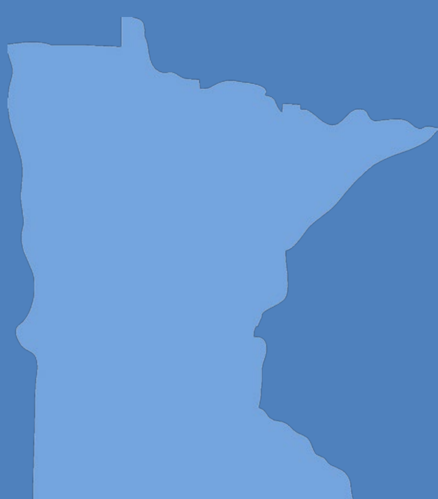
CLMP+ Report on Grass Lake (Anoka County)

Lake ID# 02-0113-00

2012-2013 CLMP+ Data Summary



Minnesota Pollution Control Agency

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Introduction

The Minnesota Pollution Control Agency (MPCA) conducts and supports lake monitoring activities to determine if water quality supports recreational uses (swimming, wading, boating, etc.) of lakes, and to measure and compare regional differences and trends in water quality with lakes from all over the state. MPCA staff, local partners (Soil and Water Conservation Districts, watershed districts, tribal entities, etc.), and citizens all play a role in sampling lake water quality.

As part of the MPCA's Advanced Citizen Lake Monitoring Program (CLMP+), Kristen Genet, Ph. D. and her class at Anoka Ramsey Community College measured water quality at Site 201 in Grass Lake from May through September in 2012 and 2013. Grass Lake is 35 acres in size and depth at sampling site was 1.5 meters (5 feet). Grass Lake is located in the town of Ramsey in Anoka County, Minnesota. CLMP+ volunteers measured water transparency, collected temperature and dissolved oxygen profiles weekly, and collected water chemistry samples monthly. This report provides a summary of the water quality data, and of other physical and ecological characteristics, of the lake (Figures 1 and 2).

Figure 1. Aerial photo of Grass Lake

Ecoregion and land use characteristics

When investigating lake water quality, it is important to consider how land within the lake's catchment (the area of land surrounding the lake that drains water directly to it) is used. Certain uses of the land increase pollutant loading to the lake. For instance, phosphorus in animal waste and commercial fertilizers can runoff to surface waters during heavy rain events. In urban areas, runoff from impervious surfaces (roofs, driveways, and roads) reaches surface waters via overland runoff and storm water drainage. Additionally, phosphorus binds tightly to soil, so eroded soil from developed lakeshore or stream banks is often a large source of phosphorus to lakes and streams. Conversely, forested areas, undeveloped land, and wetlands are important features that preserve good water quality by serving as a buffer to filter water that flows across the catchment and into the lake.

Minnesota is divided into seven ecoregions, as defined by soils, land surface form, natural vegetation and current land use. Grass Lake is located in the North Central Hardwood Forests (NCHF) ecoregion. Throughout this report, Grass Lake characteristics are compared to the typical range of values from reference lakes within the NCHF ecoregion.

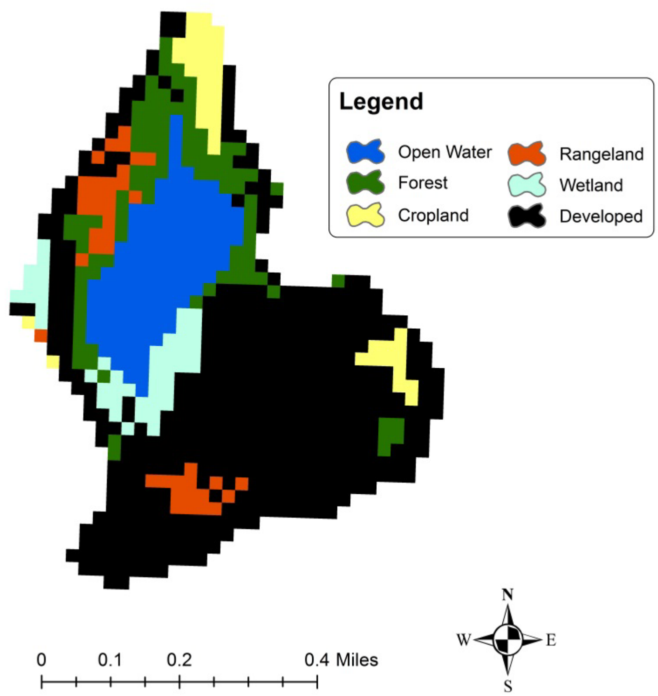

Figure 2. Grass Lake catchment land use

Table 1. Land use composition

Land use	Grass Lake catchment land use percentage	NCHF typical land use percentage
Developed	57	2 – 9
Cultivated (Ag)	5	22 – 50
Pasture & open	5	11 – 25
Forest	12	6 – 25
Water & wetland	21	14 – 30

Grass Lake has a catchment area of 178 acres. This is a small-sized watershed relative to the size of the lake (5:1 watershed: lake area ratio). With such a small catchment area, Grass Lake has a very small water load – meaning that water drainage into Grass Lake, either by ground or surface water, is minimal. One of the main concerns in regards to water load is the amount of nutrients present within the load, which could affect water quality and clarity. The nutrient content of any water load depends upon land use within the catchment area. Highly developed or cultivated land often contributes higher amounts of nutrients (fertilizers, erosion and organic debris such as leaves and grass clippings) than forest, pasture or wetland areas, which capture nutrients and sediment before they enter lakes. Grass Lake has the potential for an elevated nutrient content water load since its catchment area is highly developed – 50% higher than typical lakes located in the NCHF ecoregion (Table 1). The catchment area is balanced out by a below average percentage of cultivated and pastureland and an average percentage of forest, water and wetland (Figure 2).

Lake mixing and stratification

Lake size, depth and the shape of the basin, affect whether a lake stratifies (forms distinct temperature layers) and how it mixes, which have a significant influence on water quality. Deep lakes that stratify during the summer months fully mix, or turn over, twice per year; typically in spring and fall. Shallow lakes (maximum depths of six meters or less), in contrast, typically do not stratify and mix continuously. Lakes with moderate depths may stratify intermittently during calm periods, but mix during heavy winds and during spring and fall. Mixing events allow nutrient-rich lake sediments to be re-suspended, which, under high temperature, can introduce phosphorus into the water where it may encourage the growth of algae. As a result, lakes that continuously mix are at more risk of developing algal blooms than deeper lakes that stratify. Lakes that strongly stratify often have little or no oxygen near the lake bottom. Low oxygen can allow phosphorus to be released from the lake sediments, which is another way nutrients are introduced to the water and can stimulate the growth of algae after the fall turn over. To determine if a lake stratifies or not, water temperature and dissolved oxygen are measured throughout the water column (surface to bottom) at selected intervals (e.g. every meter) several times during the open-water season. These measurements, called “profiles”, will reveal specific patterns if the lake stratifies and will also show how oxygen changes with depth.

The small size and shallow conditions of Grass Lake led to frequent mixing during 2012 and 2013 – typical for a lake of this size and depth. Lakes that mix frequently are referred to as polymictic. Both 2012 and 2013 temperature and dissolved oxygen profiles for Grass Lake show consistent uniformity in readings from surface to lake bottom during the monitoring season, with no stratification taking place in either year.

Dissolved oxygen concentration of five milligrams per liter (mg/L) or more is required to maintain a healthy game fish population. The Department of Natural Resources has not conducted a fish survey on Grass Lake, so fish population and species diversity information is not available at this time, but dissolved oxygen concentrations in Grass Lake are generally high enough to support a fish population.

Water quality

Nutrients, typically phosphorus and nitrogen, are the primary drivers of algal productivity in lakes. In general, high nutrient levels increase the likelihood that nuisance algal blooms will grow and that lakes will not support aquatic recreational uses; however, there are other factors at play that also must be considered. For this reason, it’s important to collect information on suspended solids, temperature, dissolved oxygen, and a number of other parameters.

All May through September water chemistry data for Grass Lake gathered in 2012 and 2013 were averaged (referred to as "summer mean" values) and compared to minimally impacted reference lakes in the NCHF ecoregion (Table 2). References lakes included in the last column in Table 2 include those selected to be typical of the ecoregion and minimally impacted, and allow for comparison to Grass Lake.

Table 2. Grass Lake 2012-2013 as compared to typical range for NCHF ecoregion reference lakes

Parameter	Grass Lake 2012	Grass Lake 2013	Grass Lake 2-year summer mean values	Typical range for minimally impacted lakes in NCHF
Number of reference lakes				43
Total phosphorus (µg/L)	13.8*	12.3*	13.0*	23 – 50
Chlorophyll mean (µg/L)	6.7	4.9	5.8	5 – 22
Transparency (feet) (meters)	3.9 1.2	4.3 1.3	4.3 1.3	4.9 – 10.5 1.5 – 3.2
Total kjeldahl nitrogen (mg/L)	0.91	0.82	0.87	< 0.60 – 1.2
Alkalinity (mg/L)	104	107	105.7	75 – 150
Chloride (mg/L)	35	30	33	4 – 10
Total suspended solids (mg/L)	2.8	2.7	2.76	2 – 6
Total suspended inorganic solids (mg/L)	0.24	0.24	0.24	1 – 2
TN:TP ratio	70:1	71:1	71:1	25:1 – 35:1

* One TP reading in 2012 and two in 2013 were below detectable lab limits. For the purposes of summarizing data, both non-detect samples were rounded up to the lowest detectable limit for phosphorus, which is 10 ug/L.

Total phosphorus (TP) is often considered the nutrient that "limits" algal growth in lakes. This is because it is essential to algal growth and it is typically in the shortest supply. Grass Lake's summer-mean TP is much better than the typical range for NCHF lakes (Table 2), notable since it is located in such a highly developed area. For the purposes of summarizing the data for Grass Lake, three non-detect samples were rounded up to the lowest detectable limit for total phosphorus of 10 ug/L. The majority of the remaining samples hovered near the lowest detectable limit level, with only July 2012 and 2013 readings reaching 17 and 18 ug/L, indicating that even during the hottest and driest time of the year, Grass Lake's water quality is excellent.[1]

Nitrogen, while also an essential nutrient for algal growth, is typically not the "limiting nutrient" in most Minnesota lakes. Total Kjeldahl nitrogen is a measure of organic nitrogen (i.e., nitrogen found in algae) and ammonia- nitrogen. When combined with inorganic nitrogen, this represents total nitrogen (TN). Since inorganic nitrogen is often at or below detection in lakes, we often use total Kjeldahl alone to represent TN. The ratio of TN to total phosphorus (TP) is used as a simple basis for discerning which nutrient, TN or TP, is the limiting nutrient. Lakes are often considered "nitrogen-limited" when the TN:TP ration falls below about 10:1. In the case of Grass Lake, its 71:1 ratio is very high, over the typical range for NCHF lakes, indicating that phosphorus is the nutrient controlling algal growth in this lake. The addition of phosphorus to the lake could increase the production of algae and aquatic plants.

Chlorophyll-a (a pigment found in algae) is used to estimate the amount of algal production in a lake and, therefore, the lake's response to nutrients. As would be anticipated with the low total phosphorus results found in Grass Lake, the chlorophyll –*a* summer mean concentration was also quite low. The mean summer concentration of chlorophyll-*a* was 5.8 ug/L. With concentrations from 10-20 ug/L indicating a mild algal bloom and concentrations greater than 30 ug/L indicating severe nuisance conditions, an algal bloom on Grass Lake in 2012 or 2013 would have been a rare occurrence, if at all.

[1] The phosphorus detection method used by the Minnesota Department of Health changed in 2012 and 2013, and phosphorus taken up by chlorophyll-*a* was not being included in final lab results, resulting in a low bias. The phosphorus values should be considered estimates.

Secchi transparency measures the depth of water clarity in a lake. Grass Lake's average two year transparency is 1.3 meters (4.3 feet). Several transparency readings were at lake bottom and in other instances, the presence of rooted vegetation prevented an "at bottom" reading.

In some lakes, high total suspended sediment or high color may also limit transparency. High total suspended sediment may arise from suspended sediments (e.g. from runoff or wind mixing). In the case of Grass Lake, the total suspended sediment is within the typical range for NCHF lakes.

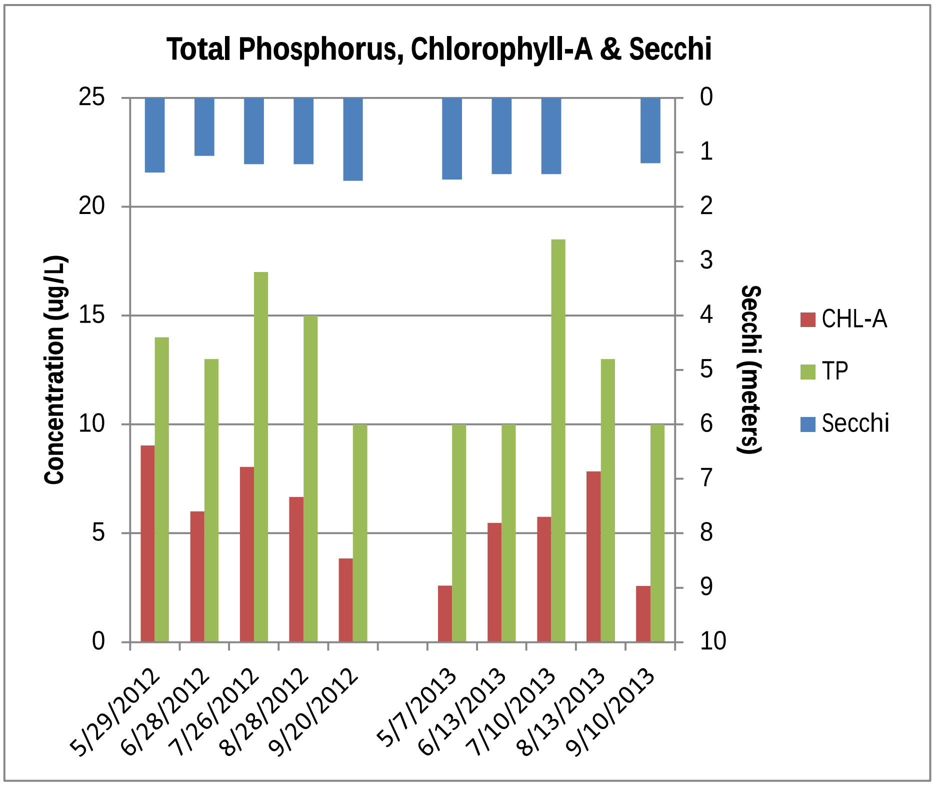

Figure 3. Phosphorus, Chlorophyll-*a* & Secchi 2012 & 2013

Chloride (Cl) for Grass Lake was worse than the typical range for NCHF lakes (Table 2). The primary source of Cl to Minnesota lakes is winter application of road de-icing (road salt) compounds; however, other potential sources include runoff from agricultural lands, water softeners, treated wastewater effluent, and seepage from septic systems. Cl will likely continue to increase in the years to come since it is a conservative pollutant, meaning that it does not break down or leave the lake system over time. Without further examination of the potential sources it is difficult to say which one is the primary contributor for Grass Lake; however, the Cl concentration in the lake is far below the water quality standards so there is no immediate concern relative to adverse environmental impacts at these low concentrations.

CLMP+ data collected for Grass Lake shows that in terms of total phosphorus, chlorophyll and Secchi disk transparency, the water quality of the lake is equal to or better than minimally impacted (reference) lakes in the ecoregion.

Trends

The primary purpose of CLMP monitoring is to gather water clarity information for as many lakes as possible over a long period of time to determine if the water clarity trend for the lake over time is increasing, declining or remaining stable. At least 20 data points spread over eight years are required for a basic trend analysis, and more data are often needed to see an actual increasing or declining trend. As part of the CLMP, citizens have monitored Site #201 on Grass Lake for three separate years (1975, 2012 and 2013). At this time, there are not enough data for Grass Lak to statistically determine if there is a long-term trend in transparency. Based on the three years of data available, summer transparency ranged between 0.61 meters and 1.5 meters (Figure 4).

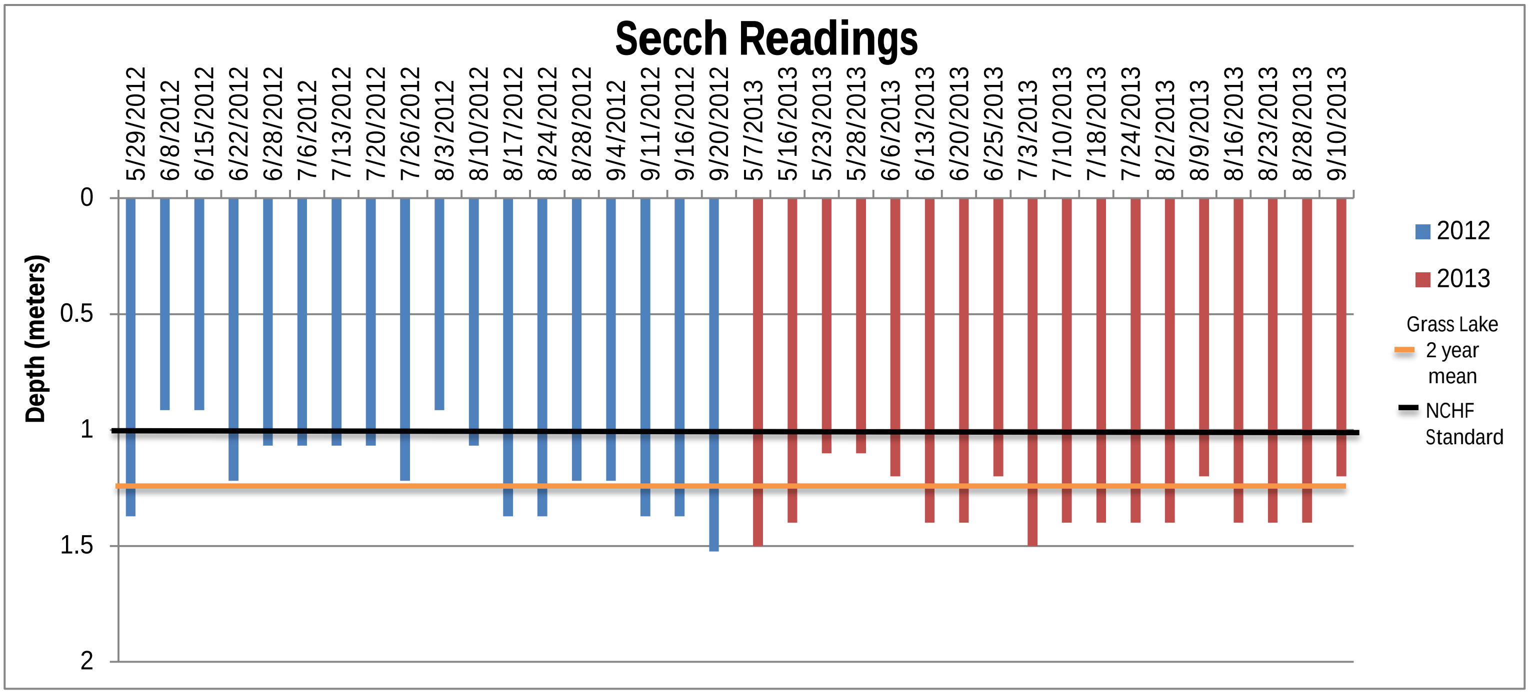

Figure 4. Secchi readings 2012 and 2013 for Site 201

Summary

Grass Lake has very good water quality and appears to be fully meeting the thresholds set to protect shallow lakes in the NCHF ecoregion for aquatic recreation (Table 3).

Grass Lake's shallow nature, combined with its location, make it susceptible to an influx of nutrients as well as pollutants such as chloride. Engagement at the local level will be required to maintain Grass Lake's high level of water quality.

Recommendations:

- Continue to participate in the CLMP and regularly collect transparency data to provide the continuous water quality records needed for trend assessment.
- Engage with city and county officials to ensure protection of wetlands in the surrounding watershed. Wetlands trap and filter sediments and nutrients, limiting their eventual run-off into Grass Lake.
- Best management practices should be used when applying road deicers. Specifically, minimize the salting of roads near the lake, and stockpile snow in upland areas away from the lakeshore. Grass Lake had chloride concentrations higher than the ecoregion expectations. This is most likely due to "urban" runoff.
- Maintain native aquatic plant beds to support fishery habitat. Native aquatic plants also provide natural wave breaks and results in decreased shoreline erosion. Increased wave action stirs lake sediments, clouding the water, making it difficult for new plants to grow.
- Maintain remaining shoreline emergent aquatic vegetation – potentially important habitat for invertebrates and juvenile fish in addition to being a natural trap for washed in sediments and nutrients. Educate shoreland homeowners on the benefits of this habitat. The Minnesota Shoreland Management Guide (http://shorelandmanagement.org) provides useful information on this and other issues relevant to conserving the lake's beneficial uses.

Table 3. A comparison of water quality data from Grass Lake to the shallow lake eutrophication standards for the NCHF ecoregion

	TP (µg/L)	Chl-*a* (µg/L)	Secchi (m)
Thresholds set to protect shallow lakes in the NCHF ecoregion for aquatic recreation use	<60	<20	>1.0
Grass Lake 2-year summer mean values	13	5.8	1.3

All of the water quality data from the MPCA's monitoring activities, those of its citizen volunteers, and of other state and local partners are gathered together and used to assess the condition of Minnesota lakes by determining if thresholds set to protect a lake's recreational uses (swimming, wading, boating, etc.) are being met. Annual assessments of lake and stream data are conducted on a rotating watershed basis. The MPCA monitors each watershed for a two year period, once every ten years. Grass Lake is located within the Rum River major watershed and monitoring of a selection of streams and lakes within this watershed began in 2013 and will continue through 2014. A report detailing the results will be completed by the spring of 2015. Based on the findings, specific segments of the watershed will be recommended for either restoration or protection activities. Involvement by citizens, counties, cities and local organizations are highly encouraged by the MPCA during the restoration and protection development process. Please continue to check the Rum River Watershed page for additional information:
http://www.pca.state.mn.us/index.php/water/water-types-and-programs/watersheds/rum-river.html#overview.

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