

December 2019

Green Lake

(46.203223 N, -99.466931 W)

McIntosh County

- Green Lake is a large, shallow natural lake in south-central North Dakota (Figure 1). See map at (<https://gf.nd.gov/gnf/maps/fishing/lakecontours/green2004.pdf>).
- There is one public, paved boat ramp on Green Lake on the west side of the lake.
- The Green Lake watershed is about 35,000 acres of mostly agriculture and grassland/pasture. The most common crops grown are soybeans, spring wheat and corn (Table 1).
- Green Lake is a Class II fishery, which are “capable of supporting natural reproduction and growth of cool water fishes (e.g., northern pike and walleye) and associated aquatic biota.”
- Green Lake is managed for walleye, with fingerlings stocked annually. Yellow perch, northern pike and walleye were captured during the last sample by the ND Game and Fish.
- Green Lake was previously assessed in 1991-1992 and 2006.

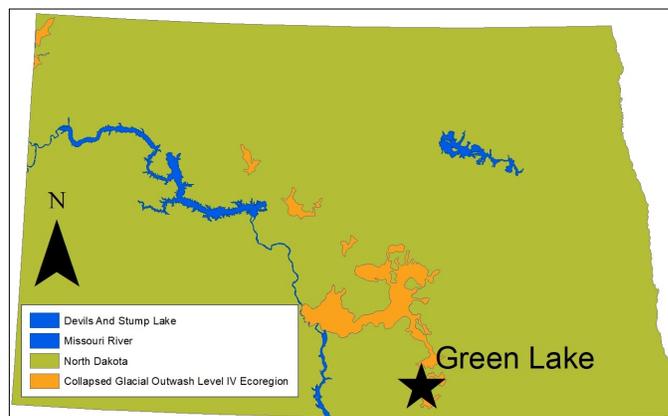


Figure 1. Location of Green Lake within the state

Table 1. Percentage of land cover in the watershed and near the lake (NASS, 2018). Value listed of crop type represents percentage of total production

Land Cover Type	% in Watershed	% within 500 meters
Agriculture	52.3%	18.4%
Soybeans	40.1%	35.4%
Spring Wheat	19.9%	3.1%
Corn	14.6%	0.3%
Grassland/Pasture	35.9%	66.8%
Open Water	5.8%	7.7%
Developed	3.9%	3.7%
Shrubland	1.4%	0.7%
Wetlands	0.5%	1.9%
Forest	0.1%	0.7%

Temperature and Dissolved Oxygen

- Green Lake can stratify in the summer, with warm, well-oxygenated water at the top of the water column, and cold, low-oxygen water near the bottom.
- There was no thermal stratification recorded in 2019. Temperature change in the water column was 0.0 degrees Celsius (°C), 0.1°C and 0.1°C in May, July and September, respectively.
- Dissolved oxygen concentrations were relatively high throughout the water column during all samples.

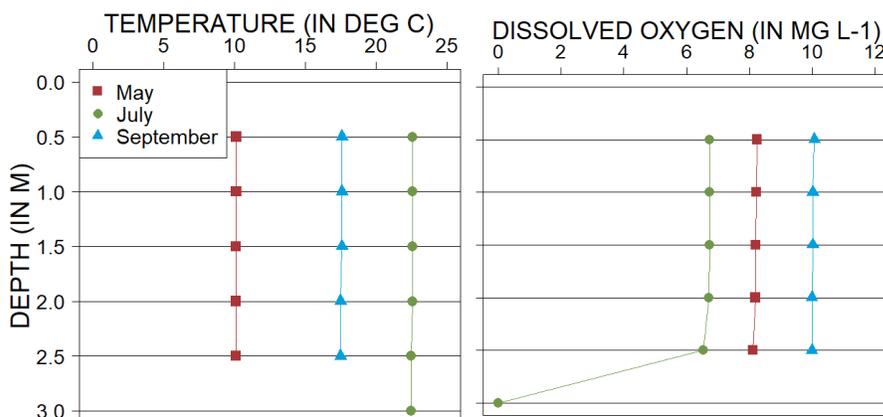


Figure 2. 2019 profiles of temperature (left) and dissolved oxygen (right) in milligrams per liter ($mg\ L^{-1}$)

Trophic State Indices

- Trophic state is a measure used by scientists to assess the condition (where lower scores indicate better water quality) of a lake using three common measures: total phosphorus (TP), Secchi disk transparency and chlorophyll-a concentration.
- Green Lake is a eutrophic lake (Figure 3) that has high nutrient concentrations and high algal growth.
- Current trophic state has improved compared to historical data, but this may not reflect true condition.
- There have been confirmed **harmful** algal (cyanobacteria) blooms at Green Lake, as the lake has been on the state's advisories and warnings list in 2016, 2017 and 2018.

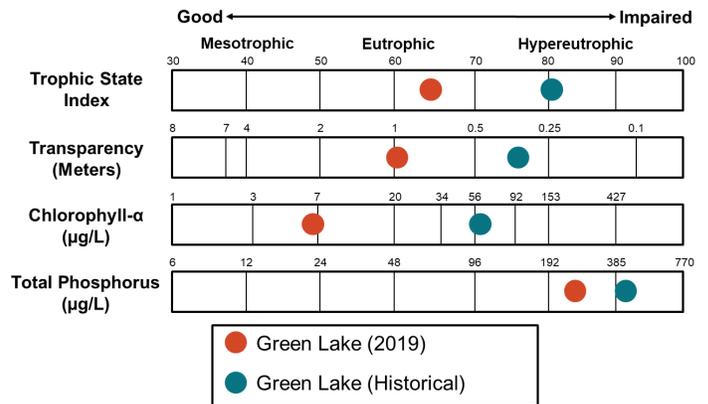


Figure 3. Trophic state indices for 2019 and historical samples

Nutrients

- Median concentration of total nitrogen (TN) in 2019 was less than the historical median for the lake and less than the median for the Collapsed Glacial Outwash Level IV Ecoregion (hereafter, Ecoregion) where Green Lake is located (Figure 4).
- Median concentration of dissolved TN was slightly less than TN.
- Median TP concentration in 2019 was less than the median for the lake but greater than the median for the Ecoregion (Figure 4).
- Median concentration of dissolved phosphorus was slightly less than TP.
- Ammonia and nitrate-plus-nitrite were only detected in the spring at low concentrations at Green Lake in 2019.

Nutrient Concentrations (in mg L⁻¹) in Green Lake

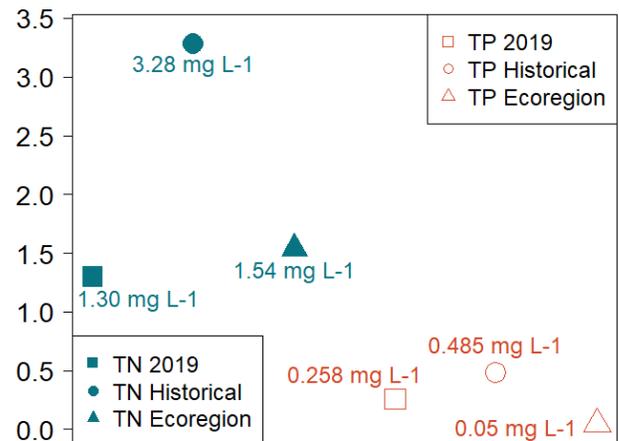


Figure 4. Median concentrations of TN and TP in mg L⁻¹ compared to regional medians

Water Chemistry

Table 2. Median concentrations of selected constituents for 2019 and historical samples and from all Ecoregion natural lakes.

Measure	2019 Median	Historical Median	Ecoregion Median
Alkalinity	344 mg L ⁻¹	400 mg L ⁻¹	464 mg L ⁻¹
Bicarbonate (HCO ₃ ⁻)	376 mg L ⁻¹	334 mg L ⁻¹	463 mg L ⁻¹
Calcium (Ca ²⁺)	41.3 mg L ⁻¹	29.0 mg L ⁻¹	26.1 mg L ⁻¹
Carbonate (CO ₃ ²⁻)	22 mg L ⁻¹	103 mg L ⁻¹	56 mg L ⁻¹
Conductivity	1,220 µS cm ⁻¹	1,730 µS cm ⁻¹	1,760 µS cm ⁻¹
Dissolved Solids	799 mg L ⁻¹	1,180 mg L ⁻¹	1,240 mg L ⁻¹
Magnesium (Mg ²⁺)	66.4 mg L ⁻¹	78.4 mg L ⁻¹	86.7 mg L ⁻¹
Sodium (Na ⁺)	129 mg L ⁻¹	237 mg L ⁻¹	164 mg L ⁻¹
Sulfate (SO ₄ ²⁻)	310 mg L ⁻¹	492 mg L ⁻¹	547 mg L ⁻¹

- Sulfate and bicarbonate are the dominant anions in Green Lake, while sodium and magnesium are the co-dominant cations (Figure 5).
- Median concentrations of most cations and anions are less than the historical median for the lake and less than the median for the Ecoregion.

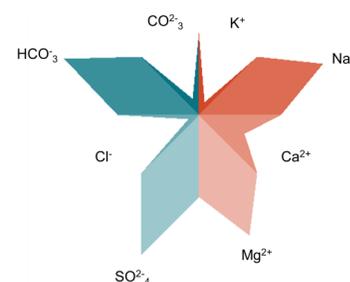


Figure 5. Maucha diagram showing ionic balance based on 2019 data