Blackwater Lake 11-0274-00 CASS COUNTY

Lake Water Quality

Summary

Blackwater Lake is located 7 miles southwest of Longville, MN in Cass County. It is a basin lake covering 761 acres (Table 1).

Blackwater Lake has two inlets and one outlet, which classify it as a drainage lake. Water enters Blackwater Lake from Mule Lake in the southeast and Island Lake in the southwest. It flows out of Blackwater Lake in the north on to Woman Lake.

Blackwater Lake has been monitored consistently since 1988 (Tables 2–3). These data show that the lake is on the oligotrophic/mesotrophic border (TSI = 40) with clear water conditions most of the summer and excellent recreational opportunities.

The Blackwater Lake Association has been in existence for almost 20 years now and they are proud of their many accomplishments. To list a few: removal of a wandering bogs (ongoing), fish stocking and studies (in cooperation with the DNR), water level control (beavers, culvert and water control device), aquatic plant study, secchi disk readings, the acquisition of the eagles nest property to preserve it forever, free septic system testing, the BLURB (their news letter which we mail to people's home), and a web site (minnesotawaters.org/blackwater). They are also a member of the Association of Cass County Lakes (ACCL).

Table 1. Blackwater Lake location and key physical characteristics.

Location Data		Physical Characteristics	
MN Lake ID:	11-0274-00	Surface area (acres):	767
County:	Cass	Littoral area (acres):	476
Ecoregion:	Northern Lakes and Forests	% Littoral area:	62
Major Drainage Basin:	Upper Mississippi River	Max depth (ft):	67
Latitude/Longitude:	46.90739822/-94.3042984	Inlets:	2
Invasive Species:	None as of 2011	Outlets:	1
		Public Accesses:	1

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

Data Availability

Transparency data		Excellent data source from 1988–2011.
Chemical data		Good data set, but not enough for trend analysis.
Inlet/Outlet data		Not available.

Recommendations **For recommendations refer to page 20.**

Lake Map

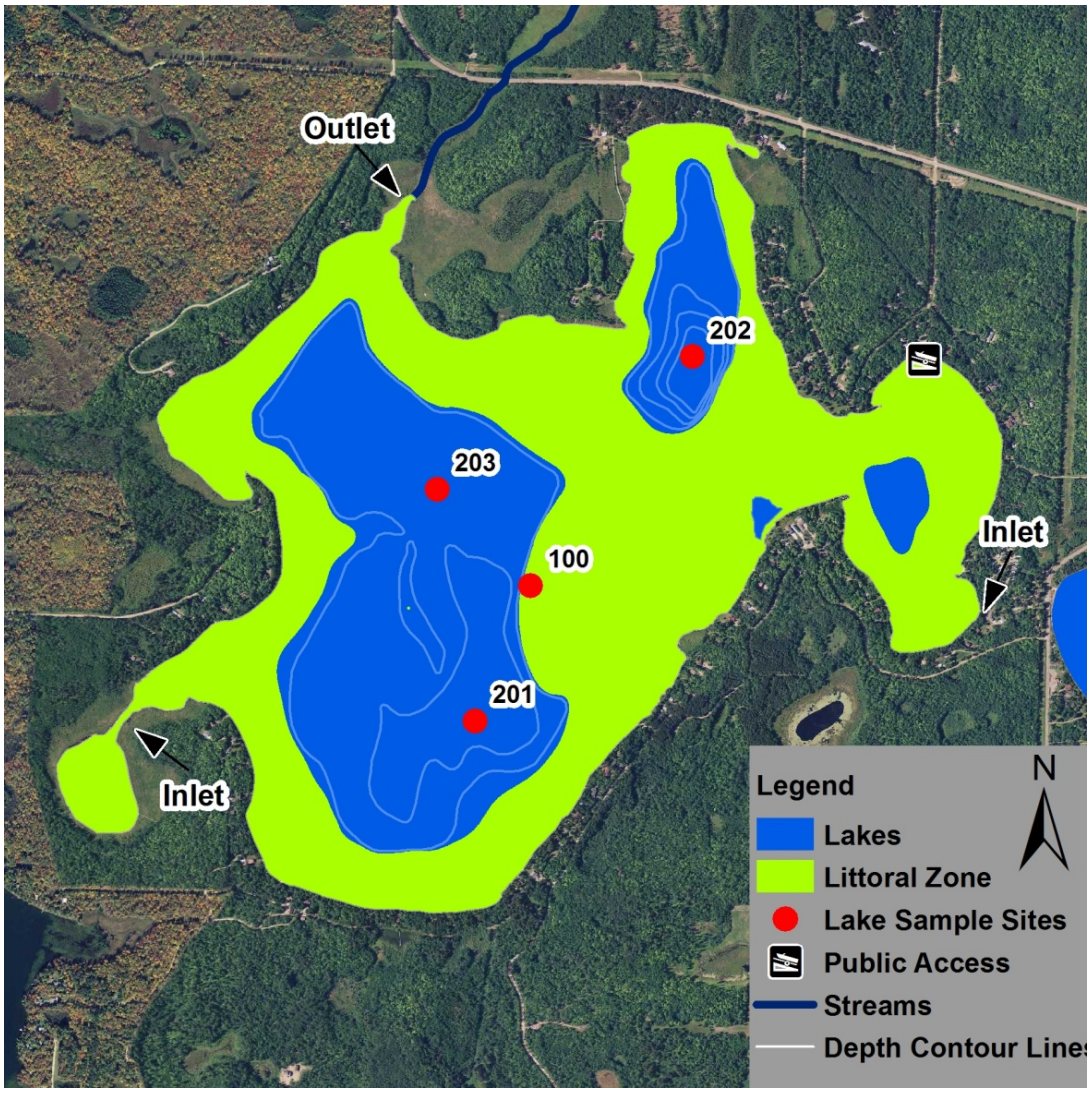


Figure 1. Map of Blackwater Lake with 2010 aerial imagery and illustrations of lake depth contour lines, sample site locations, inlets and outlets, and public access points. The light green areas in the lake illustrate the littoral zone, where the sunlight can usually reach the lake bottom allowing aquatic 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), Cass County Citizens Lake and Stream Monitoring (CCCL), Whitefish Chain and Surrounding Lakes WAPOA (WCSL), Outdoor Corps Lake Monitoring (OCLM) and RMB Environmental Laboratory Monitoring Program (RMBEL).

Lake Site	Depth (ft)	Monitoring Programs
100	40	MPCA: 1989
201	54	CLMP: 1988–2011; MPCA: 1989
202* Primary Site	67	CCCL: 2008–2009; CLMP: 1988–1991, 2001-2011; MPCA: 1989; RMBEL: 2007, 2010–2011; WCSL: 2002
203	40	CLMP: 1989–2005; OCLM: 2003–2006

Average Water Quality Statistics

The information below describes available chemical data for Blackwater Lake through 2011 (Table 4). Data for total phosphorus, chlorophyll a, and secchi depth are from the primary site 202. All additional chemical data is from site 201 and reflects mean values from 1989.

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 10.

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)	13	14 - 27	> 30	Results are better than or within the expected range for the ecoregion.
[3]Chlorophyll *a* (ug/L)	3	4 - 10	> 9	
Chlorophyll *a* max (ug/L)	7	<15		
Secchi depth (ft)	14	7.5 - 15	< 6.5	
Dissolved oxygen	Dimictic *see page 8*			Dissolved oxygen depth profiles show that the deep areas of the lake are anoxic in late summer.
Total Kjeldahl Nitrogen (mg/L)	0.55	0.40 - 0.75		Indicates insufficient nitrogen to support summer nitrogen-induced algae blooms.
Alkalinity (mg/L)	120	40 - 140		Indicates a low sensitivity to acid rain and a good buffering capacity.
Color (Pt-Co Units)	10	10 - 35		Indicates clear water with little to no tannins (brown stain).
pH	8.7	7.2 - 8.3		Indicates a hard water lake. Lake water pH less than 6.5 can affect fish spawning and the solubility of metals in the water.
Chloride (mg/L)	2.0	0.6 - 1.2		Slightly above the expected range for the ecoregion, but still considered low level.
Total Suspended Solids (mg/L)	3	<1 - 2		Slightly above the expected range for the ecoregion, but still considered low level.
Specific Conductance (umhos/cm)	215	50 - 250		Within the expected range for the ecoregion.
Total Nitrogen:Total Phosphorus	20:1	25:1 – 35:1		Indicates the lake is phosphorus limited, which means that algae growth is limited by the amount of phosphorus in the lake.

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

Water Quality Characteristics - Historical Means and Ranges

Table 5. Water quality means and ranges for primary sites. Years monitored for chemical data: 1989, 2004–2011. Years monitored for secchi data: 1988–2011.

Parameters	Primary Site 202	201	203	100
Total Phosphorus Mean (ug/L):	**13**	**27**	**16**	
Total Phosphorus Min:	8	27	5	
Total Phosphorus Max:	20	27	39	
Number of Observations:	25	1	13	
Chlorophyll *a* Mean (ug/L):	**3**	**3**	**4**	
Chlorophyll-a Min:	1	3	1	
Chlorophyll-a Max:	7	3	5	
Number of Observations:	25	1	13	
Secchi Depth Mean (ft):	**14**	**13**	**12**	**12**
Secchi Depth Min:	10	8	8	12
Secchi Depth Max:	21	21	17	12
Number of Observations:	97	132	83	1

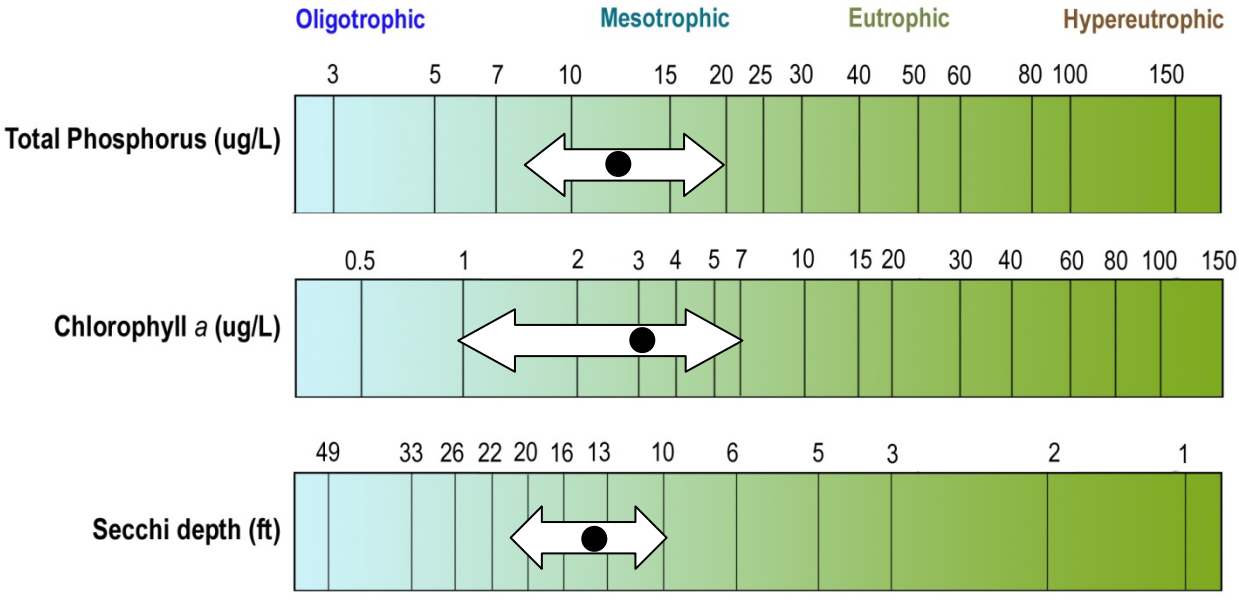


Figure 2. Blackwater Lake total phosphorus, chlorophyll *a* and transparency historical ranges. The arrow represents the range and the black dot represents the historical mean (Primary Site 202). Figure adapted after Moore and Thornton, [Ed.]. 1988. Lake and Reservoir Restoration Guidance Manual. (Doc.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

Transparency (Secchi Depth)

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

The mean transparency in Blackwater Lake ranges from 11.1 to 20.0 feet. The transparency throughout the lake appears to be relatively uniform. This is typical for a moderately-sized lake. Transparency monitoring should be continued annually at sites 201 and 202 in order to track water quality changes.

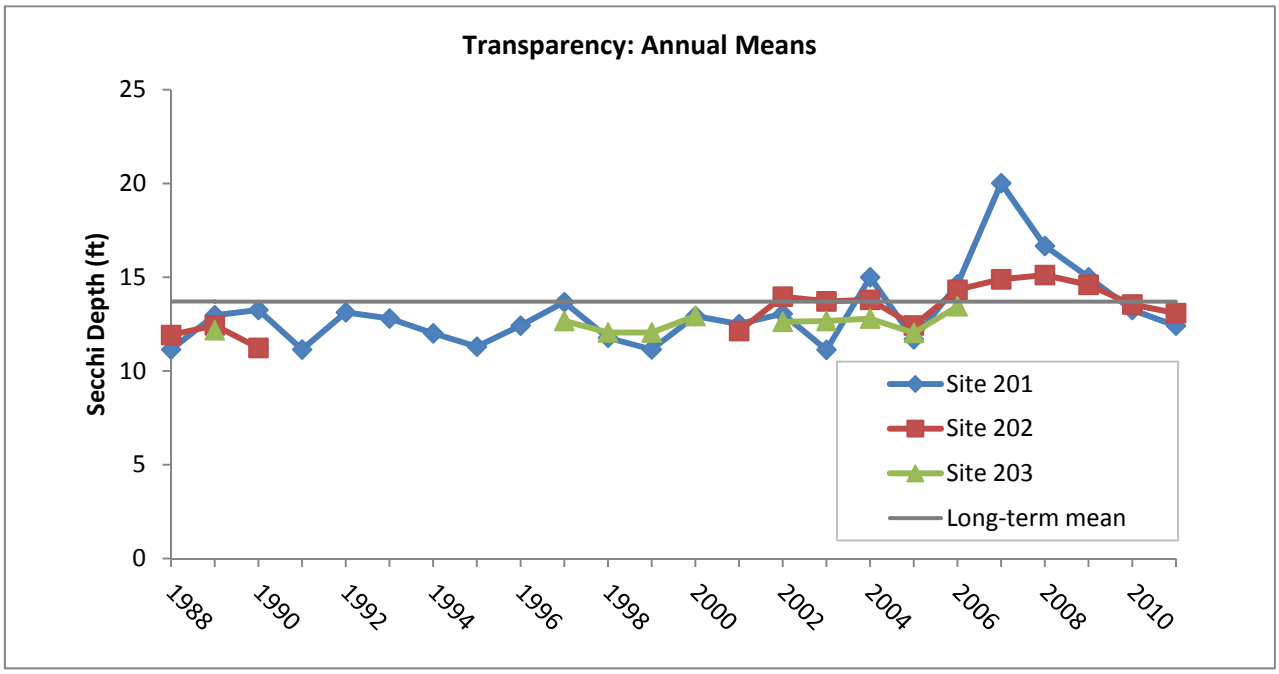


Figure 3. Annual mean transparency compared to long-term mean transparency.

Blackwater Lake transparency ranges from 10 to 21 ft at the primary site (202). Figure 4 shows the seasonal transparency dynamics. The maximum Secchi reading is usually obtained in early summer. Blackwater Lake's transparency remains fairly consistent most of the summer. This is common for lakes with low nutrients and good clarity.

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.

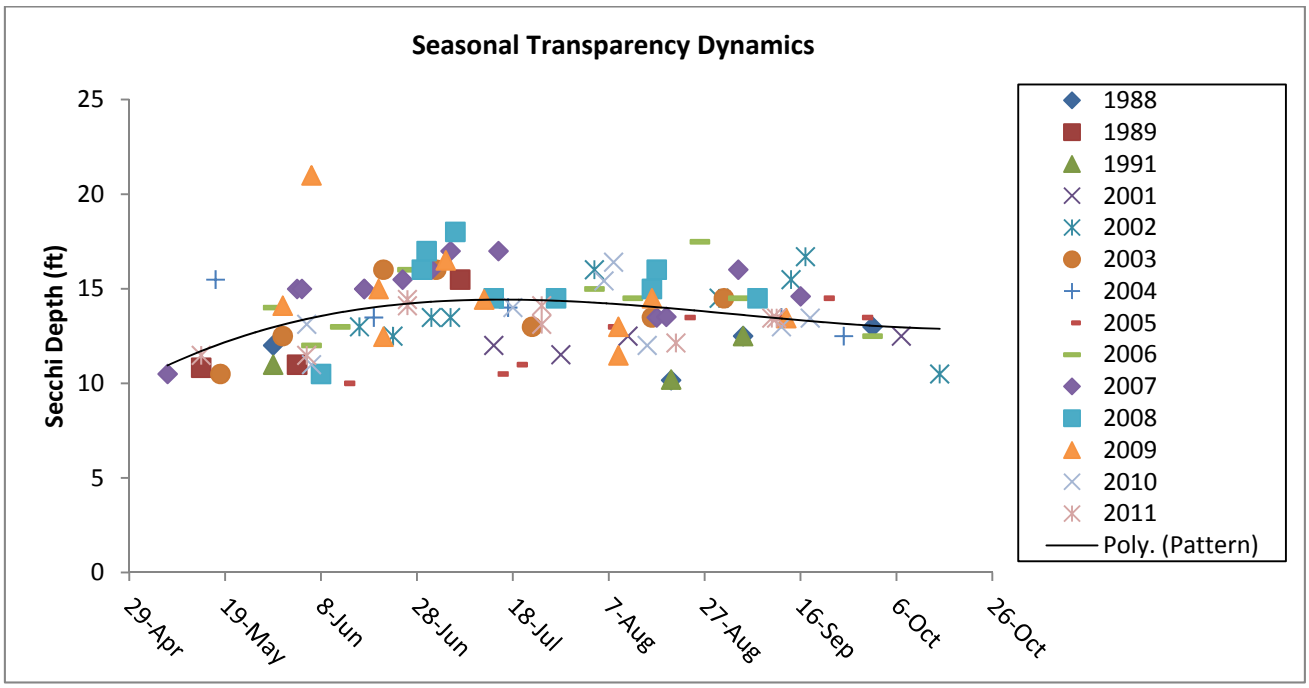
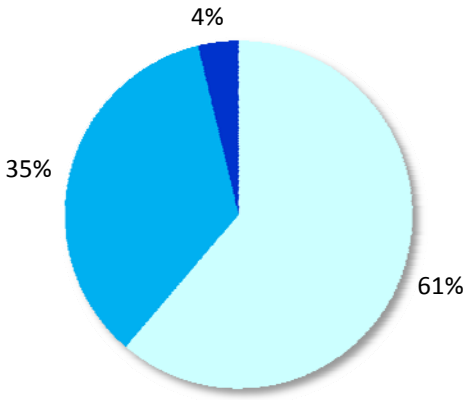


Figure 4. Seasonal transparency dynamics and year to year comparison (Primary Site 202). The black line represents the pattern in the data.

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. Blackwater Lake was rated as being "crystal clear" 61% of the time by samplers at site 202 between 1988-1991, 2003-2011 (Figure 5).

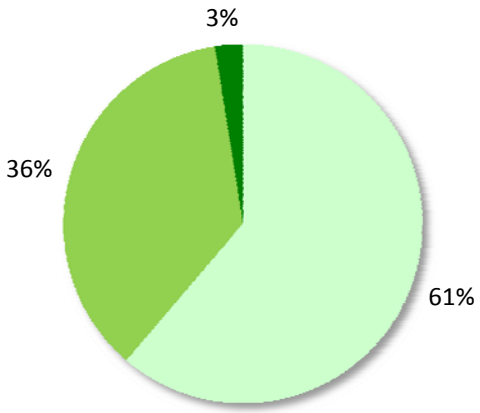


Physical Appearance Rating

61%	Crystal clear water
35%	Not quite crystal clear – a little algae visible
4%	Definite algae – green, yellow, or brown color apparent
13%	High algae levels with limited clarity and/or mild odor apparent
0%	Severely high algae levels

Figure 5. Blackwater Lake physical appearance ratings by samplers at site

As the secchi depth decreases, the perception of recreational suitability of the lake decreases. Blackwater Lake was rated as being "beautiful" 61% of the time from 1988-1991, 2003-2011 (Figure 6).



Recreational Suitability Rating

61%	Beautiful, could not be better
36%	Very minor aesthetic problems; excellent for swimming, boating
3%	Swimming and aesthetic enjoyment of the lake slightly impaired because of algae levels
0%	Desire to swim and level of enjoyment of the lake substantially reduced because of algae levels
13%	Swimming and aesthetic enjoyment of the lake nearly impossible because of algae levels

Figure 6. Recreational suitability rating, as rated by the volunteer monitor at site 202.

Total Phosphorus

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

Total phosphorus was evaluated in Blackwater Lake in 1989 and 2004–2011. The data do not indicate much seasonal variability or variation between sites. The majority of the data points fall into the oligotrophic and mesotrophic ranges (Figure 7).

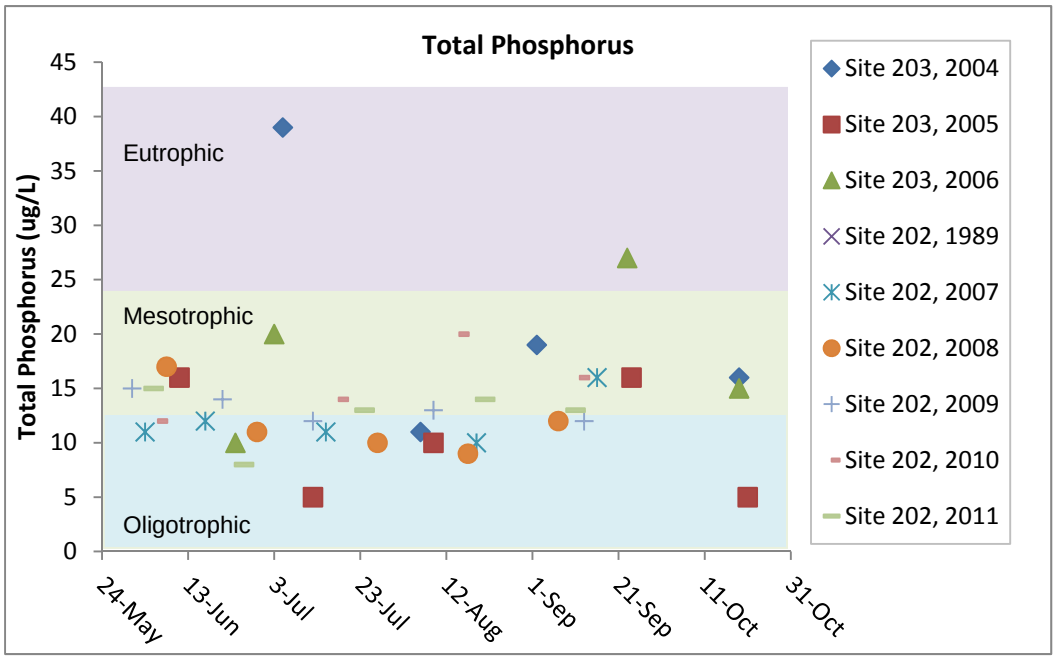


Figure 7. Historical total phosphorus concentrations (ug/L) for Blackwater Lake.

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

Chlorophyll *a*

Chlorophyll *a* is the pigment that makes plants and algae green. Chlorophyll *a* is tested in lakes to 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.

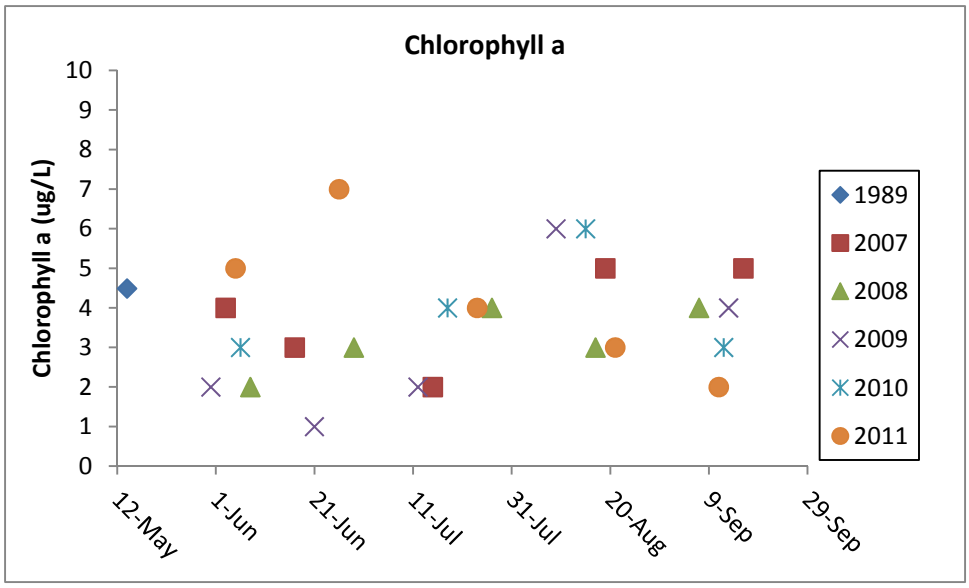
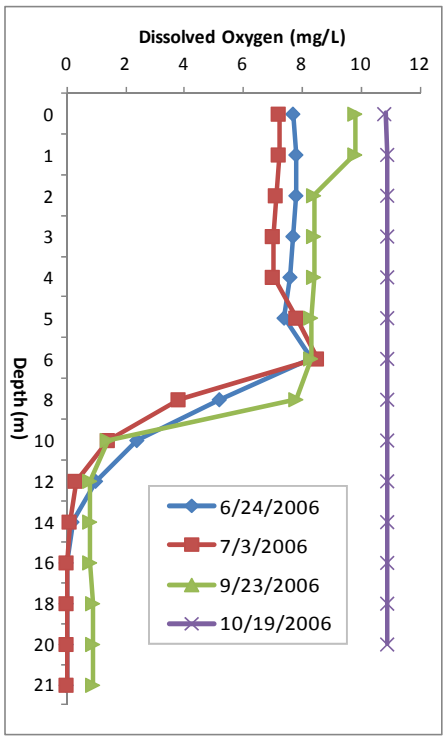


Figure 8. Chlorophyll *a* concentrations (ug/L) for Blackwater Lake.

Chlorophyll *a* was evaluated in Blackwater Lake at site 202 in 1989, and 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, which corresponds with the phosphorus concentrations (Figure 7).

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.

Blackwater Lake is a relatively deep lake, with a maximum depth of 67 feet. Dissolved oxygen profiles from data collected in 2006 at site 203 show stratification developing mid-summer. The thermocline occurs at approximately 6-7 meters (20-23 feet), which means that gamefish will be scarce below this depth. Figure 9 is a representative dissolved oxygen profile for Blackwater Lake.

Figure 9. Dissolved oxygen profile for Blackwater Lake in 2006 at site 203.

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 Blackwater Lake falls onto the border between oligotrophic and mesotrophic (Figure 10). There is good agreement between the TSI for phosphorus, chlorophyll *a* and transparency, indicating that these variables are strongly related (Table 6).

Lakes on the oligotrophic/mesotrophic border (TSI 39–41) are characteristic of clear water throughout the summer and are excellent for recreation. The bottom of the deep areas of the lake becomes anoxic (no oxygen) during the summer, which is inhospitable to game fish (Table 7). This occurrence is common in Minnesota lakes.

Table 6. Trophic State Index for site 202.

Trophic State Index	Site 202
TSI Total Phosphorus	41
TSI Chlorophyll-a	41
TSI Secchi	39
TSI Mean	40
Trophic State:	Oligotrophic/ Mesotrophic

Numbers represent the mean TSI for each parameter.

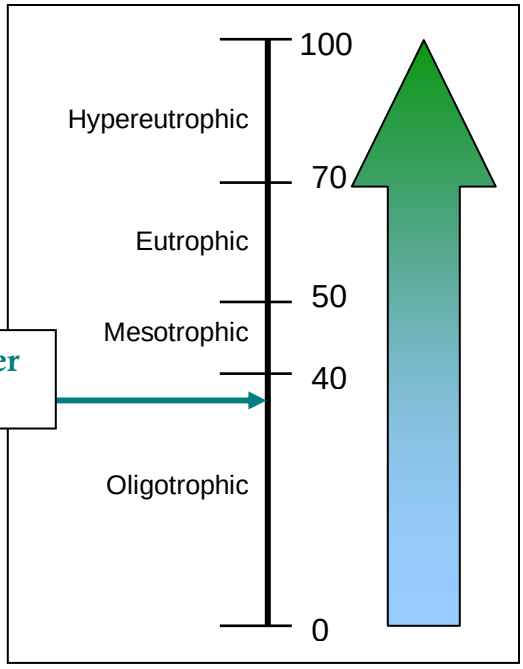


Figure 10. Trophic state index chart with corresponding trophic status.

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* on Blackwater Lake. Site 201 had over 8 years of transparency data, which was enough data to perform a long-term trend analysis (Table 8). The data was analyzed using the Mann Kendall Trend Analysis.

Table 8. Trend analysis for Blackwater Lake.

Lake Site	Parameter	Date Range	Trend	Probability
202	Total Phosphorus	2007–2011	No trend	--
202	Chlorophyll a	2007–2011	No trend	--
201	Transparency	1988–2011	Improving	90%

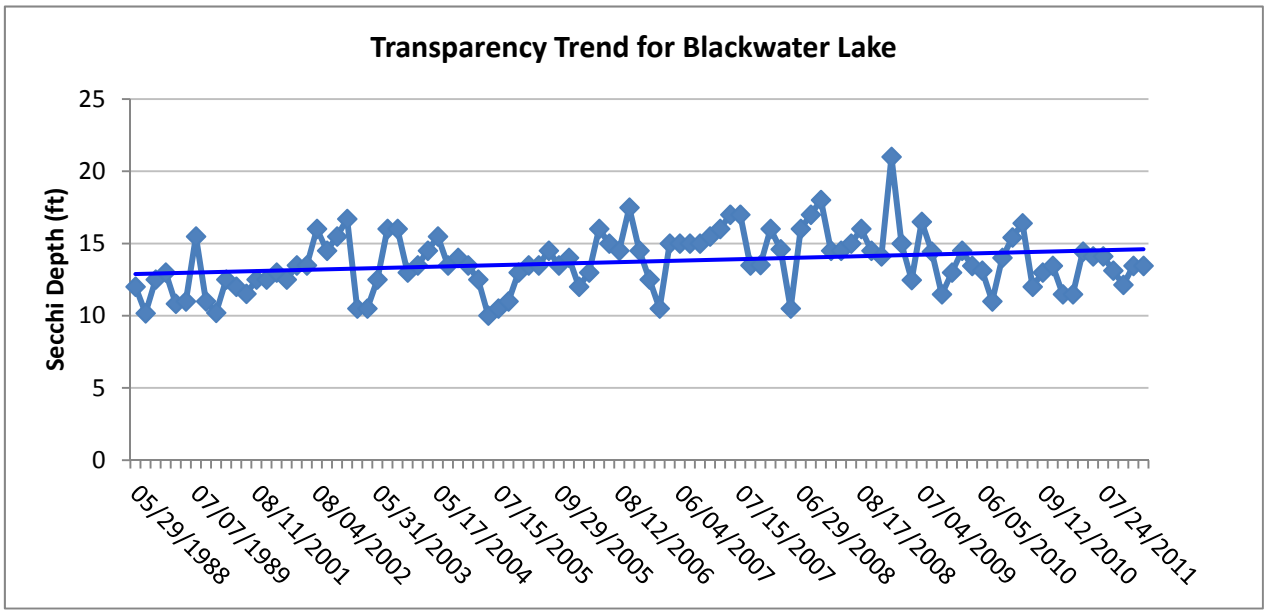


Figure 11. Transparency (ft) trend for site 202 from 1988-2011.

Blackwater Lake shows a significant improving trend in transparency from 1988-2011 (Table 8, Figure 11), and no trend from 2000-2011. That means that over the long-term, the transparency is improving, but in the short term it 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.

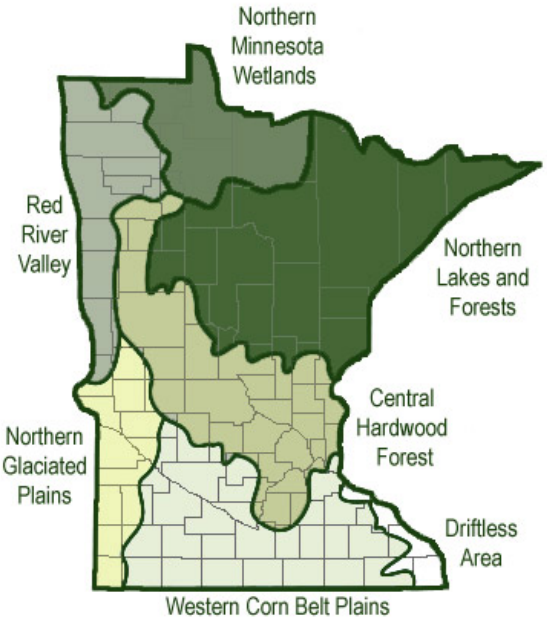
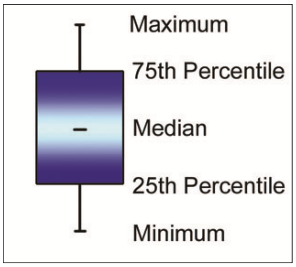
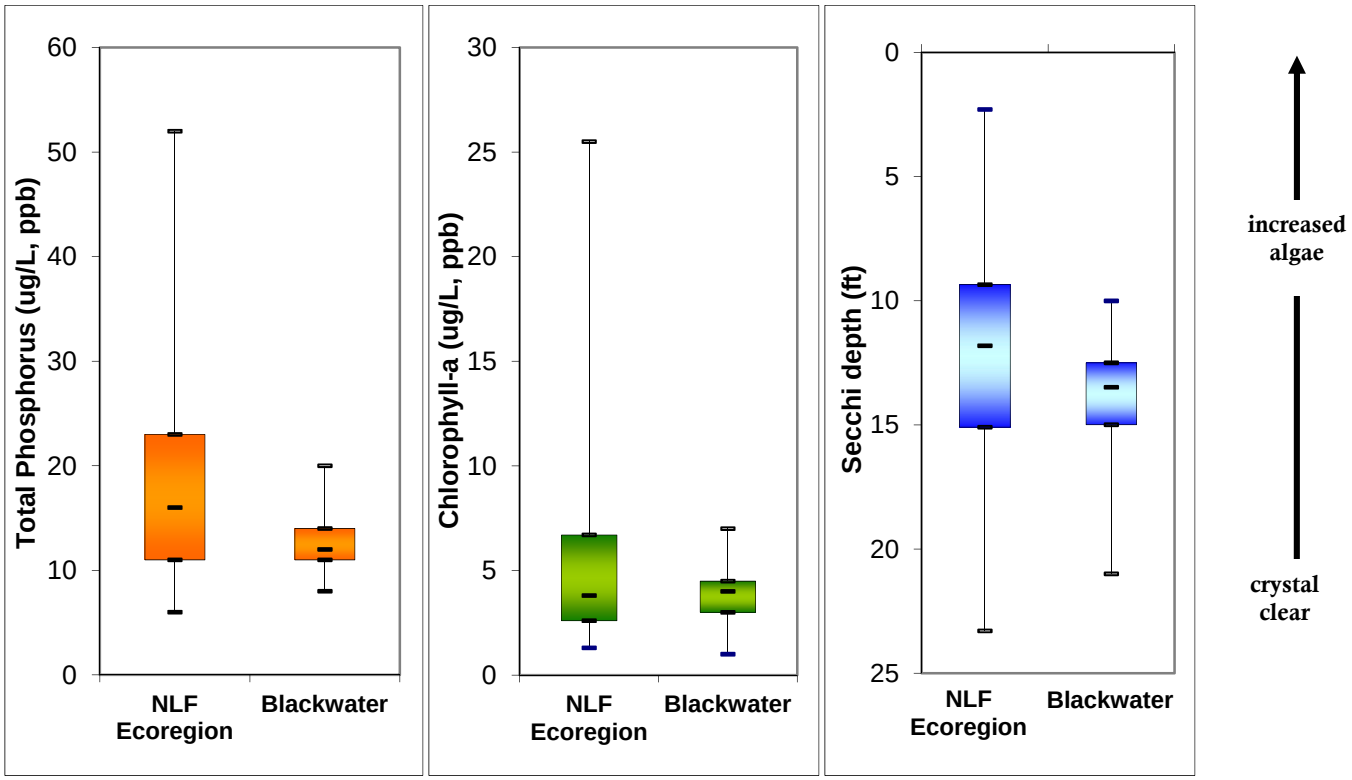


Figure 12. Minnesota Ecoregions.

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





Figures 13a-c. Blackwater Lake ranges compared to Northern Lakes and Forests Ecoregion ranges. The Blackwater Lake total phosphorus and chlorophyll *a* ranges are from 50 data points collected in May-September of 1989, 2004–2011. The Blackwater Lake secchi depth range is from 101 data points collected in May-September from 1988–2011.

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 **Leech Lake River Major Watershed** is one of the watersheds that make up the Upper Mississippi River Basin, which drains south to the Gulf of Mexico (Figure 14). This major watershed is made up of 75 minor watersheds. Blackwater Lake is located in **minor watershed** 8056 (Figure 15).

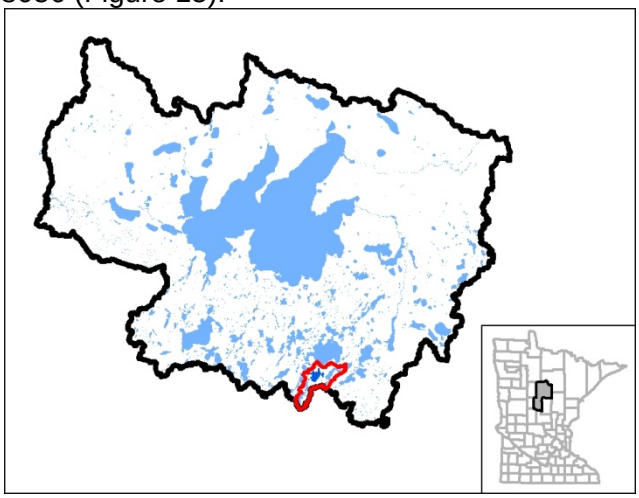


Figure 14. Leech Lake River Major Watershed.

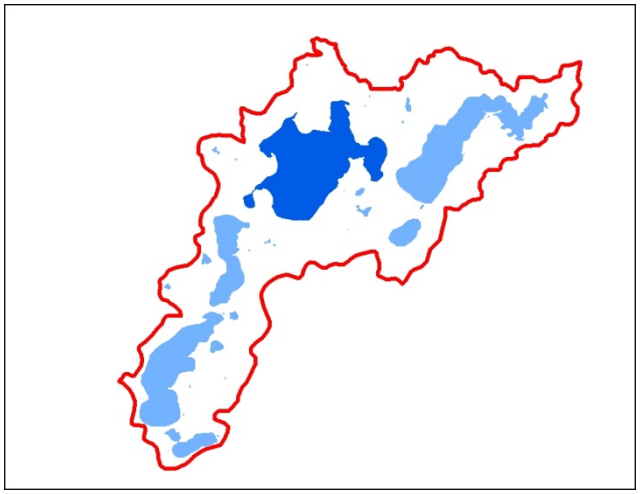


Figure 15. Minor Watershed 8056.

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. Blackwater Lake falls within **lakeshed 0805601** (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

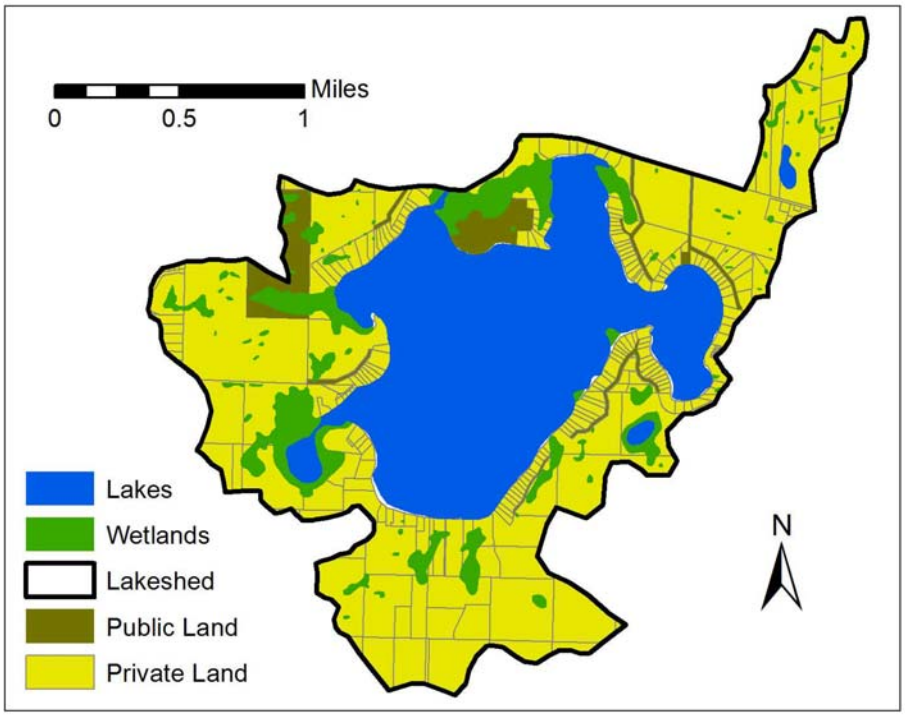


Figure 16. Blackwater Lake lakeshed (0805601) with land ownership, lakes, and wetlands illustrated.

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

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

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

Table 9. Blackwater Lake lakeshed vitals table.

Lakeshed Vitals		Rating
Lake Area	767 acres	descriptive
Littoral Zone Area	476 acres	descriptive
Lake Max Depth	67 ft.	descriptive
Lake Mean Depth	19 ft.	
Water Residence Time	NA	NA
Miles of Stream	None	descriptive
Inlets	2	
Outlets	1	
Major Watershed	8 - Leech Lake River	descriptive
Minor Watershed	8056	descriptive
Lakeshed	0805601	descriptive
Ecoregion	Northern Lakes and 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)	9:1	
Wetland Coverage	9%	
Aquatic Invasive Species	None as of 2011	
Public Drainage Ditches	None	
Public Lake Accesses	1	
Miles of Shoreline	7.7	descriptive
Shoreline Development Index	2.0	
Public Land to Private Land Ratio	0.09:1	
Development Classification	Recreational Development	
Miles of Road	3.95	descriptive
Municipalities in lakeshed	None	
Forestry Practices	None	NA
Feedlots	None	
Sewage Management	Individual Waste Treatment Systems (last county-wide upgrade in 2006), and the Lake Association sponsors an ongoing program for anyone who needs an inspection.	
Lake Management Plan	Healthy Lakes and Rivers Program, 2001	
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.

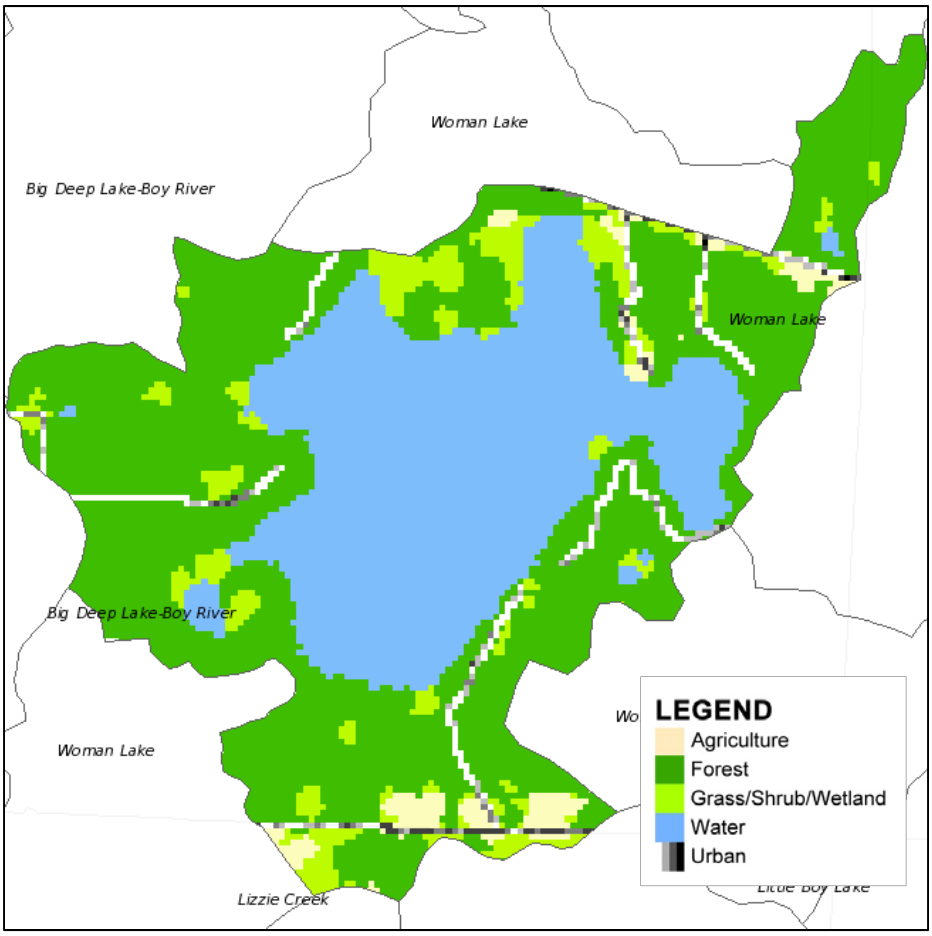


Figure 17. Blackwater Lake lakeshed (0805601) land cover (http://land.umn.edu).

Changes in land use, and ultimately land cover, impact the hydrology of a lakeshed. Land cover is also directly related to the 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. Impervious intensity describes the land's 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 Blackwater 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 10 describes Blackwater Lake's lakeshed land cover statistics and percent change from 1990 to 2000. Due to the many factors that influence demographics, one cannot determine with certainty the projected statistics over the next 10, 20, 30+ years, but one can see the transition within the lakeshed from agriculture, grass/shrub/wetland, and water acreages to forest and urban acreages. The largest change in percentage is the decrease in agricultural cover (33%). In acres, forest cover changed the most, with an increase of 72 acres.

Table 10. Blackwater Lake's lakeshed land cover statistics and % change from 1990 to 2000 (http://land.umn.edu).

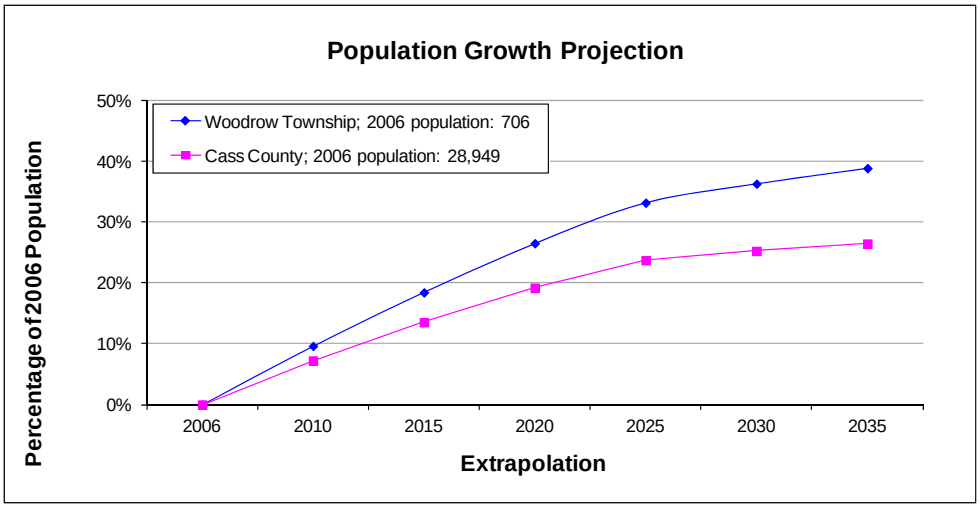
	1990		2000		% Change
Land Cover	**Acres**	**Percent**	**Acres**	**Percent**	**1990 to 2000**
Agriculture	57	2.52	38	1.68	33.3% Decrease
Forest	1189	52.56	1261	55.75	6.1% Increase
Grass/Shrub/Wetland	159	7.03	151	6.68	5.0% Decrease
Water	777	34.35	732	32.36	5.8% Decrease
Urban	81	3.58	81	3.58	No Change
Impervious Intensity %					
0	2230	98.54	2220	98.1	0.4% Decrease
1-10	14	0.62	14	0.62	No Change
11-25	9	0.4	17	0.75	88.9% Increase
26-40	6	0.27	7	0.31	16.7% Increase
41-60	3	0.13	4	0.18	33.3% Increase
61-80	0	0	1	0.04	0.04% Increase
81-100	0	0	0	0	No Change
Total Area	2262		2262		
Total Impervious Area (Percent Impervious Area Excludes Water Area)	6	0.4	8	0.52	33.3% Increase

Demographics

Blackwater 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 Cass County as a whole, Woodrow Township has a higher extrapolated growth projection (Figure 18). (source:http://www.demography.state.mn.us/resource.html?Id=19332)

Figure 18. Population growth projection for Woodrow Township, and Cass County.



Blackwater 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 Blackwater Lake's lakeshed is covered by privately owned forests (Table 11). This land can be the focus of development and protection efforts in the lakeshed.

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

	Private (61%)					**34%**	**Public (5%)**		
	Developed	**Agriculture**	**Forested Uplands**	**Other**	**Wetlands**	**Open Water**	**County**	**State**	**Federal**
Land Use (%)	2%	1%	44.3%	6.3%	7.4%	34%	2.6%	2.4%	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	18–60	6–21	90		15		6	5	0
Description	Focused on Shoreland	Cropland	Focus of develop-ment and protection efforts	Open, pasture, grass-land, shrub-land	Protected				
Potential Phase 3 Discussion Items	Shoreline restoration	Restore wetlands; CRP	Forest stewardship planning, 3rd party certification, SFIA, local woodland cooperatives		Protected by Wetland Conservation Act		County Tax Forfeit Lands	State Forest	National Forest

DNR Fisheries approach for lake protection and restoration

Credit: Peter Jacobson and Michael Duval, Minnesota DNR Fisheries

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

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

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

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

Blackwater Lake's lakeshed is classified with having 36.0% of the watershed protected and 3.3% of the watershed disturbed (Figure 19). Therefore, this lakeshed should have a protection focus. Goals for the lake should be to limit any increase in disturbed land use. Figure 20 displays the upstream lakesheds that contribute water to the lakeshed of interest. All of the land and water area in this figure has the potential to contribute water to Blackwater Lake, whether through direct overland flow or through a creek or river. There are 4 upstream of the Blackwater Lake lakeshed.

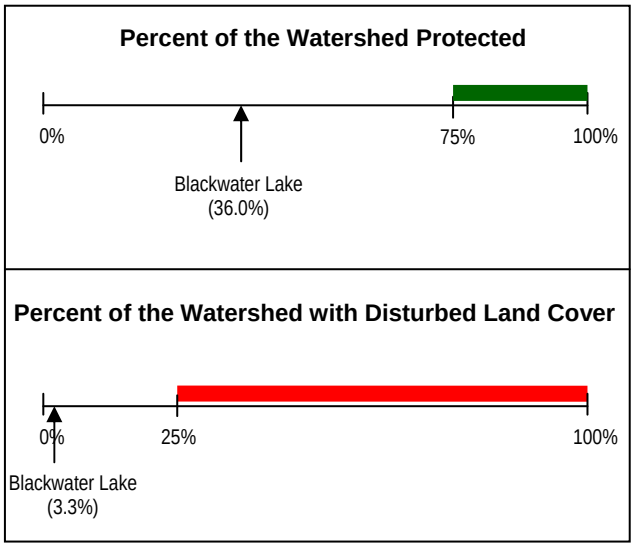


Figure 19. Blackwater Lake's lakeshed percentage of watershed protected and disturbed.

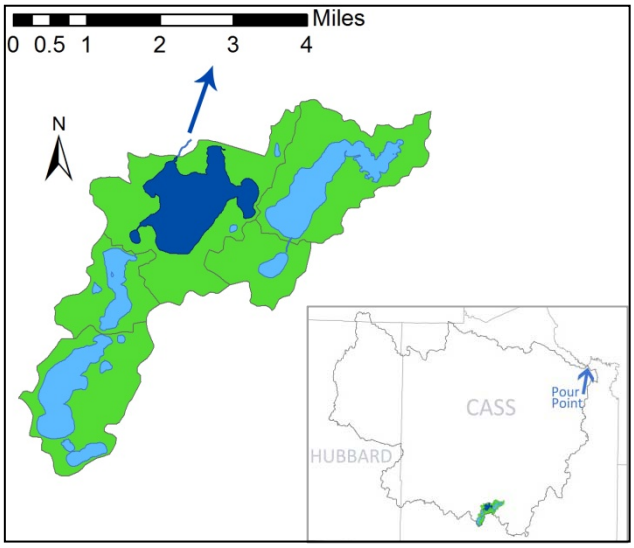


Figure 20. Upstream lakesheds that contribute water to the Blackwater lakeshed. Color-coded based on management focus (Table 12).

Conservation Easement Potential

In an ever-growing society, today's landscapes are being urbanized more and more to sustain the ever-growing population and behavior of recreational usage. In Minnesota, the land of ten thousand lakes, it is only natural to develop properties within the boundaries and beauty of our lakes and streams. Conservation efforts to limit or slow down the development process can only assist in the preservation of the lakeshed and inevitably the water quality of water bodies found within. Figure 21 identifies parcels within the lakeshed that are large enough to warrant the investigation of parcel conservation practices and purchase.

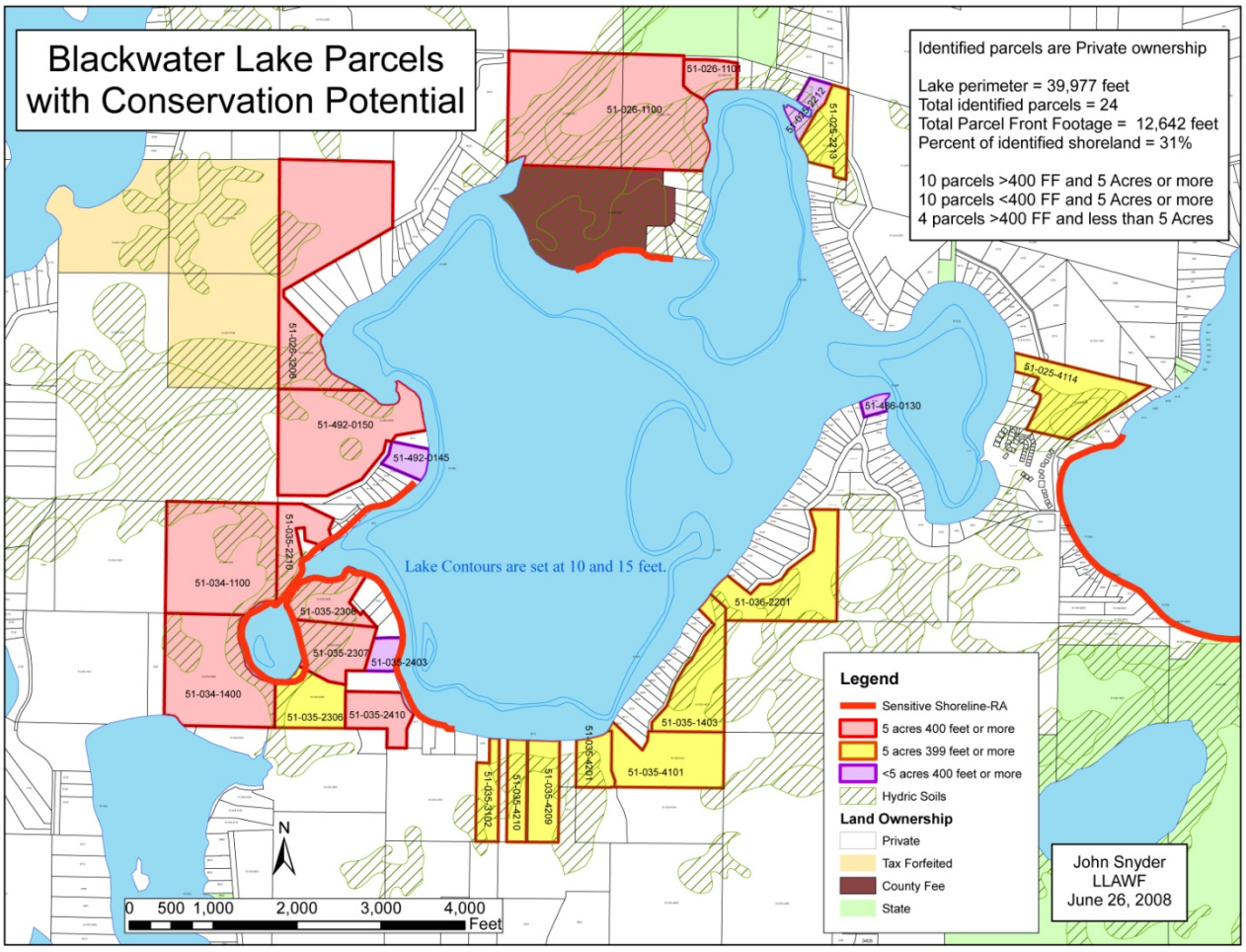


Figure 21. Lake parcels with conservation potential (developed by John Snyder, LLAWF).

Status of the Fishery (DNR, as of 07/25/2011)

Blackwater Lake is a 766.7-acre lake located near Longville, MN that has 7.5 miles of shoreline and a maximum depth of 67 feet. There is a Minnesota Department of Natural Resources (DNR) public access on the north shore of the east bay off County Road 11. The DNR has classified Minnesota's lakes into 43 different classes based on physical, chemical and other characteristics. Blackwater Lake is in Lake Class 25; lakes in this class are deep, clear, and irregularly shaped lakes.

Blackwater has been known as an excellent lake to catch quality-sized largemouth bass, and the lake has a special regulation for bass requiring all bass caught greater than 12 inches to be released. Largemouth bass sampled by the DNR in 2011 were abundant and had an average length of 14 inches with fish up to 19 inches long sampled. Anglers fishing the deepwater structure might catch a bonus smallmouth bass, which also has to be released if greater than 12 inches due the special regulation. The black crappie population is in good condition and anglers targeting black crappie may find an excellent evening bite during early spring. Anglers should be careful to avoid over-harvesting crappie at such times. The walleye population is moderately abundant with excellent size structure. The 2011 gill net catch rate of 3.75 fish/net was similar to historical catch rates. Lengths of walleye sampled ranged from 7 to 28 inches and averaged 17 inches. The size structure for walleye consisted of larger fish with 38% of the walleye sampled greater than 20 inches. Anglers targeting northern pike have often been successful in Blackwater Lake, frequently catching small to medium size fish which can be excellent candidates for pickling or baking. Northern pike are abundant in Blackwater Lake and the catch rate has been historically high compared to other Lake Class 25 lakes. The mean length for northern pike was 21 inches and fish up to 31 inches were sampled.

People can have significant impacts on lakes and the fish populations they support. Selective harvest by anglers (harvest of smaller to medium-sized fish) promotes balanced fish communities and sustainable fishing quality. Removal of shoreline vegetation on private lake lots and mowing grass to the water's edge can reduce water quality, which in turn can adversely affect fish populations. Similarly, removal of woody debris and aquatic plants from near-shore areas reduces critical habitat needed to support quality fish populations.

Currently no aquatic invasive species (AIS) have been identified in Blackwater Lake. These species are moved from infested to non-infested waters by anglers, boaters, and lake-shore owners and can adversely impact lakes and fish populations. To avoid spreading AIS, lake users are required to remove all aquatic plants or animals from their watercraft and drain all water from their boat away before leaving the access. If you suspect an infestation of an invasive species in this lake, save a specimen and report it to a local natural resource office.

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=11027400

Key Findings / Recommendations

Monitoring Recommendations
Transparency monitoring at sites 201 and 202 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 at site 202, as the budget allows, to track trends in water quality.

Overall Conclusions
Blackwater Lake is in good shape for water quality and lakeshed protection. It is an oligotrophic/mesotrophic lake (TSI=40) with an improving trend in transparency since 1988. Five percent (5%) of the lakeshed is in public ownership, and 36% of the watershed is protected, while only 3% of the watershed is disturbed (Figure 19). In addition, Blackwater Lake's Lakeshed is 44% forests and 34% water, which is excellent protection (Table 11).

It is often difficult to determine why a lake has an improving trend in transparency. It could be due to natural causes. It could also be due to the fact that the county did a lake-wide septic system upgrade in 2006, and the Lake Association sponsors an ongoing program for providing inspections to anyone who wants or needs one.

Priority Impacts to the Lake
Blackwater Lake is mostly developed in the first tier (Figure 16). From 1990-2000, there was essentially no change in urban or impervious acreage in the lakeshed (Table 10). If the first and second tier were to experience more development pressure, it could change the drainage around the lake.

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

There are numerous large parcels of land that could be protected with conservation easements, and many of these areas are along DNR-designated sensitive shorelines. See Figure 21 for the location of these parcels.

Project Implementation
The best management practices above can be implemented by a variety of entities. Some possibilities are listed below.

Individual property owners
- Shoreline restoration
- Rain gardens
- Aquatic plant bed protection (only remove a small area for swimming)
- Conservation easements

Lake Associations
- Lake condition monitoring
- Ground truthing – visual inspection upstream on stream inlets
- Watershed mapping by a consultant
- Shoreline inventory study by a consultant
- Conservation easements

Soil and Water Conservation District (SWCD) and Natural Resources Conservation Service (NRCS)

- Shoreline restoration
- Stream buffers
- Wetland restoration

Organizational contacts and reference sites

Blackwater Lake Association	http://www.minnesotawaters.org/group/blackwater/welcome
Cass County Soil and Water Conservation District	Courthouse, 1st Floor, 303 Minnesota Avenue W, PO Box 3000, Walker, MN, 56484-3000 218-547-7399 http://www.co.cass.mn.us/soil_conservation/soil_water.html
DNR Fisheries Office	07316 State 371 Northwest, Walker, MN, 56484 218-547-1683 walker.fisheries@state.mn.us
Regional Minnesota Pollution Control Agency Office	7678 College Road, Suite 105, Baxter, MN 56425 218-828-2492, 1-800-657-3864 http://www.pca.state.mn.us/pyri3df