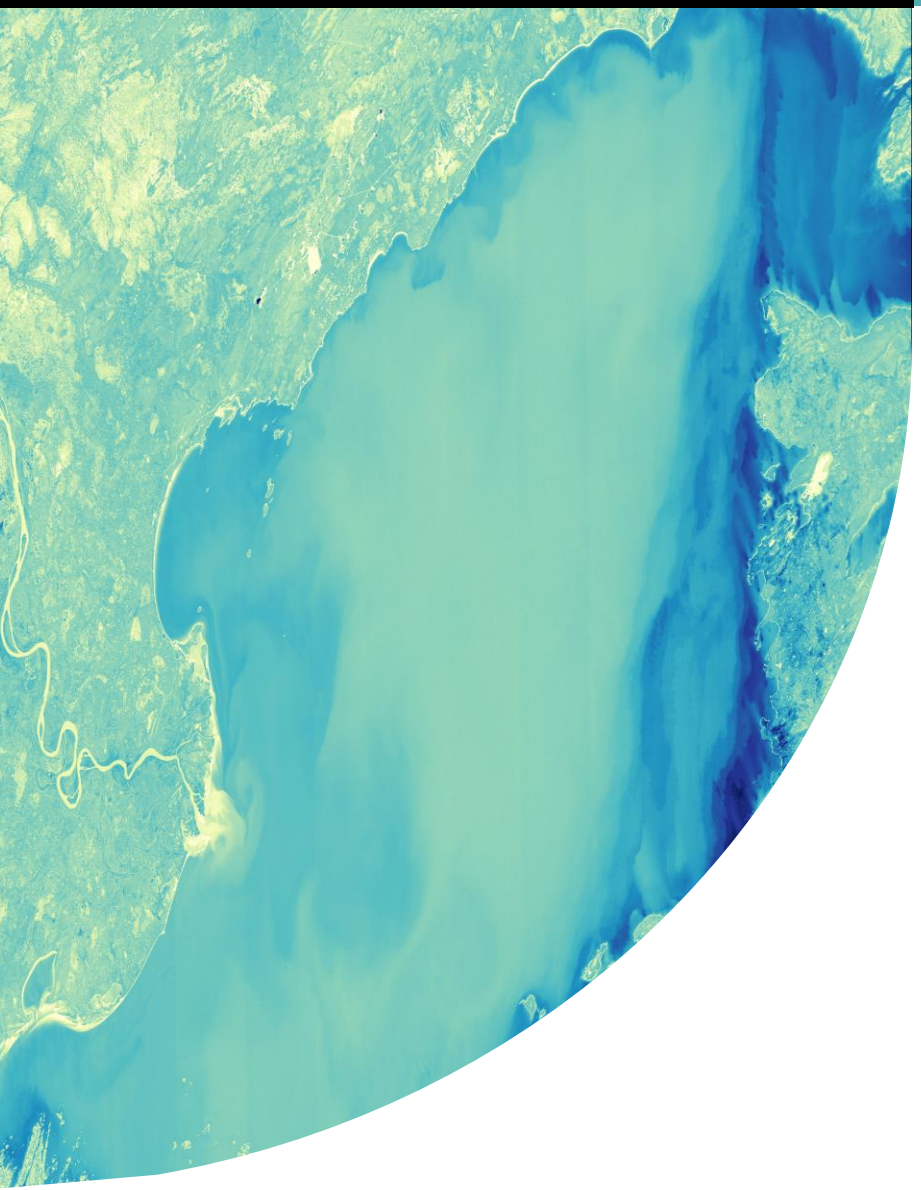
National Aeronautics and Space Administration



Great Slave Lake Water Resources

Using Earth Observations to Monitor Water Quality of Great Slave Lake in the Northwest Territories, Canada

Christopher Fan, Declan Hogan, Eliza Lawrence, Rachel Vered (Analytical Mechanics Associates)

Massachusetts – Boston | Spring 2025

The Team

Christopher Fan

Declan Hogan

Eliza Lawrence

Rachel Vered

Study Area & Period

Study Area: Great Slave Lake, Northwest Territories, Canada

Study Period: June to October, 2002 to 2024

Partners

End User:

Government of the Northwest Territories,
Water Research and Monitoring Section

Collaborators:

- K'atl'odeeche First Nation
- Akaitcho Territory Government
- Deninu K'ue First Nation

Image Credits: Cedric Fichot

Community Concerns

Environmental Concerns

- Increased turbidity from large sediment plumes
- Hydrological variability

Public Health Concerns

- Fish contamination
- Harmful algal blooms

Economic Concerns

- Impacts on fishery, tourism, and transportation industry


Image Credits: Cedric Fichot

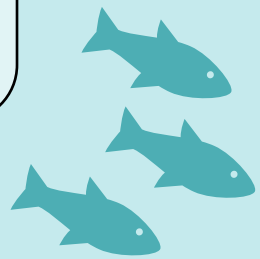

Image Credit: USGS

Objectives

Identify most suitable Earth observation sensor for calculating turbidity

Analyze spatial and temporal changes in turbidity

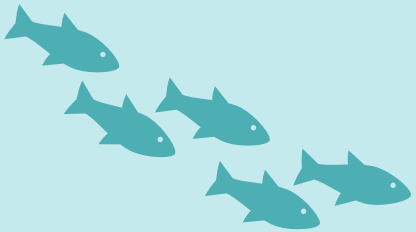
Provide partners with temporally and spatially consistent water quality monitoring data for improved decision making

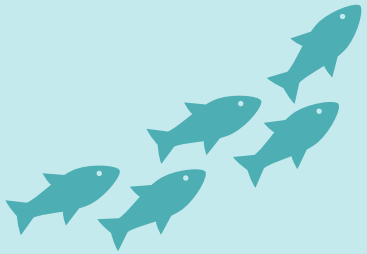


Turbidity Overview

Turbidity measures the amount of light scatter to assess water clarity

Reflectance is the amount of light detected by a satellite

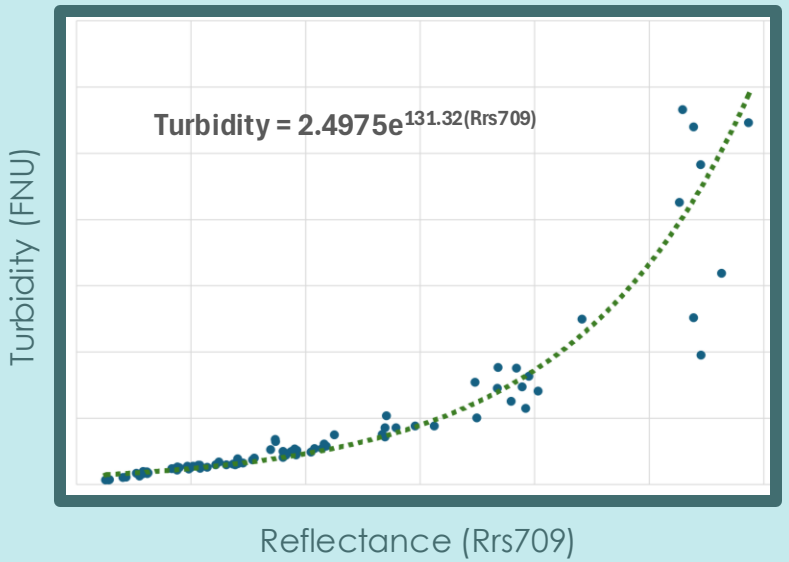




In-situ data allows us to establish a relationship between turbidity and reflectance

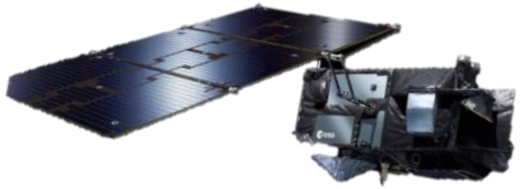
The relationship is then defined by a regression equation and applied to earth observations

***In-situ* turbidity vs. reflectance**



Earth Observations

Sentinel-3 OLCI



Sentinel-2 MSI

Aqua MODIS

Ocean Colour CCI

Composite imagery

Image Credit: NASA, Ocean Color

In Situ Data

Turbidity & Reflectance

- Sampling by Dr. Fichot, Boston University (Science Advisor)

Turbidity

- NWT-wide Community-based Monitoring Program

Slave River Discharge

- Environment and Climate Change Canada (ECCC)

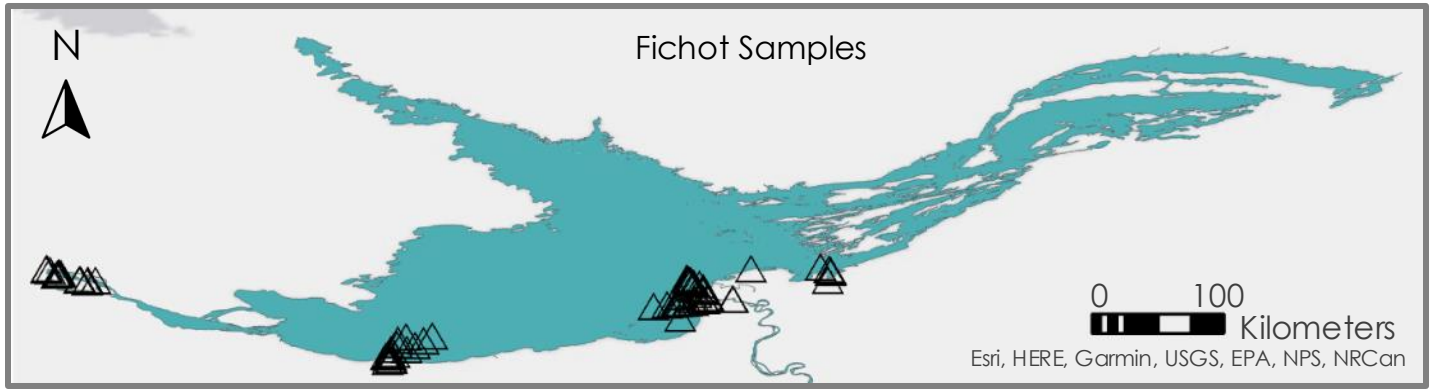


Image Credits: Cedric Fichot

Methodology

Data Aquisition

In-Situ
- Reflectance & Turbidity
- Turbidity
- Slave River Discharge

Earth Observations
- Reflectance

Processing

Algorithms
- Turbidity vs Reflectance

Imagery
- Turbidity

In-Situ Comparison
- Turbidity

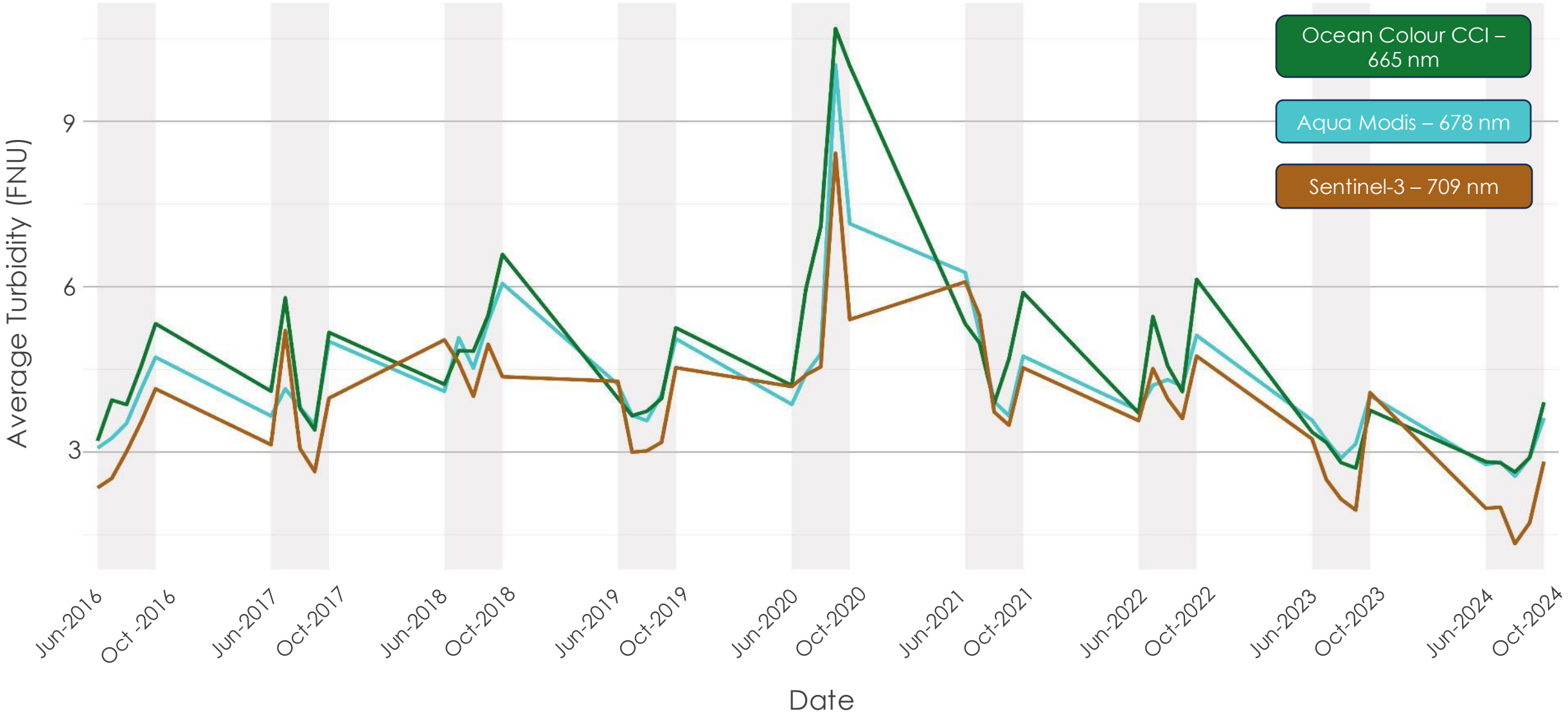
Analysis

Sensor Comparison

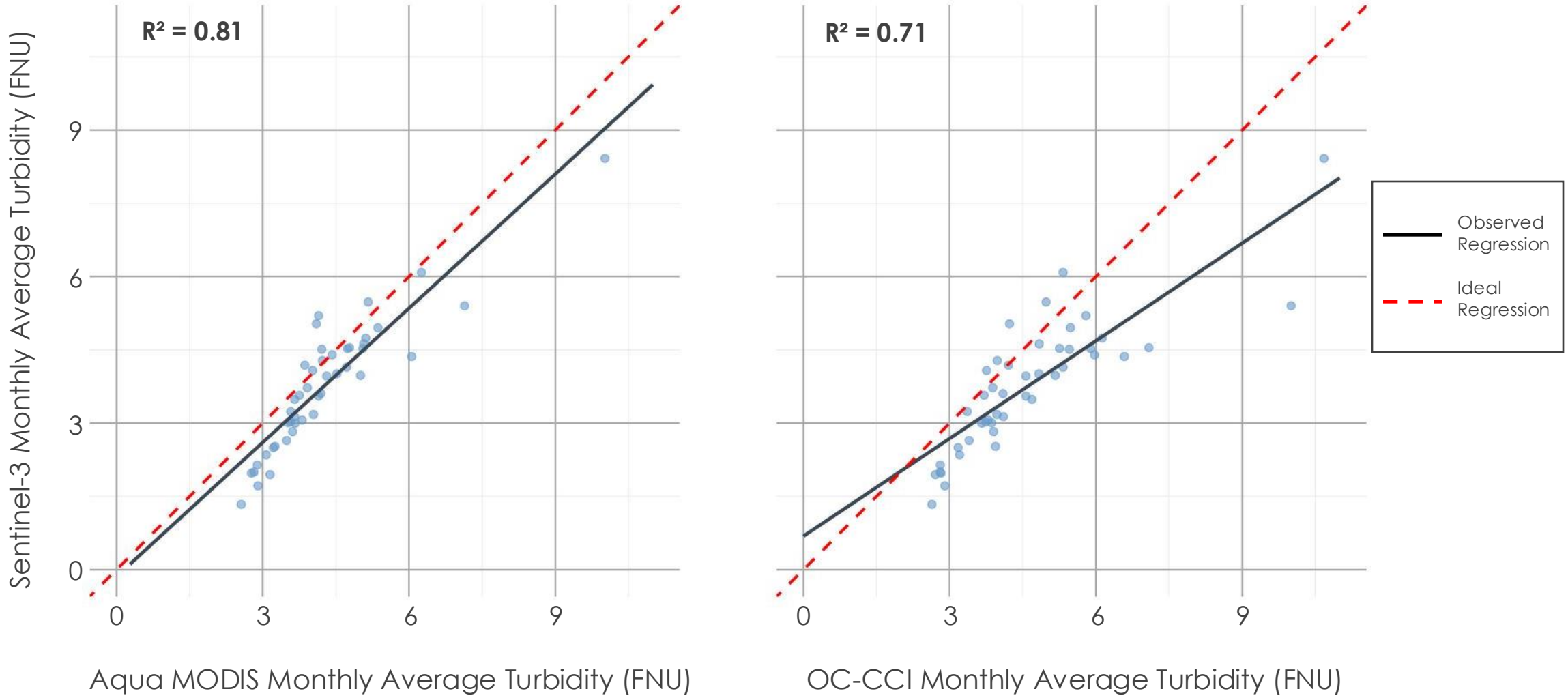
Time Series
- Turbidity
- Seasonality
- Slave River Discharge

Validation
- Remote Sensing vs In-Situ Turbidity

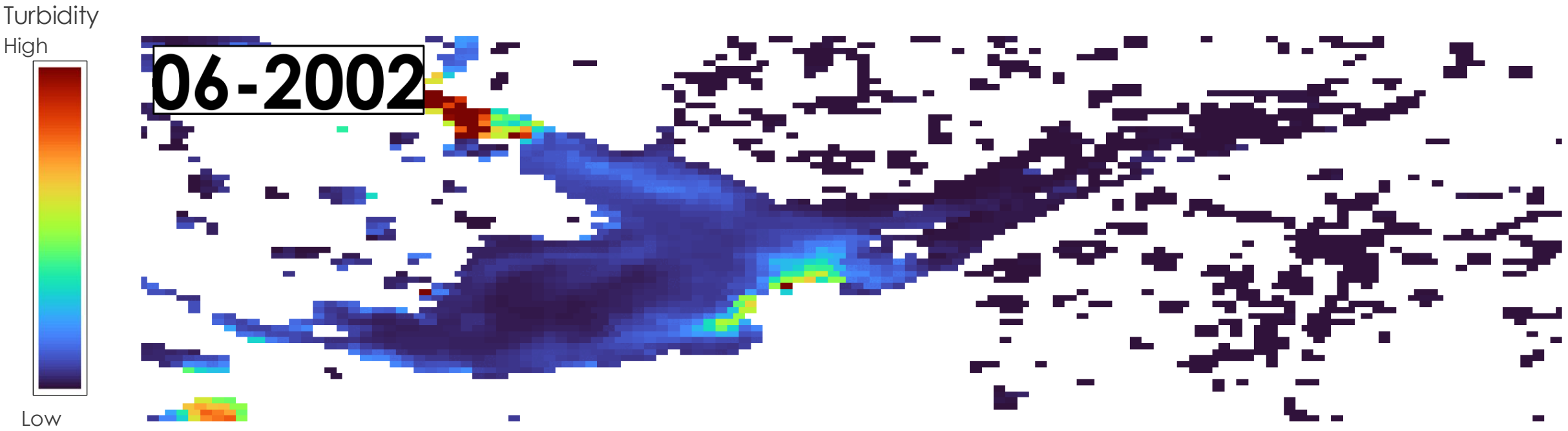
Sensor Comparison of Monthly Turbidity



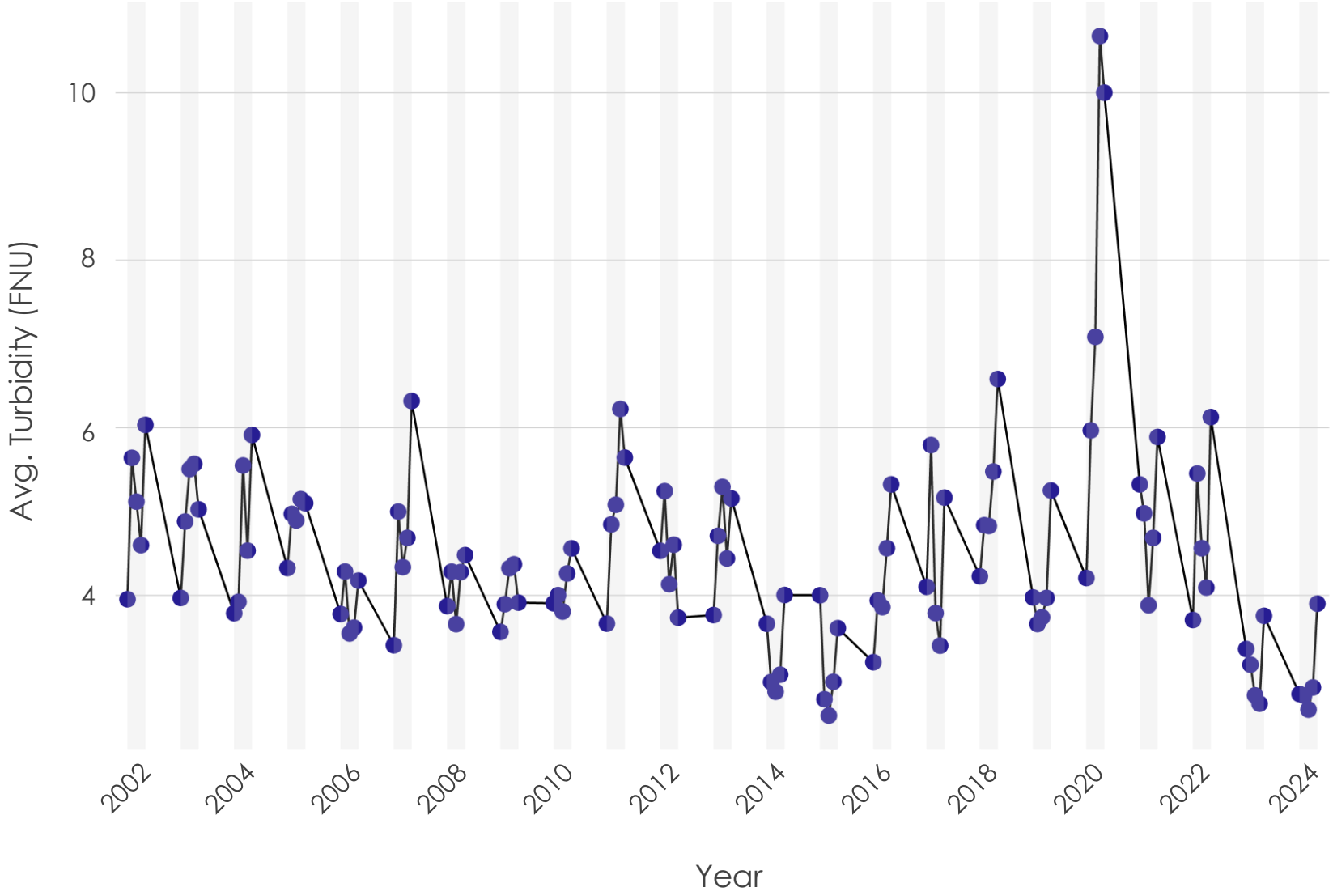
Sensor Comparison of Monthly Turbidity

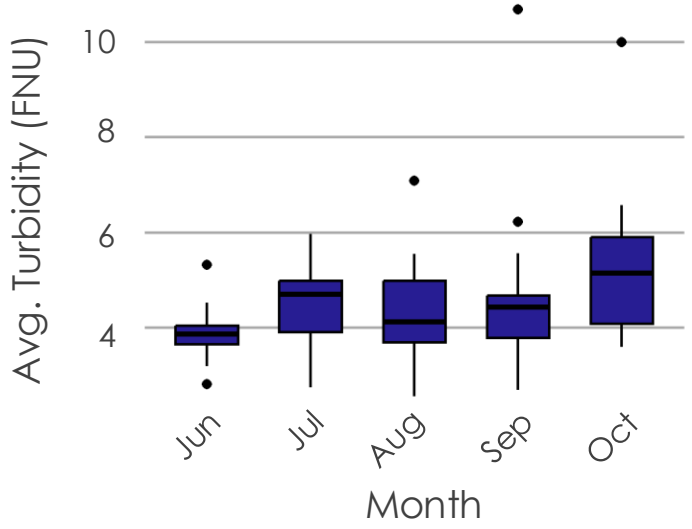


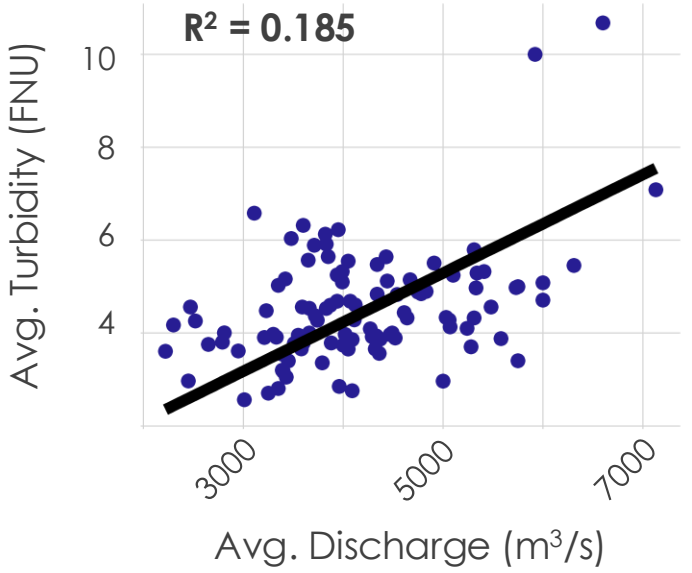
Great Slave Lake Turbidity Visualization



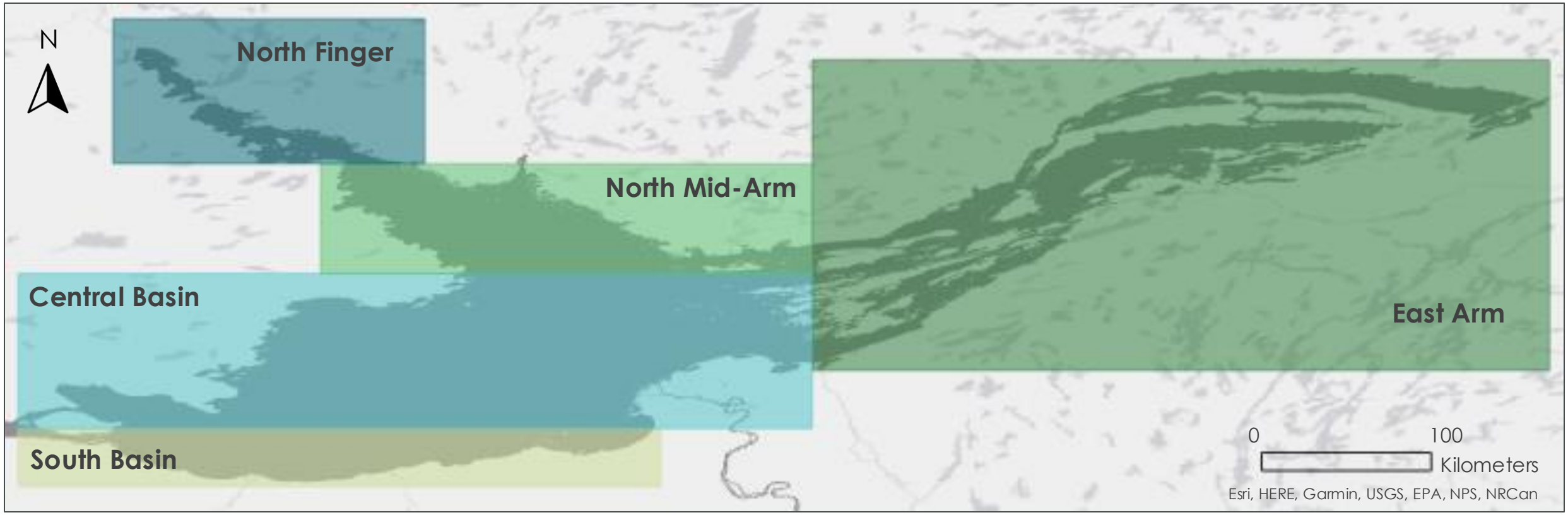
Great Slave Lake Turbidity





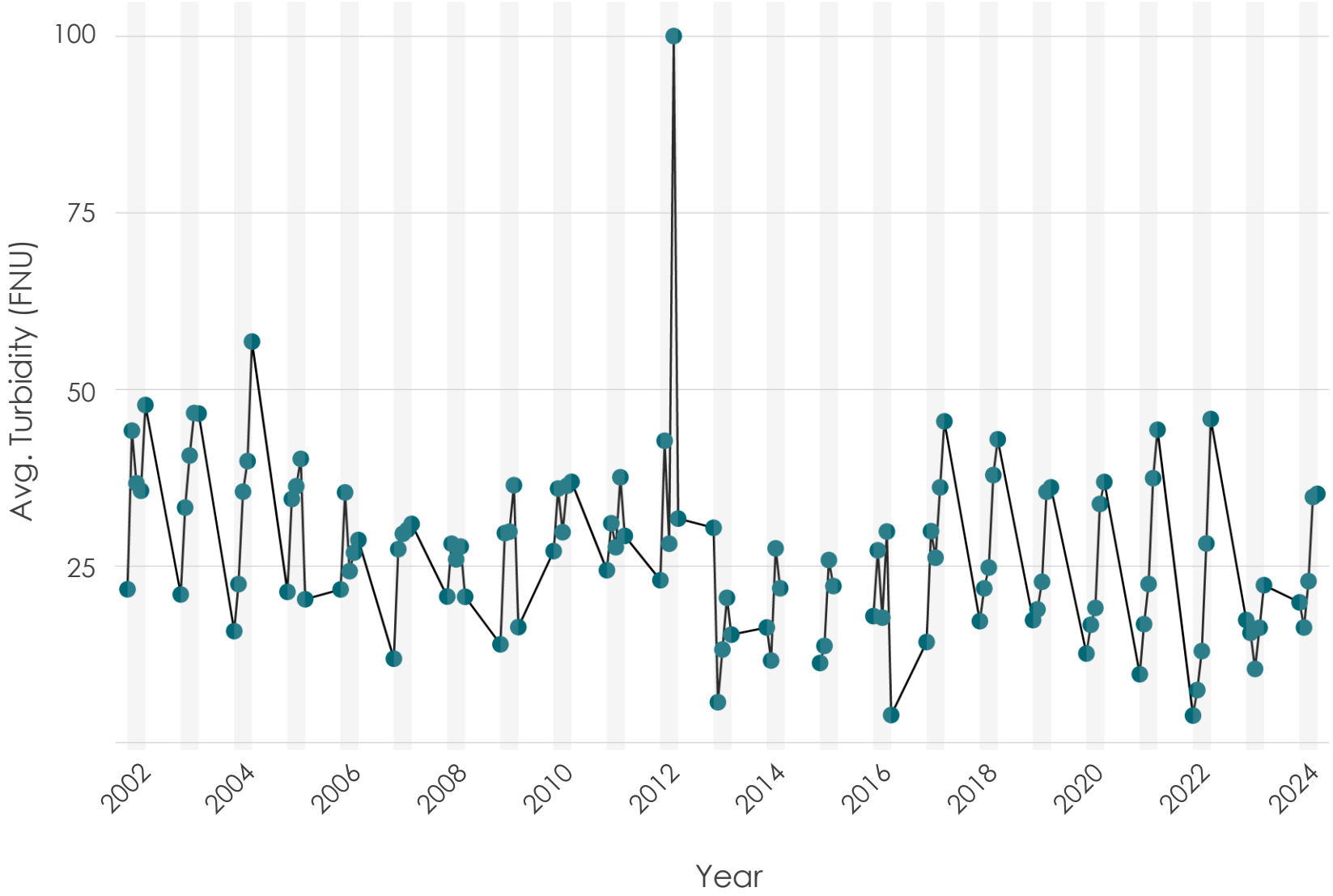


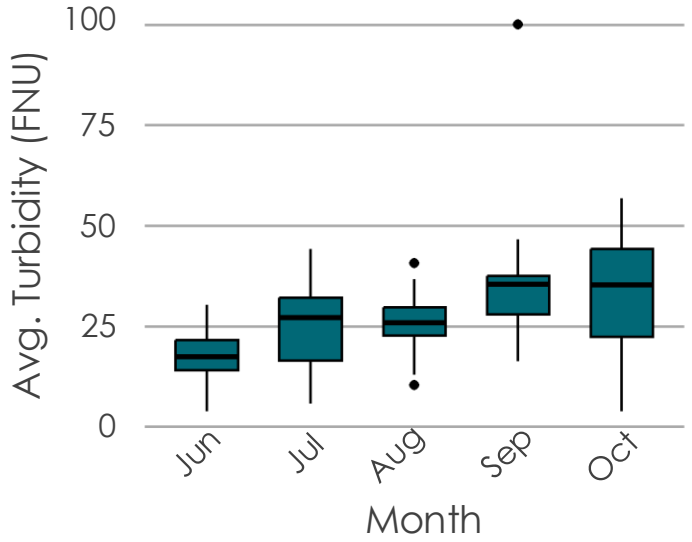
Regional Analysis of Great Slave Lake

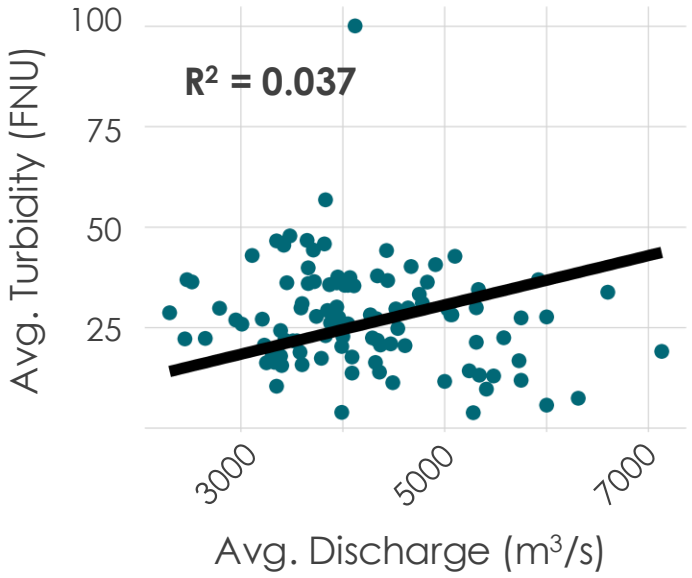


Localized Regions | South Basin | Central Basin | North Mid-Arm | North Finger | East Arm

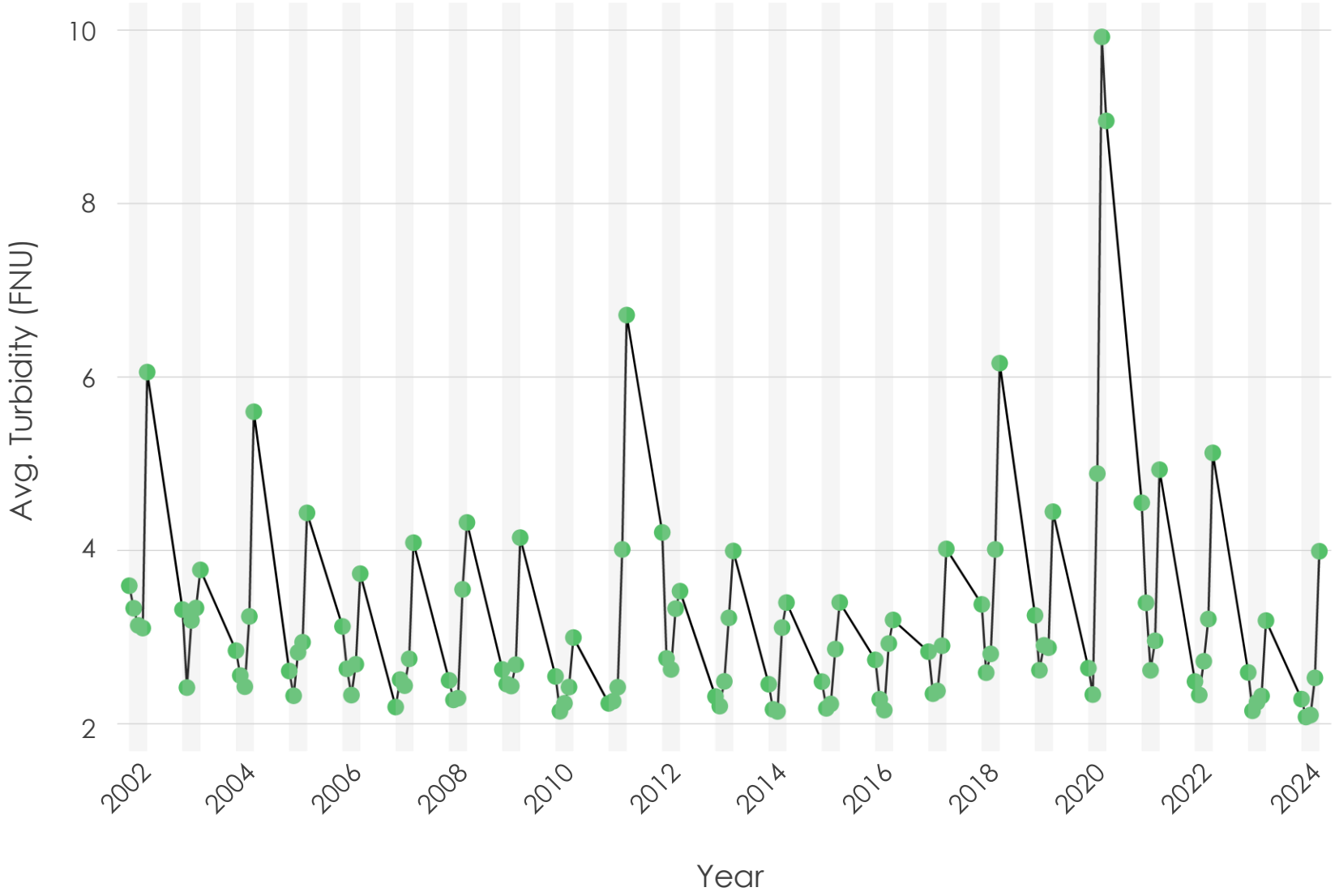
North Finger Turbidity

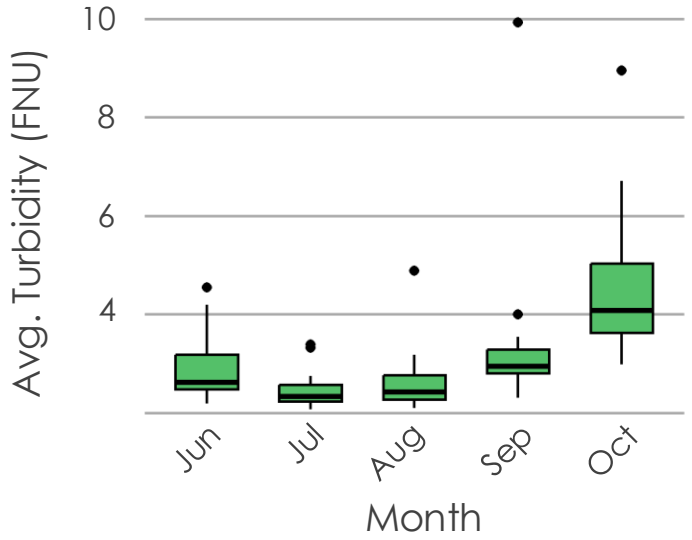


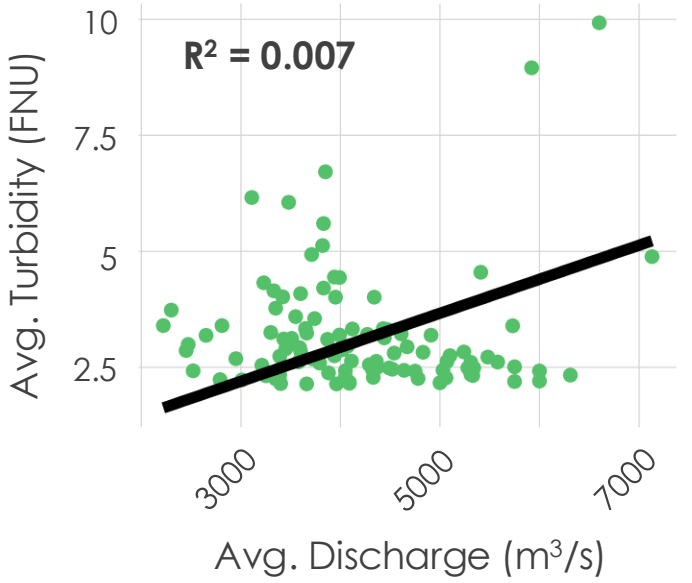




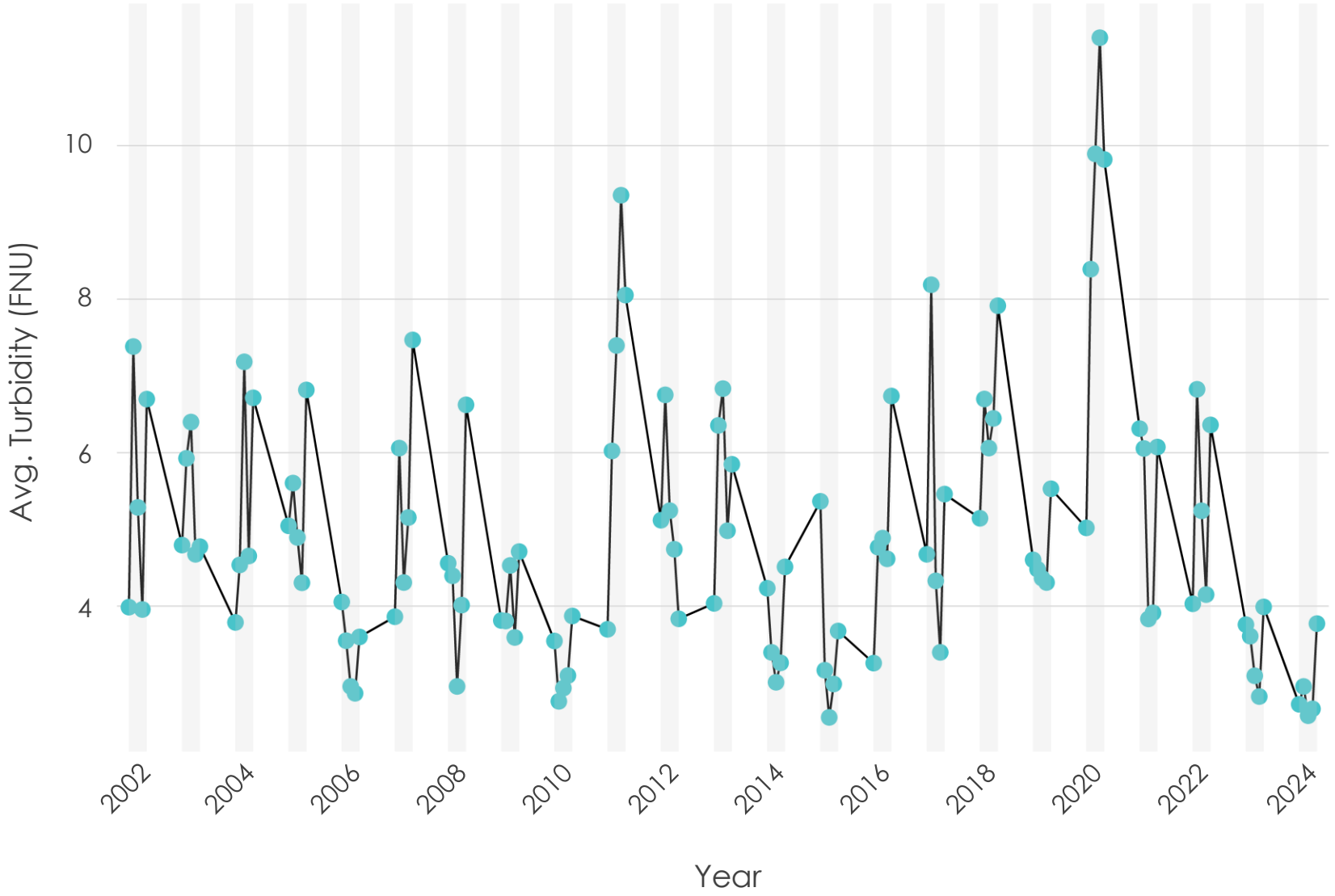
North Mid-Arm Turbidity

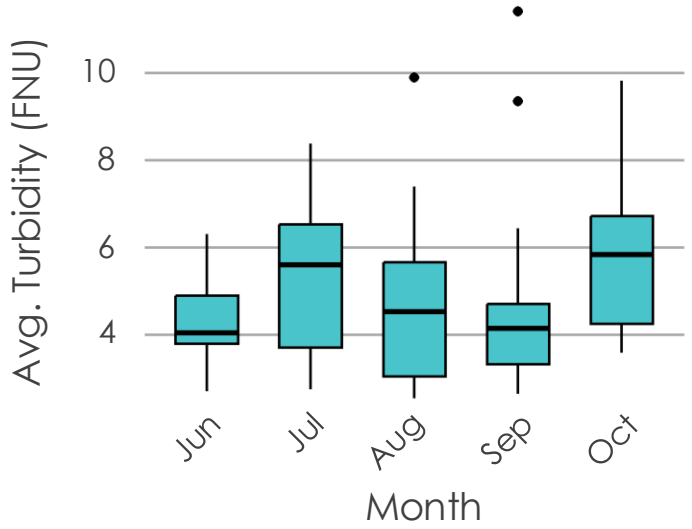


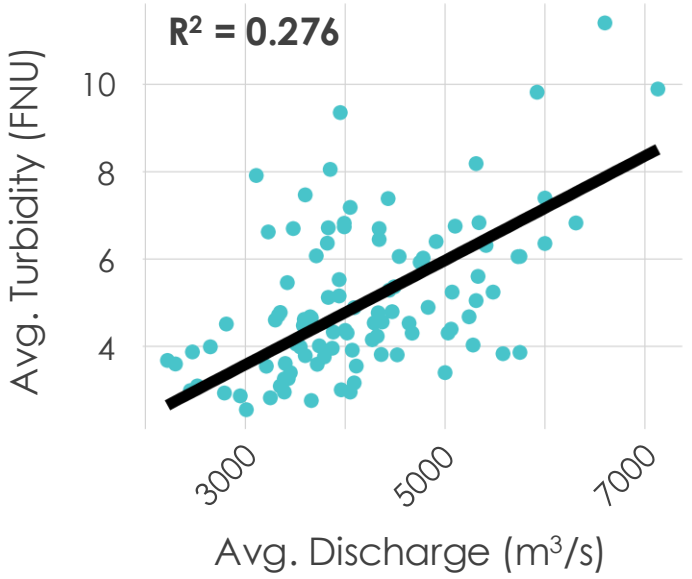




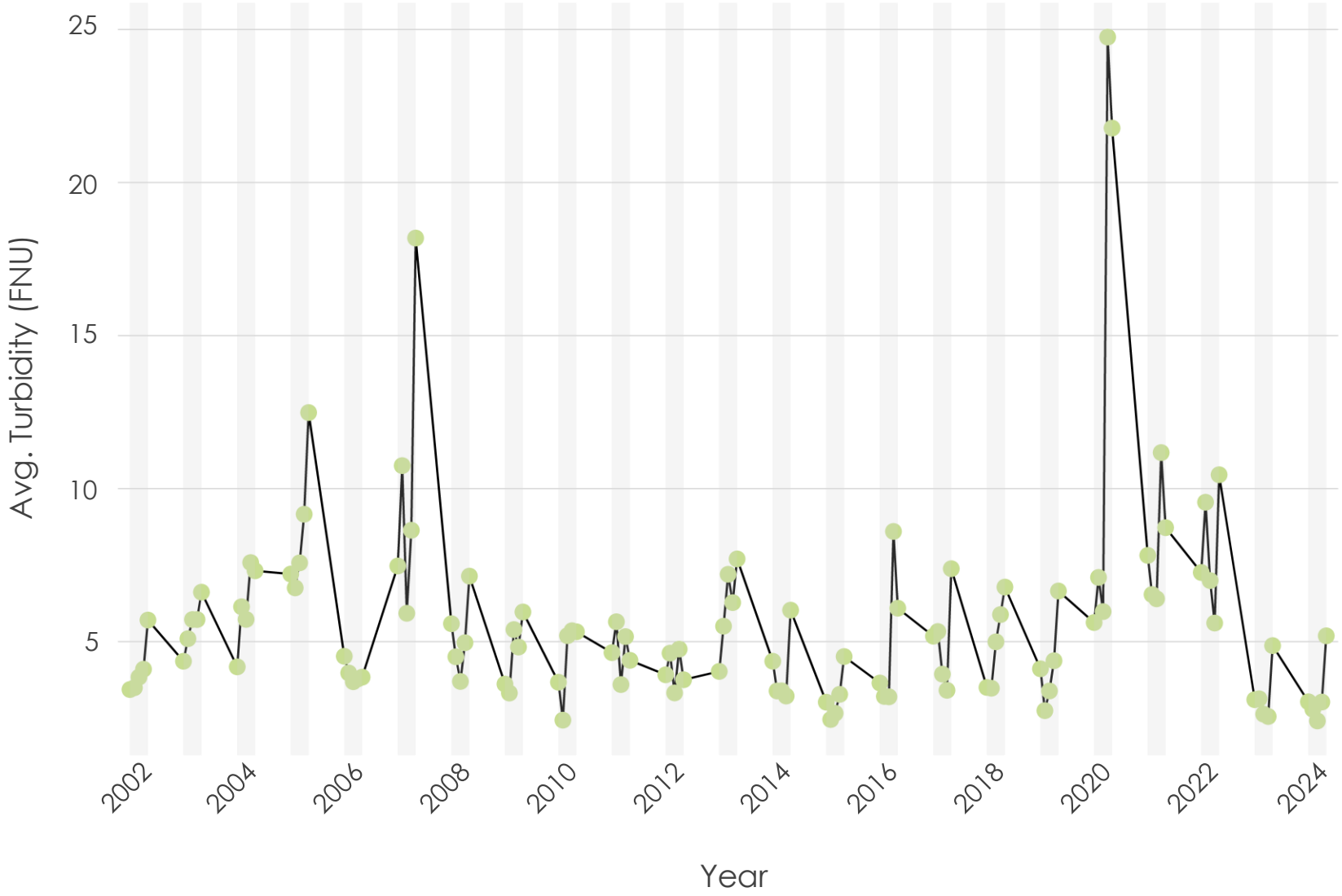
Central Basin Turbidity

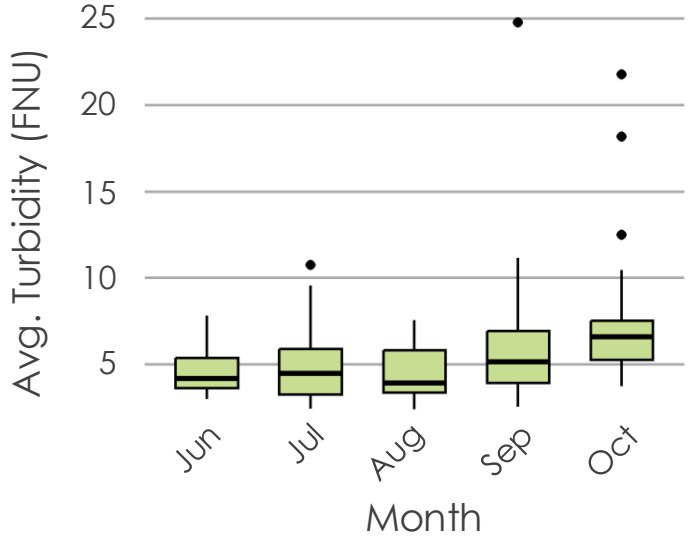


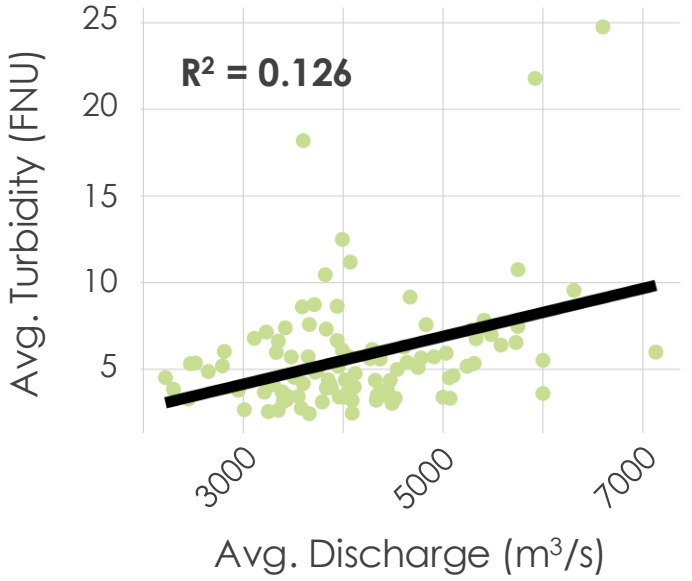




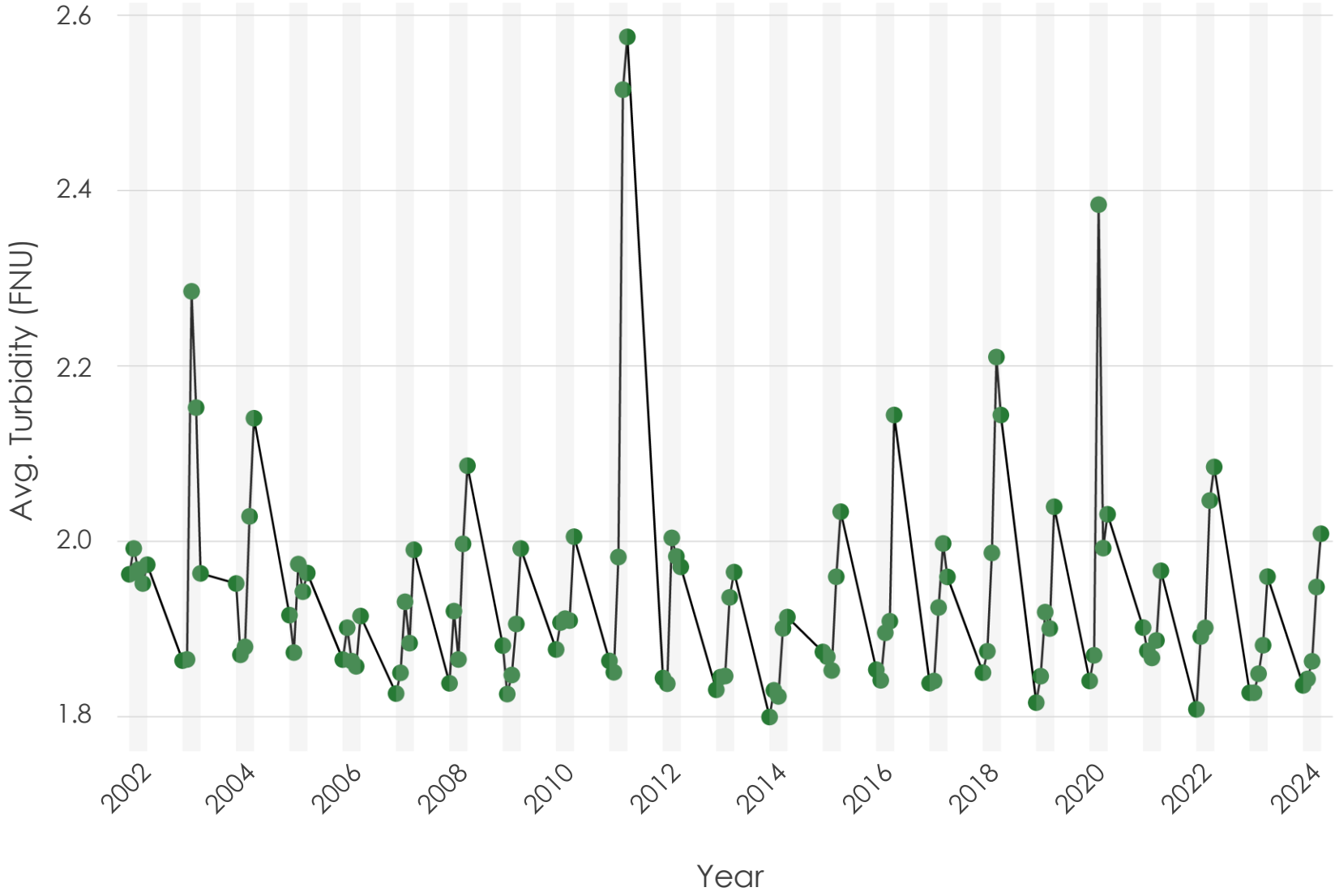
South Basin Turbidity

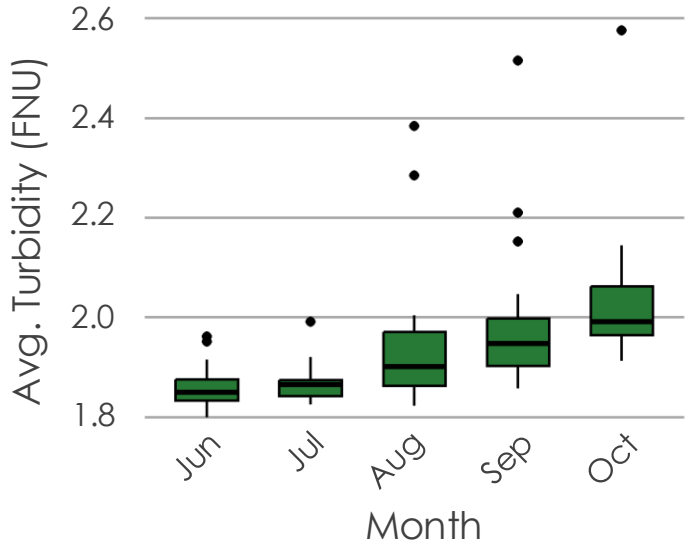


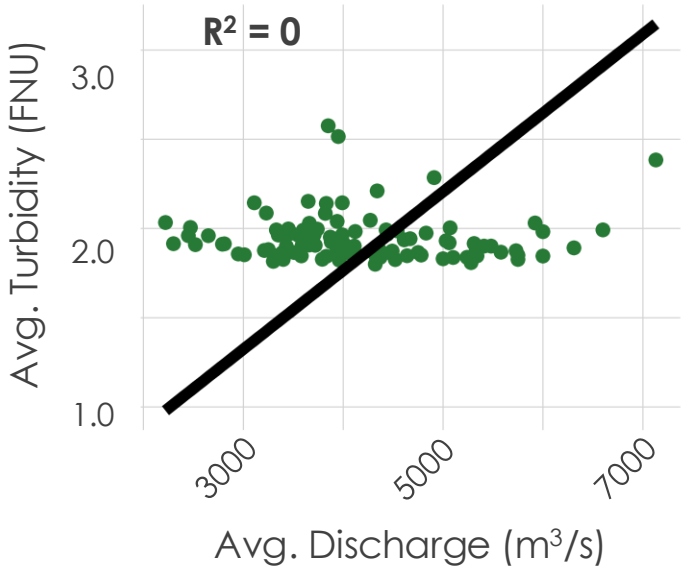




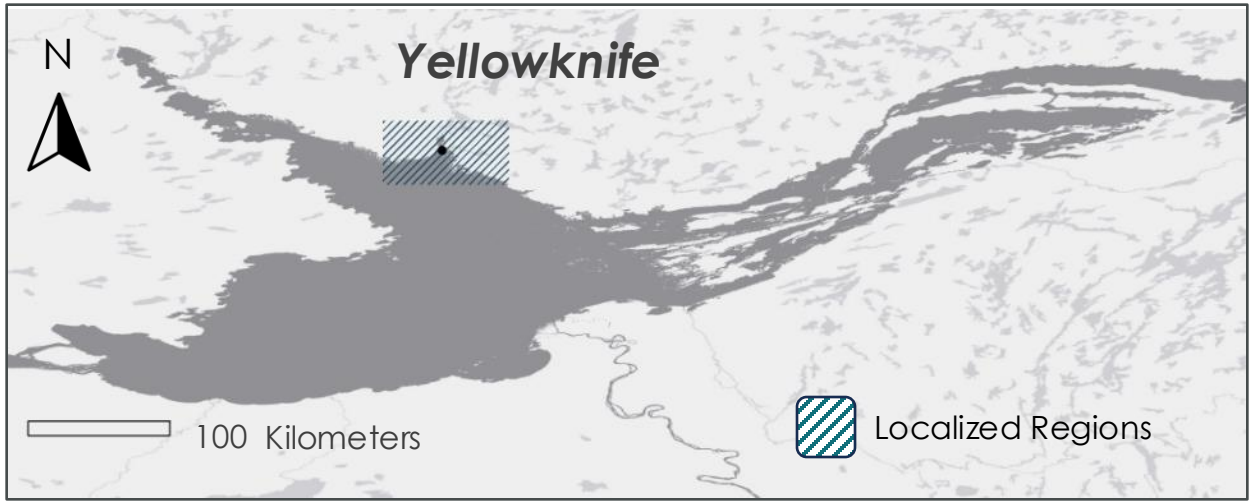
East Arm Turbidity





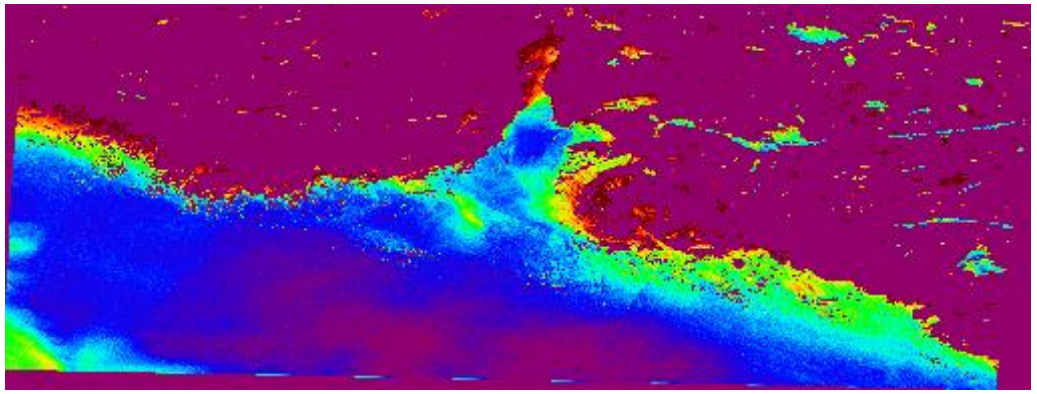


Localized Analysis of Yellowknife



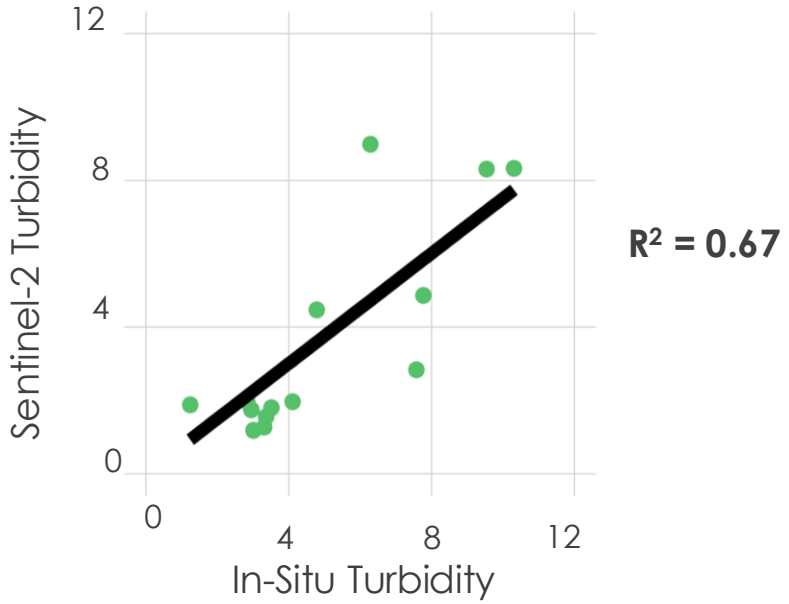
Purpose

- **Validate** the use of turbidity algorithms for monitoring Great Slave Lake
- **Provide** detailed imagery



June 30, 2016

1.46 Turbidity 6.14



Errors, Uncertainties, and Limitations

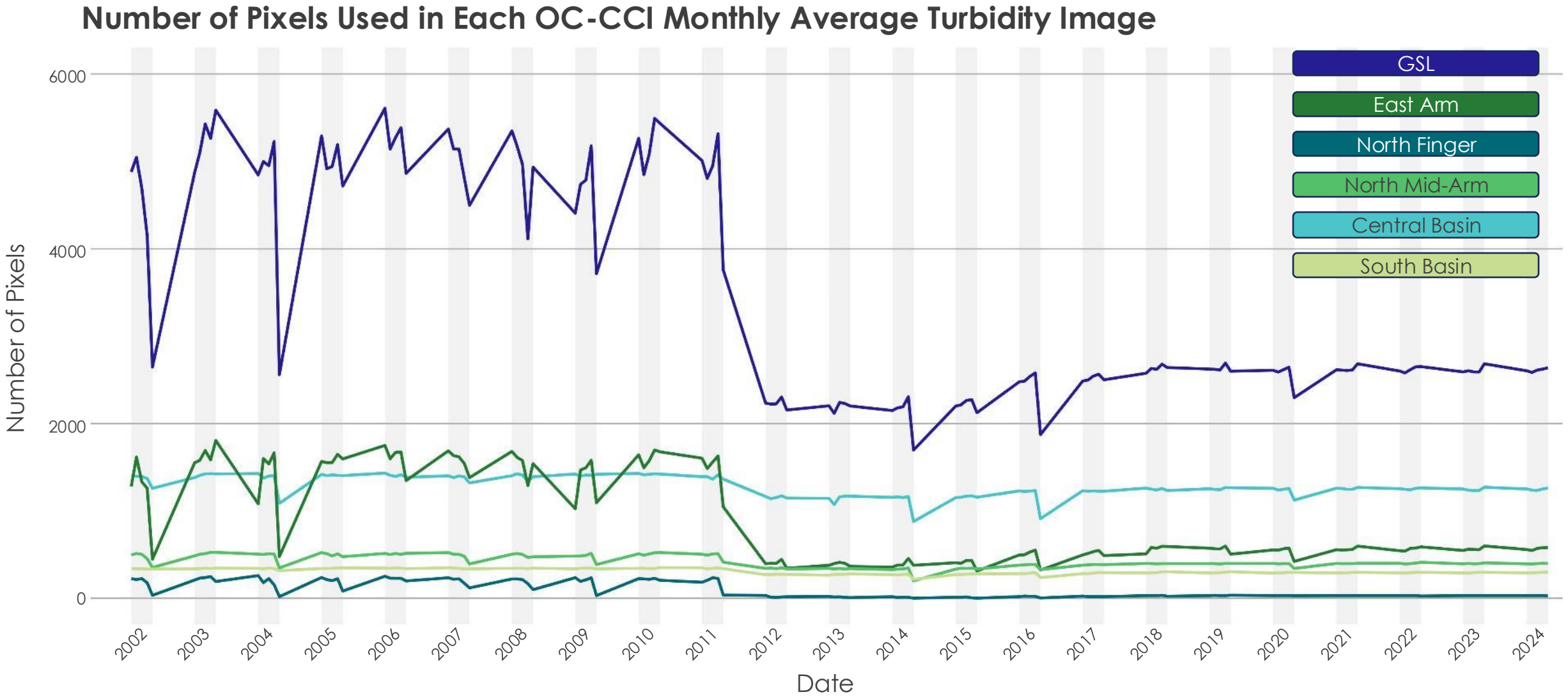
Earth Observations

- Spectral Resolution
- Temporal Resolution
- Ice Coverage
- Spatial Resolution

In Situ

- Sampling Locations
- Temporal Availability
- Ice Coverage

Pixel Counts Limitation



Feasibility & Partner Implementation

- Using Earth observations to analyze turbidity is feasible
- Earth observations compliment in-situ data and can be used together to provide consistent water quality monitoring
- Earth observations can help address limitations for in situ water quality monitoring

Image Credits: Cedric Fichot

Conclusions

1. Shorter wavelength imagery from OC-CCI can be used predict turbidity

2. High Slave River discharge increases turbidity in GSL, primarily in the Central Basin, with similar temporal trends in the South Basin and North Mid-Arm

3. There are no distinct long-term trends in turbidity in any sections of GSL but turbidity is on average highest in the North Finger and lowest in the East Arm

Acknowledgements

- **Science Advisors**:
  - Dr. Cédric Fichot (Boston University)
  - Hangjie Lin (Boston University)

- **Partners**:
  - Guylaine Ross (Government of the Northwest Territories)
  - Robin Staples (Government of the Northwest Territories)
  - Jennifer Hickman (Government of the Northwest Territories)

- **Collaborators**:
  - Mike Tollis (Akaitcho Territory Government)
  - Claudia Azigwe (K'atl'odeeche First Nation)

- **Lead**: Madison Arndt (DEVELOP MA – Boston)

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