Isabella Arroyo Research Abstract
Interactive map and independent research posted to my website:
https://nitrogenfootprint.org/gis-map-skaneateles-lake

Project Title: Using Geographic Information System (GIS) mapping to monitor dissolved oxygen levels within Skaneateles Lake

Affiliation: Under the mentorship of Robert Becker, Project & GIS Manager at EKN Engineering in Irvine, CA.

Introduction: Skaneateles Lake is experiencing eutrophication due to excessive levels of nitrogen and phosphorus introduced into the water through local agricultural run-off. Eutrophication results in hypoxia, or the growth of dense plant life in aquatic environments, which leads to the death of fish and marine animals.

Skaneateles Lake is part of the Finger Lakes region in New York State, an area with significant agricultural endeavors, including commercial farms surrounding the lake. The lake is a watershed, and it serves as the primary source of drinking water for the City of Syracuse. It is a glacial lake, and the second cleanest lake in the US. It measures 17 miles long, averages 3/4 miles wide, and is 315 feet deep at the deepest point. It is a crucial environmental site that needs protection as it serves as a community water source but is also open for recreational use.

In July 2023, I submitted a plan to the Skaneateles Lake Association (SLA) to prepare a Geographic Information System (GIS) map of Skaneateles Lake. I have collected and compiled dissolved oxygen data points to create a baseline GIS to better understand eutrophication in the lake. My initial scope was to establish a base or raster map of the lake and provide a GIS file to which additional data can be appended over time by SLA volunteer scientists.

My hypothesis is that oxygen depletion occurs in the lake at points nearest to areas of increased agricultural activity. By correlating eutrophication and agricultural runoff, we can target efforts to bring the local use of fertilizers in agriculture under better control. I hope to change the perceptions and behaviors of consumers, farmers, and regulators. We can easily farm, manufacture, and landscape more sustainably, and I believe that measuring our "Nitrogen Footprint" is a first step in making this change.

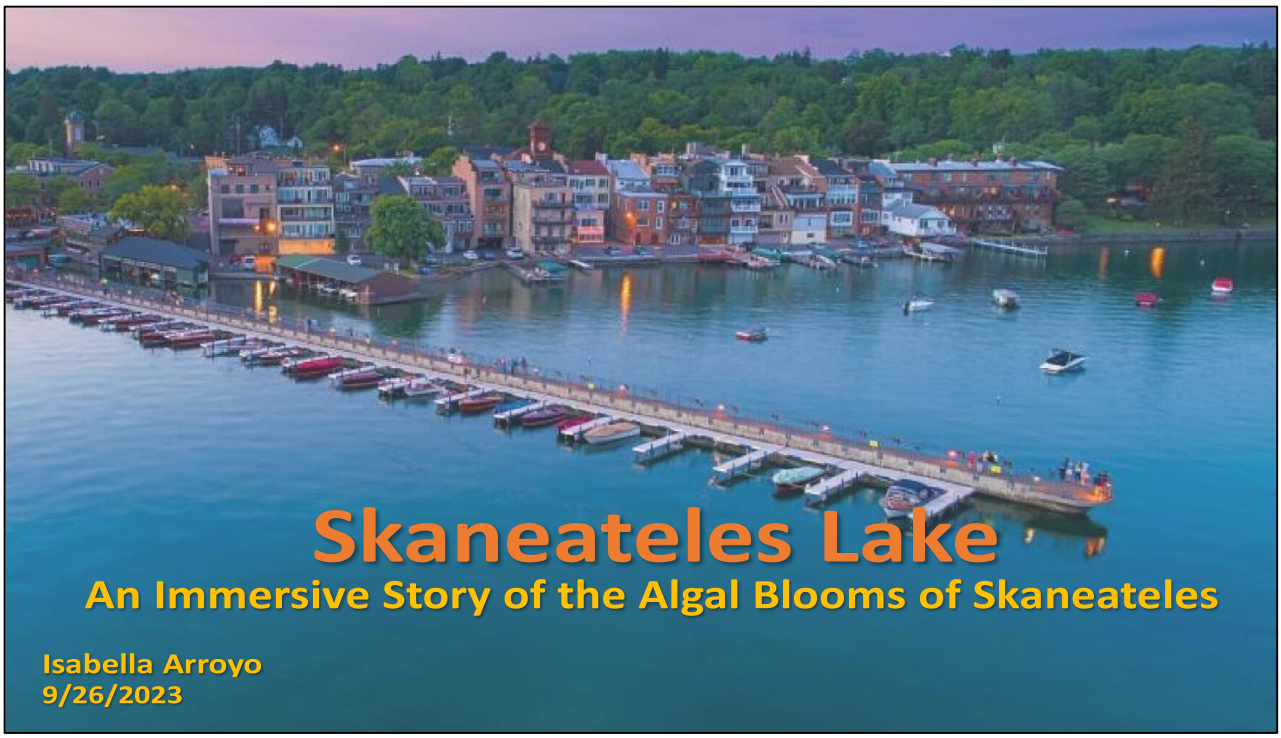
Objective: Through this initiative, I have: (i) established a baseline GIS map of the lake basin that the SLA can use to aggregate data over time, (ii) acquired dissolved oxygen samples from various points on the lake, (iii) plotted these data measurements in a GIS environment, and (iv) supported my hypothesis that oxygen depletion occurs in the lake at points adjacent to areas of increased agricultural activity.

The initial scope of this research was to establish a base or raster map of the lake and provide a GIS file to which additional data can be appended over time. The value of the GIS file is that it will be a central resource for aggregating data collected by SLA volunteer scientists.

Methods and Results: During the summer of 2023, I created a GIS map of Skaneateles Lake. Initial data points included farm locations and some historic algal bloom location data. With this information in hand, I used a personal watercraft to collect and measure the dissolved oxygen (DO) levels in water samples taken from the lake at various locations, including both near and far from areas of agricultural activity. These data were collected on three occasions, including once after a heavy rain and once in overcast conditions. On the first date, I was able to measure DO levels at 56 points around the perimeter of the Lake. On the second occasion I was only able to collect 49 samples as my equipment failed, however the data remains accurate.

I layered the DO levels into the GIS mapping environment. My materials included a Milwaukee MW600 LED Economy Portable Dissolved Oxygen Meter with 2 Point Manual Calibration, lake water samples, and a GIS file.

Preliminary Conclusions: The data collection and GIS plots reveal a correlation between dissolved oxygen levels and agricultural activity, indicating that the presence of algal blooms aligns with farm locations which contribute to detrimental nutrient run-off into the lake.



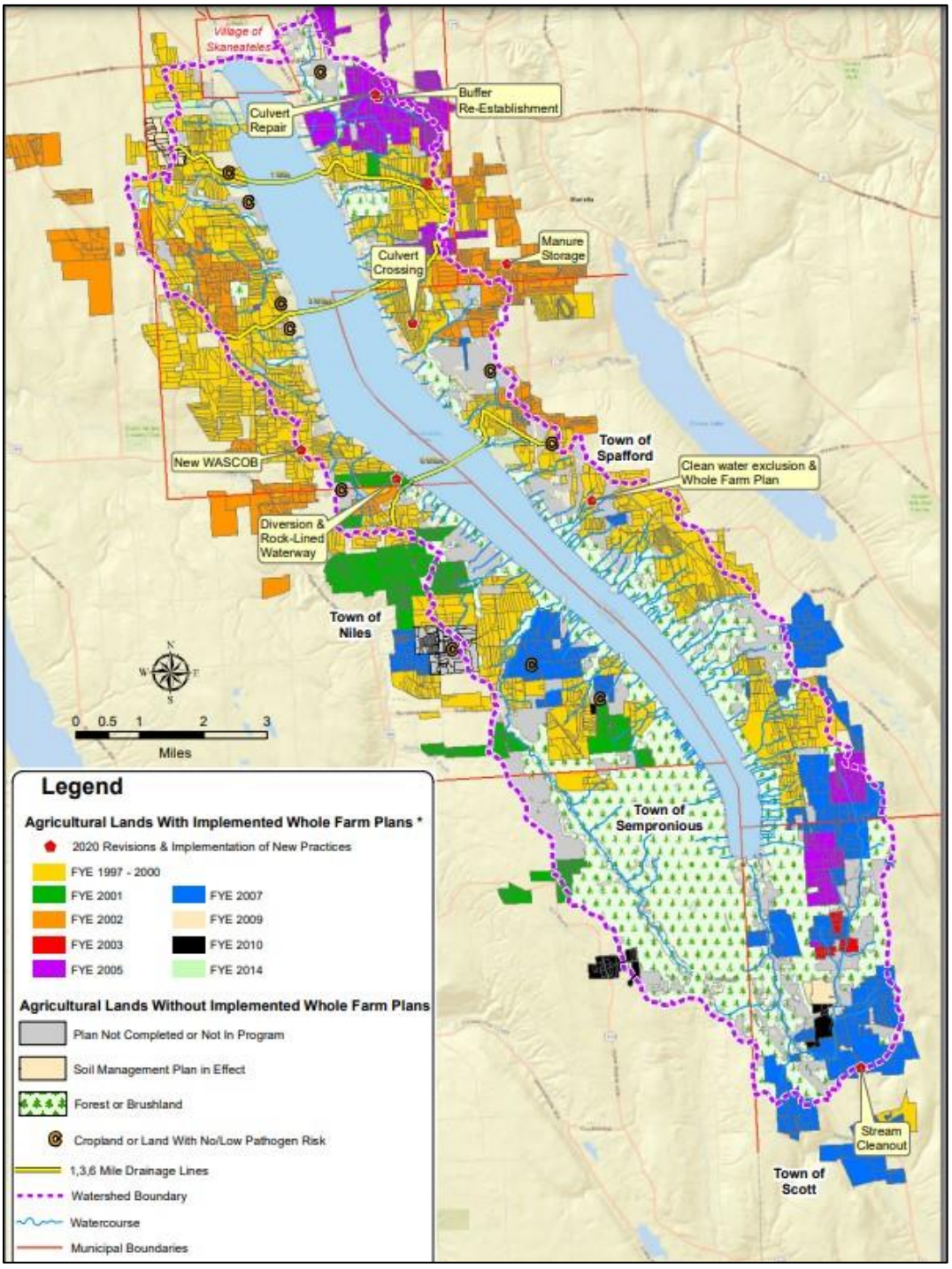
Project Background

The overuse of fertilizers in farming can cause eutrophication. Nitrogen, phosphorus, and other nutrients enter bodies of water, leading to the dense growth of plant life and a lack of dissolved oxygen. Overuse of agricultural fertilizers also leads to toxic algal blooms, tainted drinking water, and the collapse of aquatic ecosystems as fish suffocate. In Skaneateles Lake, there is a correlation between farm runoff and algal blooms, which have terrible consequences for the environment and our water systems.

Bird's-eye View - Street vs. Satellite

Areas of Investigation

Over the summer, when farming activity is heavy, there is a general trend of increased algal blooms. Data has shown that algal blooms are more common in coastal areas within close proximity of agricultural land. Fertilizer drainage and runoff enter the watershed, carrying phosphorus and nitrogen into the lake and causing blooms. According to NYDEC, 80% of all phosphorus runoff comes from agricultural land, and there are 46 established farms in the Skaneateles watershed.


Village of Skaneateles
Buffer Re-Establishment
Culvert Repair
Culvert Crossing
Manure Storage
New WASCOB
Diversion & Rock-Lined Waterway
Town of Spafford
Clean water exclusion & Whole Farm Plan
Town of Niles
Town of Sempronious
Stream Cleanout
Town of Scott
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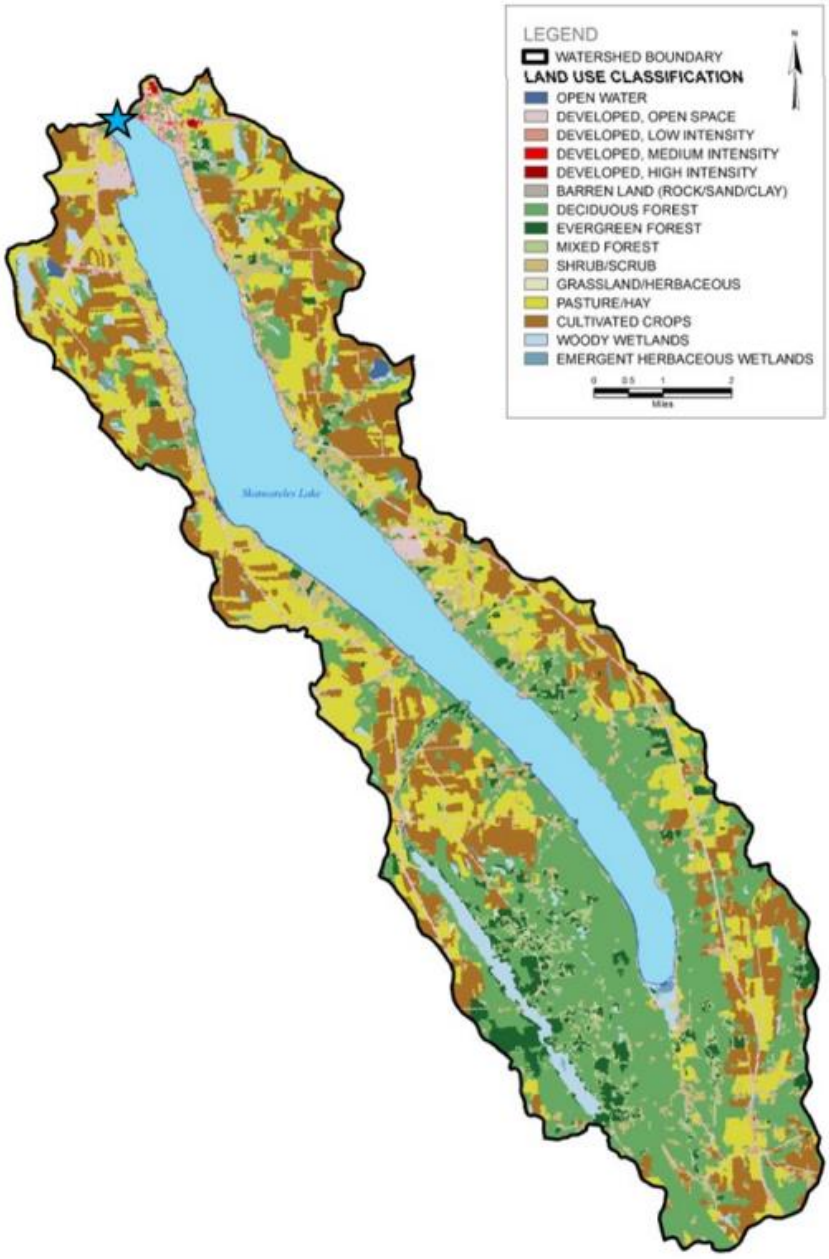
Miles
Legend
Agricultural Lands With Implemented Whole Farm Plans *
2020 Revisions & Implementation of New Practices
FYE 1997 - 2000
FYE 2001
FYE 2002
FYE 2003
FYE 2005
FYE 2007
FYE 2009
FYE 2010
FYE 2014
Agricultural Lands Without Implemented Whole Farm Plans
Plan Not Completed or Not In Program
Soil Management Plan in Effect
Forest or Brushland
Cropland or Land With No/Low Pathogen Risk
1,3,6 Mile Drainage Lines
Watershed Boundary
Watercourse
Municipal Boundaries



Watershed and Land Usage

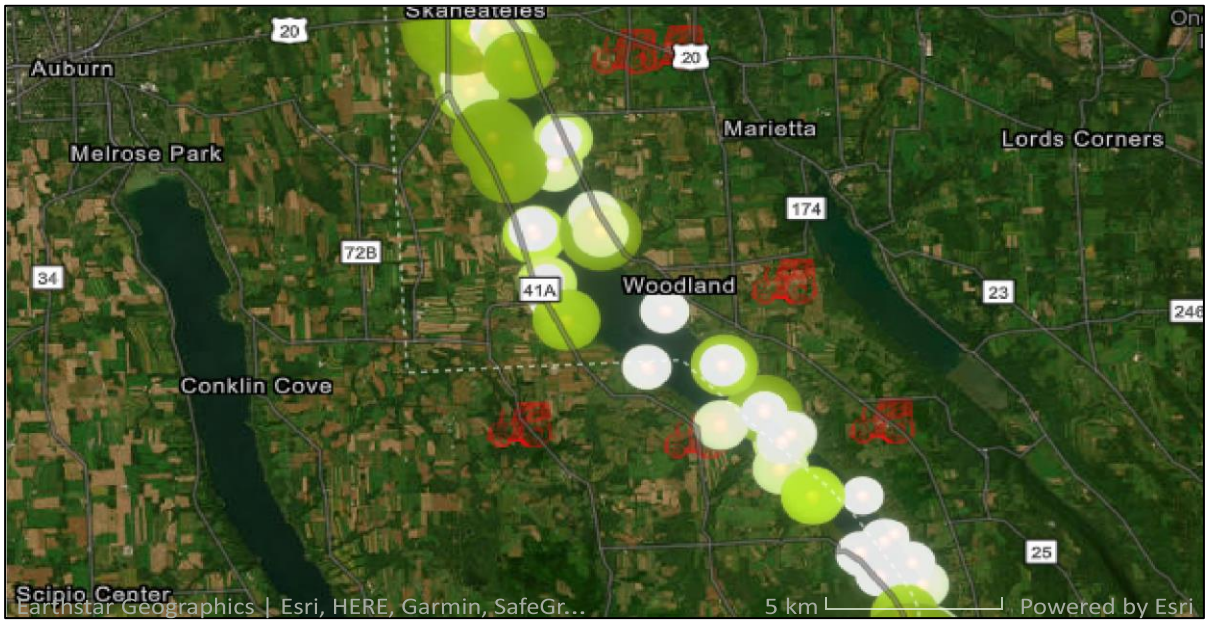
Field Collection

Non-Point Sources

Many non-point sources of fertilizer runoff, such as lawns, contribute to algae growth within the lake. Many properties, ranging from personal lawns to golf courses, use fertilizers to create lush grass. Although they don't use the concentrated amount of chemicals that farms do, contaminants accumulate and cause a massive effect on the lake.

Soil erosion is another big contributor to the level of phosphorus in the lake. In land with more foliage/plant life (and therefore more root systems), runoff does not flow as easily into the lake. Therefore, when land is being developed and forests are cleared to make lawns and roads, there is an increased flow of phosphorus into the water.

Blue green algae, a cyanobacteria, forms easily with an abundance of nutrients such as phosphorus. These bacteria can harm human life. Through contact, ingestion, and inhalation, humans can begin to develop allergic reactions, experience eye/skin irritation, and have diarrhea or vomiting.



Field Collection

Field Collection and Dissolved Oxygen Levels

Increased plant life can affect dissolved oxygen levels in water. An abundance of plants would produce more oxygen that needs to dissolve into the water, as demonstrated by the darker green circles. Therefore, it might seem helpful to increase fertilizer runoff into lakes, so that aquatic plants will become nutrient rich, thereby increasing growth and dissolved oxygen levels. However, when algae are fertilized in the lake, they grow at a faster rate, blocking sunlight for the aquatic plants below. Many other species begin to die and decompose as a result, further depleting the water of its oxygen supply. A lower dissolved oxygen level, represented by the white circles, can have many detrimental effects on the ecosystem. Fish populations will be harmed, humans will begin to face consequences like rashes and illness, and bird species will die off. This is also an issue for the residents of the City of Syracuse, as their main drinking water supply is sourced from Skaneateles Lake.

The Future

Visit this LINK to learn more about the future and existing efforts to mitigate these issues: https://www.twinbirchdairy.com/product-philosophy