

February 2022

Devils Lake

(48.03658 N, -98.97264 W)

- Devils Lake is a large natural lake in northeastern North Dakota (Figure 1). See map at (<https://gf.nd.gov/gnf/maps/fishing/lakecontours/devilslakeoverview2012.pdf>).
- There are multiple public, paved boat ramps surrounding the lake, though access to some depends on lake elevation.
- The Devils Lake watershed is about 2,500,000 acres of mostly agriculture. Agricultural production in the watershed is dominated by spring wheat, soybeans and canola (Table 1).
- Devils Lake is a Class II, cool-water fishery, which are “capable of supporting natural reproduction and growth of cool water fishes (e.g., northern pike and walleye) and associated aquatic biota.”
- Devils Lake is managed as a walleye fishery, with high numbers of fingerlings stocked most years. There is, however, strong natural reproduction of northern pike and yellow perch. Walleye, yellow perch, northern pike, white bass and white sucker were captured during the last sample by the ND Game and Fish in 2021.
- ND DEQ collects annual water quality data at Devils Lake.

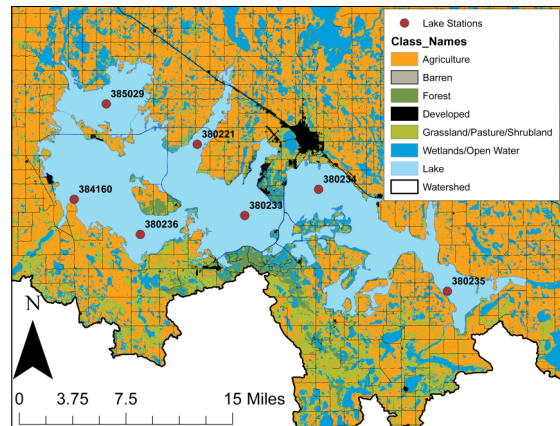


Figure 1. Sampling sites at Devils Lake with land cover surrounding the lake shown.

Table 1. Percentage of land cover in the watershed and near the lake (NASS, 2020). Value listed of crop type represents percentage of total production

| Land Cover Type | % in Watershed | % within 500 meters |
|-------------------|----------------|---------------------|
| Agriculture | 64.7% | 45.2% |
| Spring Wheat | 34.6% | 21.3% |
| Soybeans | 24.4% | 32.0% |
| Canola | 12.1% | 1.9% |
| Wetlands | 11.5% | 18.0% |
| Open Water | 11.3% | 7.5% |
| Grassland/Pasture | 8.1% | 16.0% |
| Developed | 3.2% | 6.6% |
| Forest | 1.1% | 6.5% |
| Barren | < 0.1% | < 0.1% |

Lake Elevation

Gage Height from USGS 05056500
Data from April 1913 through Dec 2021

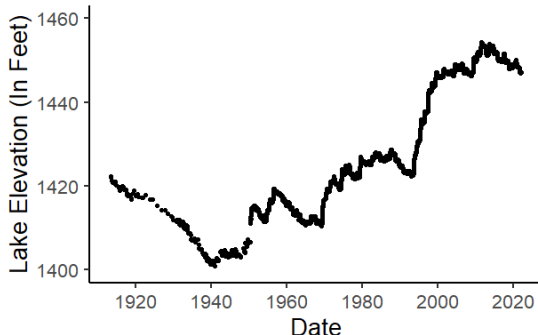


Figure 2. Lake elevation (in feet above sea level) at USGS Station 05056500 since 1913.

- Devils Lake is a highly dynamic, sentinel lake.
- Since a modern low elevation of about 1,400 feet above sea level (asl) in 1940, Devils Lake has risen to a high level of 1,454 feet asl in 2011 (Figure 2).
- At a lake elevation of 1,447 feet asl, Devils Lake naturally drains to Stump Lake via the Jerusalem Outlet.
- Lake elevation in 2021 at Devils Lake reached a high level of 1,448.5 feet asl in April, with a low of 1,447.0 feet asl in October (and continues to drop at the time of this writing) (Figure 2).

Temperature and Dissolved Oxygen

- Temperature and dissolved oxygen profiles are collected by ND DEQ staff at every staff visit. Temperature, dissolved oxygen, pH and specific conductance measurements are recorded at the surface and then every subsequent meter until 0.5 meters off the bottom.
- Devils Lake remains well-mixed throughout most of the open-water season, with true thermal stratification (defined as a change of 1°C over 1-meter of depth) only observed at the deepest sites (e.g., **East Devils Lake**).
- Thermal stratification was not recorded at Devils Lake in 2021 during the open-water season (Figure 3).
- Under ice, however, Devils Lake experiences some strong reverse-stratification.
- The strongest reverse stratification is usually observed in the western sites. For example, see warmer bottom temperatures at **Main Bay** (Figure 3b).
- The lack of thermal stratification in the open-water season leads to high concentrations of dissolved oxygen throughout the water column, providing abundant deep-water habitat throughout the lake.

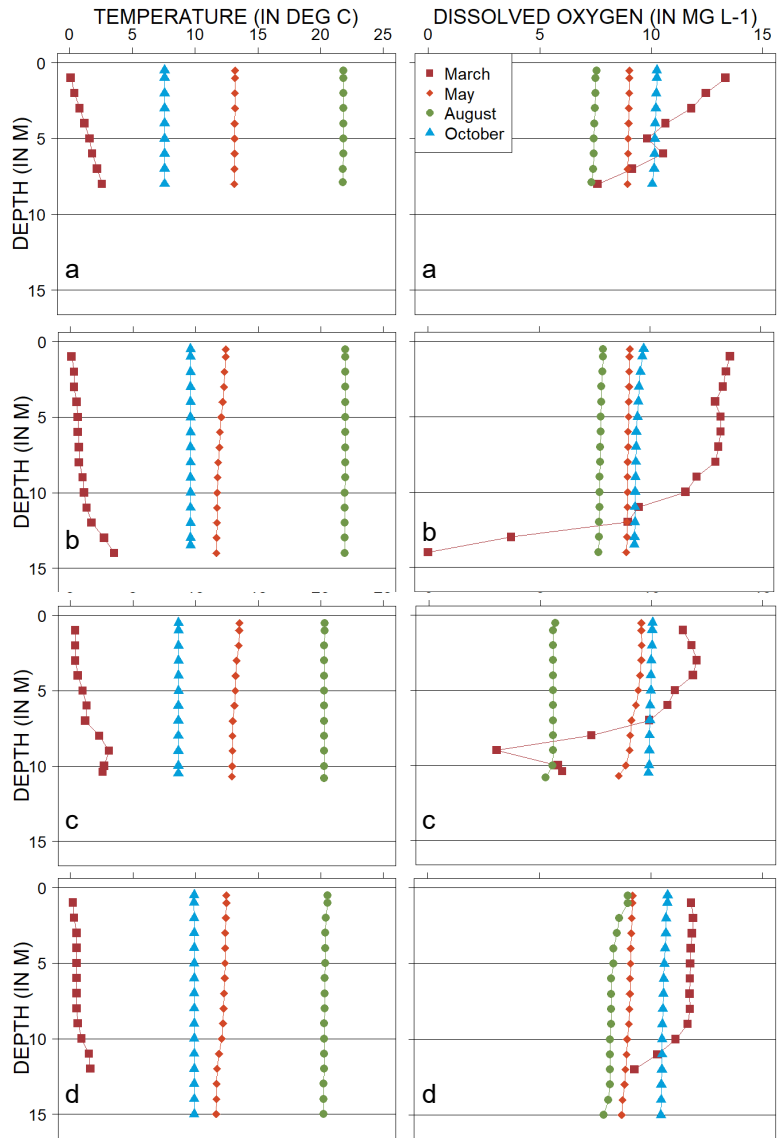


Figure 3. Temperature and dissolved oxygen profiles recorded in 2021 for West Bay (a), Main Bay (b), East Bay (c) and East Devils Lake (d).

Trophic State Indices

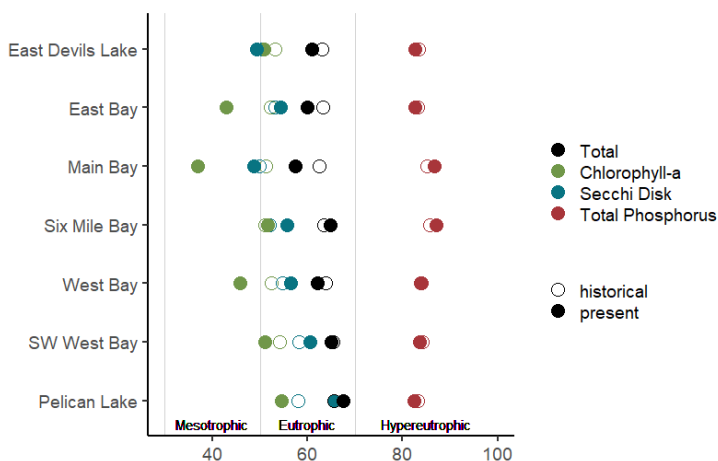


Figure 4. TSI scores for all sites at Devils Lake.

- 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.
- Devils Lake is a eutrophic lake that has relatively high nutrient concentrations and moderate algal growth (Figure 4).
- Current trophic state, particularly in the eastern part of the lake was improved in 2021, mostly driven by lower than normal algal growth.
- Devils Lake experiences large cyanobacteria (blue-green algae) blooms almost annually, though severity of those blooms, with regard to toxin production, is variable.

Secchi Disk Transparency

- Transparency is measured by lowering a black and white Secchi disk into the water on the shady side of the boat until it is no longer visible. Slowly, the sampler will pull the Secchi disk back towards themselves vertically through the water and recording the depth at which the disk reappears.
- As a whole, Devils Lake is wind-swept and highly productive, so transparency can be highly variable throughout the open-water season.
- **Main Bay** is typically more clear than the rest of the west side of the lake, and though median depth has not changed much in recent years, the range of values has become greater starting in 2010. In 2021, however, Main Bay remained relatively consistent but was still the clearest on the west side (Figure 5a).
- **East Bay** and **East Devils Lake** are relatively clear compared to the rest of the lake, likely due to their depth (Figures 5e and 5f, respectively).
- Secchi disk transparency was relatively low in **Six Mile Bay** in 2021 compared to recent years (Figure 5b).
- **Pelican Lake** is a shallow, productive bay with highly variable Secchi disk transparency (Figure 5d).
- Though Secchi disk transparency in **West Bay** has been consistent since sampling began in the mid-1990s, intra-annual variability has increased in recent years.

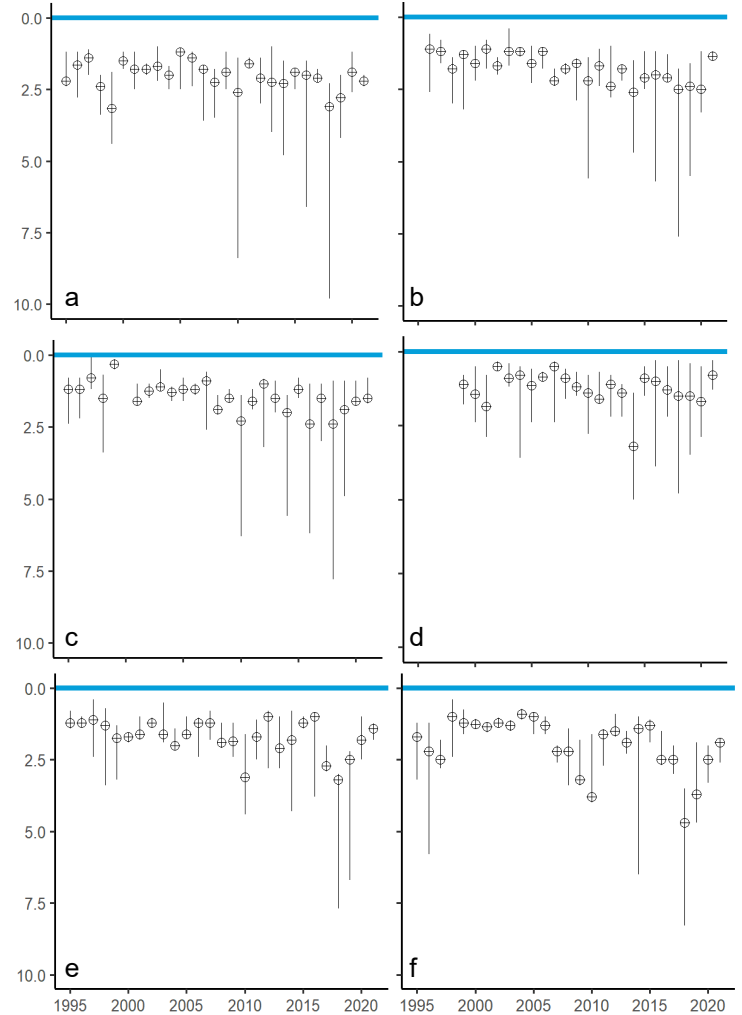


Figure 5. Annual median Secchi disk transparency (in meters) for Main Bay (a), Six Mile Bay (b), West Bay (c), Pelican Lake (d), East Bay (e) and East Devils Lake (f). Vertical lines represent range of values for that year.

Algal Growth and Cyanotoxins



Photo taken by Joe Nett (ND DEQ) on July 21, 2021, at Six Mile Bay.

- Devils Lake has large cyanobacteria blooms every year, though toxins are only found some years.
- ND DEQ did not post an advisory or warning at Devils Lake in 2021.
- Elsewhere in the watershed, ND DEQ had a *warning* or *advisory* posted on Stump Lake.
- For more information on harmful algal (cyanobacteria) blooms, visit https://deq.nd.gov/WQ/3_Watershed_Mgmt/8_HABS/Habs.aspx

Nutrients

- Nutrients (nitrogen and phosphorus) are necessary for the lake ecosystem in driving primary productivity, but excess concentrations can lead to eutrophication and oxygen depletion.
- Median concentrations of total phosphorus (TP) are relatively high at Devils Lake, with the highest concentrations at **Main Bay** and **Six Mile Bay** in 2021 (Figure 6).
- Median concentration of TP at **East Devils Lake** and **East Bay** in 2021 was less than the historical median for those sites, while all other sites were greater than or equal to the historical median (Figure 6).
- Median concentration of total nitrogen (TN) at **East Devils Lake** in 2021 was less than the historical median for the site, while the rest of the sites had a 2021 median greater than the historical median.

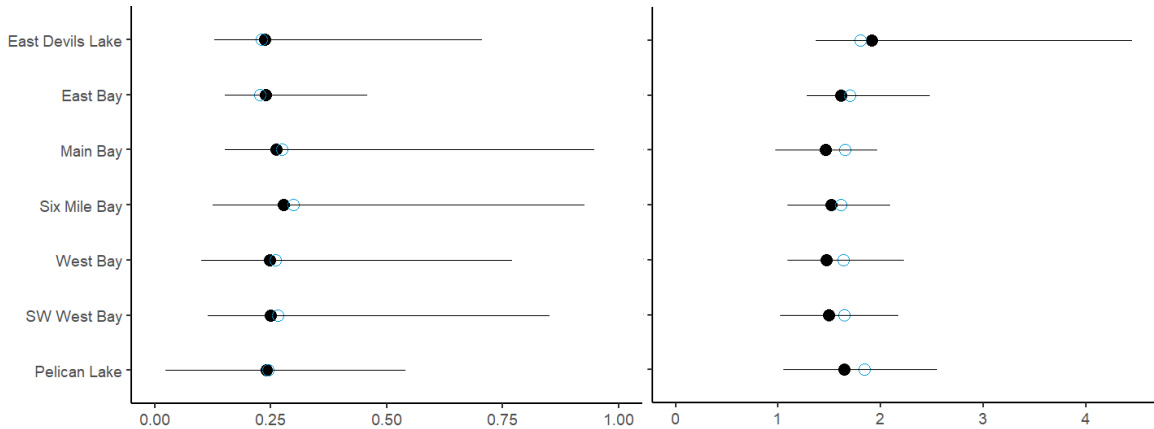


Figure 6. Median concentrations for total phosphorus (left) and total nitrogen (right) in mg L^{-1} . Solid black circles represent historical median for the site and open blue circles represent the 2021 median for each site.

Water Chemistry

- Devils Lake is a sodium-sulfate dominated waterbody, with relatively high concentrations of magnesium and bicarbonate (Figure 7).
- Devils Lake drains from west to east, with the eastern side of the lake (i.e., East Bay and East Devils Lake) being “saltier” than the rest of the lake.
- As the lake has risen, however, the entire lake has mixed and ion concentrations have become more uniform throughout the lake (Figure 8).
- Ion concentrations in the eastern half of the lake in 2021 were less than the historical medians, while the western sites were greater than or equal to the historical median (Figure 8).

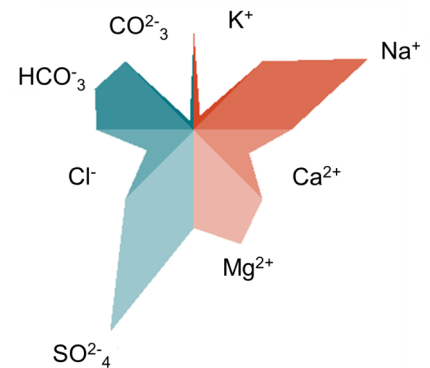


Figure 7. Maucha diagram showing ionic balance in Main Bay, which is similar to the rest of the lake.

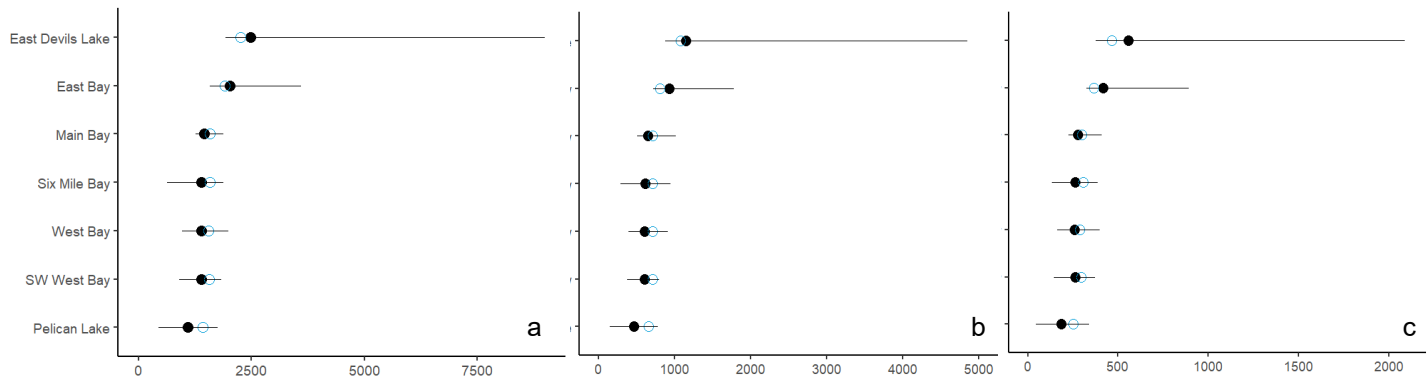


Figure 8. Median concentrations for total dissolved solids (a), sulfate (b) and sodium (c) in mg L^{-1} . Solid black circles represent historical median for the site and open blue circles represent the 2021 median for each site.