



GIS Analysis of Heavy Precipitation Events & Contamination in Lake Munson

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ABSTRACT

In the past month, nearly 40,000 gallons of contaminated wastewater has spilled into Tallahassee waterways as a result of aging infrastructure. Although these spills have harmed community health and water supplies, the City of Tallahassee is not required to test for contaminants past a certain distance from the point source of the spill. However, independent tests by the Tallahassee Sewage and Wakulla Basin Advocacy Group have suggested that these contaminants travel far beyond the bounds of municipal testing. Tallahassee's average heavy rainfall and waterway interconnectedness could suggest a correlation between heavy precipitation events and these contaminant flows. To assess potential relationships, average annual rainfall data was compared against nitrogen, phosphorus, and turbidity concentrations. An R^2 value was then calculated to evaluate correlation. Finally, HPEs and contaminant concentrations were mapped onto a GIS of Lake Munson to visualize any correlations between heavy rainfall and contaminant concentrations. Results showed a weak correlation between rainfall and contaminant concentration; the strongest relationship was between nitrogen and rainfall. This preliminary data could indicate the success of recent wastewater cleanup initiatives.

INTRODUCTION

Background

- Munson Slough is a water basin in Tallahassee, FL, that is part of the Wakulla River Basin.
- For decades, municipal wastewater containing harmful contaminants, such as nitrogen and phosphorous, have been spilling into the Slough as a result of aging infrastructure, harming human health and wildlife.
- Tallahassee experiences nearly 59 inches of rain per year, and its clay soil is well-suited for overland flows.

Currently, there is limited research on the correlation between contaminant movements in the Munson Slough and environmental factors affecting Tallahassee. There is a need for a concise analysis of these two characteristics for use in recovery and mitigation efforts. Thus, this research aims to assess the correlation between heavy precipitation events (HPEs) and contaminant amounts following wastewater spills in the Munson Slough.

Hypothesis

Based on the literature, it is hypothesized that there will be a strong correlation between rainfall and contaminant concentration because Tallahassee is prone to both overland flow and wastewater spills.

METHODS

First, a threshold for both rainfall and contaminants was established.

- To accommodate seasonal variation, the threshold for HPEs is defined by average annual rainfall numbers that are above the historical annual average.
- Data from independent samplings of Lake Munson was used to provide concentrations of the contaminants phosphorus and nitrogen, and turbidity.

Rainfall & Contaminant Correlations

1. Historical annual rainfall data was calculated with data from the Florida Climate Center.
2. Average annual contaminant concentrations were calculated from the 4 independent tests from each year.
3. Annual rainfall data from 2017–2021 was compared with average annual contaminant concentrations. An R^2 value was calculated to assess correlation.

GIS Maps

1. Contaminant concentrations from 2 different testing locations in 2017 and 2021 were mapped on a GIS to compare, shown in Figures 1, 2, and 3.
2. Levels throughout the shown years provide insight into how contaminant levels change throughout a year.

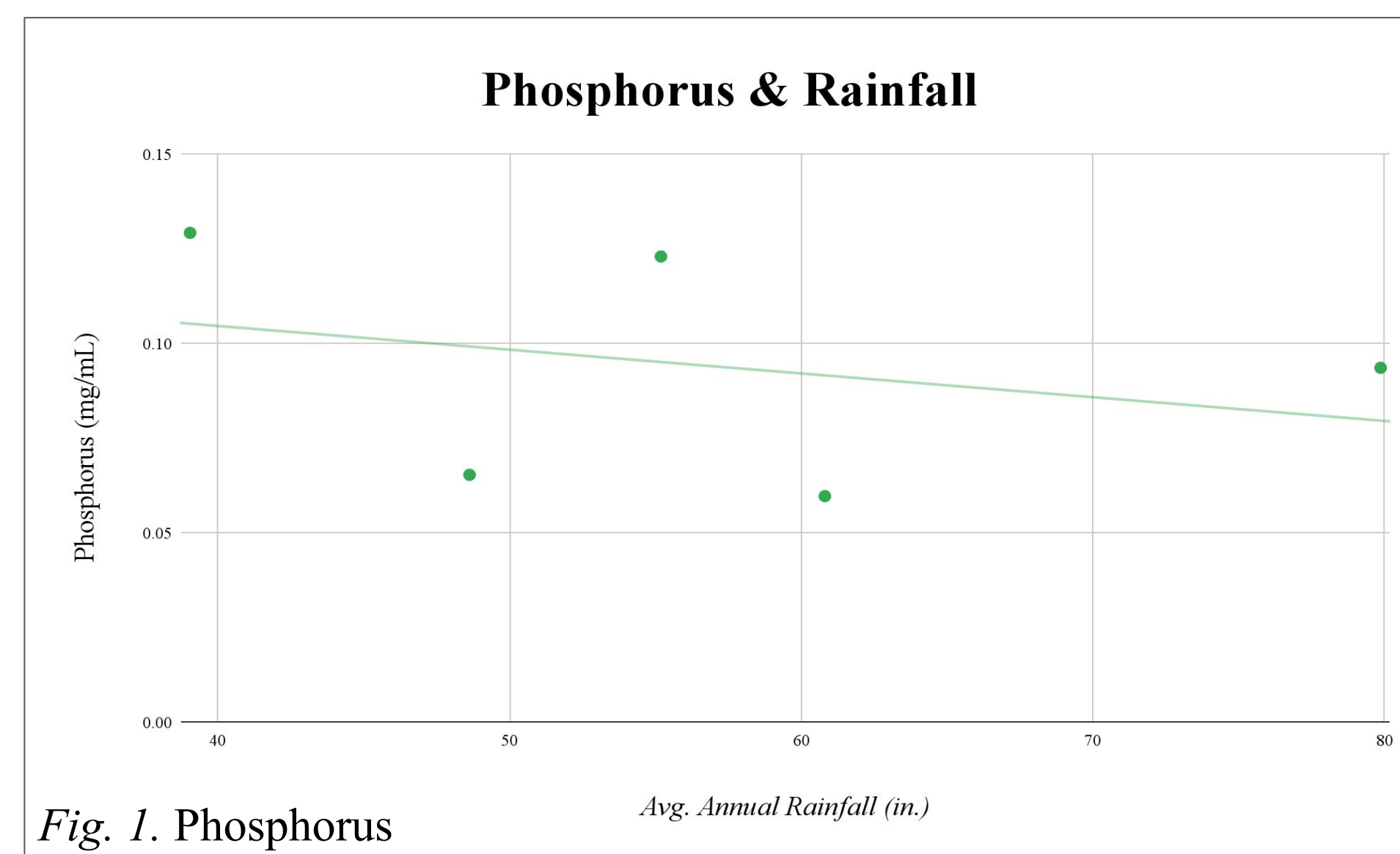


Fig. 1. Phosphorus

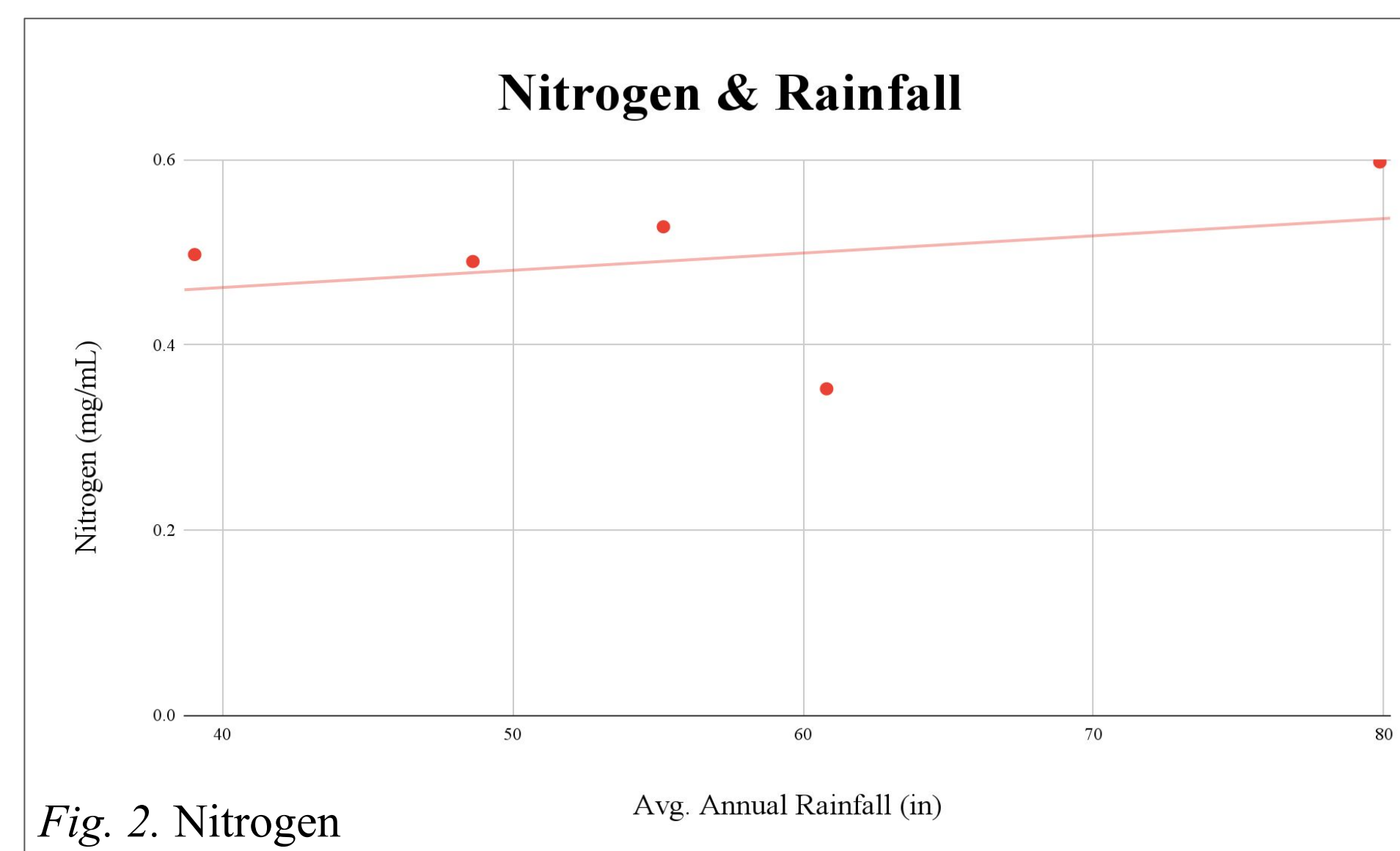


Fig. 2. Nitrogen

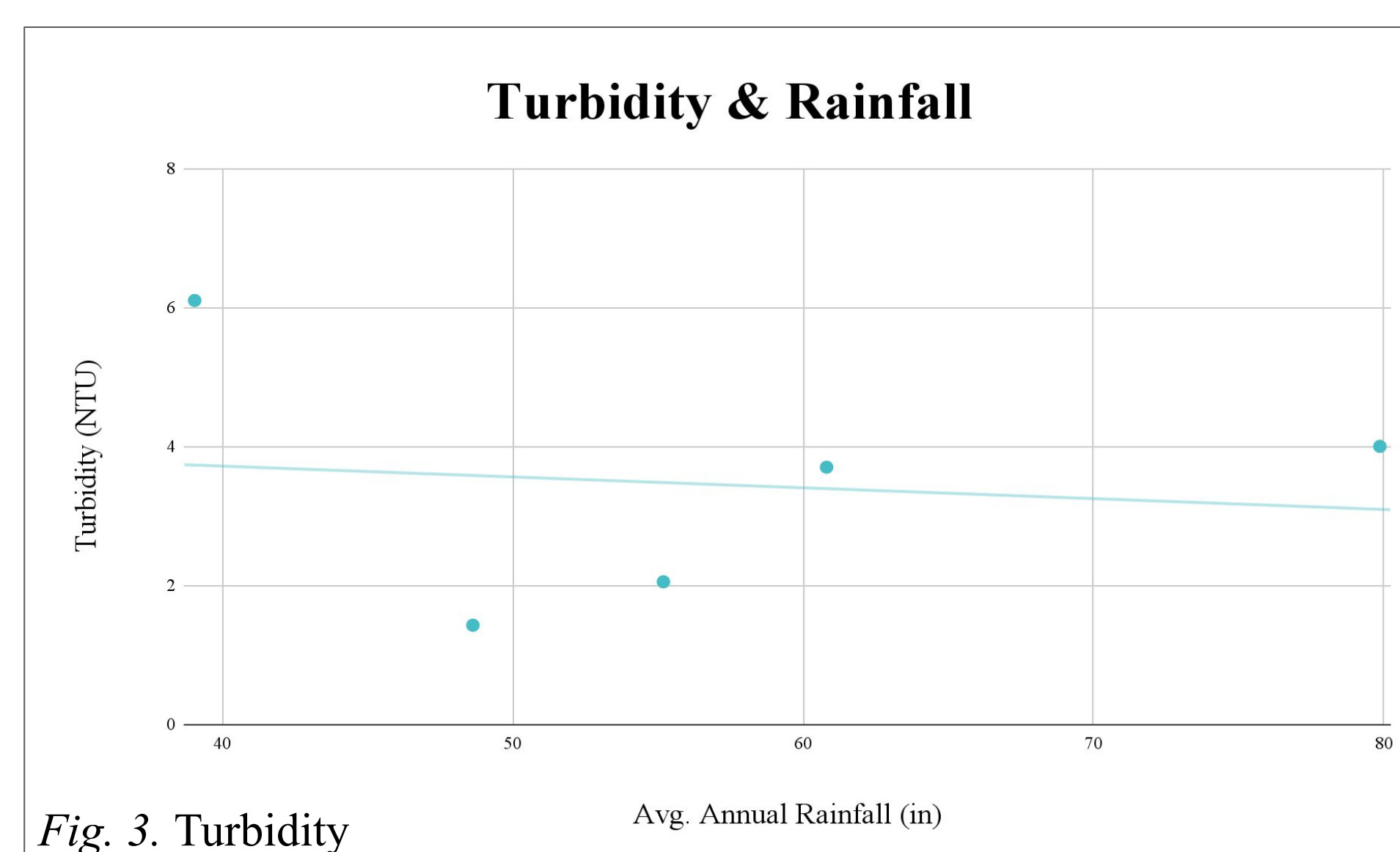
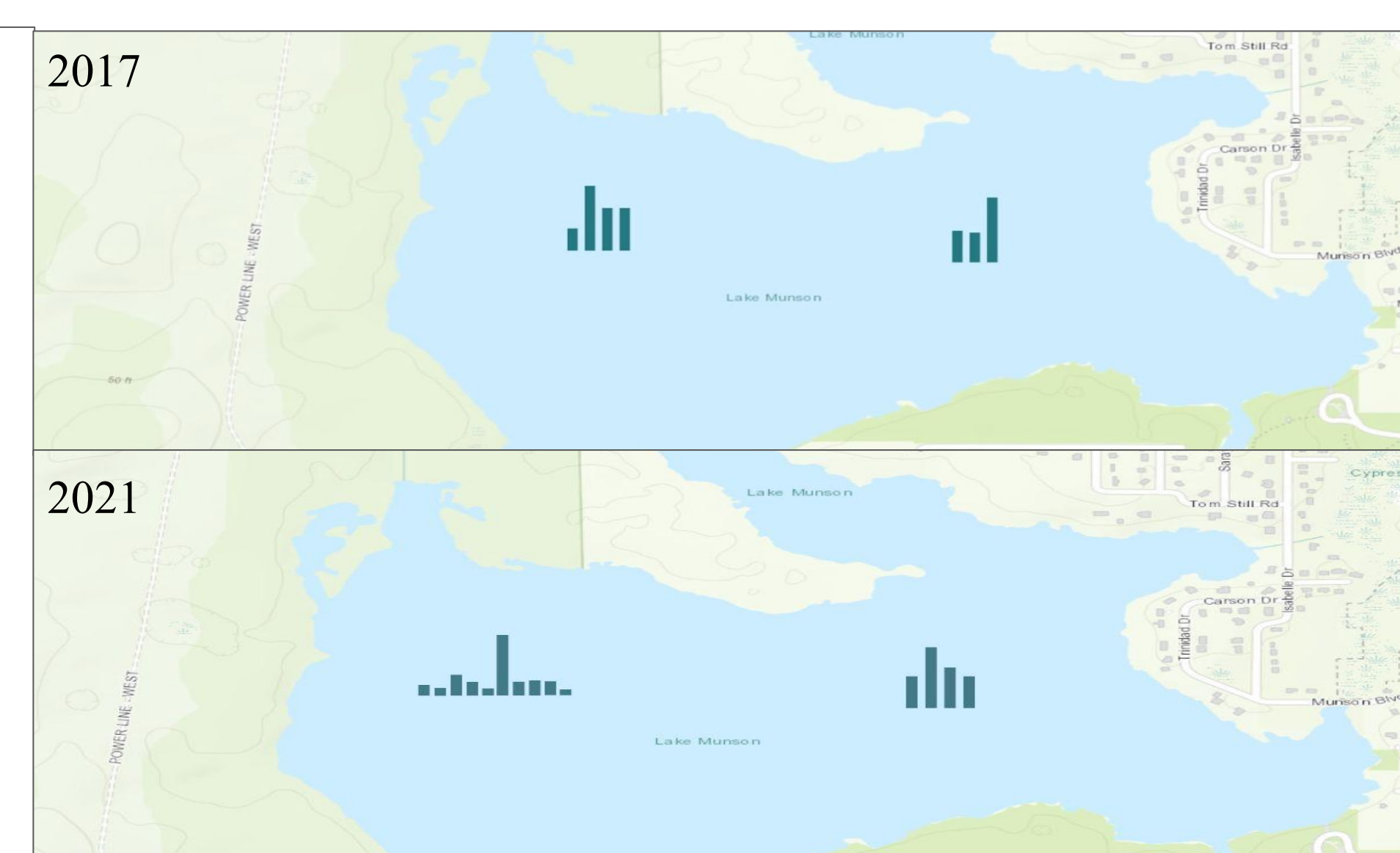
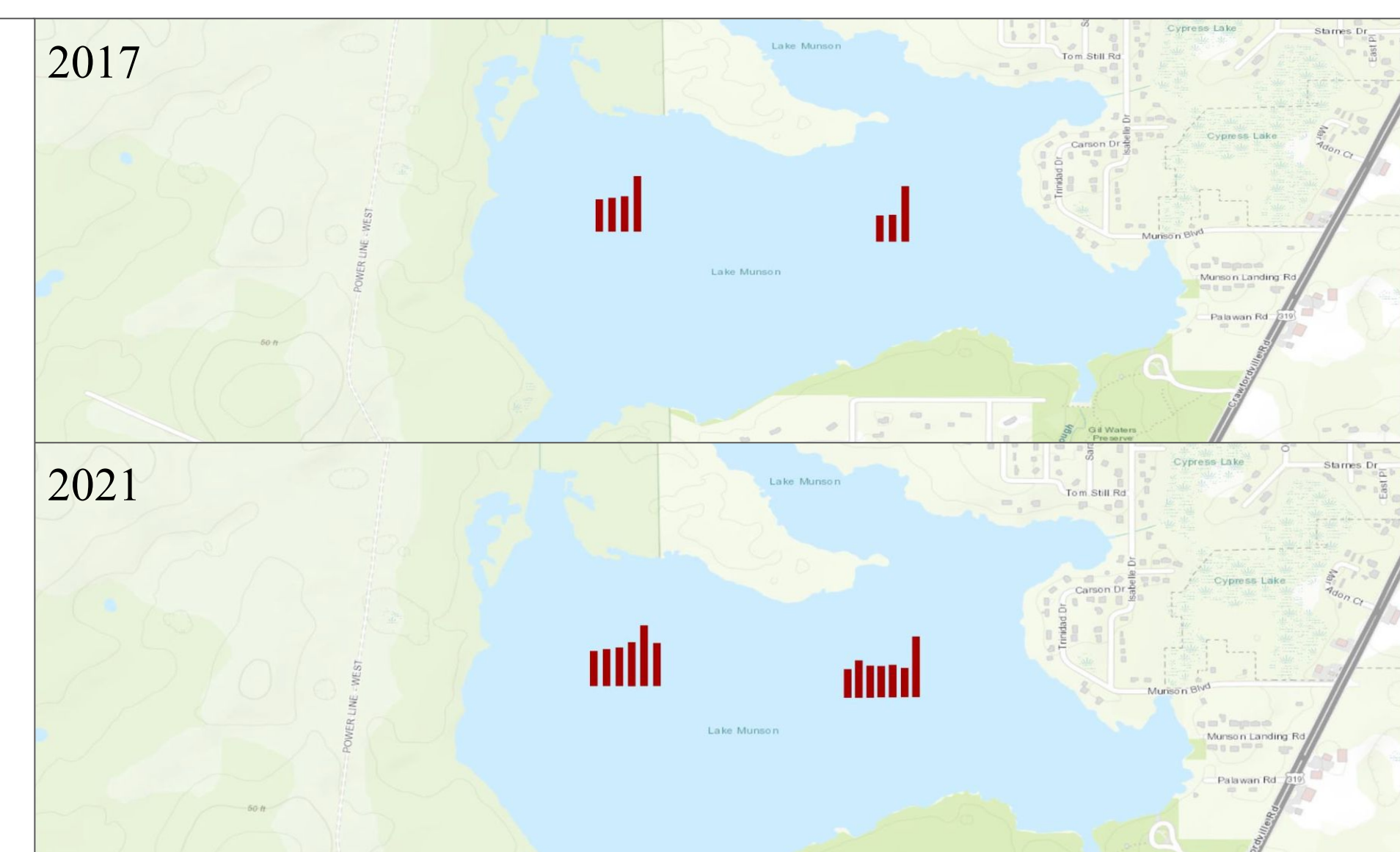
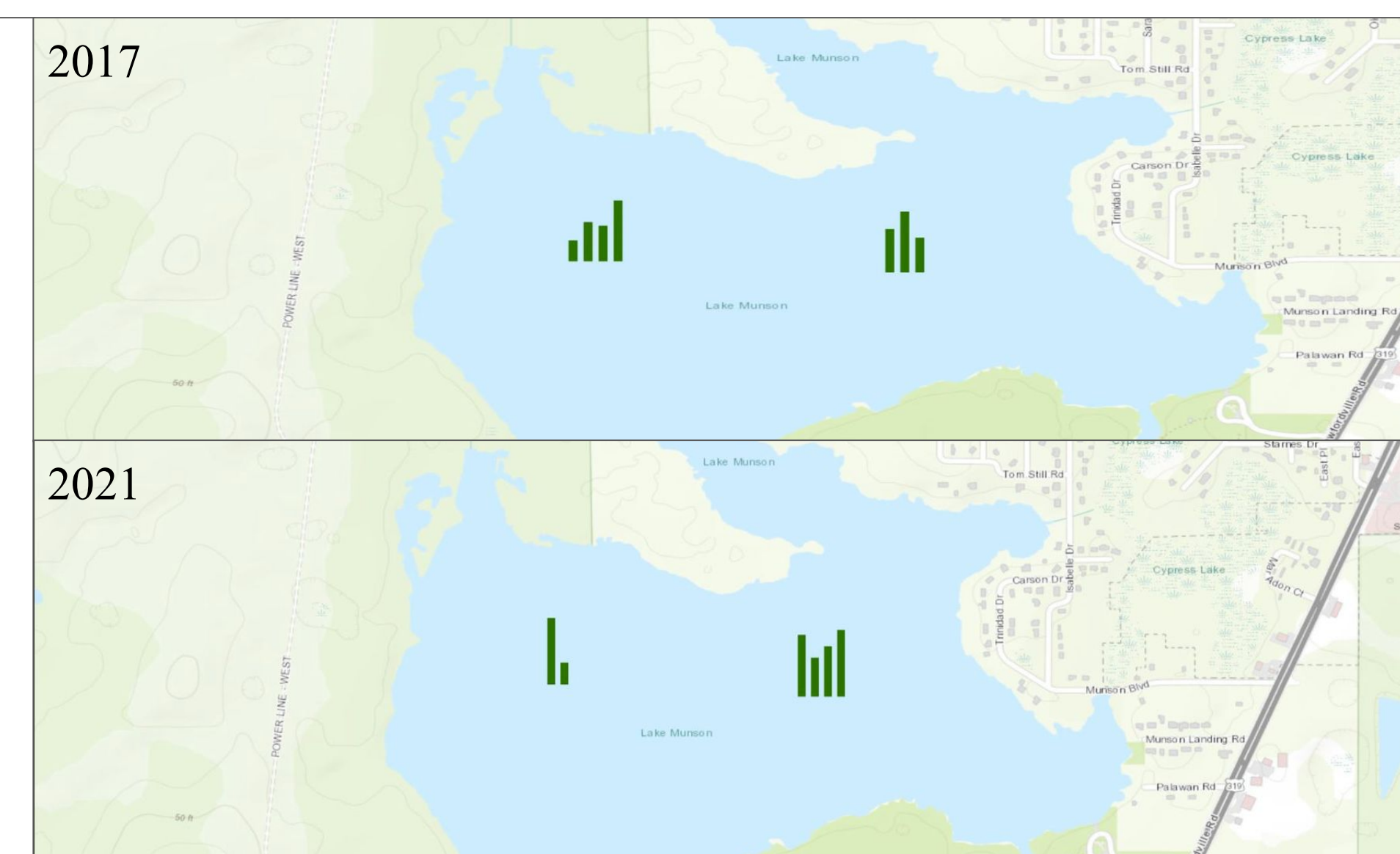


Fig. 3. Turbidity



RESULTS

Year	Avg. Rain (in)	Phosphorus (mg/L)	Nitrogen (mg/L)	Turbidity	# Sewage Spills/Yr
2017	55.19	0.123	0.5275	2.05	33
2018	79.86	0.093625	0.5975	4	32
2019	39.05	0.12925	0.4975	6.1	23
2020	60.81	0.05975	0.3525	3.7	18
2021	48.63	0.065375	0.49	1.425	12

Fig. 4. Numerical Rainfall and Contaminant Data

Contaminant concentrations and average annual rainfall between 2017 and 2021 were compared and an R^2 value was calculated to assess the strength of the correlation. The relationship between nitrogen and rainfall was the strongest, with an R^2 value of 0.1013. Turbidity had the weakest relationship with rainfall, with an R^2 value of 0.0169. Phosphorus fell to the middle, with an R^2 value of 0.0899.

DISCUSSION & FUTURE WORK

Based on the calculated R^2 values, there is a weak relationship between rainfall and contaminant concentrations in Lake Munson. Although results are preliminary, this could suggest that efforts to clean Lake Munson and prevent wastewater spills are showing some effectiveness. The lowest average rainfall amounts coincided with higher contaminant measurements, which could indicate that high rainfall washes analytes downstream or dilutes their concentrations.

Since these results are limited by their generality, future work would focus on specific spills and their potential relationship with heavy rainfall events. Additionally, future work would seek to expand the number and type of contaminants assessed.

ACKNOWLEDGEMENTS

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