Kabekona Lake 29-0075-00 HUBBARD COUNTY

Lake Water Quality

Summary

Kabekona Lake is located about 10 miles northwest of Walker, Minnesota in Hubbard County. It covers 2,252 acres and has an oblong shape.

Kabekona Lake has four inlets and one outlet, which classifies it as a drainage lake. The main inlet, the Kabekona River, enters from the west side. The other inlets include Gulch and Sucker Creek. The outlet, the Kabekona River, flows out of the east side of the lake and into Leech Lake.

Water quality data have been collected on Kabekona Lake since 1986 (Table 3). These data show that the lake is at the oligotrophic/mesotrophic border, which is characterized by clear water throughout the summer and excellent recreational opportunities.

The Kabekona Lake Association's (KLA) primary purpose "is to protect and preserve Kabekona Lake, its watershed, shores, and environs. This includes water quality, aquatic productivity, flora and fauna, its aesthetic quality, and its social and cultural climate. Other purposes are to communicate information concerning governmental agencies, lake and environmental associations, and to serve as a forum on relevant issues." KLA is involved in many activities, including water quality monitoring and education. They are also a member of the Hubbard County Coalition of Lake Associations (COLA).

Table 1. Kabekona Lake location and key physical characteristics.

Location Data		Physical Characteristics	
MN Lake ID:	29-0075-00	Surface area (acres):	2252
County:	Hubbard	Littoral area (acres):	532
Ecoregion:	Northern Lakes & Forests	% Littoral area:	23%
Major Drainage Basin:	Upper Mississippi River	Max depth (ft), (m):	133,40.5
Latitude/Longitude:	47.16361111 / -94.76611111	Inlets:	4
Invasive Species:	None as of 2011	Outlets:	1
		Public Accesses:	1

Table 2: Availability of data and an observation of the quantity of sample points.

Data Availability

Transparency data		Excellent data set through the Citizens Lake Monitoring Program.
Chemical data		Excellent data set through the RMB Lab Lakes Program.
Inlet/Outlet data		No inlet or outlet data exist for this lake.

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

Lake Map

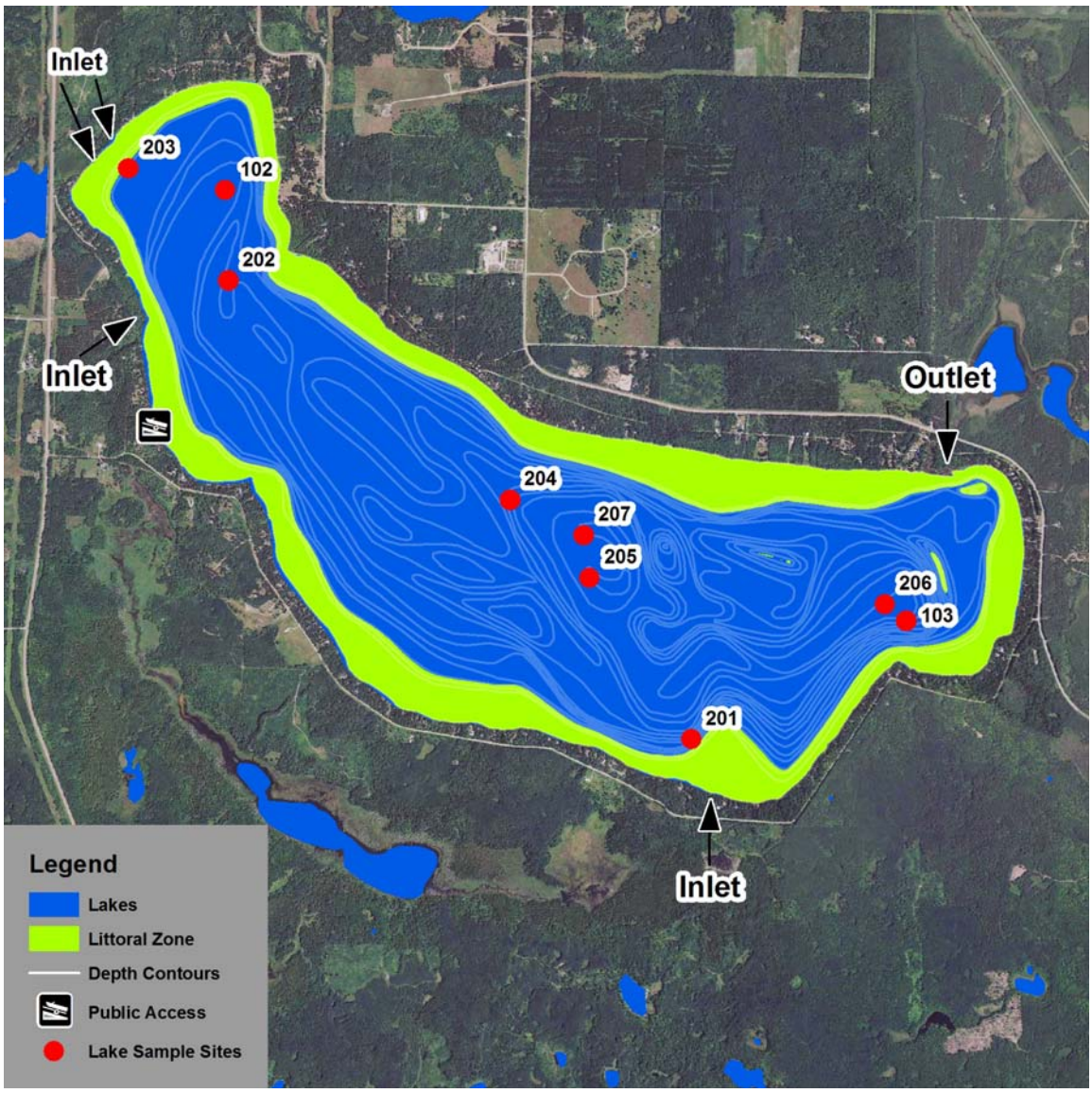


Figure 1. Map of Kabekona Lake with 2010 aerial imagery and illustrations of sample site locations, inlets and outlets, and public access points. The light green areas in the lake illustrate the littoral zone, where the sunlight can usually reach the lake bottom allowing aquatic plants to grow.

Table 3. Monitoring programs and associated monitoring sites. Monitoring programs include the Minnesota Pollution Control Agency (MPCA), Citizens Lake Monitoring Program (CLMP) and RMB Environmental Laboratories Lakes Program (RMBEL).

Lake Site	Depth (ft)	Monitoring Programs
102	60	MPCA: 1990, 1994
103	90	MPCA: 1990, 1994
201	60	CLMP: 1986-1994, 2005-2006
202	70	CLMP: 1990-1994, 1997-1998
203	30	CLMP: 1992-1993
204	100	CLMP: 1993-1994
205	130	MPCA: 1990, 1994; RMBEL: 1997-2012
206	100	CLMP: 1994-2010

Average Water Quality Statistics

The information below describes available chemical data for Kabekona Lake through 2011. The data set is limited, and all parameters, with the exception of total phosphorus, chlorophyll *a* and secchi depth, are means for just 1990 and 1994 MPCA data.

Minnesota is divided into seven 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)	12	14 - 27	> 30	Results are better than the expected range for the ecoregion.
[3]Chlorophyll *a* (ug/L)	3	4 - 10	> 9	
Chlorophyll *a* max (ug/L)	8	<15		
Secchi depth (ft)	13.2	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)	0.31	0.40 - 0.75		Indicates insufficient nitrogen to support summer nitrogen-induced algae blooms.
Alkalinity (mg/L)	178	40 - 140		Indicates a low sensitivity to acid rain and a good buffering capacity.
Color (Pt-Co Units)	9	10 - 35		Indicates very clear water with little to no tannins (brown stain).
pH	8.5	7.2 - 8.3		Characteristic of a hard water lake. Lake water with pH less than 6.5 can affect fish spawning and the solubility of metals in the water.
Chloride (mg/L)	1.9	0.6 - 1.2		Slightly above the ecoregion average but still considered low level.
Total Suspended Solids (mg/L)	1.8	<1 - 2		Within the ecoregion average range.
Specific Conductance (umhos/cm)	313	50 - 250		Above the ecoregion average range.
Total Nitrogen :Total Phosphorus	25:1	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, 1997-2011.

Parameters	Primary Site 205	Site 201	Site 202	Site 206
Total Phosphorus Mean (ug/L):	**12**			
Total Phosphorus Min:	2			
Total Phosphorus Max:	36			
Number of Observations:	99			
Chlorophyll *a* Mean (ug/L):	**3**			
Chlorophyll-a Min:	1			
Chlorophyll-a Max:	8			
Number of Observations:	92			
Secchi Depth Mean (ft):	**13.2**	**11.7**	**11.5**	**12.9**
Secchi Depth Min:	6.0	6.5	8.0	5.5
Secchi Depth Max:	21.0	17.0	16.0	25.0
Number of Observations:	121	125	51	264

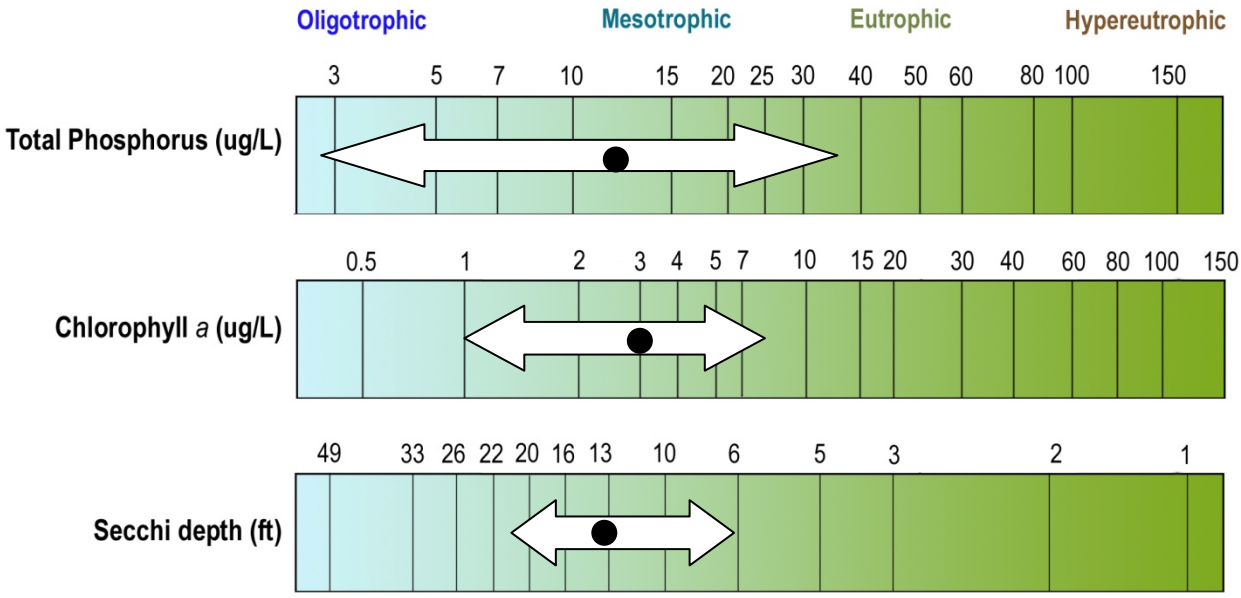


Figure 2. Kabekona Lake total phosphorus, chlorophyll *a* and transparency historical ranges. The arrow represents the range and the black dot represents the historical mean (Primary Site 205). Figure adapted after Moore and Thornton, [Ed.]. 1988. Lake and Reservoir Restoration Guidance Manual. (Doc. No. EPA 440/5-88-002)

Transparency (Secchi Depth)

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

The annual mean transparency for Kabekona Lake ranges from 8.9 – 15.7 ft (Figure 3). Transparency is fairly uniform throughout the lake, which is most likely due to its shape. Transparency monitoring should be continued to track water quality in Kabekona Lake.

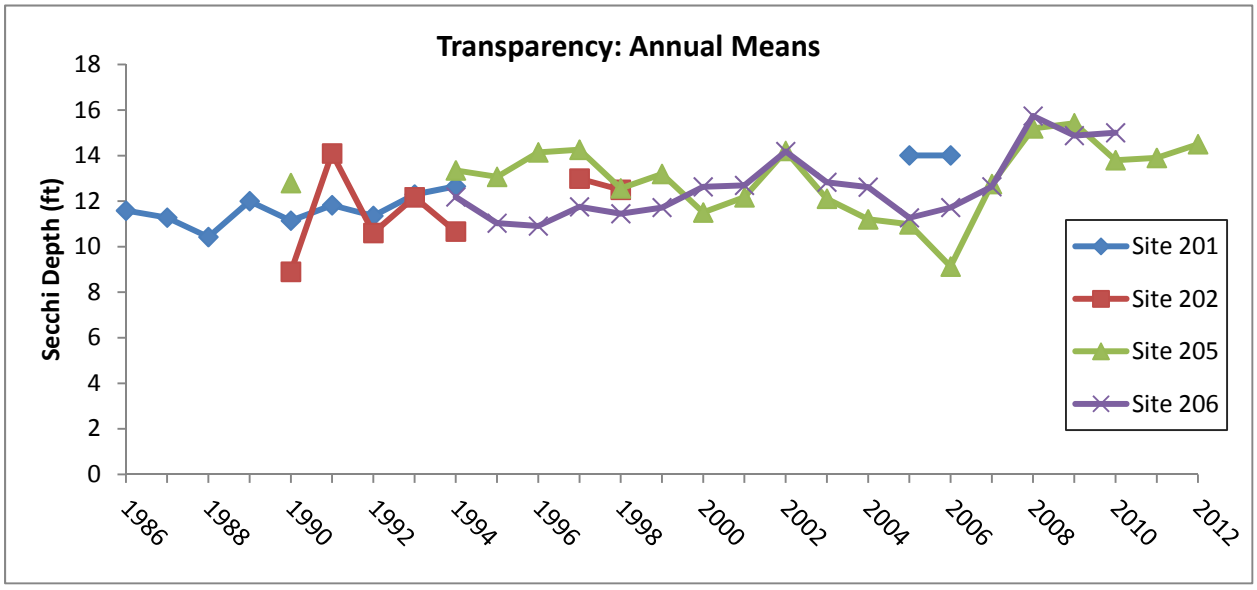


Figure 3. Annual mean transparency for sites 201, 202, 205 and 206.

Kabekona Lake transparency ranges from 6 to 21 feet throughout the summer. Figure 4 shows the seasonal transparency dynamics. The transparency does not change much throughout the summer in Kabekona Lake. This is common for a lake with low nutrients and good clarity. Some lakes change a lot over the summer while others don't. 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 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.

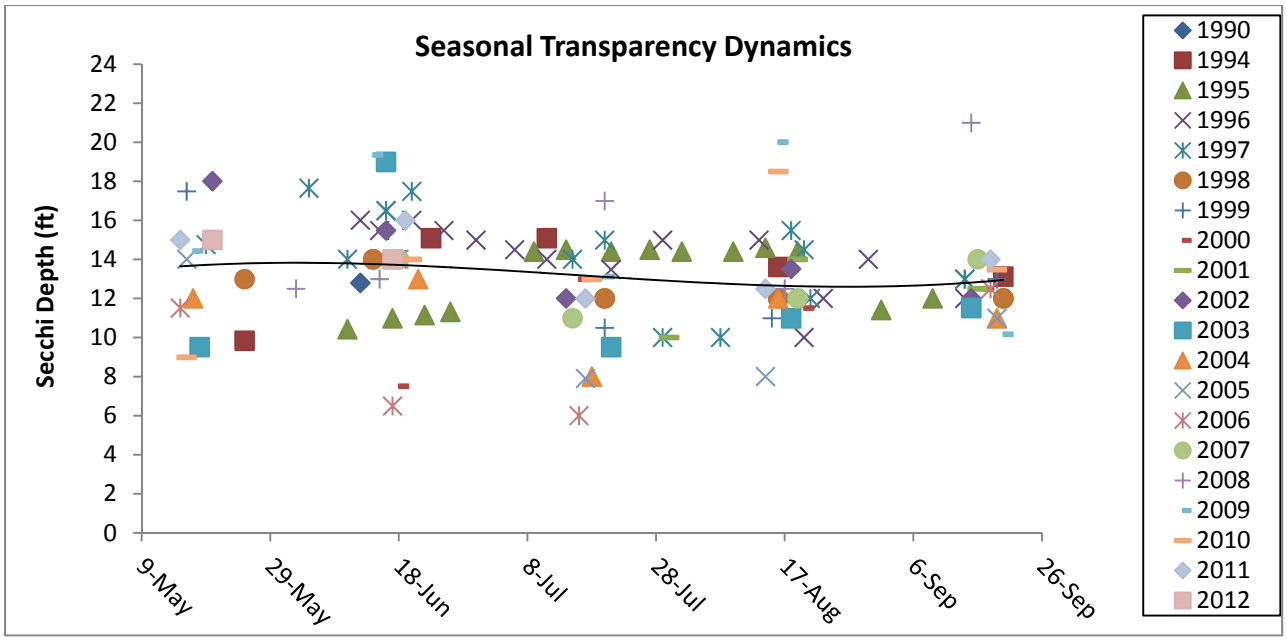


Figure 4. Seasonal transparency dynamics and year-to-year comparison (site 205). The black line represents the pattern in the data.

User Perceptions

When volunteers collect secchi depth readings, they record their perceptions of the water based on the physical appearance and the recreational suitability. These perceptions can be compared to water quality parameters to see how the lake "user" would experience the lake at that time. Looking at transparency data, as the secchi depth decreases the perception of the lake's physical appearance rating decreases. Kabekona Lake was rated as being "crystal clear" 73% of the time between 1994-2011 (Figure 5).

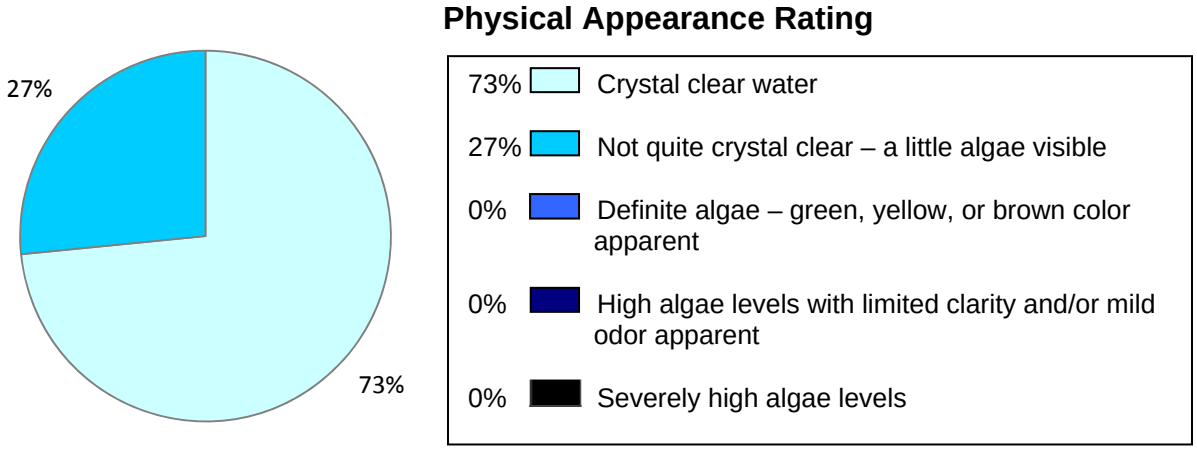


Figure 5. Physical appearance rating, as rated by the volunteer monitor.

As the secchi depth decreases, the perception of recreational suitability of the lake decreases. Kabekona Lake was rated as being "beautiful" 92% of the time from 1994-2011.

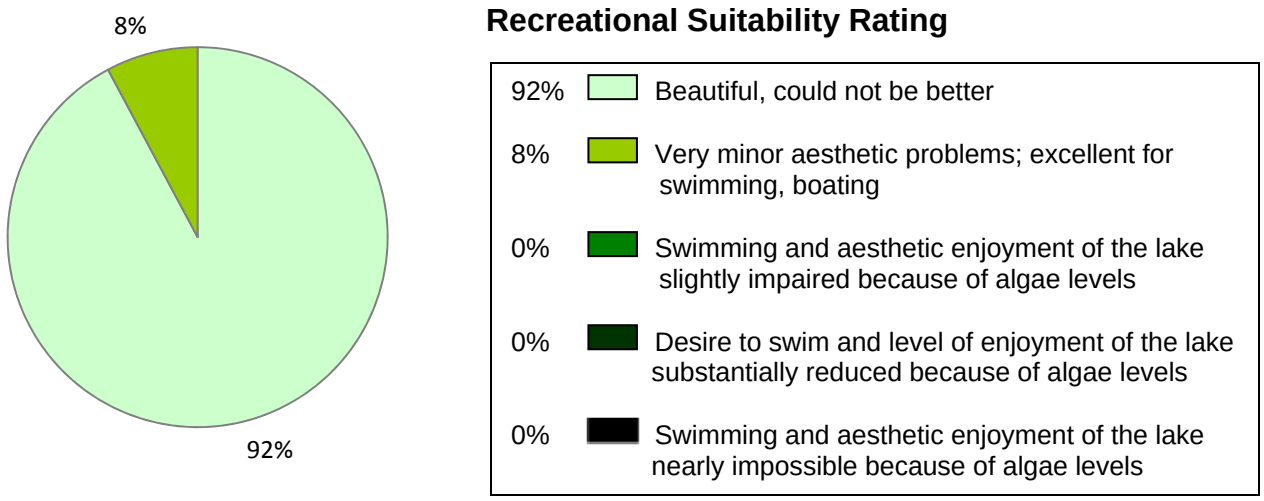


Figure 6. Recreational suitability rating, as rated by the volunteer monitor.

Total Phosphorus

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

Total phosphorus was evaluated in Kabekona Lake in 1997-2011. Most of the data points fall into the oligotrophic range (Figure 7). There is not much seasonal variation in phosphorus concentration for Kabekona Lake. The slightly higher phosphorus in spring and fall could be due to lake turnover.

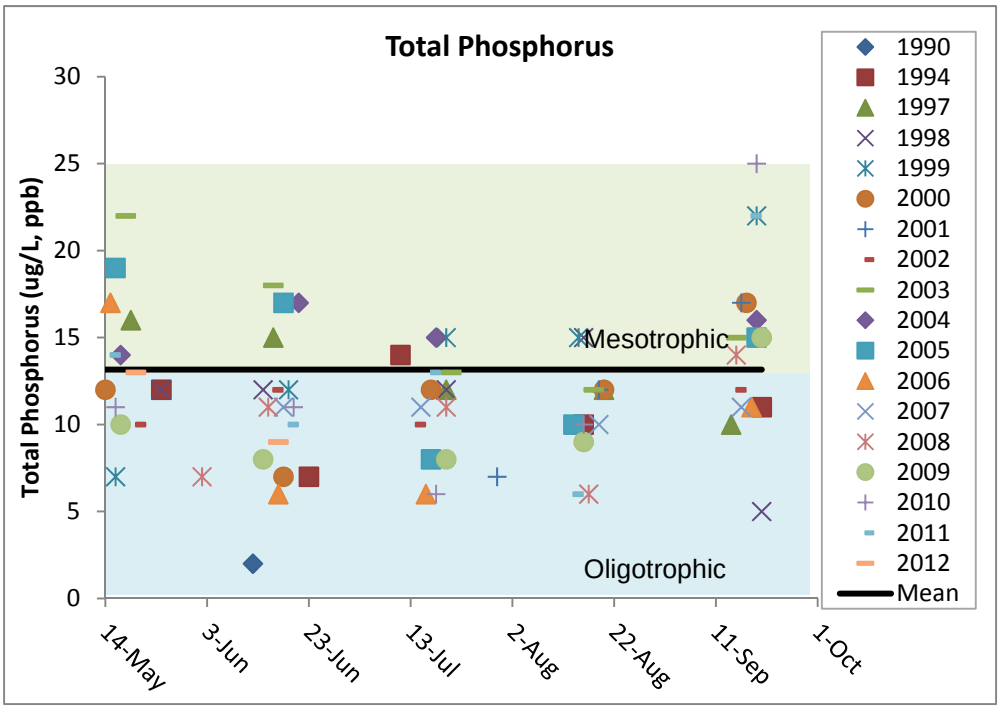


Figure 7. Historical total phosphorus concentrations (ug/L) at site 205 for Kabekona Lake.

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

Chlorophyll *a*

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

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

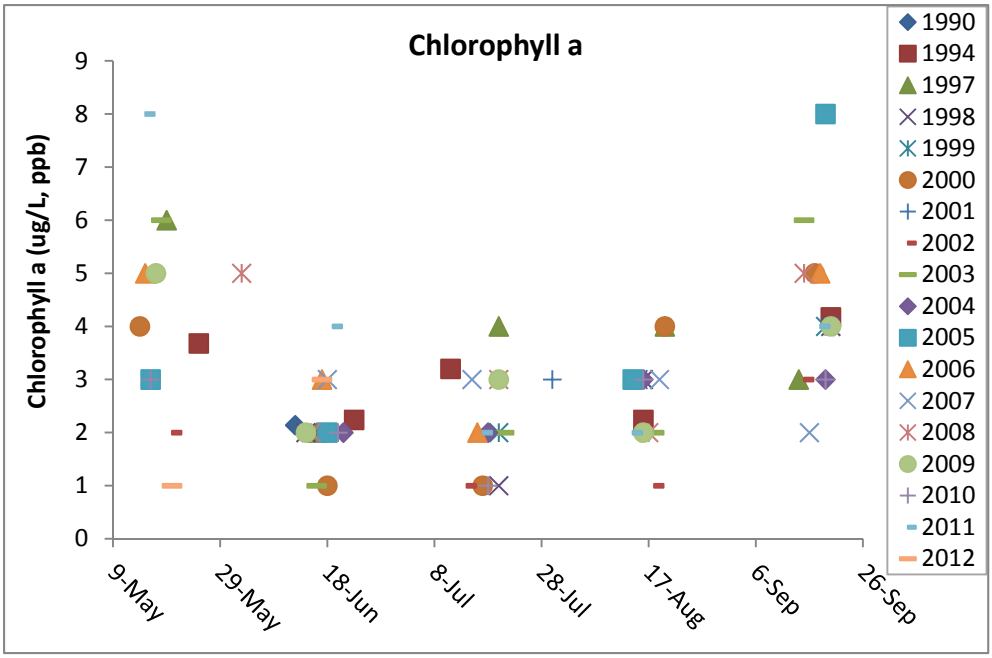
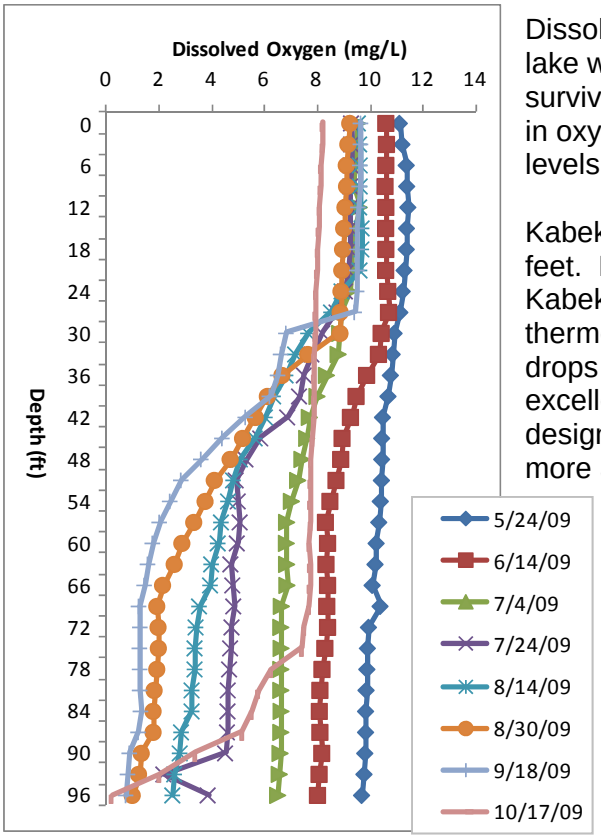


Figure 8. Chlorophyll *a* concentrations (ug/L) for Kabekona Lake.

Chlorophyll *a* was evaluated in Kabekona Lake in 1997-2011 (Figure 8). Chlorophyll *a* concentrations remained well below 10 ug/L, indicating clear water all summer and no nuisance algae blooms.

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.

Kabekona Lake is a deep lake, with a maximum depth of 133 feet. Dissolved oxygen profiles from 2007 indicate that Kabekona Lake stratifies in the summer (Figure 9). The thermocline occurs at 35-40 feet, although the oxygen only drops below 5 mg/L in August and September. This is excellent habitat for Cisco (Tullibee) fish. Kabekona Lake is designated by the DNR as a Cisco refuge lake. To read more about this designation, see the bottom of page 16.

Figure 9. Dissolved oxygen profiles for Kabekona Lake in 2009, MN DNR.

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 Kabekona Lake falls on the oligotrophic/mesotrophic border (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 (Table 7). The bottom of the deep areas of the lake becomes anoxic (no oxygen) during the summer, which is inhospitable to game fish. This occurrence is common in Minnesota lakes.

Table 6. Trophic State Index.

Trophic State Index	Site 204
TSI Total Phosphorus	40
TSI Chlorophyll-a	41
TSI Secchi	40
TSI Mean	40
Trophic State:	Mesptrophic/ Oligotrophic

Numbers represent the mean TSI for each parameter.

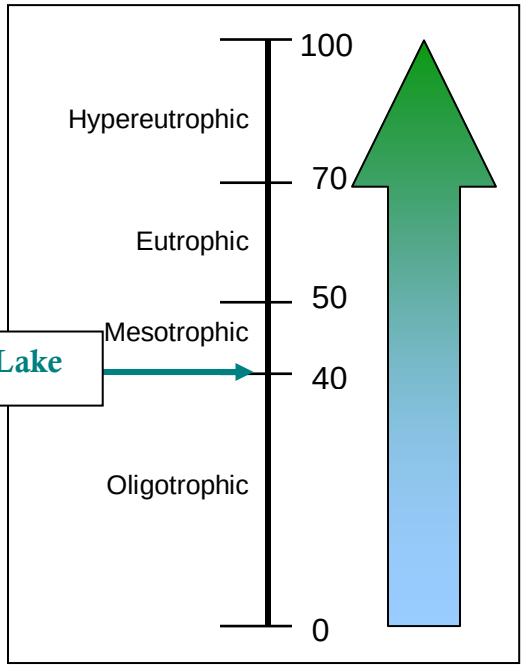


Figure 10. Trophic state index chart with corresponding trophic status.

Table 7. Trophic states and corresponding lake and fishery conditions.

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

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

Trend Analysis

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

There is enough historical data to perform trend analysis for total phosphorus, chlorophyll *a,* and transparency on Kabekona Lake (Table 8). The data was analyzed using the Mann Kendall Trend Analysis.

Table 8. Trend analysis for Kabekona Lake.

Lake Site	Parameter	Date Range	Trend	Probability
204	Transparency	2000-2011	Improving	99.9%
205	Transparency	1995-2011	No trend	-
204	Total Phosphorus	1994,1997-2010	No trend	-
204	Chlorophyll a	1994,1997-2010	No trend	-

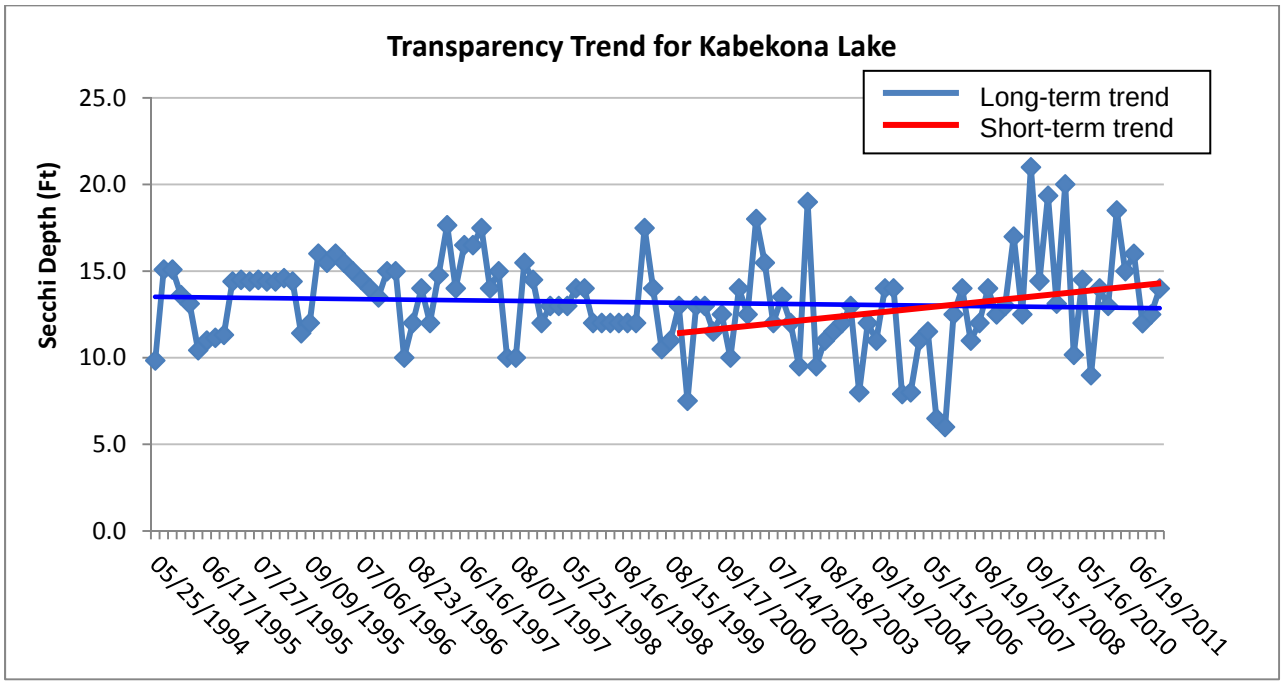


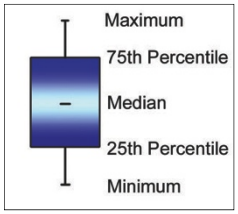
Figure 11. Long-term and short-term transparency trends for site 205 in Kabekona Lake.

Site 205 shows no detectable long-term trend from 1995-2011, and a statistically significant improving short-term trend in transparency from 2000-2011 (Figure 11). There is no detectable trend for phosphorus or chlorophyll a. Monitoring should continue at site 205 so that this trend can be tracked in future years.

Ecoregion Comparisons

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

Kabekona Lake is in the Northern Lakes and Forests Ecoregion. The means for phosphorus, chlorophyll a and transparency are better than the ecoregion ranges (Fig 13).



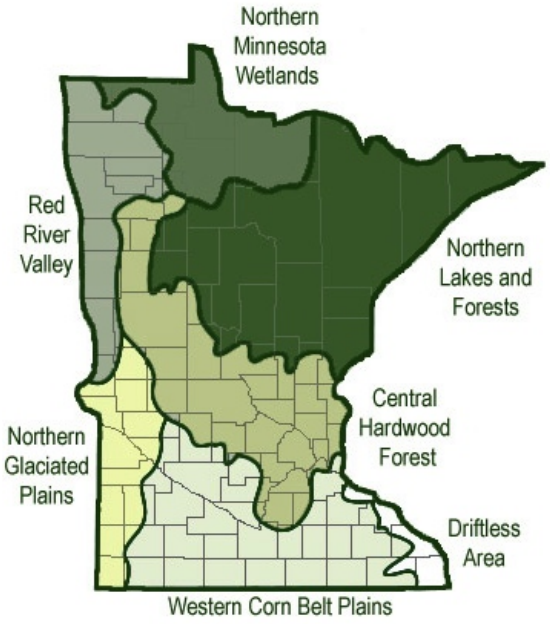
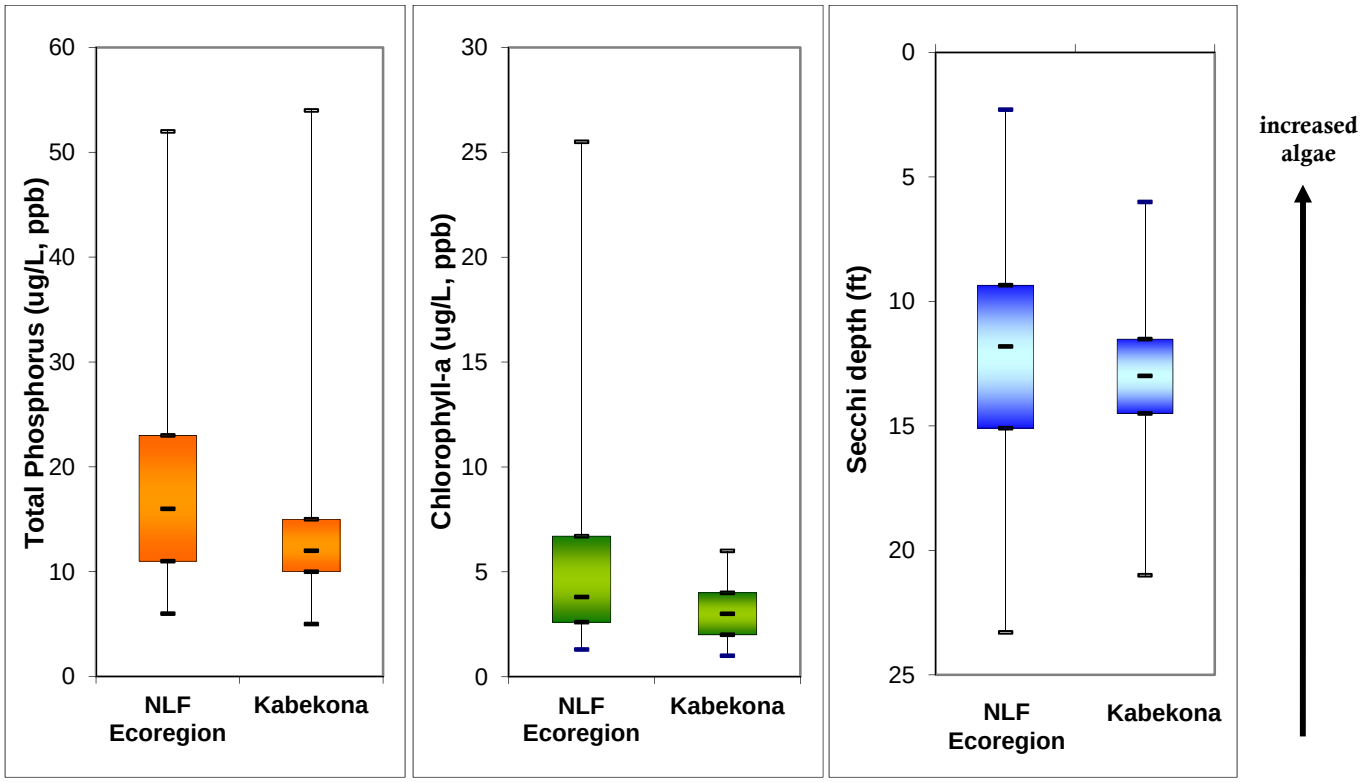


Figure 12. Map of Minnesota with the seven ecoregions.



Figures 13a-c. Kabekona Lake ranges compared to Northern Lakes and Forest Ecoregion ranges. The Kabekona Lake total phosphorus and chlorophyll *a* ranges are from 99 data points collected in May-September of 1997-2011. The Kabekona Lake Secchi depth range is from 121 data points collected in May-September from 1995-2011.

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 makes 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. Kabekona Lake is located in **minor watershed** 08020 (Figure 15).

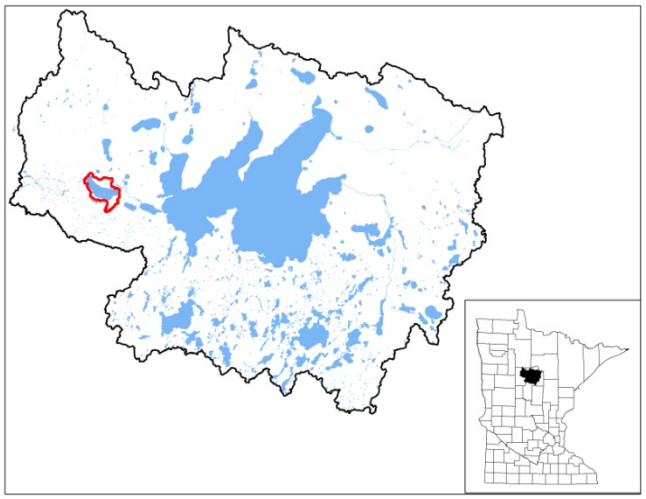


Figure 14. Leech Lake River Watershed.

Figure 15. Minor Watershed 08020

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. Kabekona Lake falls within the **Kabekona (0802000) 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 Kabekona Lake's full watershed, containing all the lakesheds upstream of Kabekona Lake lakeshed, see page 5. The data interpretation of the Kabekona

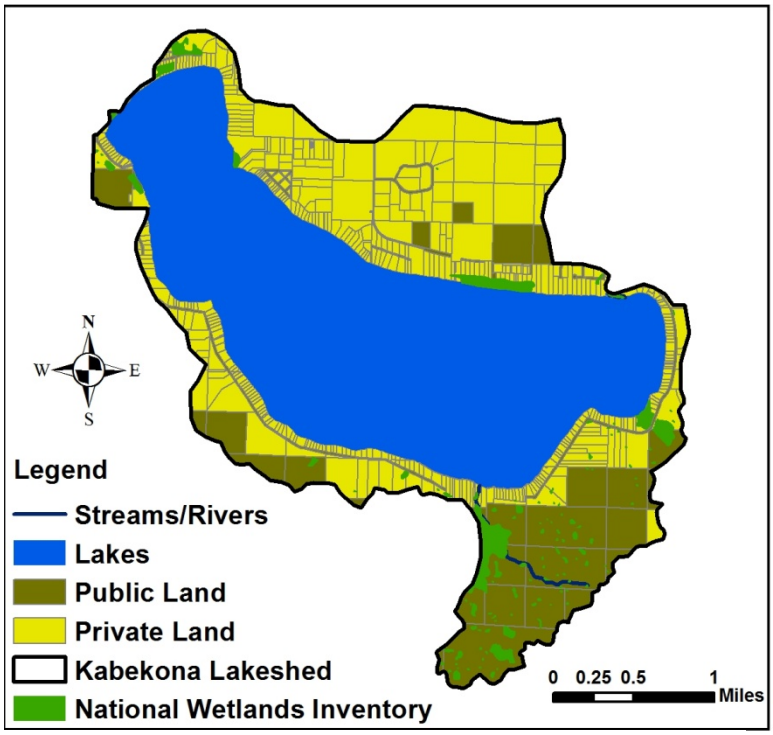


Figure 16. The Kabekona (0802000) Lakeshed with land ownership, lakes, wetlands, and rivers illustrated.

Lake lakeshed includes only the immediate lakeshed as this area is the land surface that flows directly into Kabekona Lake.

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

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

Table 9. Lakeshed vitals for Kabekona Lake.

Lakeshed Vitals		Rating
Lake Area	2433 acres	descriptive
Littoral Zone Area	532 acres	descriptive
Lake Max Depth	133 ft.	descriptive
Lake Mean Depth	50.3 ft.	
Water Residence Time	2.5 years	
Miles of Stream	1.2	descriptive
Inlets	4 – Kabekona River, Gulch & Sucker Creek	
Outlets	1 – Kabekona River	
Major Watershed	08 - Leech Lake River	descriptive
Minor Watershed	08020	descriptive
Lakeshed	0802000	descriptive
Ecoregion	Northern Lakes and Forest	descriptive
Total Lakeshed to Lake Area Ratio (total lakeshed includes lake areas)	2:1	
Standard Watershed to Lake Basin Ratio (standard watershed includes lake areas)	25:1	
Wetland Coverage	2.8	
Aquatic Invasive Species	None	
Public Drainage Ditches	None	
Public Lake Accesses	1	
Miles of Shoreline	10.2	descriptive
Shoreline Development Index	1.5	
Public Land : Private Land (excludes water)	0.6:1	
Development Classification	Recreational Development	
Miles of Road	12.5	descriptive
Municipalities in lakeshed	None	
Forestry Practices	2002 Hubbard County Forest Resources Management Plan	
Feedlots	None	
Sewage Management	Individual waste treatment systems (last lake-wide county inspection - 1992)	
Lake Management Plan	Healthy Lakes & Rivers Partnership program, 2005	
Lake Vegetation Survey/Plan	Survey completed 2005 and 2006 by DNR	

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. Kabekona Lake (0802000) 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 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 Kabekona Lake's lakeshed.

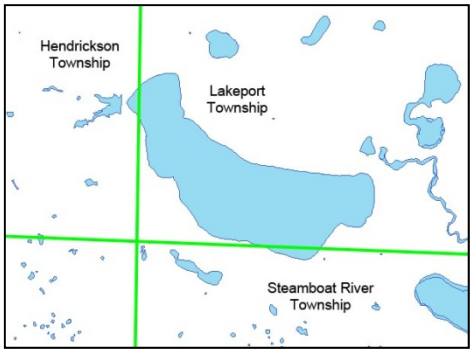
The University of Minnesota has online records of land cover statistics from years 1990 and 2000 (http://land.umn.edu). This data is somewhat outdated, but it is the most recent comparable data available. Table 2 describes Kabekona Lake's lakeshed land cover statistics and percent change from 1990 to 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 grass/shrub/wetland cover (39.7%). In addition, the impervious intensity has increased, which has implications for storm water runoff into the lake. The increase in impervious intensity is consistent with the increase in urban acreage.

Table 10. Kabekona 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	324	6.41	260	5.14	19.8% decrease
Grass/Shrub/Wetland	146	2.89	88	1.74	39.7% decrease
Forest	2004	39.65	2139	42.32	6.7% increase
Water	2439	48.26	2413	47.74	1.1% decrease
Urban	144	2.85	156	3.09	8.3% increase
Impervious Intensity %					
0	4928	97.51	4907	97.09	0.4% decrease
1-10	40	0.79	35	0.69	12.5% decrease
11-25	56	1.11	57	1.13	1.8% increase
26-40	22	0.44	32	0.63	45.5% increase
41-60	9	0.18	19	0.38	111.1% increase
61-80	1	0.02	2	0.04	100% increase
81-100	1	0.02	4	0.08	300% increase
Total Area	5054		5054		
Total Impervious Area (Percent Impervious Area Excludes Water Area)	24	0.9	37	1.4	54.2% increase

Demographics

Kabekona 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 Hubbard County as a whole, Steamboat River and Lakeport Township have a higher extrapolated growth projection (Figure 18). On the other hand, Hendrickson Township has a lower extrapolated growth projection.

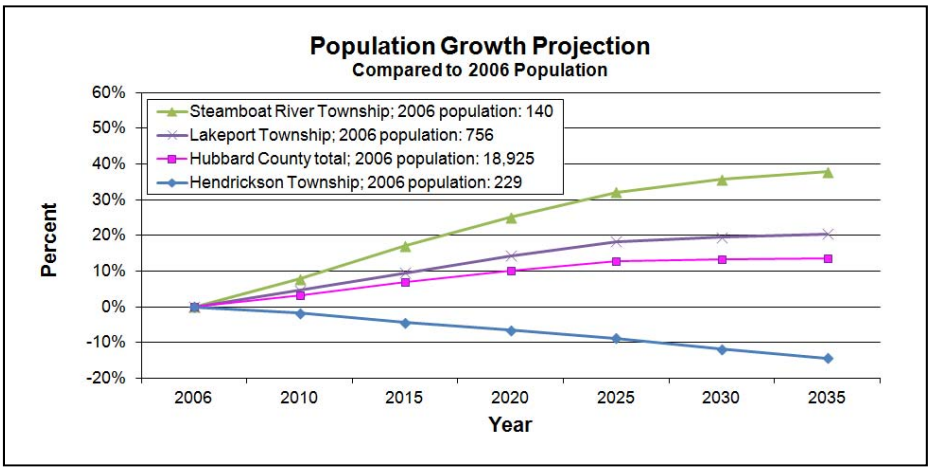


Figure 18. Population growth projection for Steamboat River, Lakeport, Hendrickson Township and Hubbard County. (source: http://www.demography.state.mn.us/resource.html?Id=19332)

Kabekona 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 Kabekona Lake's lakeshed is made up of private forested uplands (Table 11). This land can be the focus of development and protection efforts in the lakeshed.

Table 11. Percent land use in private versus publicly owned land with corresponding phosphorus loading and protection/restoration ideas (Sources: Minnesota DNR GAP Stewardship data, National Wetlands Inventory, and the 2006 National Land Cover Dataset).

	Private (33.5%)					48%	Public (18.5%)		
	Developed	**Agriculture**	**Forested Uplands**	**Other**	**Wetlands**	**Open Water**	**County**	**State**	**Federal**
Land Use (%)	1.9%	2.9%	20.9%	6.7%	1.1%	48%	5%	13.5%	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	41 – 138	37 – 128	95		5		23	61	
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.

Kabekona Lake was classified with having 63.8% of the watershed protected and 5.8% of the watershed disturbed (Figure 19). Therefore, Kabekona Lake should have a protection focus. Goals for the lake should be to limit any increase in disturbed land use. In addition, Kabekona Lake is designated as a high valued fishery lake because of its cisco population.

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 Kabekona Lake, whether through direct overland flow or through a creek or river. The majority of the watershed of Kabekona Lake is well protected.

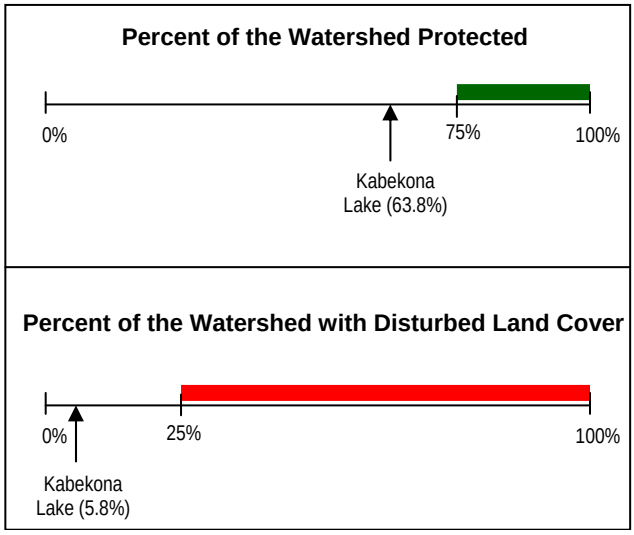


Figure 19. Kabekona Lake lakeshed's percentage of watershed protected and disturbed.

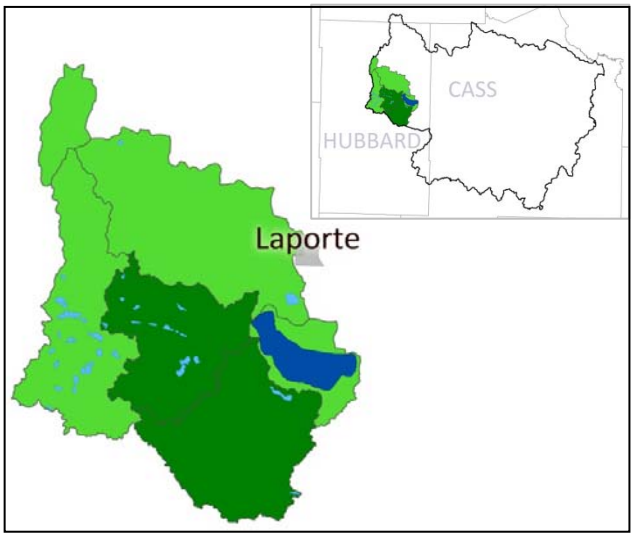


Figure 20. Upstream lakesheds that contribute water to the Kabekona lakeshed. Color-coded based on management focus (Table 3).

Kabekona, Status of the Fishery (as of 07/16/2008)

Kabekona Lake is located three miles south of Laporte in northeastern Hubbard County. Kabekona has a surface area of 2,252 acres and a maximum depth of 133 feet. A county-owned public access is located on the west shore of the lake. Kabekona is known for its walleye fishery and exceptional water quality.

The Minnesota Department of Natural Resources (DNR) has classified Minnesota's lakes into 43 different types based on physical, chemical, and other characteristics. Kabekona is in lake class 22. Other area lakes in this same classification include Big Sand, Potato, and Long Lake.

Walleye were sampled at their second highest abundance ever on Kabekona with the gillnet catch rate of 5.4 walleye/net above the current management goal (4.0 walleye/net) and within the range "typical" for this lake class. Walleye were sampled at their highest abundance (10.0 walleye/gillnet) in the 2003 survey. The walleye population in Kabekona has benefited from an aggressive and successful walleye fingerling stocking program by the DNR. Sampled walleye had an average length and weight of 18.9 inches and 2.7 lbs, with fish measured up to 30.3 inches. Fall electrofishing catch rates for young-of-the-year walleye have been very low. Kabekona has excellent walleye spawning habitat of large wind-swept rubble areas as well as inlet and outlet stream areas. It is hoped that if walleye abundance is increased that eventually natural reproduction may contribute significantly to the walleye population in Kabekona Lake. A protected slot length limit for walleye is currently in place on Kabekona, that requires the release of all walleye between 18.0 and 26.0 inches, with only one walleye over 26.0 inches allowed in possession. The possession limit for walleye on Kabekona is four. The 18.0 to 26.0 protected slot length limit for walleye should help in protecting spawning size fish in Kabekona. Yellow perch, an important forage species for walleye, were sampled in good numbers (29.2 perch/gillnet). Yellow perch and walleye abundance has fluctuated together in past surveys. Anglers will find a few yellow perch of an acceptable size for angling, with perch measured up to 11.5 inches.

Due to its physical characteristics of deep, oxygenated water, Kabekona was identified as a lake that might support a lake trout population. Yearling lake trout were stocked for four consecutive years from 2000 to 2003. It appears that the stockings haven't been successful in establishing a lake trout population. No lake trout have been sampled in recent surveys, and angler reports have been scarce. Any information from anglers on lake trout in Kabekona would be appreciated.

Northern pike abundance in Kabekona has generally remained at low levels, composed of medium to quality-sized fish. The northern pike gillnet catch rate of 2.3 pike/net is below the range "typical" for this lake class, but similar to past surveys. An abundant cisco (tullibee) and white sucker population provide an excellent forage base for northern pike.

Panfish have typically been sampled in low numbers in Kabekona, however, recent surveys have seen some changes. Bluegill abundance has been increased the past two surveys, with the 2008 catch rate of 11.4 bluegill/trapnet within the range "typical" for this lake class. Prior to 2003, bluegill were sampled in very low numbers. Anglers will find bluegill and pumpkinseed to be small in size, with few fish over 7 inches in length. Largemouth bass and smallmouth bass were sampled in low numbers, similar to past surveys.

Other species sampled included high numbers of rock bass, and low numbers of yellow bullhead, brown bullhead, bowfin (dogfish), and common shiner.

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=29007500

Key Findings / Recommendations

Monitoring Recommendations
Transparency monitoring at site 205 should be continued annually. It is important to continue transparency monitoring weekly or at least bimonthly every year to enable year-to-year comparisons and trend analyses. Phosphorus and chlorophyll a monitoring should continue as the budget allows to track future water quality trends.

Overall Conclusions
Kabekona Lake is an outstanding water resource. It is an oligotrophic/mesotrophic lake (TSI=40) with an improving water quality trend in transparency. Eighteen percent (18.5%) of the lakeshed is in public ownership, and 63.8% of the lakeshed is protected, while only 5.8% of the lakeshed disturbed (Figure 6). Forest cover has increased by 135 acres from 1990-2000 (Table 2), and the watershed to lake area ratio is relatively small (25:1).

The DNR has designated Kabekona Lake as a Cisco refuge lake, which requires cold deep water with high dissolved oxygen levels. The loss of ciscos can be an early indicator of eutrophication, so monitoring the dissolved oxygen in the lake can help track the water quality. Current DNR Fisheries data show that the dissolved oxygen levels at the lake's bottom are good for sustaining ciscos (Figure 9). Due to this deep oxygenated habitat, trout were stocked in 2000-2003, but recent surveys show they don't appear to be sustainable in this lake (page 18).

Priority Impacts to the lake
Because Kabekona Lake is such an outstanding water resource and fishery, there has been development pressure. The majority of lakeshore land parcels have been subdivided into small units and most of the development within the lakeshed occurred along these properties. From 1990-2000, the impervious surface increased by 52% (13 acres) (Table 2). The population in the Lakeport Township and Steamboat River Township is projected to grow another 25% in the next 10 years.

Best Management Practices Recommendations
The management focus for Kabekona Lake should be to protect the current water quality. Protection efforts should be focused on managing and/or decreasing the impact caused by additional development, including 2nd 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.

Organizational contacts and reference sites

Kabekona Lake Association	http://www.minnesotawaters.org/group/kabe/kla-calendar-events
DNR Fisheries Office	301 South Grove Avenue, Park Rapids, MN 56470 218-732-4153 parkrapids.fisheries@state.mn.us http://www.dnr.state.mn.us/areas/fisheries/parkrapids/index.html
Regional Minnesota Pollution Control Agency Office	714 Lake Ave., Suite 220, Detroit Lakes, MN 56501 218-847-1519, 1-800-657-3864 http://www.pca.state.mn.us/yhiz3e0
Hubbard County Soil and Water Conservation District	212 1/2 2nd St W, Park Rapids MN 56470 218-732-0121 http://www.hubbardswcd.org/