

## Crooked Lake

(47.64907 N, -100.90051 W)

### McLean County

- Crooked Lake is a long, narrow lake in central North Dakota (Figure 1). See map at (<https://gf.nd.gov/gnf/maps/fishing/lakecontours/crooked2003.pdf>).
- Crooked Lake is accessible by two public boat ramps, one on the northern end and one toward the southern end.
- The Crooked Lake watershed is about 33,000 acres of mostly grassland/pasture, agricultural land and wetlands. The most common crops grown are spring wheat, soybeans and non-alfalfa-hay (Table 1).
- Crooked Lake is a Class III fishery, which means it is “capable of supporting natural reproduction and growth of warm water fishes (e.g., largemouth bass and bluegill) and associated aquatic biota.”
- The lake is primarily managed for walleye, with fingerlings stocked annually. Northern pike, bluegill and yellow perch are also found in the lake.
- Crooked Lake was previously assessed in 1991-1992, 2005-2006 and 2010-2011.

February 2019



Figure 1. Location of Crooked Lake within the state

Table 1. Percentage of land cover in the watershed and near the lake (NASS, 2017). Value listed of crop type represents percentage of total production.

Land Cover Type	% in Watershed	% within 500 meters
Grassland/Pasture	49.8%	46.1%
Agriculture	25.3%	36.2%
Spring Wheat	42.8%	39.0%
Soybeans	18.6%	23.9%
Other Hay/Non-Alfalfa	10.2%	5.5%
Wetlands	10.7%	6.2%
Open Water	9.9%	3.9%
Developed	2.9%	6.4%
Forest	1.3%	1.2%

### Temperature and Dissolved Oxygen

- Crooked Lake rarely stratifies in the summer, with the majority of the water column typically well-oxygenated
- There was thermal stratification in May of 2018, likely related to a rapid increase in surface temperature following ice-off. Temperature change in the water column was 2.03 degrees Celsius (°C) in May, but only 0.39°C and 0.05°C in July and September, respectively (Figure 2).
- All samples in 2018 showed the lake as well-oxygenated.

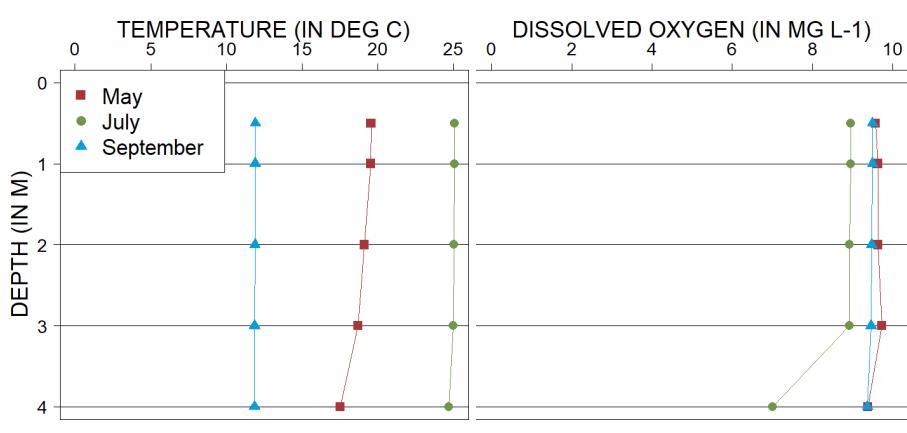


Figure 2. 2018 profiles of temperature (left) and dissolved oxygen (right) in milligrams per liter (mg L<sup>-1</sup>)

## 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.
- Crooked Lake is a eutrophic lake (Figure 3) that has relatively low nutrient concentrations and low algal growth.
- Trophic state has improved compared to historical indices, with all three scores lower than historical.
- There have been no confirmed **harmful** algal (cyanobacteria) blooms at Crooked Lake.

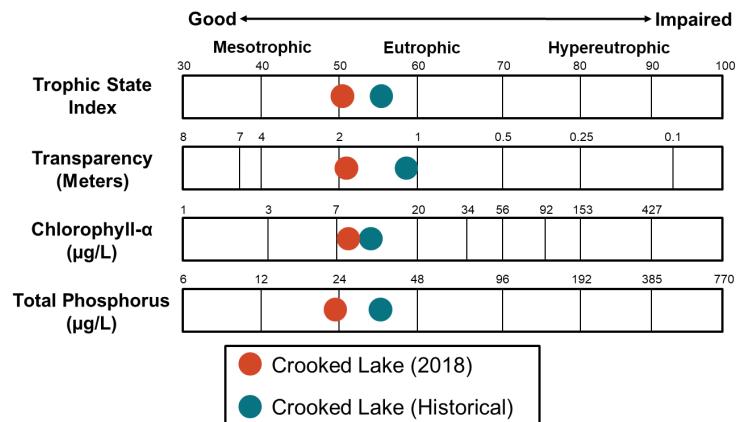


Figure 3. Trophic state indices for 2018 and historical samples

## Nutrients

- Median concentration of total nitrogen (TN) was lower in 2018 compared to the historical median and the median for the Missouri Coteau Level IV Ecoregion (hereafter, Missouri Coteau) where Crooked Lake is located (Figure 4).
- Median concentration of dissolved TN was much less than TN.
- Median TP concentration was lower in 2018 compared to historical concentrations and the median for the Missouri Coteau (Figure 4).
- Median concentration of dissolved phosphorus was slightly less than TP.
- Ammonia and nitrate plus nitrite were not above detection limits in Crooked Lake in 2018.

Nutrient Concentrations (in mg L<sup>-1</sup>) in Crooked Lake

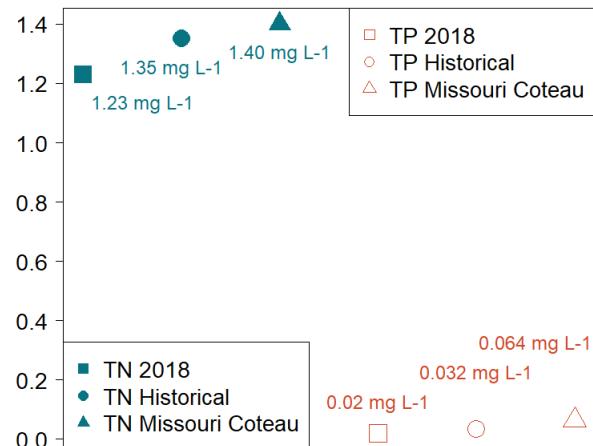


Figure 4. Median concentrations of TN and TP in mg L<sup>-1</sup> compared to regional medians

## Water Chemistry

Table 2. Median concentrations of selected constituents for 2018 and historical samples and from all Missouri Coteau lakes.

Measure	2018 Median	Historical Median	Ecoregion Median
Alkalinity	258 mg L <sup>-1</sup>	381 mg L <sup>-1</sup>	274 mg L <sup>-1</sup>
Bicarbonate (HCO <sub>3</sub> <sup>-</sup> )	247 mg L <sup>-1</sup>	357 mg L <sup>-1</sup>	289 mg L <sup>-1</sup>
Calcium (Ca <sup>2+</sup> )	25.9 mg L <sup>-1</sup>	29.6 mg L <sup>-1</sup>	39.8 mg L <sup>-1</sup>
Carbonate (CO <sub>3</sub> <sup>2-</sup> )	36 mg L <sup>-1</sup>	42 mg L <sup>-1</sup>	21 mg L <sup>-1</sup>
Conductivity	767 µS cm <sup>-1</sup>	1,010 µS cm <sup>-1</sup>	1,010 µS cm <sup>-1</sup>
Dissolved Solids	476 mg L <sup>-1</sup>	641 mg L <sup>-1</sup>	642 mg L <sup>-1</sup>
Magnesium (Mg <sup>2+</sup> )	72.8 mg L <sup>-1</sup>	95.9 mg L <sup>-1</sup>	72.4 mg L <sup>-1</sup>
Sodium (Na <sup>+</sup> )	42.2 mg L <sup>-1</sup>	61.4 mg L <sup>-1</sup>	62 mg L <sup>-1</sup>
Sulfate (SO <sub>4</sub> <sup>2-</sup> )	155 mg L <sup>-1</sup>	194 mg L <sup>-1</sup>	239 mg L <sup>-1</sup>

- Bicarbonate is the dominant anion in Crooked Lake (although sulfate is relatively high), while magnesium is the dominant cation (Figure 5).
- Median concentrations of most cations and anions are greater than the historical median for the lake but lower for the Missouri Coteau.

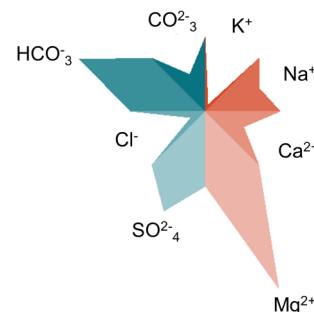


Figure 5. Maucha diagram showing ionic balance based on 2018 data