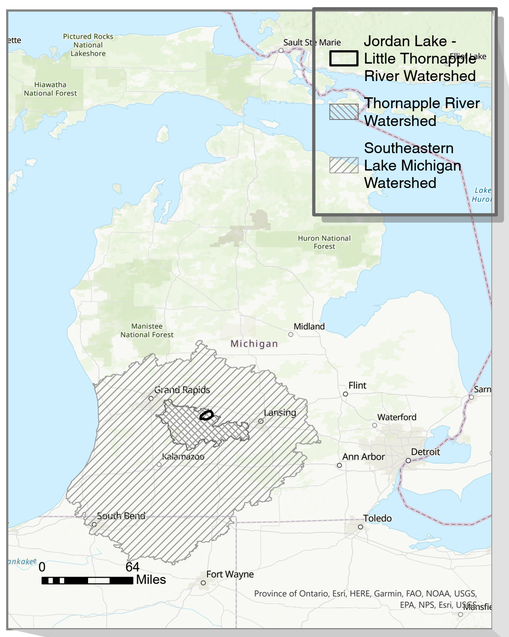
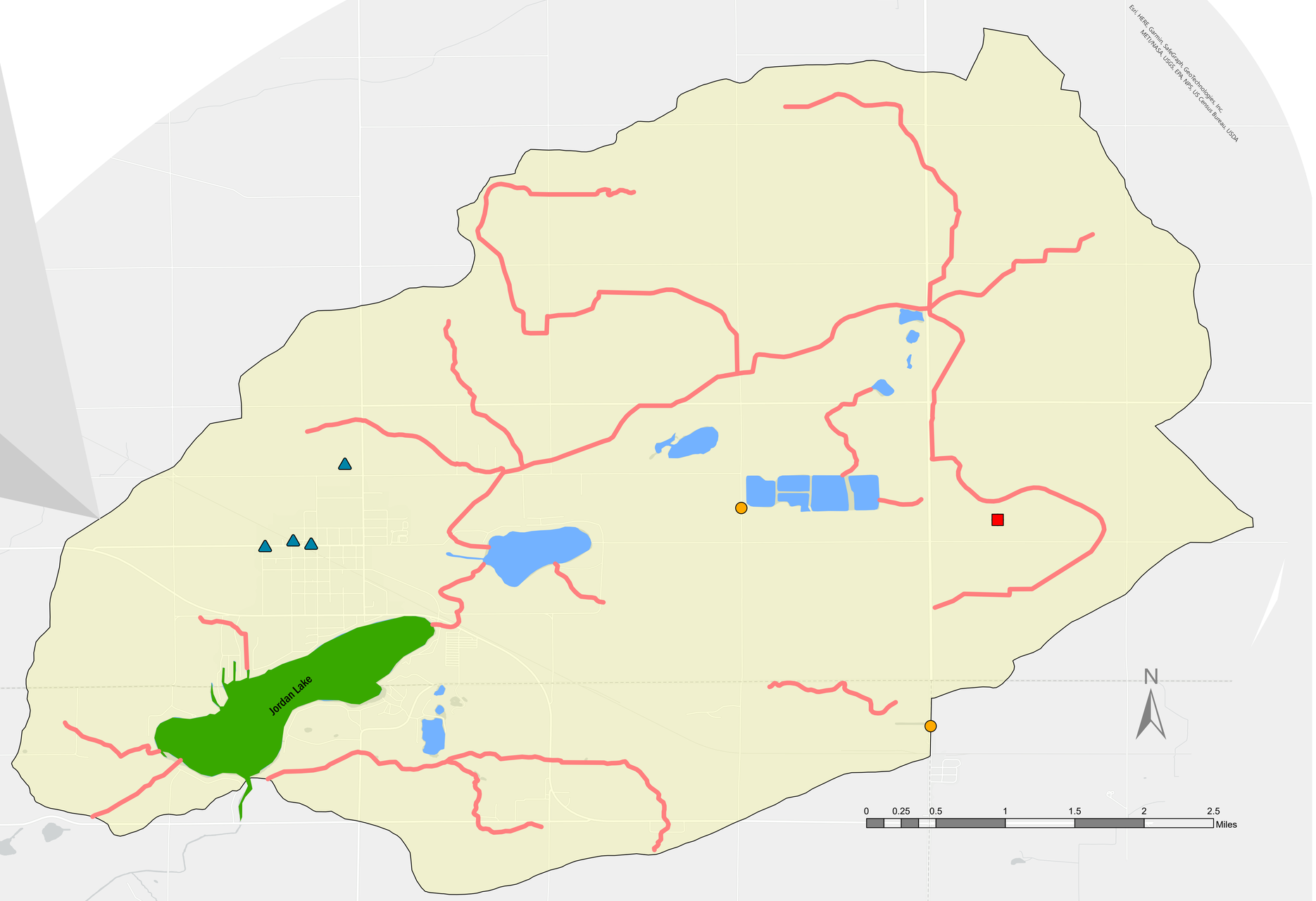
Jordan Lake Watershed: Harmful Algal Bloom Case Study

by Ashton Gibson, Earth 408





Watershed Features

- *Watershed Boundary*
- *Healthy Water Bodies*

Identified Issues

- *Impacted Streams*
- *Potential Harmful Algal Bloom*

Dischargers

- *No Violation Identified*
- *Violation Identified*
- *Meadowbrook Dairy CAFO*

Mercury, PCBs, and Algal Blooms

Using the EPA's "How's My Waterway" tool, I identified that the main pollutants within the watershed are Mercury, PCBs, and HABs.
Mercury contamination is a national issue, and it causes damage to organisms in the watershed through biological magnification. Here, this issue prevents people from eating fish that they may catch: the levels of mercury are too high for safe consumption.

PCBs, or polychlorinated biphenyls, are a type of "forever chemical" that were manufactured from 1929 - 1979 for industrial purposes, and are known to cause cancer. These can accumulate in animals and crops through water.
Harmful Algal Blooms (HABs) are an often visible overgrowth of bacterial algae in water. They are often toxic, and can contaminate drinking water.

Permitted Dischargers

Within this watershed, there are 7 organizations which are permitted to discharge their wastewater into the watershed, so long as they follow the EPA guidelines and the Clean Water Act.

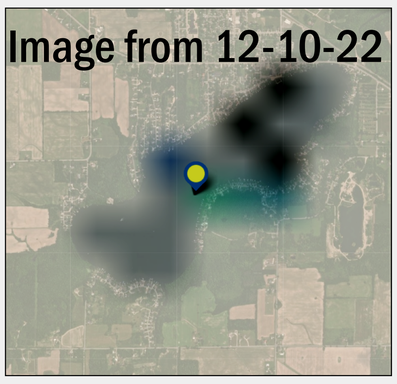
Of these, 3 have active violations. They vary by type, but none have had such serious violations that it warranted EPA intervention. Of these, I chose to focus my analysis on Meadowbrook Dairy CAFO, because it is the discharger located closest to an impaired body of water.

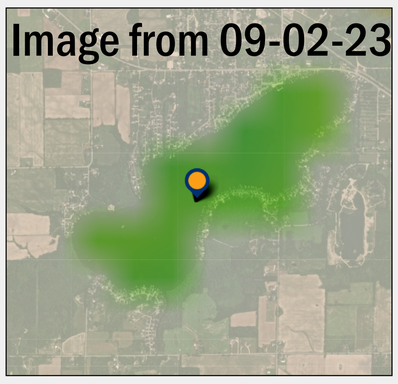
Meadowbrook Dairy has historical precedence of EPA violations, mainly in reporting inaccurate information, or failing to report at all.

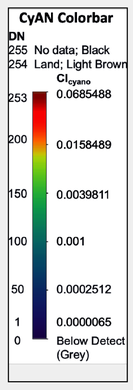
HABs in Jordan Lake

In the watershed, Jordan Lake is the only body of water impacted by HABs, according to the EPA. Their data comes from CyAN, the Cyanobacteria Assessment Network. This organization uses remote sensing to detect the amount of Algal-bloom causing cyanobacteria present in a given body of water.

There is a clear trend in the blooming of cyanobacteria, which is depicted with the satellite imagery below. During the colder months of the year, the amount of cyanobacteria is much lower than during the warmer months. This is because cyanobacteria rely on energy from the sun to thrive.







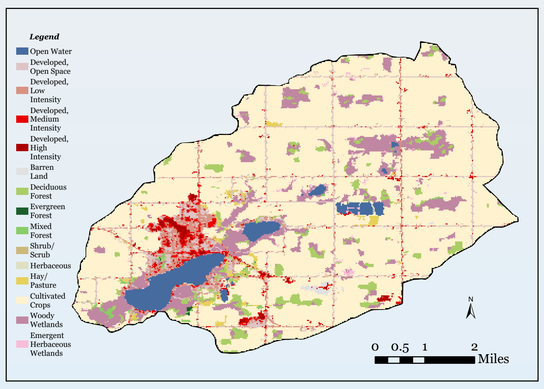
Meadowbrook Dairy

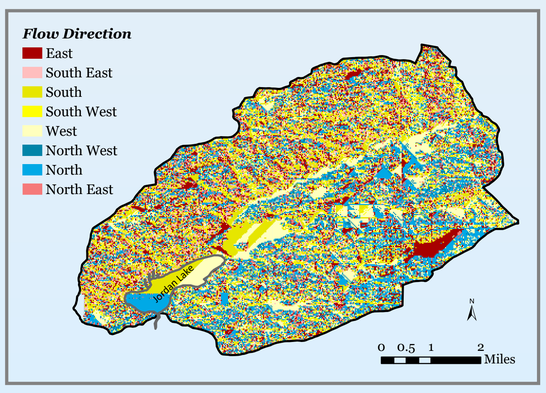
This concentrated animal feeding operation contains over 3,000 cows, and according to some estimates, has emitted 42,000,000 gallons of liquid waste.
The waste from this operation is cow manure, which is often used as fertilizer due to its high nitrogen, phosphorus and potassium content

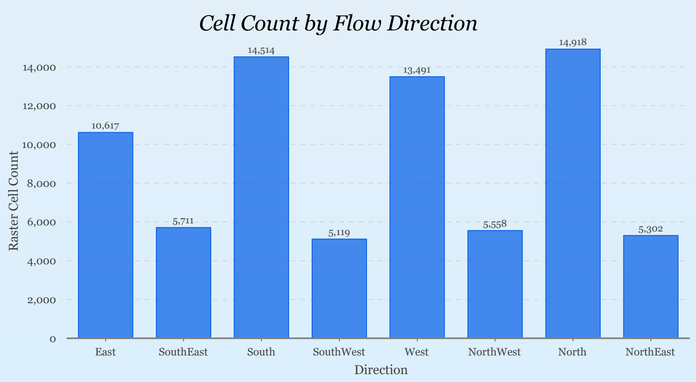
Methods

I intend to establish a connection between the formation of the HAB in Jordan Lake and the wastewater discharge of Meadowbrook Dairy CAFO. To accomplish this, I want to show evidence that Jordan Lake is the drainage basin of the watershed: that all streams and runoff will flow into it.

I used raster data from The National Map to construct a digital elevation model as the basis for my analysis. Then, I calculated the slope as well as the flow direction. I also calculated the Strahler stream order. Finally, I compared these results to the locations of the algal bloom and the dischargers.







Results

My flow direction analysis supports the assertion that Jordan Lake is the drainage basin of the watershed. Thus, all liquid wastewater discharge from Meadowbrook Dairy will end up in Jordan Lake.

Additionally, the compounds present in the wastewater discharge create ideal conditions for the growth of algal blooms. In the same way they act as fertilizers for crops, the nitrogen and phosphorus present in cow manure provide an excess of nutrients for the bacteria to flourish.

This effect cannot be attributed solely to Meadowbrook Dairy, however. My analysis of the land use shows that 70% of the total land area is used for cultivated crops. These crops will likely be treated with chemical fertilizers, which will eventually run into Jordan Lake as well.

Yet, it is worth noting that the Meadowbrook Dairy wastewater is being discharged directly into the stream in large quantities, whereas the overall crop fertilizer will enter the watershed by means of overland or throughflow. Ultimately the magnitude of the effect of the CAFO individually is unclear. We can however assert that it is a contributing factor in the formation of Harmful Algal Blooms in Jordan Lake.

For further research, I would recommend that more primary data collection be done. To asses the individual impact of any discharger, water samples could be collected upstream from the discharge site and downstream, and then compared to assess differences in chemical concentrations. Also, remote sensing should continue to be utilized, just with an increased frequency and scope. To address the impacts of dischargers on algal bloom formation, the EPA should more strictly monitor wastewater discharge, and require more measures for CAFOs to prevent mass amounts of fertilizers from being dumped.

Data sources: Watershed Boundary Data, Michigan Flowlines from National Hydrography Dataset, The National Map. Land Use Raster from NLCD 2021, The National Map. DEM constructed using Ionia County Elevation, National Elevation Dataset, USGS. Identified Issues, Dischargers, and Algal Bloom Layers from EPA "My Waterway" Esri web map embedded tool, https://mywaterway.epa.gov/community/lakee%20odessa/overview. Satellite images from CyAN Web app, https://qed.epa.gov/cyanweb/comparelocations.
References: EPA MeadowBrook Dairy Facility Report, https://echo.epa.gov/detailed-facility-report?fid=110069589136. Michigan CAFO mapping, https://www.sierraclub.org/michigan/michigan-cafo-mapping-report. Handler, A., J. Compton, et al. Identifying lakes at risk of toxic cyanobacterial blooms using satellite imagery and field surveys across the United States. SCIENCE OF THE TOTAL ENVIRONMENT. Elsevier BV, AMSTERDAM, Netherlands, 869:161784, (2023). https://doi.org/10.1016/j.scitotenv.2023.161784. Polychlorinated Biphenyls, EPA.