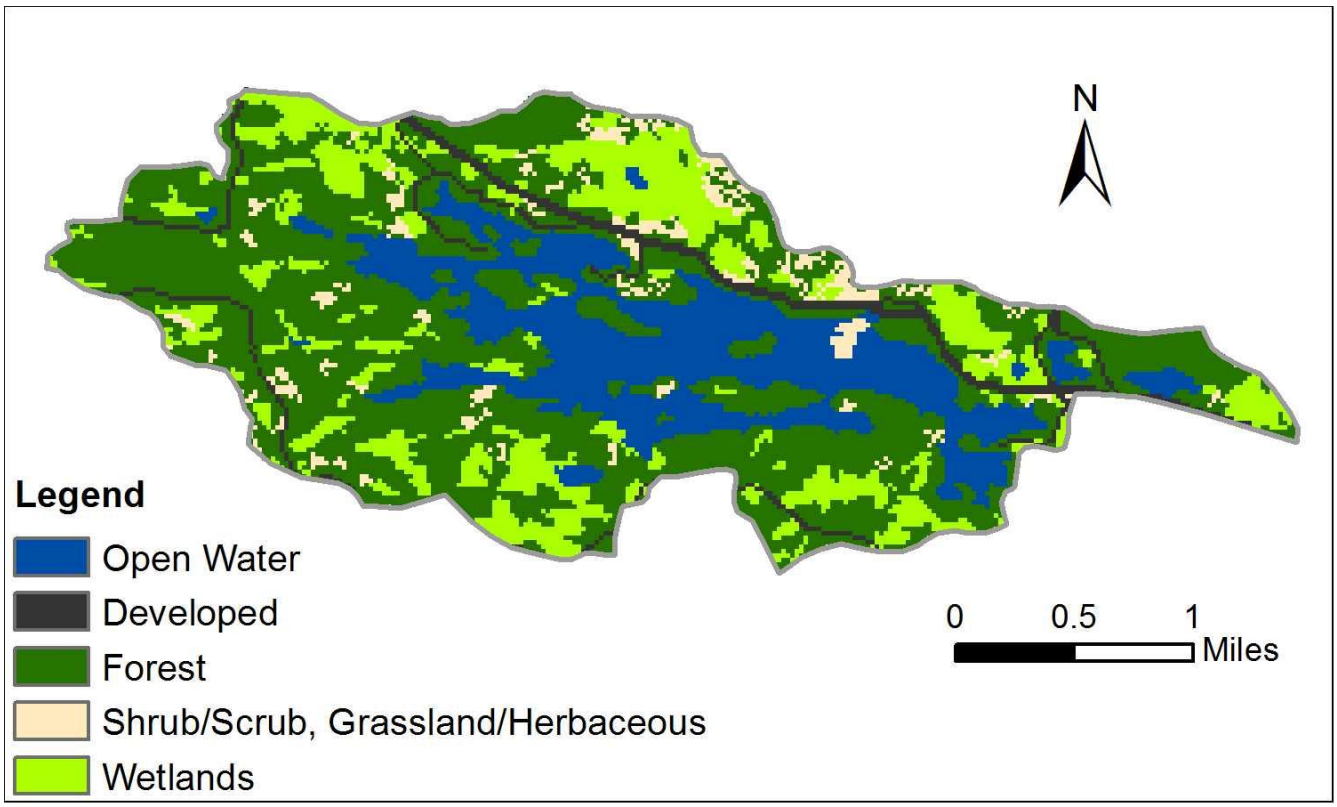



Figure 17. Land cover for Poplar Lake lakeshed (0104301). Data Source: National Land Cover Dataset 2006.

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.

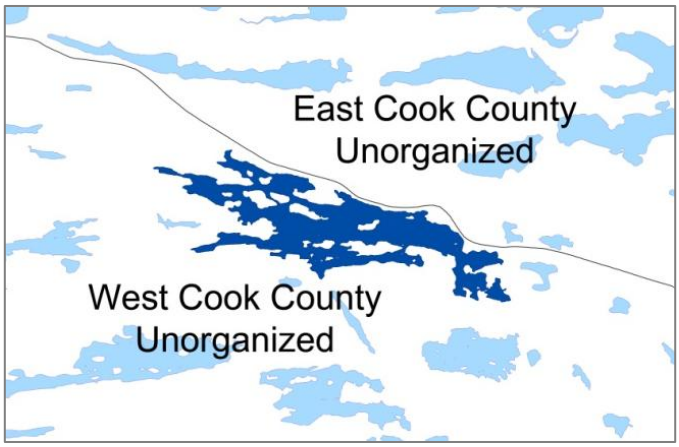
Phosphorus export, which is the main cause of lake eutrophication, depends on the type of land cover occurring in the lakeshed. Figure 17 depicts the land cover in Poplar Lake's lakeshed. Acreage estimates for the major land use types are listed in Table 10. Evergreen and deciduous forests are the main 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.

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

| Land Cover | Acres | Percent |
|---|---|---|
| **Forest** | 1860 | 51.5 |
| **Water** | 754 | 20.9 |
| **Wetland** | 675 | 18.7 |
| **Developed** | 174 | 4.8 |
| **Shrub/Grassland** | 147 | 4.1 |

# Demographics

Poplar 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 have a higher extrapolated growth projection (Figure 18). (source:http://www.demography.state.mn.us/resource.html?Id=19332)

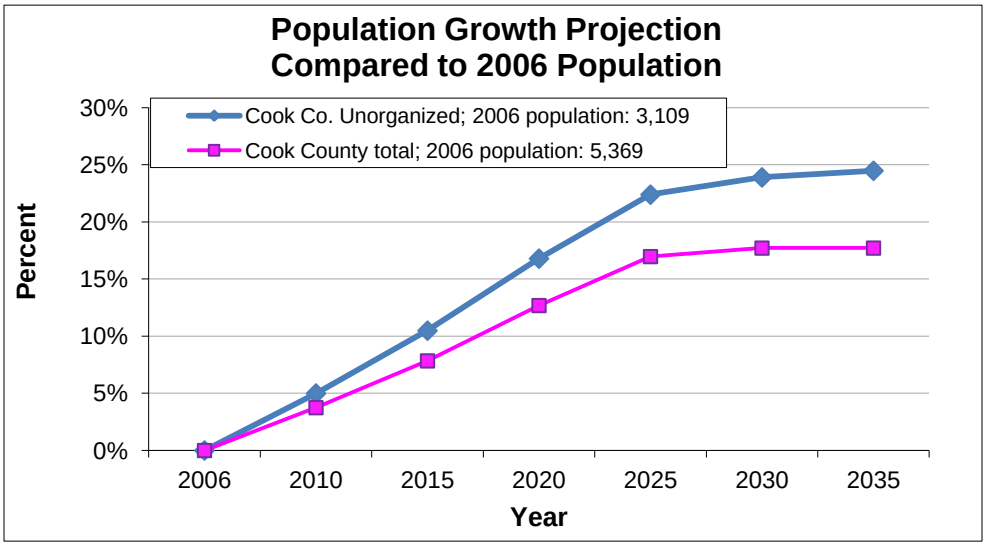



Figure 18. Population growth projection for Cook County, MN and Unorganized Territories within Cook County, MN.

# Poplar 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 land within Poplar Lake's lakeshed is in public ownership as part of the Boundary Waters Canoe Area and National Forest (Table 11), and this 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 Poplar lakeshed (Sources: Cook County parcel data, National Wetlands Inventory, and the 2006 National Land Cover Dataset).

| | Private (20%) | | | | | 22% | Public (58%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Developed** | **Agriculture** | **Forested Uplands** | **Other** | **Wetlands** | **Open Water** | **County** | **State** | **Federal** |
| **Land Use (%)** | 2.9 | 0.0 | 10 | 4.5 | 2.6 | 22 | 1 | 3 | 54 |
| **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 | 47–158 | 0 | 29 | | 8 | | 4 | 12 | 175 |
| **Description** | Focused on shoreland | Cropland | Focus of development and protection efforts | Open, pasture, grassland, shrubland | 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.

Poplar Lake's lakeshed is classified with having 78.8% of the watershed protected and 1.6% of the watershed disturbed (Figure 19). Therefore, this lakeshed should have a vigilance focus. Goals for the lake should be to maintain the protected status. 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 Poplar Lake, whether through direct overland flow or through a creek or river. All 3 upstream lakesheds have the same management focus (vigilance).

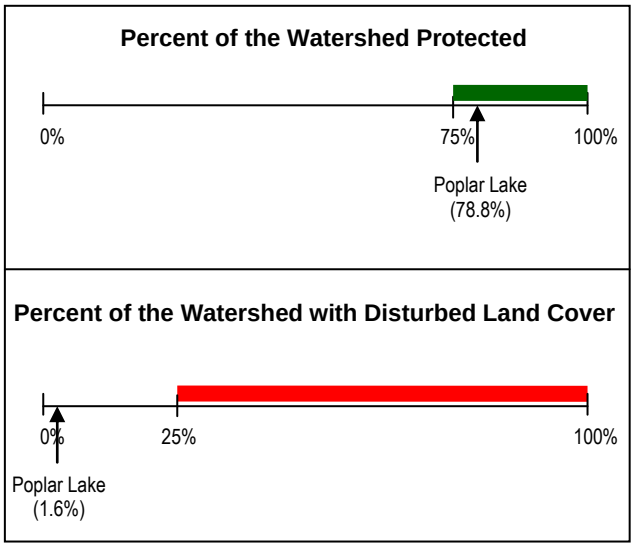



Figure 19. Poplar Lake's lakeshed percentage of watershed protected and disturbed.

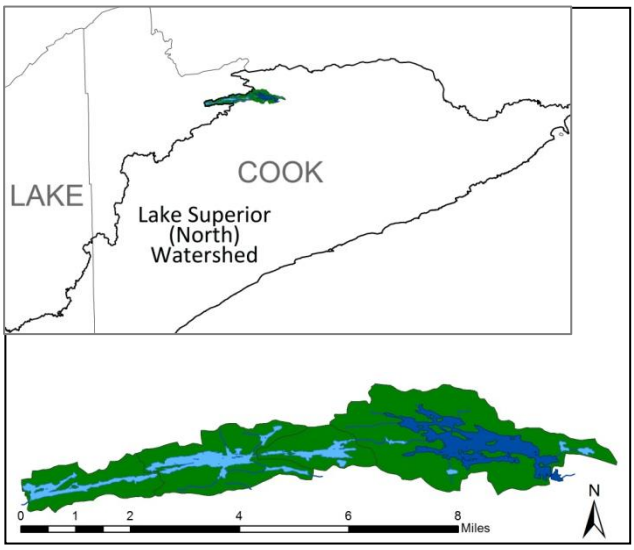



Figure 20. Upstream lakesheds that contribute water to the Poplar lakeshed. Color-coded based on management focus (table 12).

## Status of the Fishery (DNR, as of 08/03/2009)

Walleye abundance was low in Poplar Lake in 2009, as it has been in this lake since the mid 1980s. Stocking since 2001 has not succeeded in improving walleye abundance. About half of the walleye collected in 2009 had come from years when stocking was done, and about half had been produced naturally. No strong year classes were identified. Walleye growth rates had been about average for the area, with fish reaching a length of 14.2 inches at the end of their fourth year.

Northern pike abundance in 2009 was average for a lake of this type, and for Poplar Lake historically. Northern pike collected in Poplar Lake historically have generally been small, and that was again the case in 2009. Most were one or two-year-old fish, and no fish over three years of age were taken. Growth of young northern pike had been fairly fast, despite the lack of a good yellow perch forage base.

The 2009 smallmouth bass gill net catch was low for a lake of this type, but not for this lake historically. Smallmouth bass were probably more abundant than the gill net catch would indicate.

Poplar Lake is one of a handful of Cook County lakes open to fall netting of tullibee or lake whitefish. The 2009 lake whitefish catch was low for a lake of this class, but was similar to past catches in this lake. Lake whitefish abundance in this lake appears to have been stable since 1982.

Poplar Lake is also one of just a few lakes in this area to support black crappie. The gill net catch in 2009 was low for a lake of this type, but was typical of past catches in this lake. Growth of the two black crappie collected had been relatively fast.

Yellow perch have typically not been abundant in Poplar Lake, and the catch in 2009 was again fairly low. Yellow perch collected in 2009 would have been too small to have been of much interest in anglers, but they did provide some forage for walleye and northern pike.

No lake trout were taken in 2009, suggesting that long-term survival of lake trout stocked in 1999, 2003, and 2005 had been very poor. The temperature-oxygen profile done during this assessment found conditions suitable for lake trout (temperature under 55 F, oxygen over 5 ppm) at depths of about 32 to about 42 ft. Six gill net sets were made in that depth range, and collected mostly lake whitefish.

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=16023900

# Key Findings / Recommendations

**Monitoring Recommendations**
Due to the irregular shape of Poplar Lake, it is difficult to find a lake site that can represent the water quality of the whole lake. Keeping this in mind, site 204 is the best location for continued monitoring and trend analysis. Transparency monitoring at site 204 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.

Transparency alone is not a good indicator of nutrient levels and productivity of Poplar Lake because of the brown stain of the water. To track trends in water quality, total Phosphorus and chlorophyll a monitoring should continue as the budget allows. If monitoring every year is not an option, every other year, or one in three years will provide a continual check-up of lake nutrient levels.

**Overall Summary**
Poplar Lake is a typical lake for northeast Minnesota. It has very low nutrient levels, but the brown-stained water from tannins limits the clarity. It is in great shape for water quality, and the watershed is very well protected due to the Boundary Waters Canoe Area Wilderness. Poplar is an oligotrophic lake (TSI=39) with no strong trends in water quality. Fifty-eight percent (58%) of the lakeshed is in public ownership, and 79% of the lakeshed is protected, while only 1.6% of the lakeshed is disturbed (Figure 19).

The Ham Lake fire of 2007 extended very near to Poplar Lake, but not to Poplar Lake's boundary. The fire area included Rush Lake just west of Poplar Lake, which is within Poplar Lake's watershed, and flows toward Poplar Lake (Figure 20). The ash and exposed ground from this fire could have contributed phosphorus to Poplar Lake.

**Fisheries in relation to water quality**
The DNR indicates that lake whitefish abundance (ciscos) in this lake appears to have been stable since 1982. A decline in ciscos can be an early indicator of eutrophication in a lake because they require cold hypolimnetic temperatures and high dissolved oxygen levels.

No lake trout were found in the DNR fisheries survey of 2009, suggesting that long-term survival of lake trout stocked in 1999, 2003, and 2005 had been very poor. The temperature-oxygen profile done during this assessment found conditions suitable for lake trout (temperature under 55 F, oxygen over 5 ppm) at depths of about 32 to about 42 ft. Six gill net sets were made in that depth range, and collected mostly lake whitefish (page 17).

**Priority Impacts to the lake**
Continued development of private lakeshore parcels along the northern shoreline is a priority concern. Compared to other regions of the state, Poplar Lake's shoreline properties remain in larger parcels and are less developed. However, since 1990 new homes have steadily appeared on shoreline parcels and 2$^{nd}$ tier development has begun. Clearing forest cover for new lake homes in the near shoreline area may increase erosion and phosphorus export to the lake.

Disturbance within the lakeshed from active logging is another potential impact to Poplar Lake. Some logging on federal land is evident in historical aerial images of the lakeshed, but the extent is likely limited by significant wetland coverage.

**Recommendations of Best Management Practices**
The management focus for Poplar Lake should be to protect the current water quality and limit the impacts of future development in the lakeshed. This can be done by encouraging forestry

stewardship on private parcels, enforcing county shoreline ordinances, smart development, shoreline restoration, and septic system 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<br>218-387-3647<br>http://www.co.cook.mn.us/index.php/government/departments/soil-and-water |
| DNR Fisheries Office | 1356 Highway 61 East, Grand Marais, MN 55604<br>218-387-3056<br>grandmarais.fisheries@state.mn.us |
| Regional Minnesota Pollution Control Agency Office | 525 Lake Avenue South, Suite 400, Duluth, MN 55802<br>218-723-4660, 1-800-657-3864<br>http://www.pca.state.mn.us/index.php/about-mpca/mpca-overview/agency-structure/mpca-offices/duluth-office.html |