Investigating Greenhouse Gas Emissions and Biogeochemical Processes in the St. Joseph River

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1. Introduction

Background and Significance

Global warming has intensified interest in the global carbon cycle.

- Inland water systems, especially rivers, play a key role in carbon transfer between land, atmosphere, and oceans.

Photo credit: Derek Jensen

Figure 1. Overview picture of St. Joseph River.

- River biogeochemical processes (GPP, NPP, CR) determine whether they act as carbon sources or sinks.
- Rivers emit not only CO_2 but also CH_4 and N_2O through microbial activity in sediments and water columns.
- Riverine GHG emissions are still underexplored in many watersheds, limiting our understanding of their climate influence.

Research Objectives

- Continuing routine field sampling across seasonal cycles to capture variability.
- Assessing how metabolic processes, nutrient availability, and hydrological changes influence GHG emissions (CO_2, CH_4, N_2O).

Goal: Assessing the contribution of tributaries to the water quality of St. Joseph River.

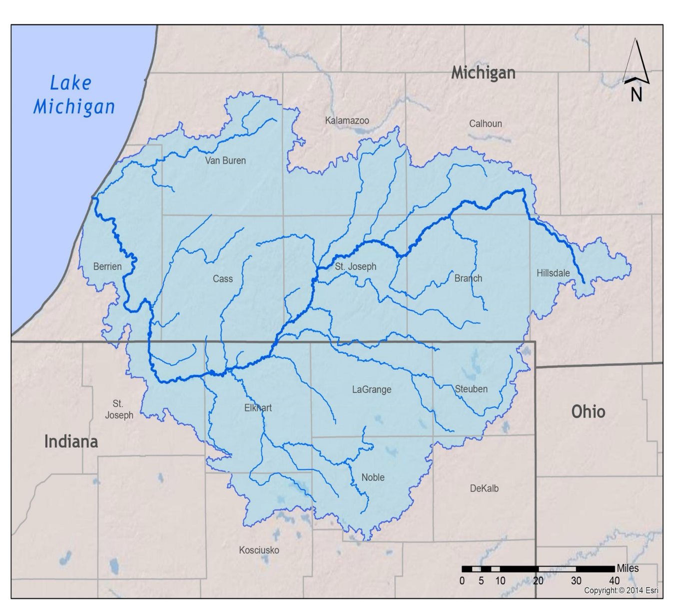

Figure 2. Sample of E Coli. from St. Joseph River.

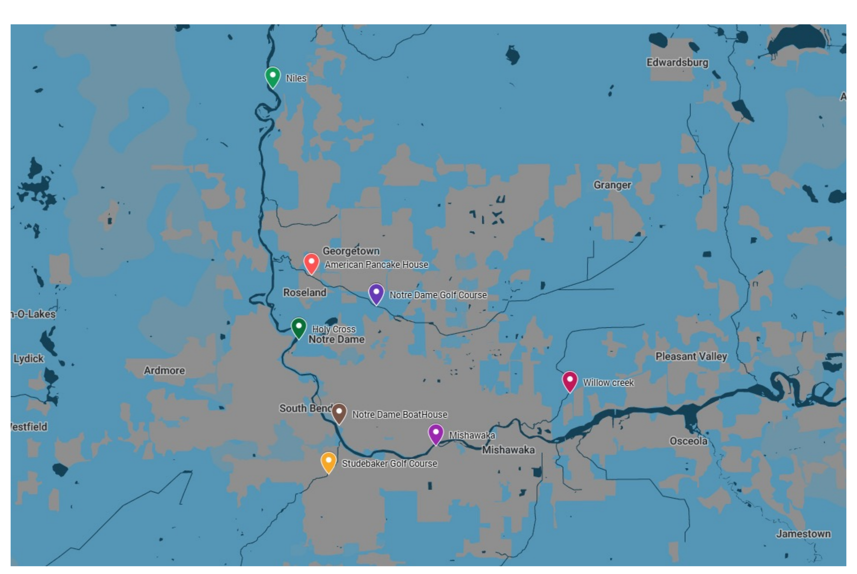

Figure 3. Site locations: Niles, APH, HC, NDBH, NDGC, MISH, WC, GC

2. Methods

- **Watershed:** Lake Michigan watershed (Great Lakes Basin)
- **Watershed area:** 1.2 million ha.
- **Sampling Period:** Aug 2024 to Nov 2024
- **Sampling:** Monday weekly sampling periods.
- **Sites:** Willow Creek, Mishawaka, Holy Cross, Notre Dame Boathouse, Niles, American Pancake House, and Studebaker Golf Course.

Photo credit: SJRBC

Figure 4. Map of St. Joseph River and its surrounding tributaries.

3. Methods (Cont'd)

Analytical Workflow:

- **Organic Carbon/Nitrogen Analysis (CEST Shimadzu TOC-L/TNM):**
  Measures Dissolved Inorganic Carbon (DIC), Dissolved Organic Carbon (DOC), and Total Nitrogen (TN) in water.
  They are vital for measuring carbon transport and assessing CO_2 fluxes linked to oxygen metabolism.

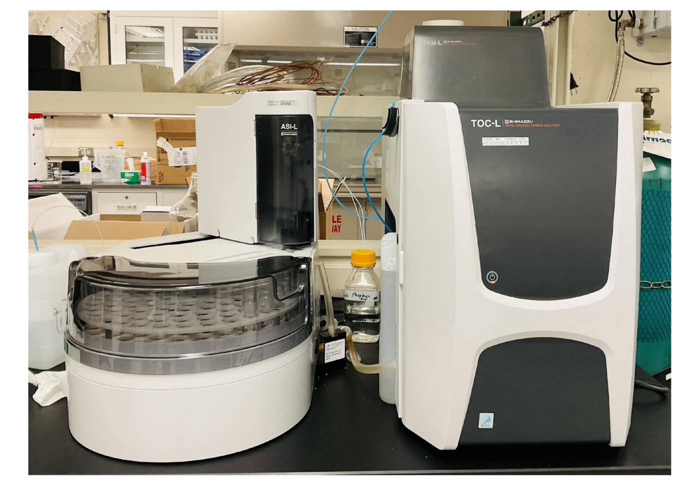

Figure 5. CEST Shimadzu TOC-L/TNM

- **Greenhouse Gas Profiling (Bay Instruments MIMS):**
  Membrane Inlet Mass Spectrometry (MIMS) for dissolved O_2, N_2, and N_2O concentrations in river water.
  Providing GHG emission profiles under changing environmental conditions.

Figure 6. Bay Instrument MIMS

- **Metrohm Ion Chromatography (IC):**
  Detects concentrations of nitrate (NO_3^-), nitrite (NO_2^-), and phosphate (PO_4^{3-}), which are essential for characterizing nutrient cycling and evaluating their roles in GHG generation.

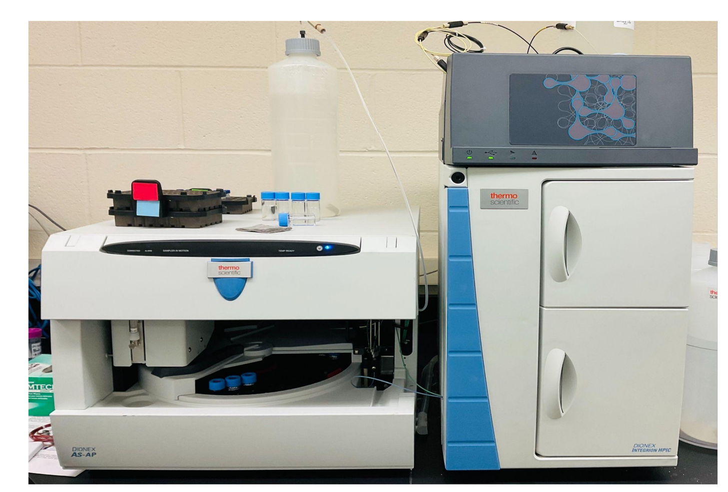

Figure 7. Top row: flow from the No CC

4. Results

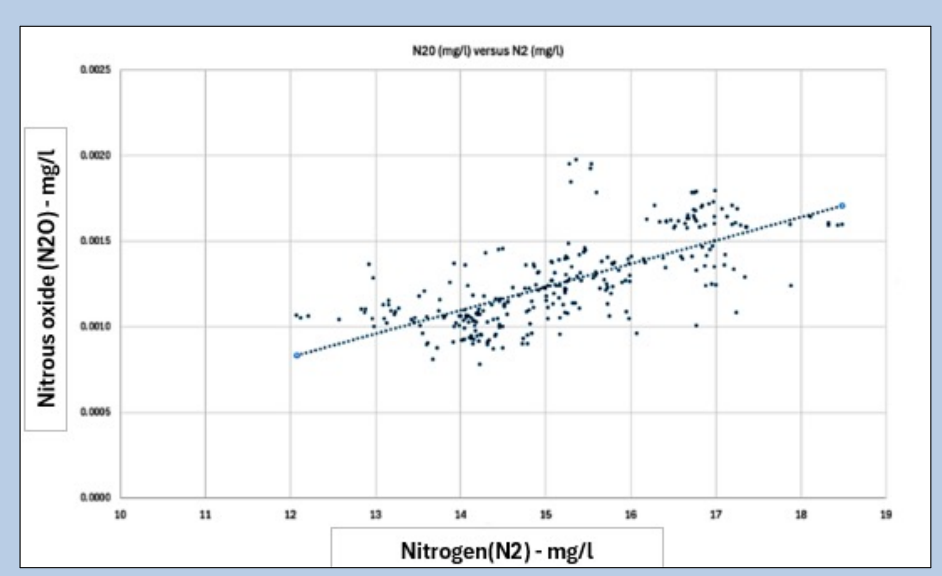

Figure 8. A positive correlation between nitrous oxide (N_2O), a potent greenhouse gas, and nitrogen gas (N_2) suggests active denitrification processes. This link implies that microbial nitrogen transformations contribute to N_2O production alongside N_2, especially in nitrogen-rich or oxygen-limited conditions.

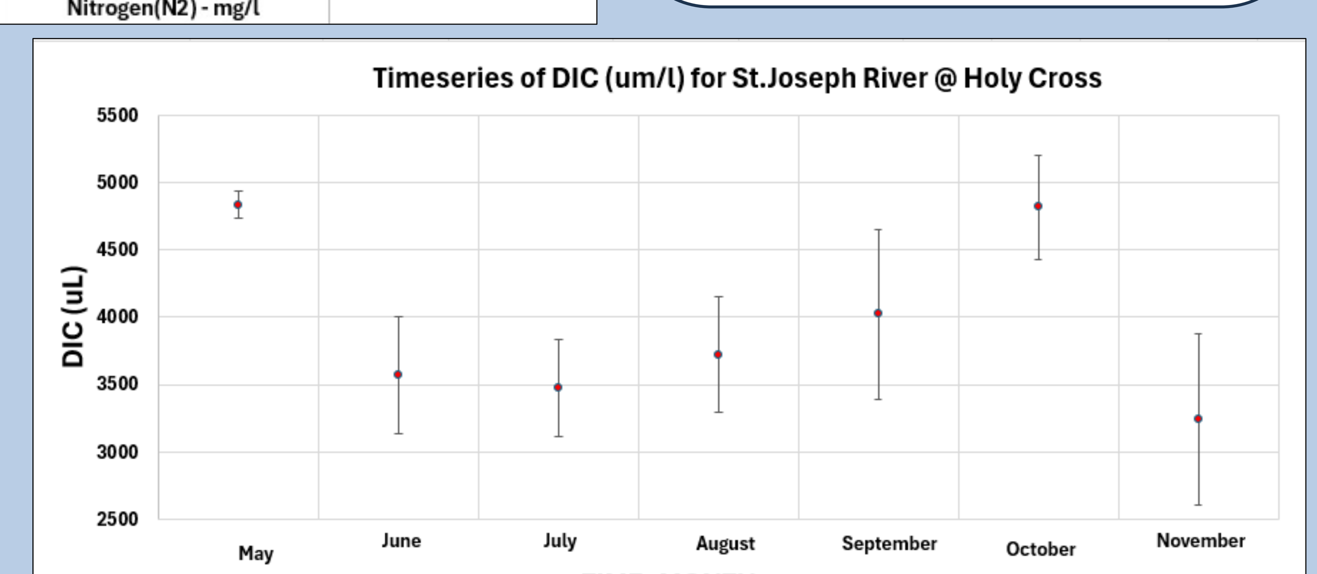

Figure 9. Time series of DIC for the St. Joseph River at Holy Cross in May through November

5. Results (Cont'd)

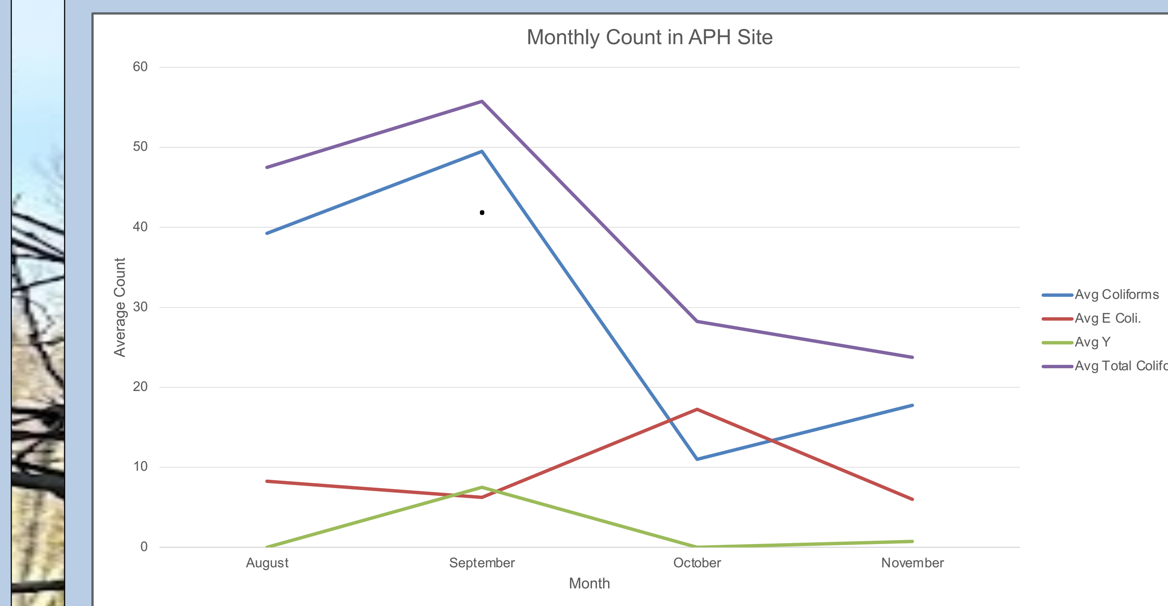

Figure 10. Monthly Count in APH Site

Analysis: These findings affirm the sensitivity of riverine GHG dynamics to nutrient inputs, hydrological variability, and temperature factors that are expected to shift further under climate change.

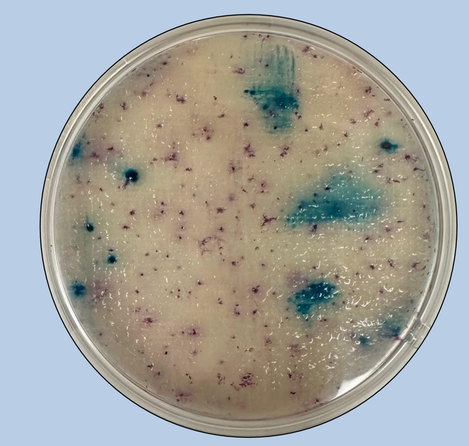

Figure 2. Sample of E. coli. at St. Joseph River

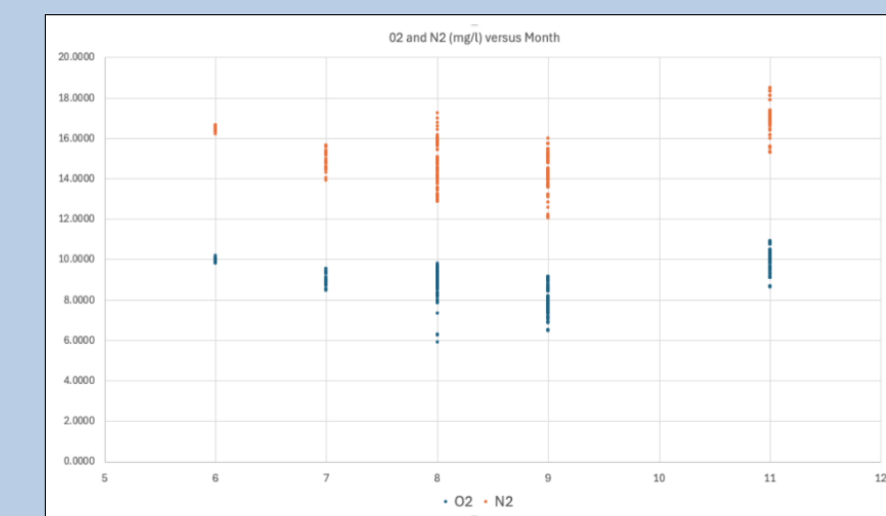

Figure 12: Table of Oxygen and Nitrogen Gas

Outcome: generates a long-term dataset on temperature, pH, dissolved oxygen, DIC, nutrient levels, and GHGs.

- Contributing critical insights into the carbon balance and climate influence of freshwater systems.
- These data will provide a valuable scientific baseline for future investigations into climate change impacts, ecosystem metabolism, and GHG mitigation strategies.

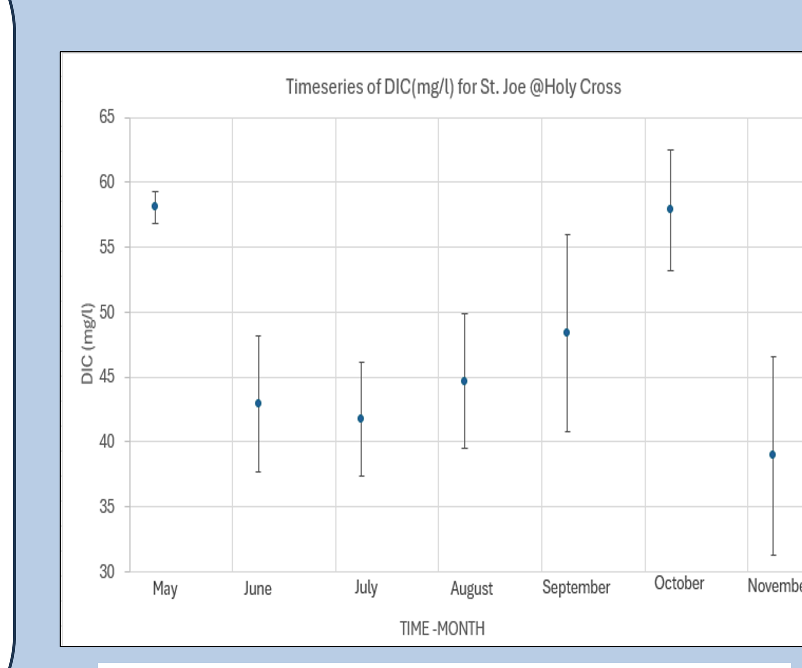

Figure 11: A Timeseries of DIC for St. Joseph River at the Holy Cross site.

6. Conclusions

Scientific Impact:

- The research enhances understanding of how freshwater ecosystems respond to climatic and biogeochemical changes.

Policy Relevance:

- Findings provide a scientific basis for informing policy.

Overall, this research highlights freshwater GHG sensitivity to climate change, nutrient input, and hydrological variability.

7. Acknowledgements

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