CLMP+ Report on East Sunburg Lake (Kandiyohi County)

Lake ID# 34-0336-00
2010-2011 CLMP+ Data Summary

Minnesota Pollution Control Agency

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Contents

Introduction

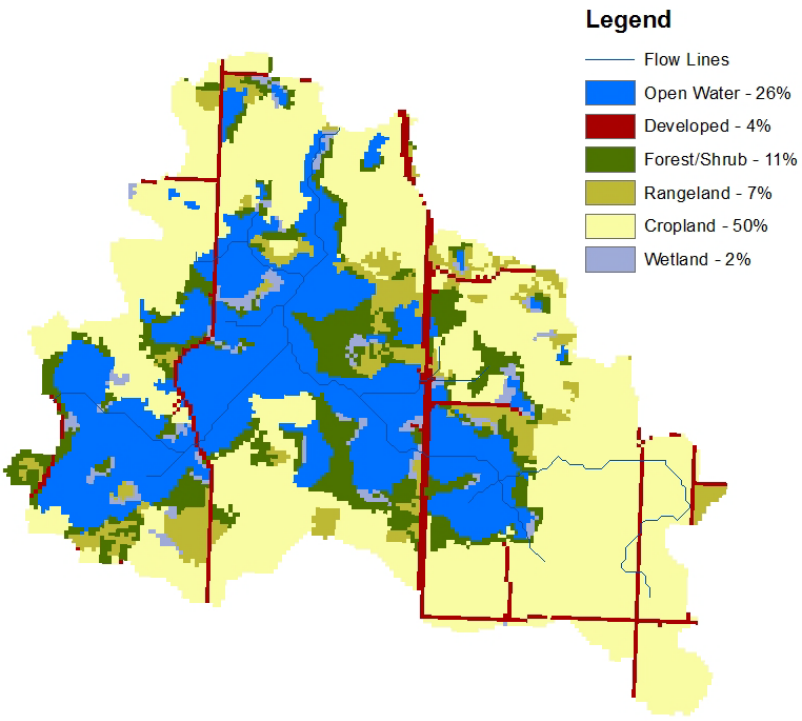
The Minnesota Pollution Control Agency (MPCA) conducts and supports lake monitoring activities both to determine if water quality is suitable for recreational uses (swimming, wading, boating, etc.), and to measure and compare regional differences and trends in water quality around the state. MPCA staff, local partners (SWCDs, 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+), Rod Gronseth measured water quality at two sites in East Sunburg Lake from May through September in 2010 and June through September in 2011. East Sunburg Lake is located in Kandiyohi County, approximately 1.3 miles southwest of Sunburg, Minnesota. It is 213 acres in size, and has a maximum depth of 4 meters (13 feet). The CLMP+ volunteer 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 East Sunburg 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 can runoff from feedlots to surface waters during heavy rain events. Likewise, manure and commercial fertilizers can be washed from cultivated fields over land or through tiling systems to lakes. Phosphorus binds tightly to soil, so eroded soil from developed lakeshore or stream banks is also a source of phosphorus to lakes and streams. Conversely, catchments dominated by forested areas, undeveloped land, and wetlands 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. East Sunburg Lake is located in the North Central Hardwood Forests (NCHF) ecoregion. Throughout this report, East Sunburg Lake characteristics are compared to the typical range of values from reference lakes within the NCHF ecoregion. East Sunburg Lake has a catchment area of 3,478 acres.

This is a moderate-sized watershed relative to the size of the lake (16:1 watershed: lake area ratio). Lakes with large watersheds relative to lake area, often receive high water and nutrient loads; in contrast, those with small watersheds often receive lower water and nutrient loads.

In general, land use in the East Sunburg Lake catchment is similar to the typical land uses found in the NCHF ecoregion (Table 1). Watersheds, such as this one, that transition from forested areas to more agricultural uses typically deliver higher amounts of nutrients to lakes (Figure 2).

Table 1. Land use composition

Land use	East Sunburg Lake catchment land use percentage	NCHF typical land use percentage
Developed	4	2-9
Cropland	50	22-50
Rangeland	7	11-25
Forest/shrub	11	6-25
Water and wetland	28	14-30

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 6 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 during turnover events. 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.

To determine whether East Sunburg Lake stratified in the summer of 2010 and 2011, we plotted temperature and dissolved oxygen (DO) profile measurements taken at the two monitoring sites onto scatter graphs (Figures 3, 4, 5, 6, 7, 8, 9, and 10). Figures 3, 5, 7, and 9 shows a consistency in temperature readings from surface to lake bottom in both 2010 and 2011, indicating the lake did not stratify in either year. Figures 4, 6, 8, and 10 depict generally consistent dissolved oxygen levels from surface to lake bottom, except for July and August, where DO levels are high at the surface and low near the bottom. The July and August DO readings could indicate a high level of algae productivity in the lake during that time of year. Algae photosynthesizing at the water’s surface produce oxygen, while decaying algae at the bottom of the lake deplete oxygen levels. High algae levels in July and August would be consistent with the high levels of phosphorus and chlorophyll-a found in East Sunburg, discussed further in the “Water Quality” section of this report. Because East Sunburg Lake does not stratify, it is considered to be polymictic, meaning that it mixes frequently. Shallow lakes are often polymictic and can be sensitive to excess nutrient levels since nutrients are continually dispersed throughout the water column through mixing rather than settling to the lake bottom.

A DO concentration of 5 milligrams per liter (mg/L) or more is required to maintain a healthy game fish population. As is typical in well-mixed lakes, the DO concentrations in East Sunburg Lake are generally greater than 5 mg/L and only drop below 5 mg/L near the bottom of the lake. Little is known about the game fish population in East Sunburg at this time, so details cannot be provided on how the lake's fish populations are responding to current conditions.

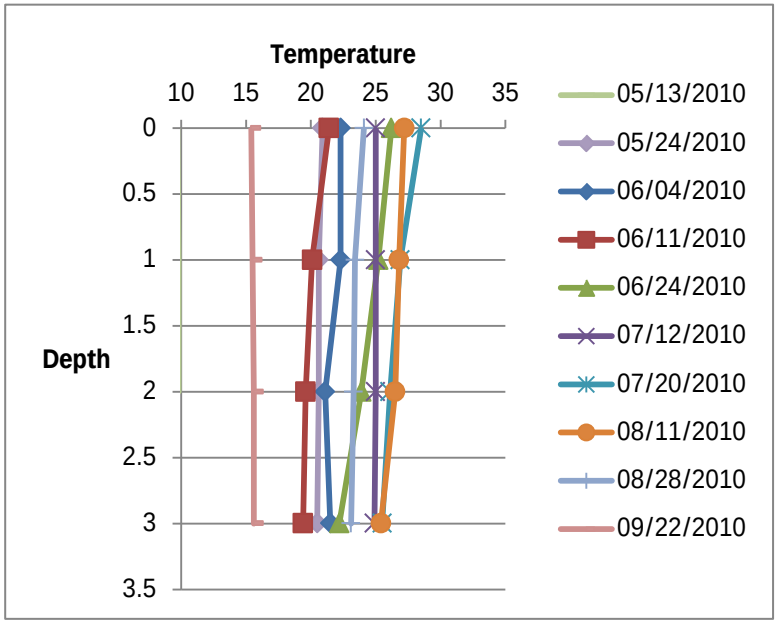


Figure 3. 2010 Temperature Readings for Site 203

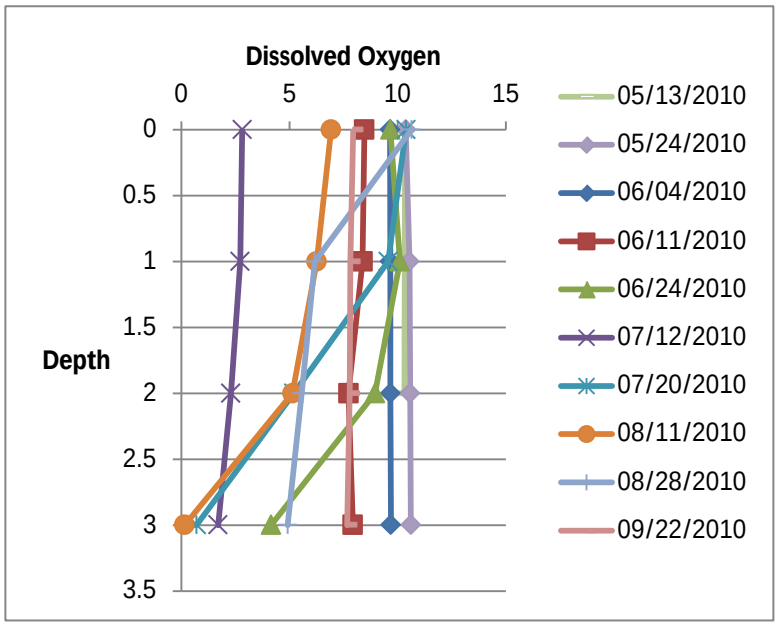


Figure 4. 2010 Dissolved Oxygen Readings for Site 203

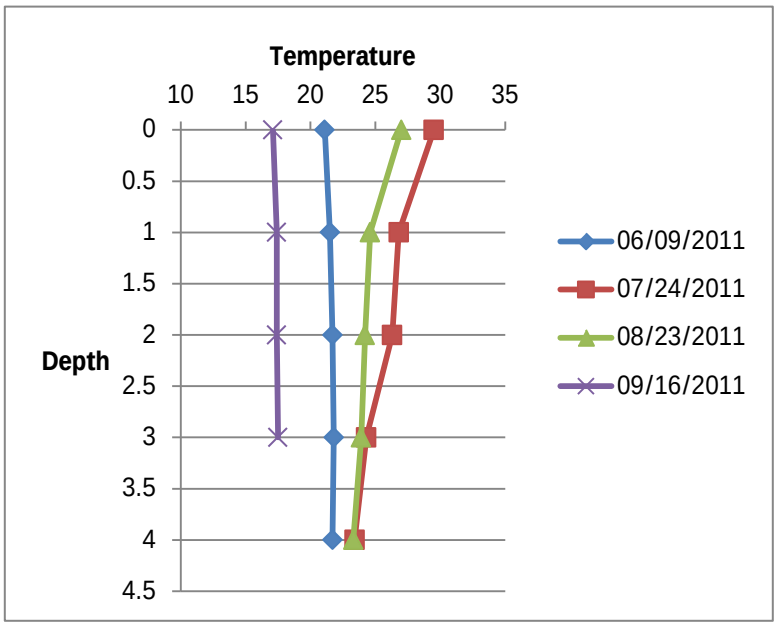


Figure 5. 2011 Temperature Readings for Site 203

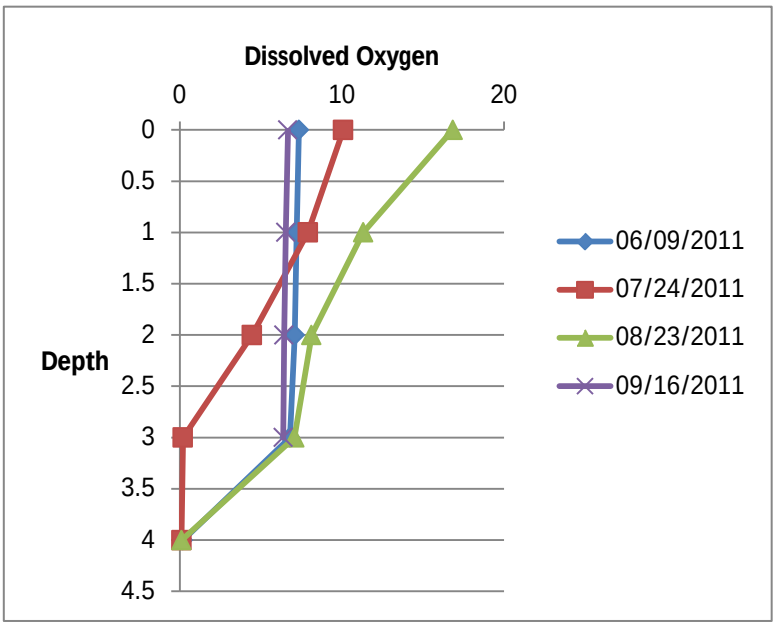


Figure 6. 2011 Dissolved Oxygen Readings for Site 203

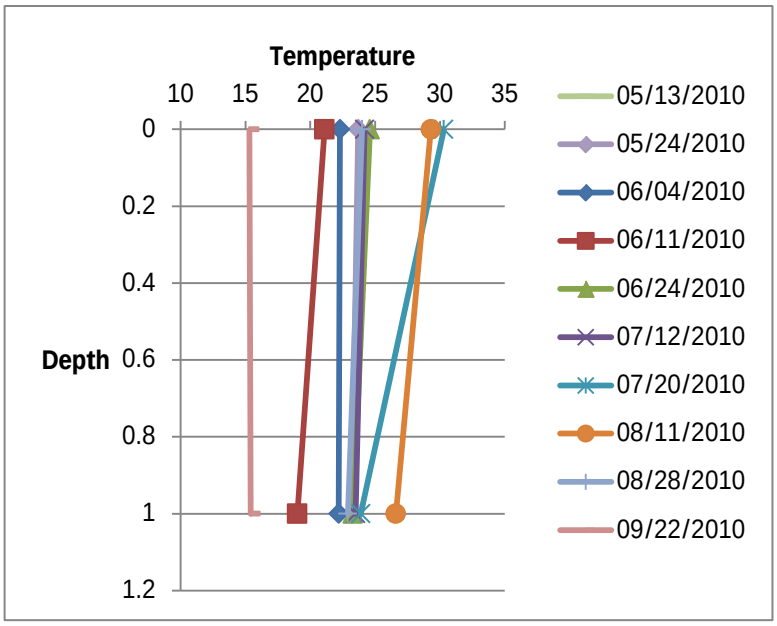


Figure 7. 2010 Temperature Readings for Site 204

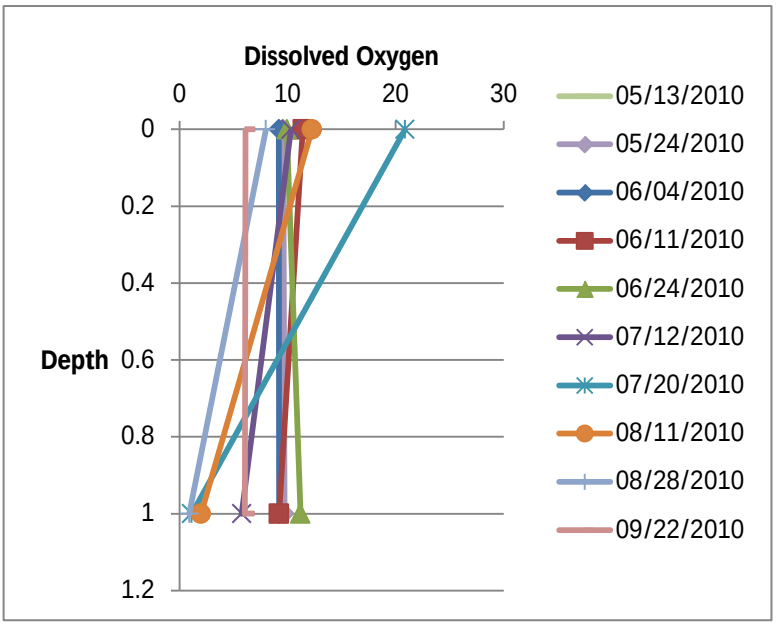


Figure 8. 2010 Dissolved Oxygen Readings for Site 204

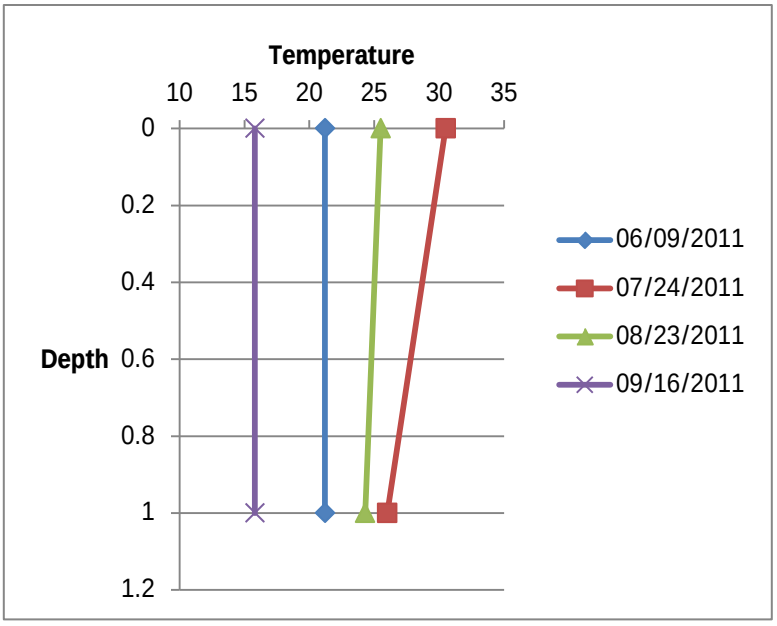


Figure 9. 2011 Temperature Readings for Site 204

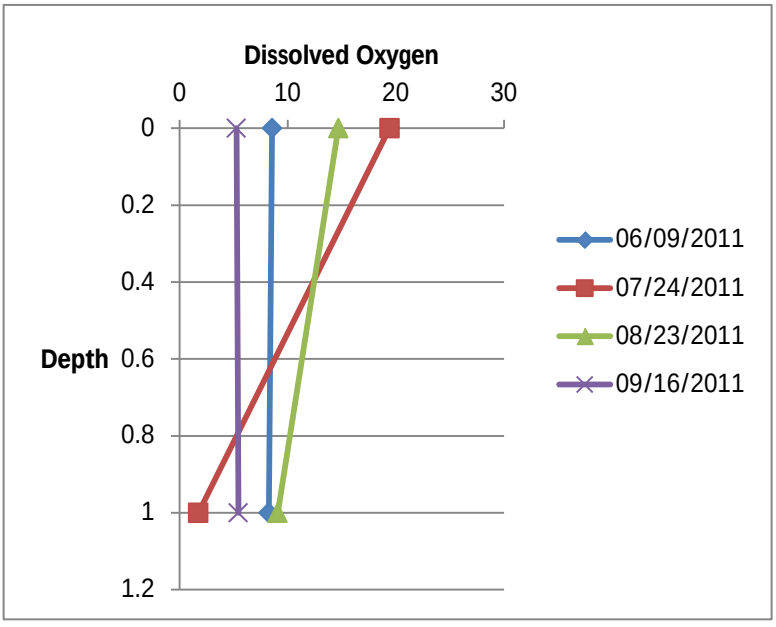


Figure 10. 2011 Dissolved Oxygen Readings for Site 204

Water quality

Nutrients, such as phosphorus, are the primary drivers of algal productivity in lakes. An increase in nutrients often leads to an increase in plant or algal growth and a decrease in water clarity (Figures 11 and 12). 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 sometimes other factors at play that also must be considered. For this reason, it's important to collect information on water color, suspended solids, temperature, dissolved oxygen, and a number of other parameters. May through September in 2010 and June through September 2011 water chemistry data for East Sunburg Lake was gathered, averaged (referred to as "summer mean" values) and compared to minimally impacted reference lakes in the NCHF ecoregion (Table 2). Reference 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 East Sunburg Lake.

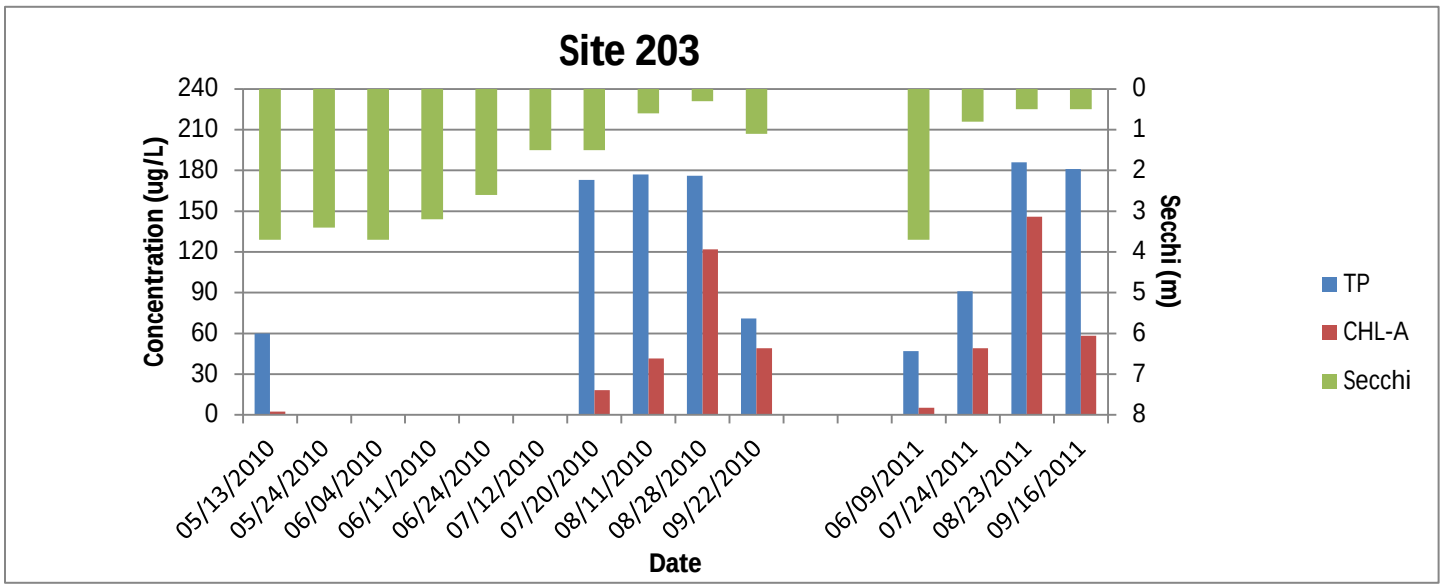


Figure 11. 2010 & 2011 total phosphorus, chlorophyll-a and Secchi data for Site 203

Figure 12. 2010 & 2011 total phosphorus, chlorophyll-a and Secchi data for Site 204

Table 2. East Sunburg Lake 2010-2011 as compared to typical range for North Central Hardwood Forests (NCHF) ecoregion reference lakes[1]

Parameter	East Sunburg Lake 2010 Site 203	East Sunburg Lake 2011 Site 203	East Sunburg Lake 2010 Site 204	East Sunburg Lake 2011 Site 204	East Sunburg Lake 2-year summer mean values	East Sunburg range for minimally impacted lakes in NCHF
Number of reference lakes						43
Total phosphorus (µg/L)	131	126	327	295	220	23 – 50
Chlorophyll mean (µg/L)	47	65	170	108	99	5 – 22
Transparency (feet) (meters)	7.2 2.2	4.6 1.4	3.0 0.9	3.6 1.1	4.9 1.5	4.9 – 10.5 (1.5 – 3.2)
Total kjeldahl nitrogen (mg/L)	2.3	2.3	4.8	3.5	3.3	0.6 – 1.2
Alkalinity (mg/L)	164	158	164	165	163	75 – 150
Color (Pt-Co U)	20	-	32	-	26	10 – 20
Chloride (mg/L)	19	18	25	21	21	4 – 10
Total suspended solids (mg/L)	5	11	22	25	16	2 – 6
Total suspended inorganic solids (mg/L)	1.04	1.15	2.32	2.25	1.69	1 – 2
TN:TP ratio	18:1	19:1	15:1	12:1	15:1	25:1 – 35:1

[1]Concentrations shown are the mean of samples taken May-September (i.e., summer means) ug/L = micrograms per liter; mg/L = milligrams per liter; Pt-Co-U = Platinum Cobalt Units

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. East Sunburg Lake summer-mean TP is well above the typical range for NCHF lakes (Table 2), resulting in a high level of nutrients available to contribute to algal growth.

Nitrogen, while also 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 nitrogen alone to represent TN. The ratio of TN to 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 East Sunburg Lake, the ratio is lower than the reference lake range, but higher than 10:1, confirming our belief that phosphorus is the nutrient controlling algal growth in this lake.

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. East Sunburg Lake's mean summer concentration of chlorophyll-*a* was 99 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, severe nuisance blooms would be common on East Sunburg Lake.

The amount of algae can have a direct influence on the transparency of the lake. Even though East Sunburg Lake's mean secchi transparency results are above one meter and falling within the typical range for lakes in that ecoregion, there are times during the summer where the transparency falls to 0.5 meters or below. These times of low transparency readings correspond with higher levels of phosphorus and chlorophyll-a. 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). Elevated color, also referred to as bog-stain, may occur when high amounts of runoff from wetland and forest areas enter a lake. This runoff brings in natural organic matter that lends a coffee coloration in to the water. In the case of East Sunburg Lake, the total suspended sediment and color values are high and could contribute to limiting water clarity levels.

Chloride (Cl) was above 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, treated wastewater effluent, and seepage from septic systems. In the case of East Sunburg Lake, excess Cl could arise from use of road salt on roads in the watershed and from surrounding cropland. Without further examination of these sources it is difficult to say which one is the primary contributor; however, the Cl concentration in East Sunburg is far below the water quality standards so there is no immediate concern relative to adverse environmental impacts at these low concentrations.

Since East Sunburg Lake is fairly shallow and mixes regularly, the abundance of nutrients entering the system is resulting in a highly productive lake in terms of algae development as compared to the reference lakes sampled within the NCHF ecoregion. Highly productive lakes, such as East Sunburg Lake, are termed 'hypereutrophic'.

Summary

Based on water quality data collected in 2010-2011, East Sunburg Lake has low water quality and appears to not be meeting the thresholds set to protect lakes for aquatic recreation in the NCHF ecoregion (Table 3).

Table 3. A comparison of water quality data from East Sunburg Lake to the Lake Eutrophication Standards for the NCHF ecoregion

	TP (µg/L)	Chl-*a* (µg/L)	Secchi (m)
Thresholds set to protect lakes in the NCHF ecoregion for aquatic recreation use for shallow lakes	<60	<20	>1.0
East Sunburg Lake 2-year summer mean values	220	99	1.5

East Sunburg 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 help restore East Sunburg Lake's water quality. Additionally, consistent monitoring through the Citizen Lake Monitoring Program will be needed for a future water clarity trend analysis to take place.

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. The Chippewa River Watershed, where East Sunburg Lake resides, was assessed by the MPCA in 2009 and currently a Watershed Restoration and Protection Strategy is in development. 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 Chippewa River Watershed page for additional information:
http://www.pca.state.mn.us/index.php/water/water-types-and-programs/watersheds/chippewa-river.html

Citizens within the East Sunburg Lake catchment do not need to wait until the Chippewa River watershed protection plan has been developed to protect the water quality of East Sunburg Lake. One of the most important protective measure citizens can take is to minimize as much as possible the potential for phosphorus to be routed, or loaded, to the lake. This entails limiting lakeshore development and retaining as much undeveloped land in the lake catchment as possible. The loss of native aquatic plant beds in lakes results in a number of serious water quality problems. Removing aquatic plants destroys fishery habitat and the quality and balance of the fish community. It also eliminates natural wave breaks and results in increased shoreline erosion. Increased wave action stirs lake sediments, clouding the water, making it difficult for new plants to grow. Lastly, the loss of native aquatic plants can encourage the introduction of invasive species. For these reasons, native aquatic plants should also be protected to the greatest extent possible.

For questions regarding this report, please contact:
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