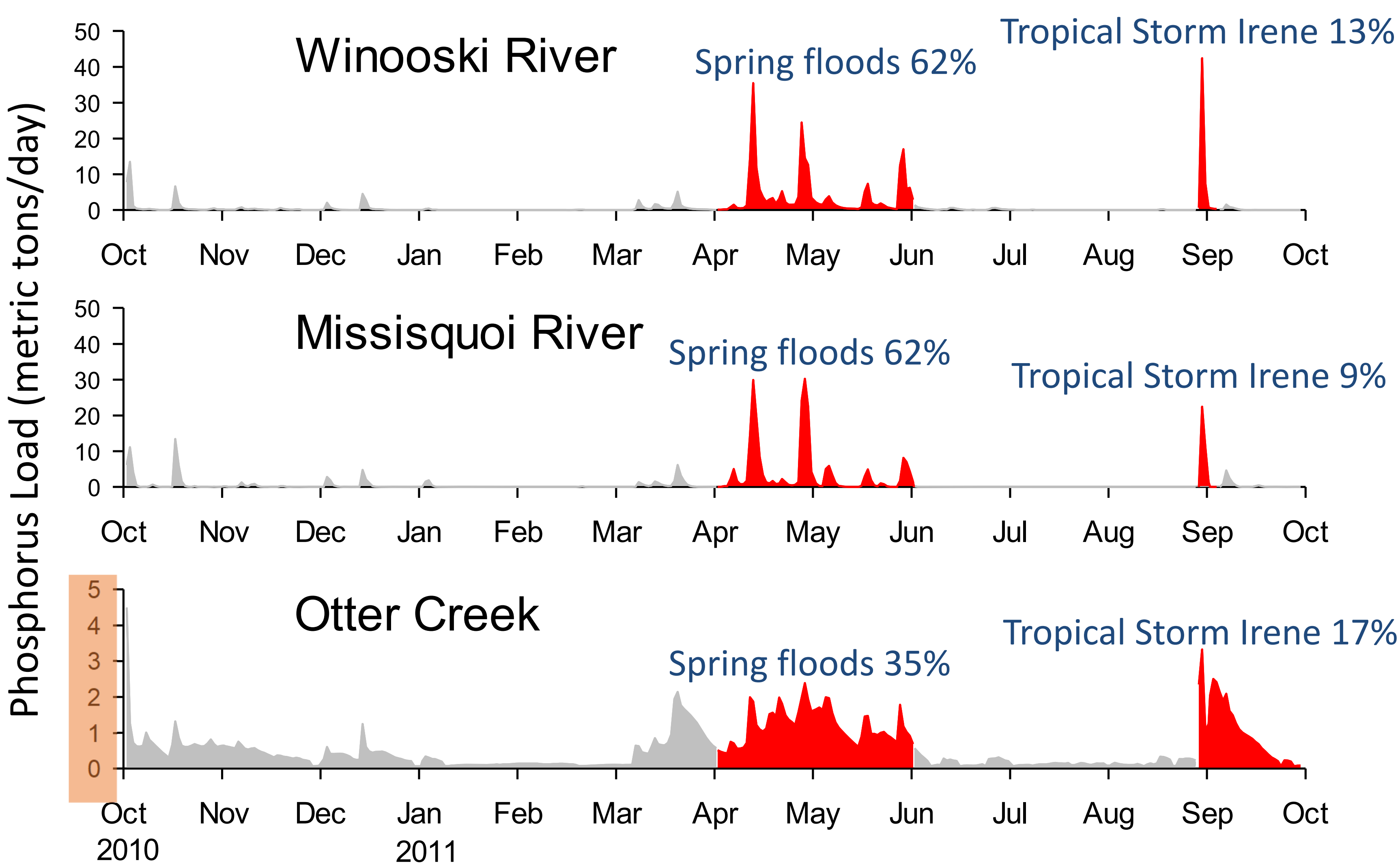

Ecological Team
BREE RESEARCH

Extreme Events: Daily P Loads from Tributaries, 2011



Water Quality Resilience

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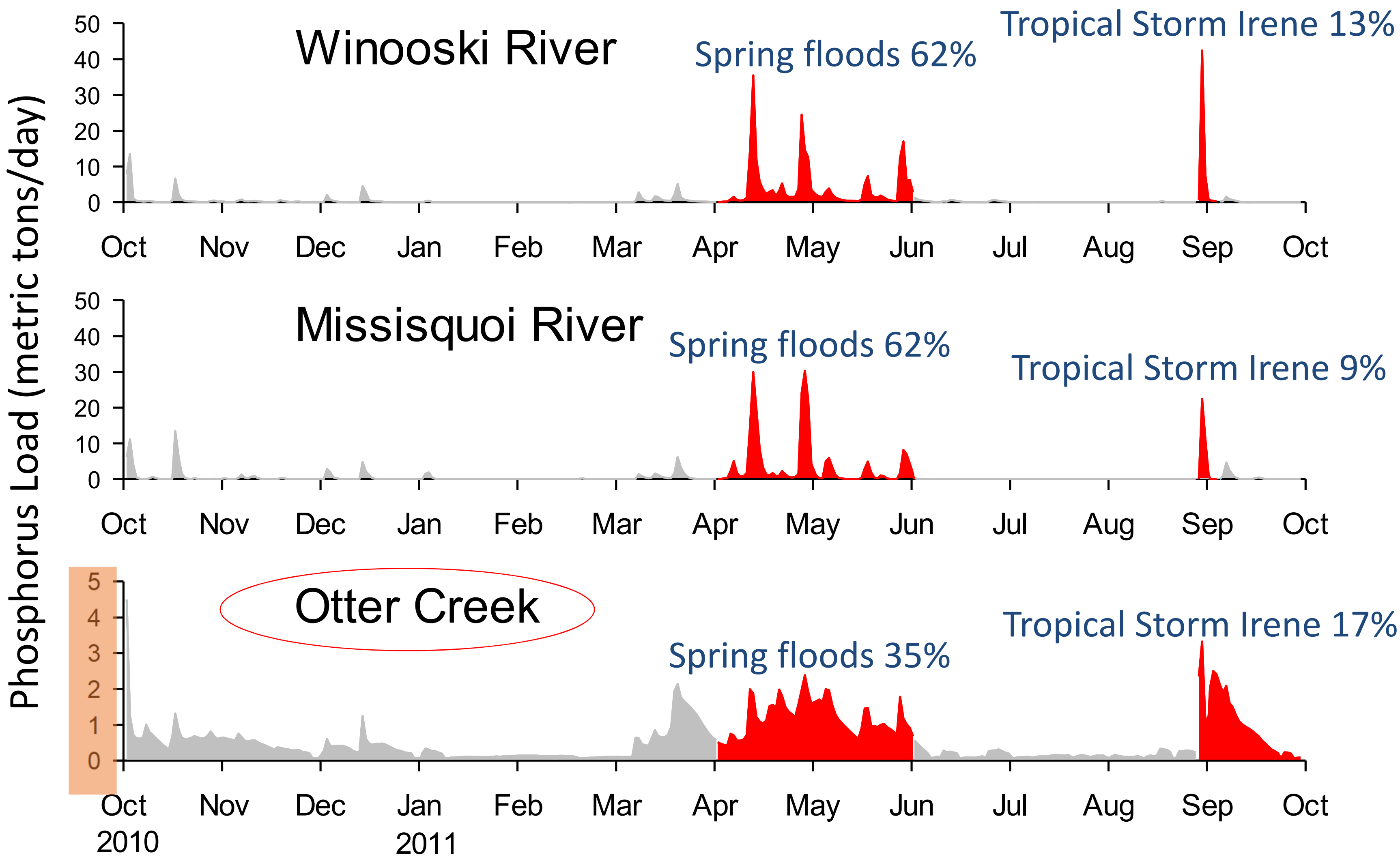
Basin Resilience to Extreme Events
in the Lake Champlain Basin

The ability of a soil, river, or lake to maintain or recover similar water quality as prior to the event.

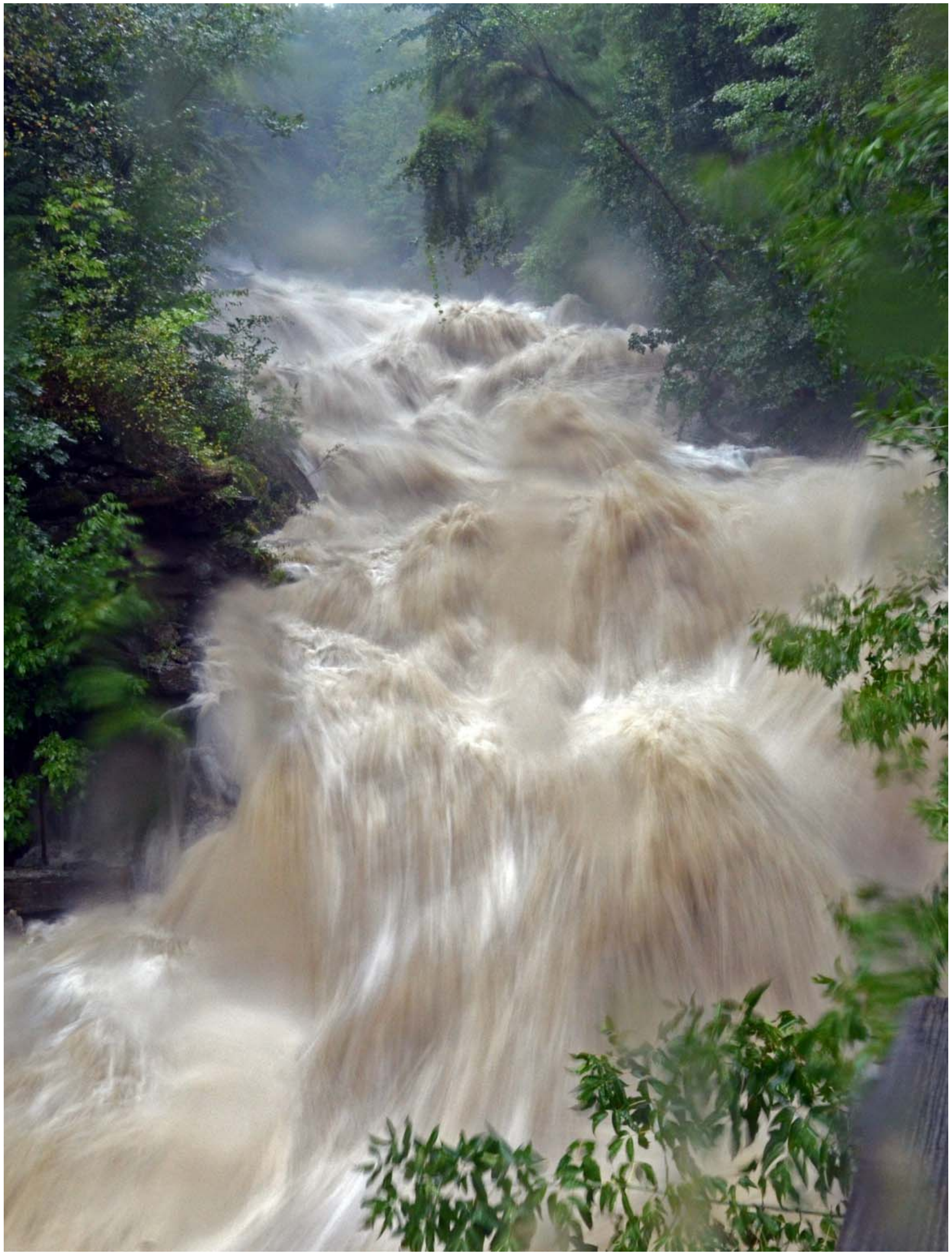
Extreme Events:
Daily P Loads from Tributaries, 2011



Missisquoi River Riparian Area

Otter Creek Riparian Area

Urban Watersheds: Stormwater



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Basin Resilience to Extreme Events
in the Lake Champlain Basin

Focus on Extreme Events and Resilience

What makes some soils, streams and receiving waters resilient?

What are the properties and processes critical to maintaining water quality resilience?

Tropical Storm Irene, Aug. 27, 2011
(Gordon Miller)

Thrust 1: Ecological Research

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Basin Resilience to Extreme Events
in the Lake Champlain Basin

Goal 1.1: Determine and model properties & processes critical to maintaining water quality

- Objective 1.1a: Enhance the hydrology model to include representation of urban stormwater infrastructure
- Objective 1.1b: Develop Biome-BGC model for RHESSys in Missisquoi

Goal 1.2: Develop new lake model for projecting impacts of climate change & extreme events on water quality

- Objective 1.2a: Develop and calibrate lake model

Resilience to Extreme Events Across Soil-River-Lake Continuum

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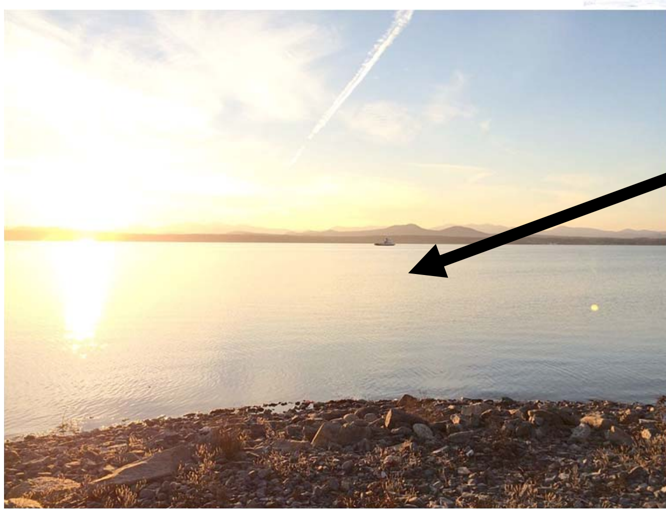
in the Lake Champlain Basin

Cutting edge
sensor network



Thrust 1: Ecological Systems

Resilience to Extreme Events Across Soil-River-Lake Continuum

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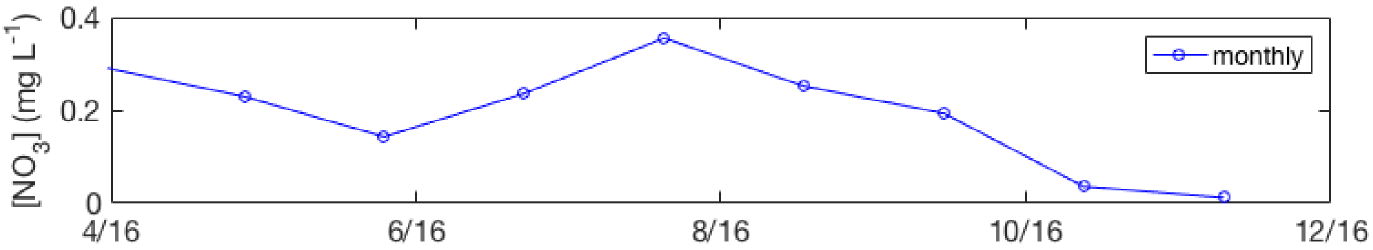
in the Lake Champlain Basin

Cutting edge sensor network

Thrust 1: Ecological Systems

High Frequency Essential for Capturing Episodic Events

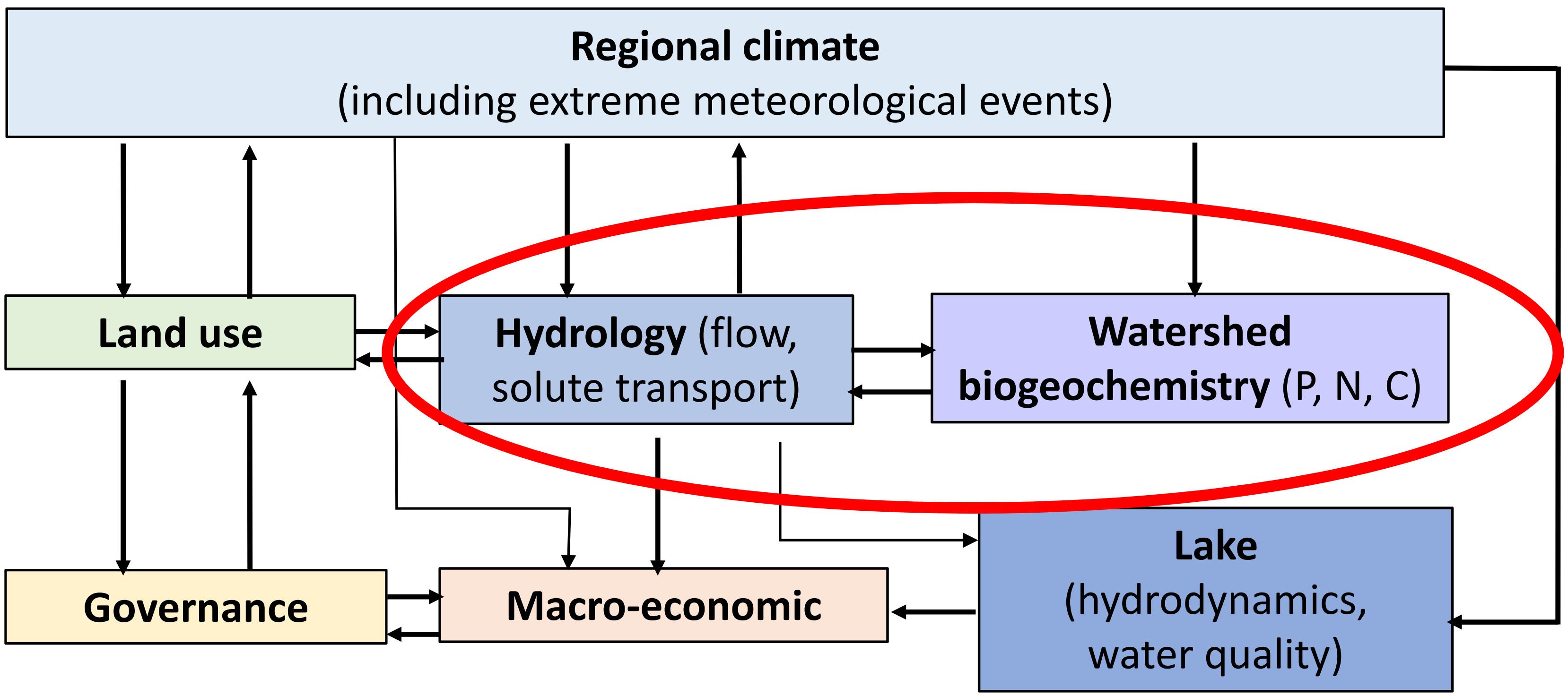


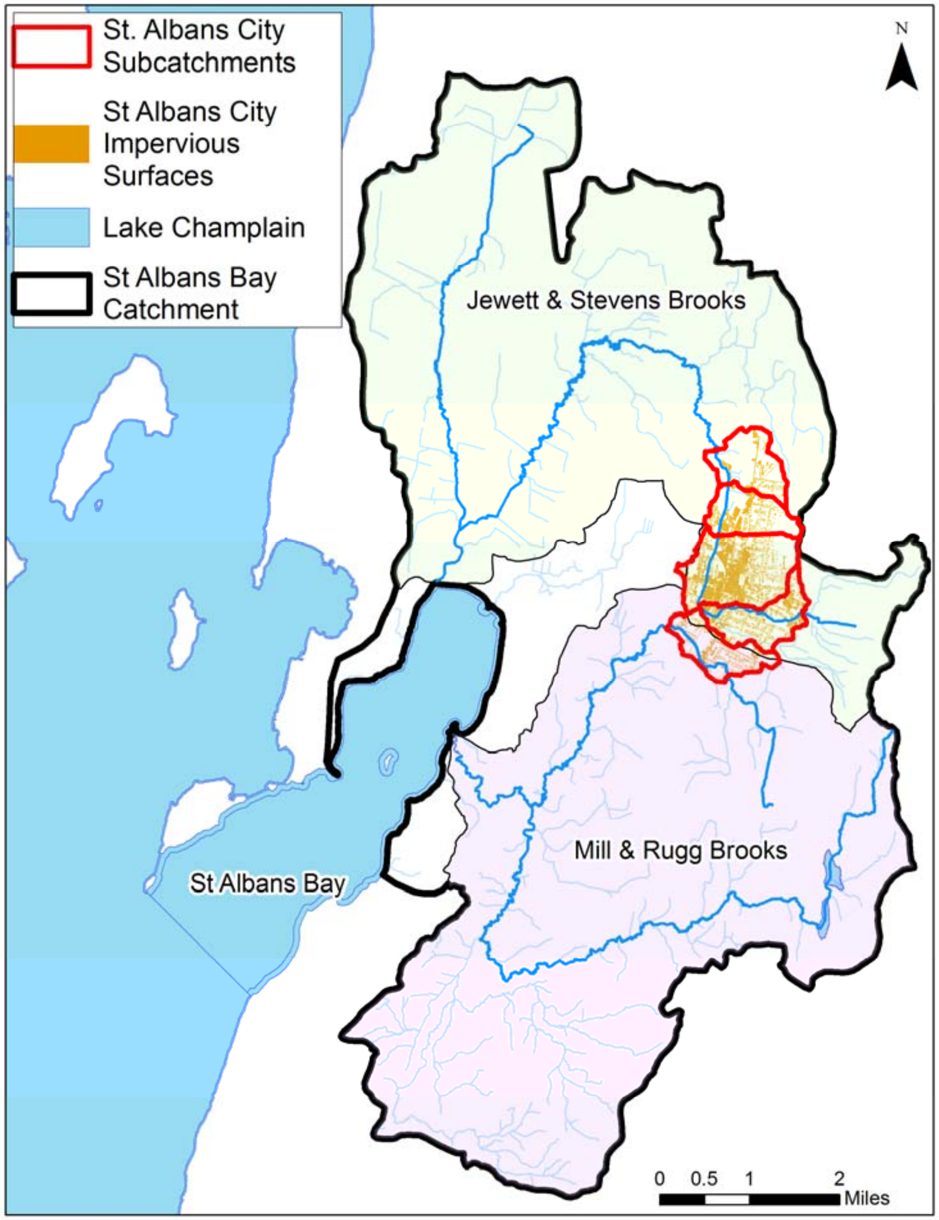
Thrust 1: Ecological Systems

Urban Stormwater and Hydrology

Thrust 1: Ecological Systems
Objective 1.1a: Model stormwater infrastructure

Major Features of the BREE Integrated Assessment Model

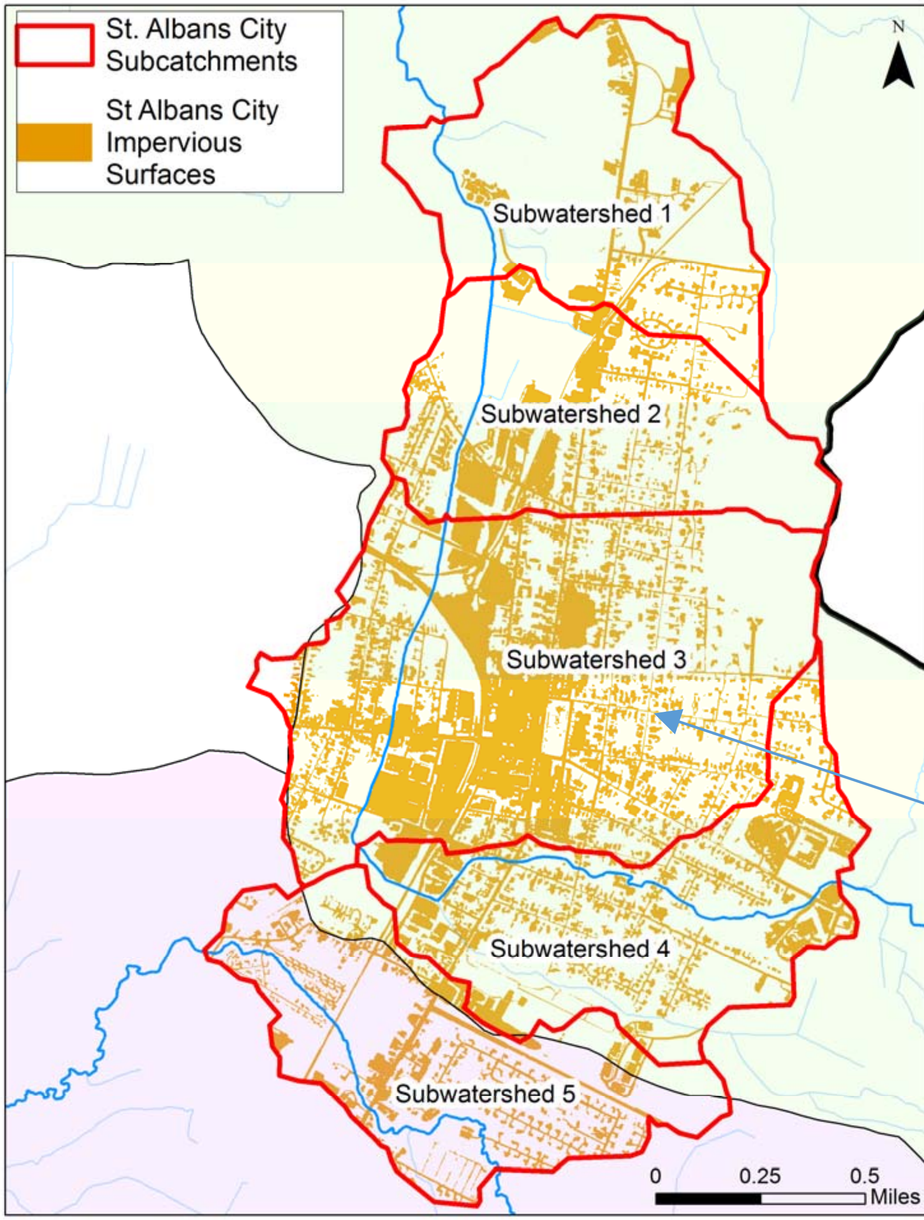




BREE Basin Resilience to Extreme Events in the Lake Champlain Basin

Enhance the hydrological model to include representation of urban stormwater infrastructure: SWMM model linked with RHESSys

Thrust 1: Ecological Systems
Objective 1.1a: Model stormwater infrastructure



Build and calibrate the urban stormwater models for Burlington and St. Albans

Spatial stormwater infrastructure data for stormwater (SWMM) model (pipe diameters, slopes, junctions, inlets, etc.)

Thrust 1: Ecological Systems

Objective 1.1a: Model stormwater infrastructure

Build and Calibrate the Urban Stormwater Models for Burlington and St. Albans

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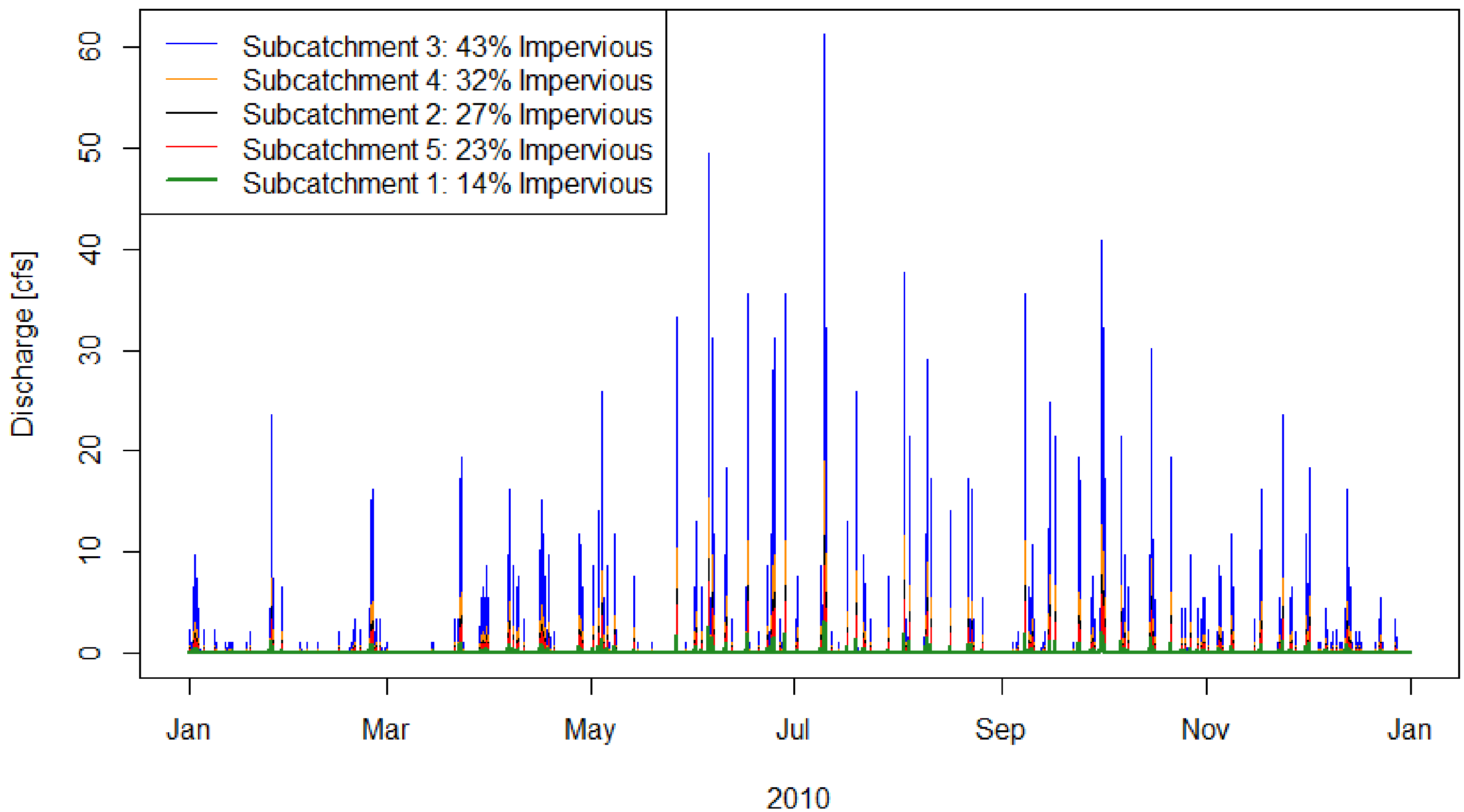
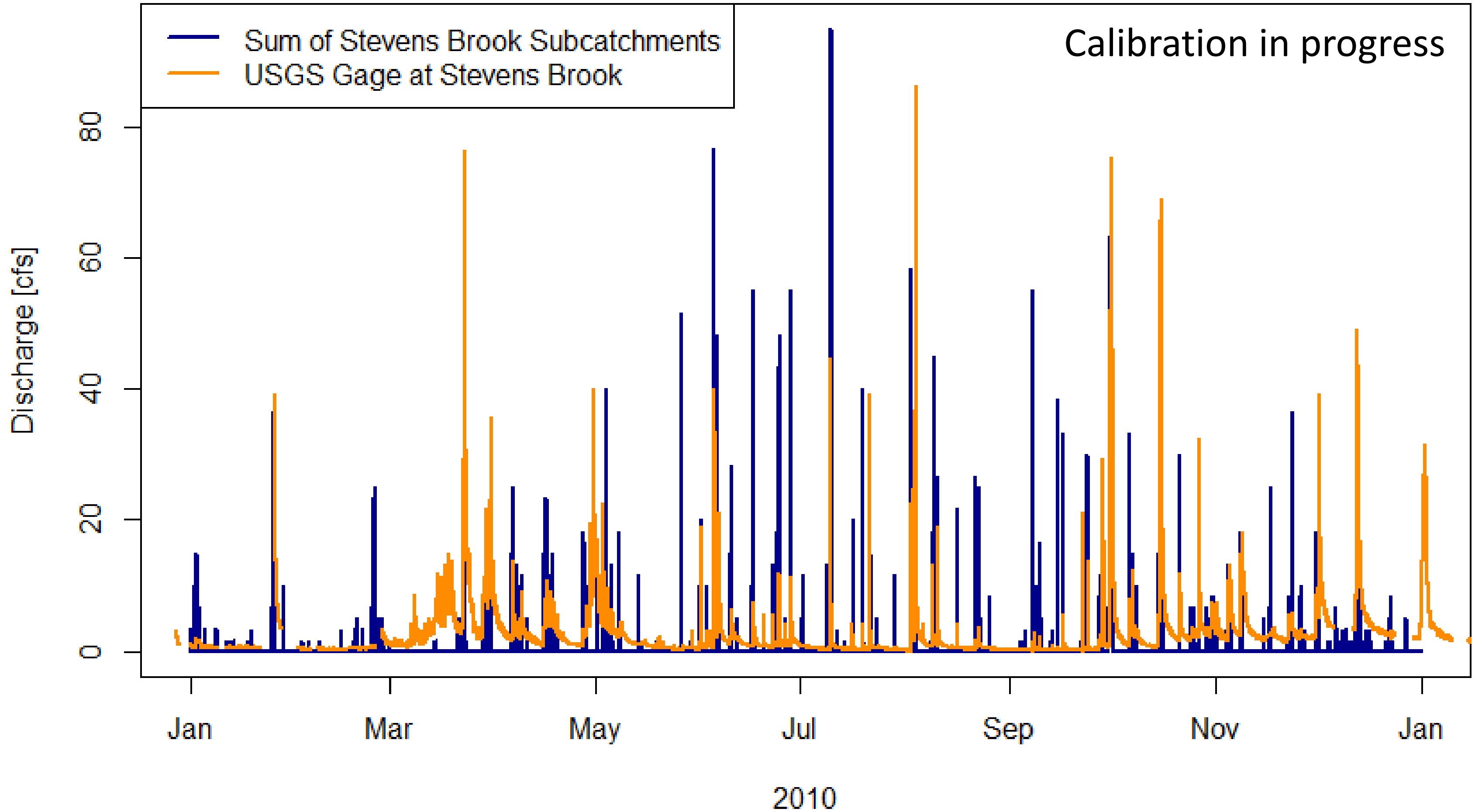
in the Lake Champlain Basin

St. Albans Model Output



Thrust 1: Ecological Systems
Objective 1.1a: Model stormwater infrastructure

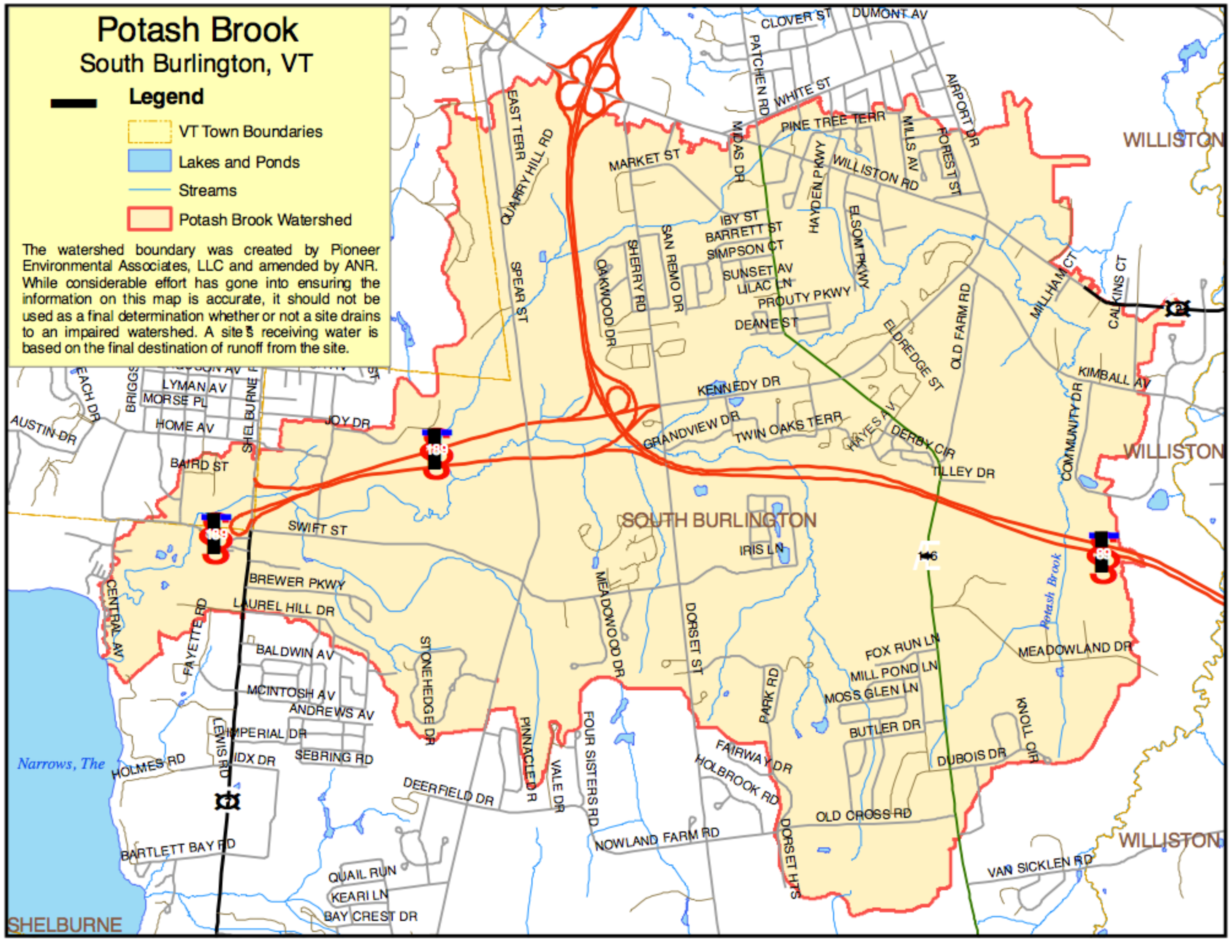
Build and Calibrate the Urban Stormwater Models for Burlington and St. Albans



Thrust 1: Ecological Systems

Objective 1.1a: Model stormwater infrastructure

Urban: Potash Brook Watershed

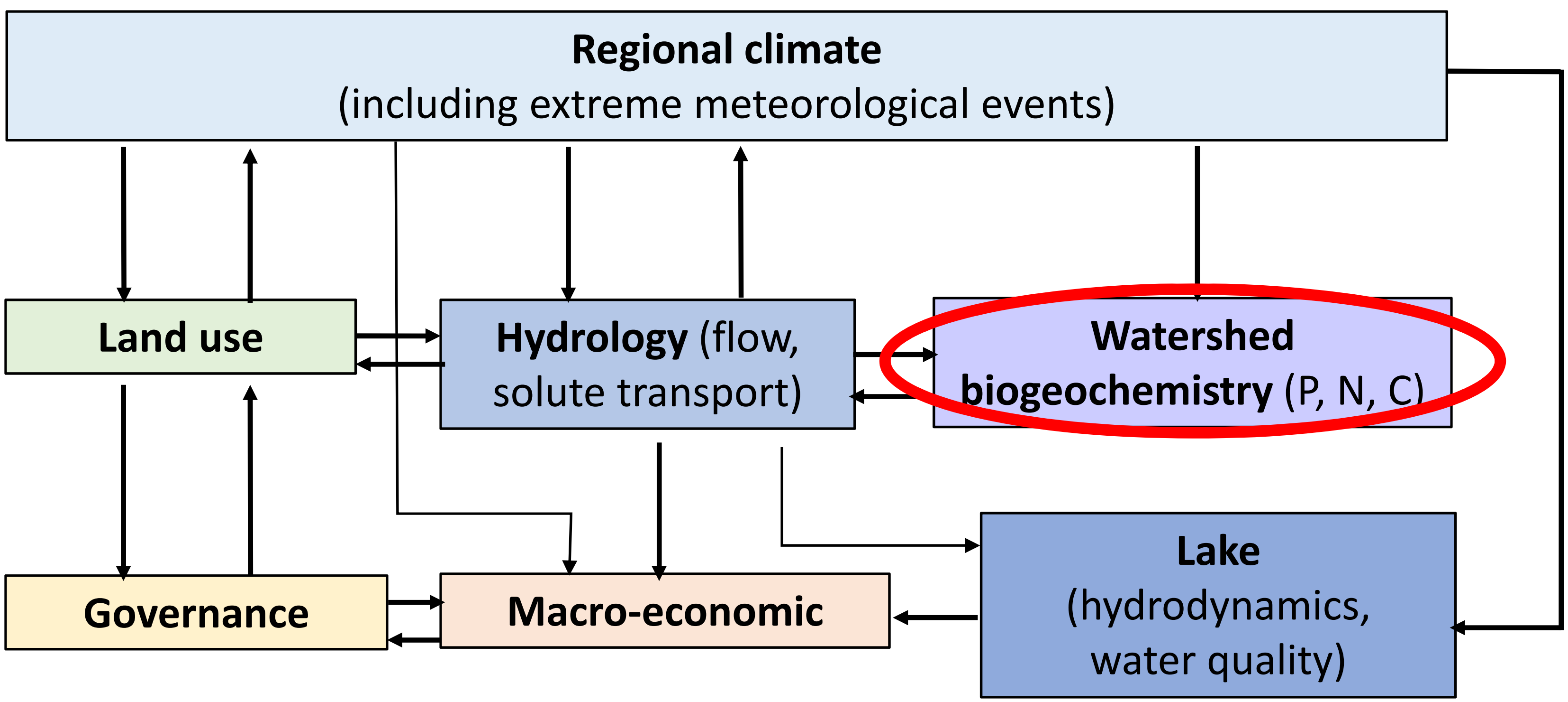


Thrust 1: Ecological Systems
Objective 1.1a: Model stormwater infrastructure

Watershed

Thrust 1: Ecological Systems
Objective 1.1b: Model watershed to lake nutrient flows

Major Features of the BREE Integrated Assessment Model



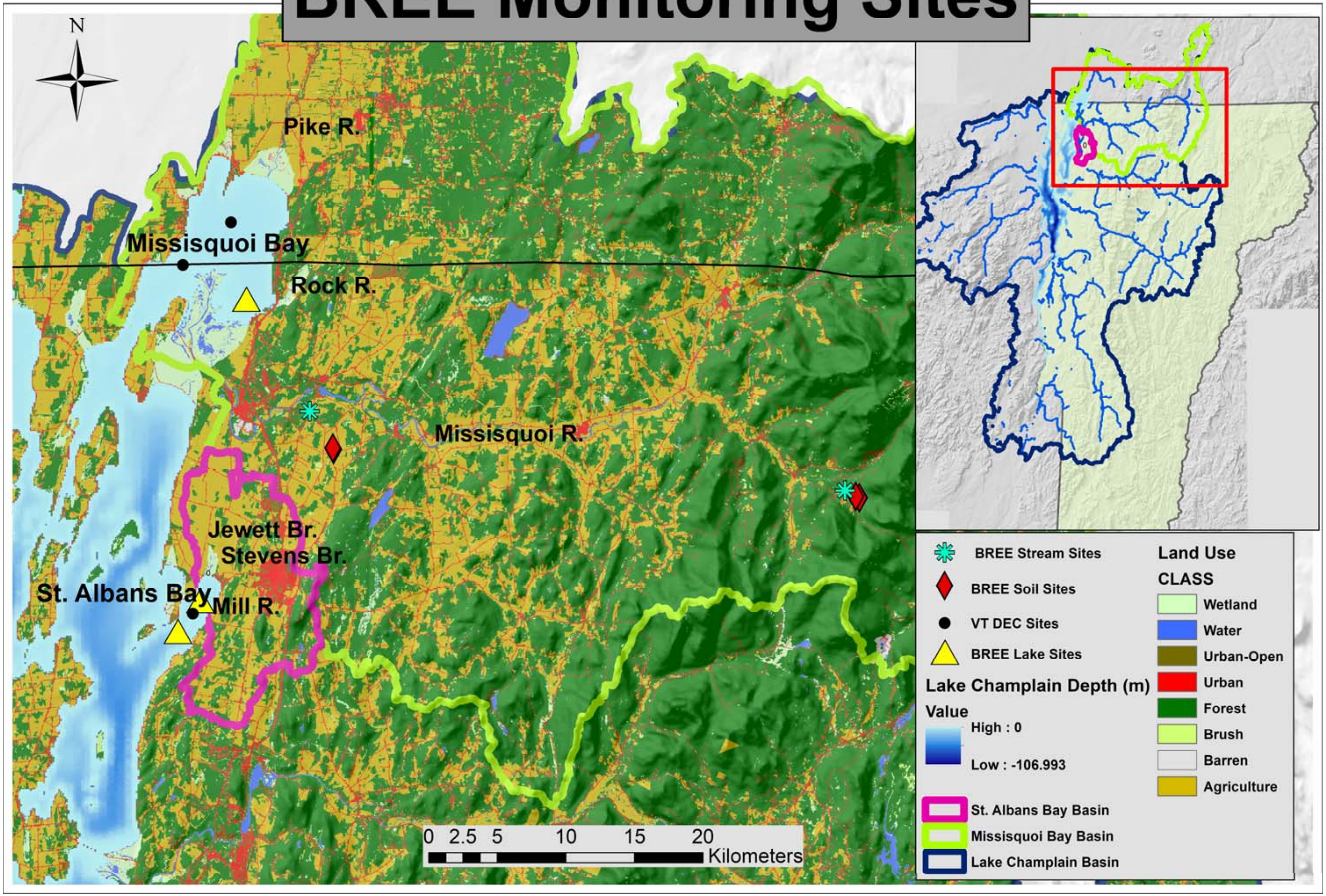
Thrust 1: Ecological Research

Goal 1.1: Determine and model properties & processes critical to maintaining water quality

- Objective 1.1b: Develop Biome-BGC model for RHESSys in Missisquoi
  - Installed and maintained river and riparian sites
  - Collected sensor and grab sample data
  - Modified and validated P-Biome-BGC version of RHESSys

Thrust 1: Ecological Systems
Objective 1.1b: Model watershed to lake nutrient flows

BREE Monitoring Sites



Missisquoi Watershed Site Installations

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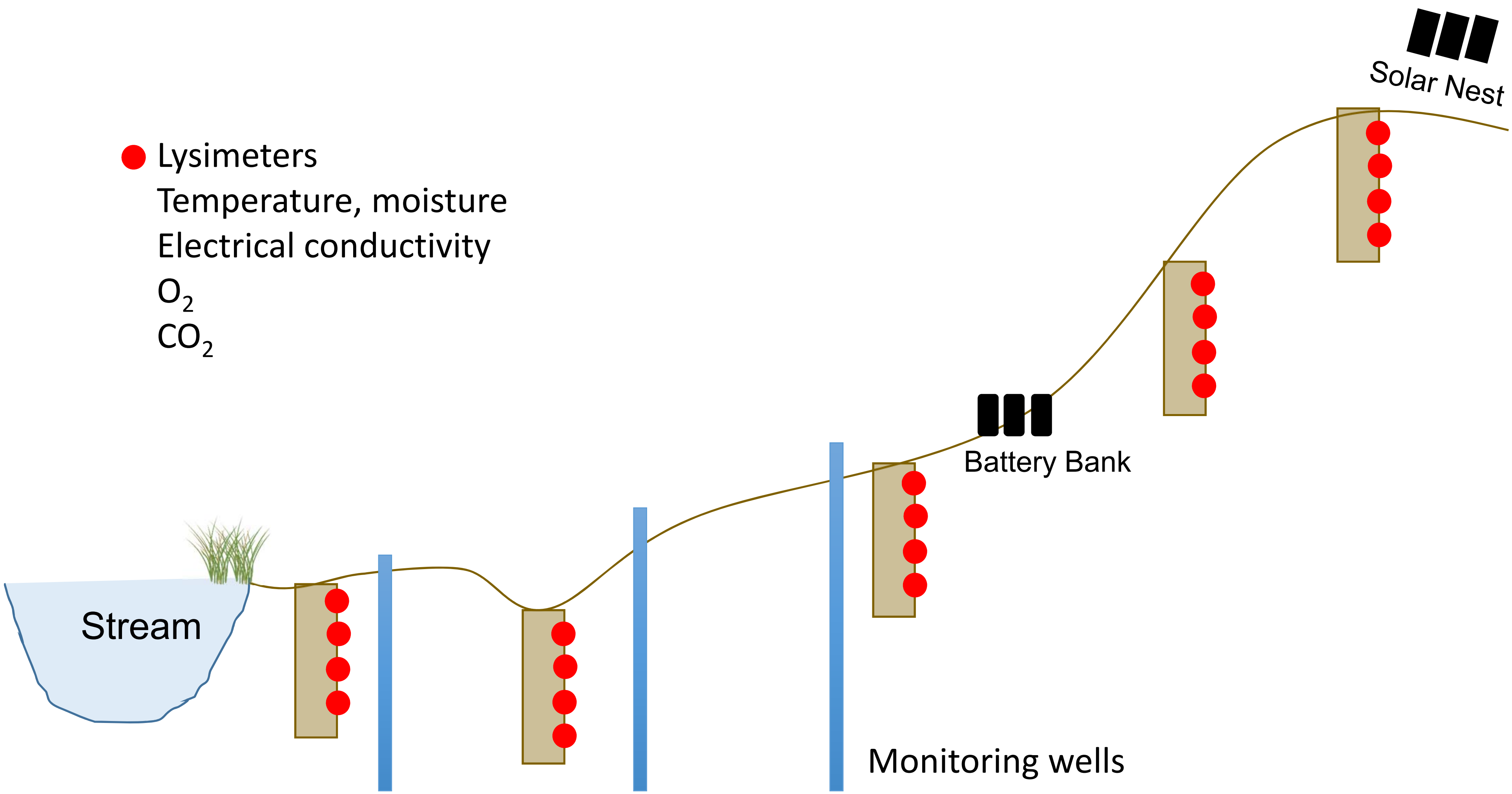
in the Lake Champlain Basin

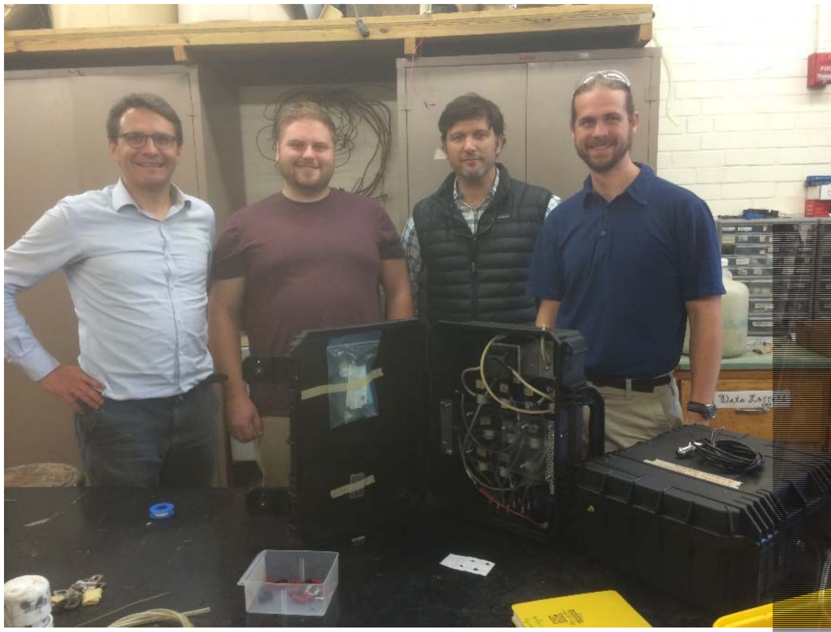
Thrust 1: Ecological Systems
Objective 1.1b: Model watershed to lake nutrient flows

Missisquoi Watershed Site Installations

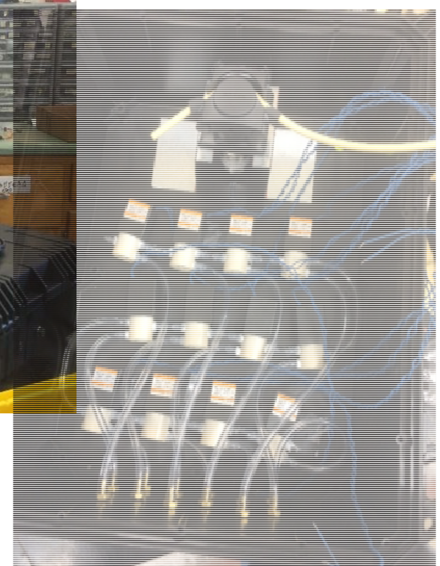


Thrust 1: Ecological Systems
Objective 1.1b: Model watershed to lake nutrient flows

Missisquoi Watershed Data and Sensors



Mulitplexer building and testing



- High frequency nutrient data from groundwater

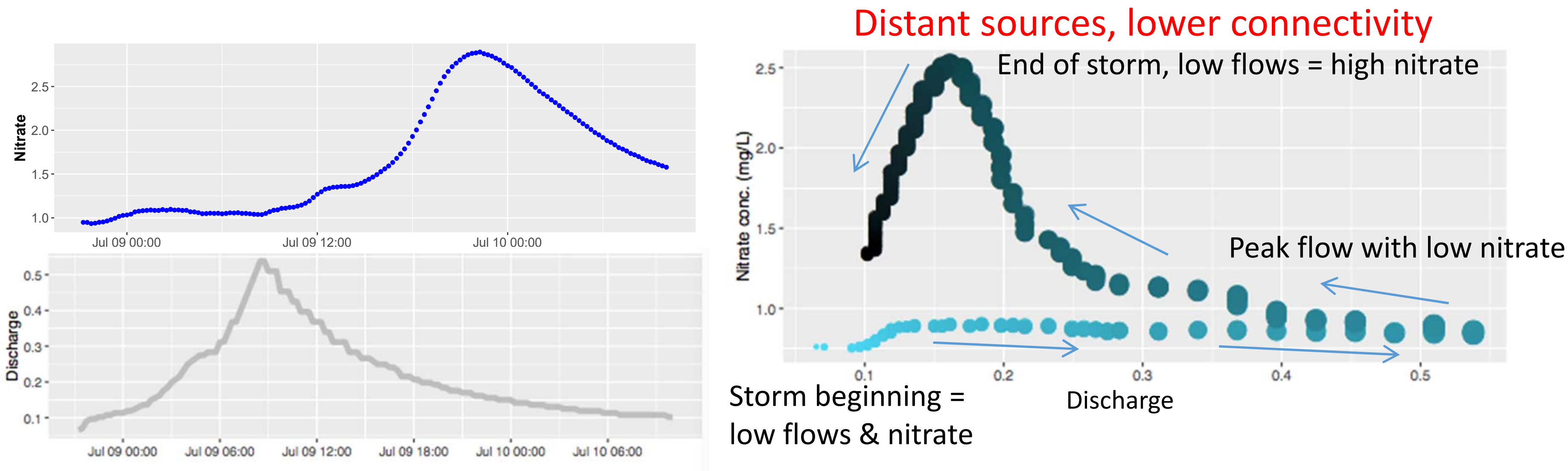
Thrust 1: Ecological Systems
Objective 1.1b: Model watershed to lake nutrient flows

Missisquoi River Sensors

- Flow
- Sensor data
  - DOC, POC, fDOM
  - NO_3, turbidity (Phosphorus)
  - Temperature, DO, pH, conductivity
- ISCO: nutrients and sediment
  - Targeted Water 'Grab' Sampling

Thrust 1: Ecological Systems
Objective 1.1b: Model watershed to lake nutrient flows

What Controls Water Quality Resiliency in the Missisquoi Watershed?



Thrust 1: Ecological Systems
Objective 1.1b: Model watershed to lake nutrient flows

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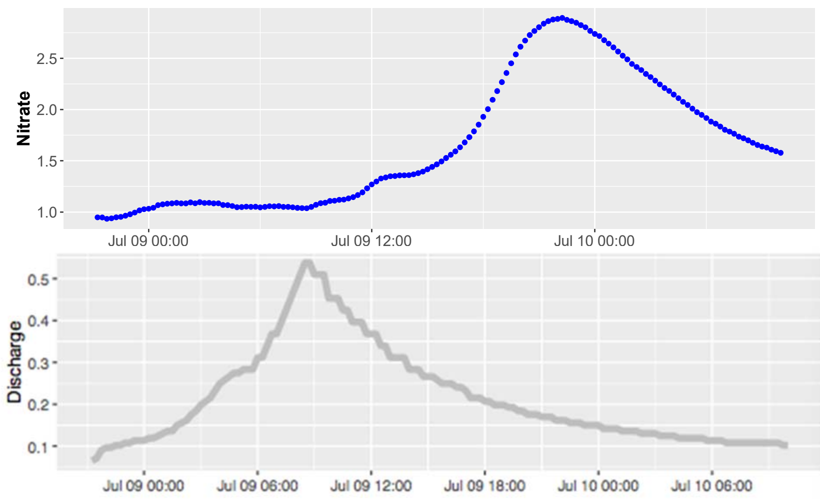

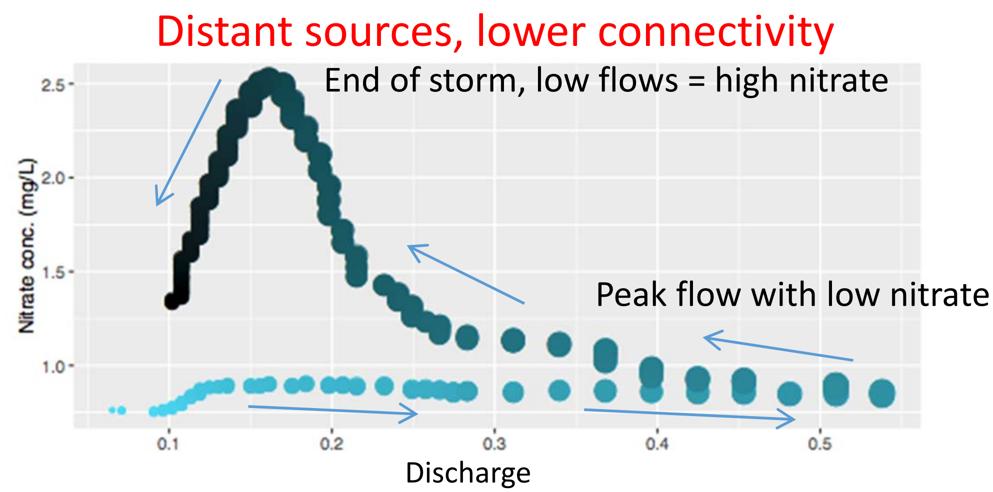

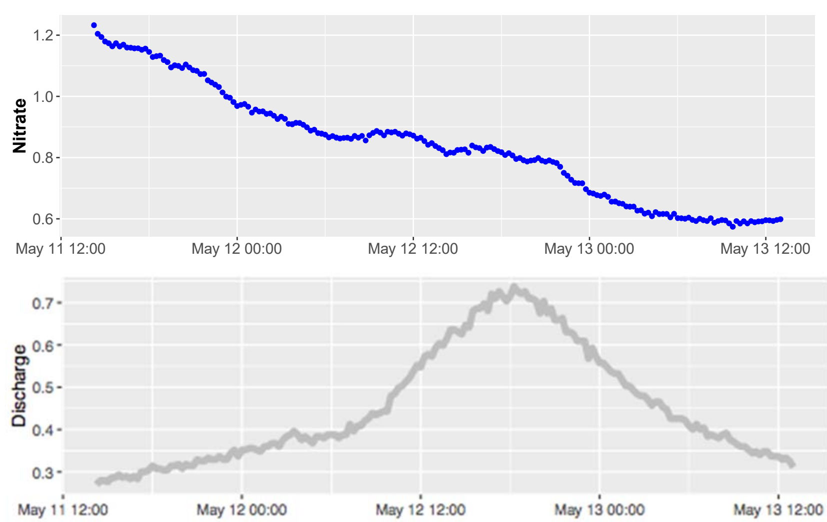

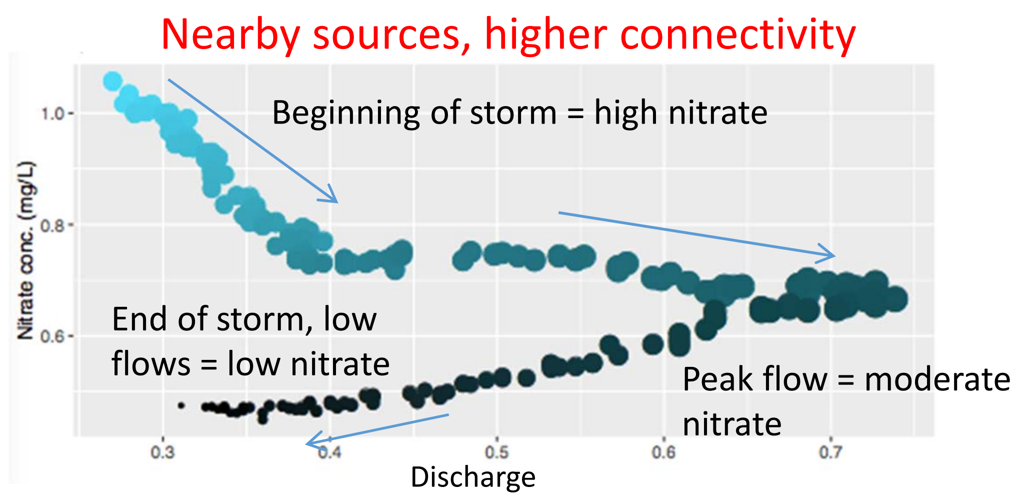

Thrust 1: Ecological Systems

Objective 1.1b: Model watershed to lake nutrient flows

What Controls Water Quality Resiliency in the Missisquoi Watershed?

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in the Lake Champlain Basin

Same location

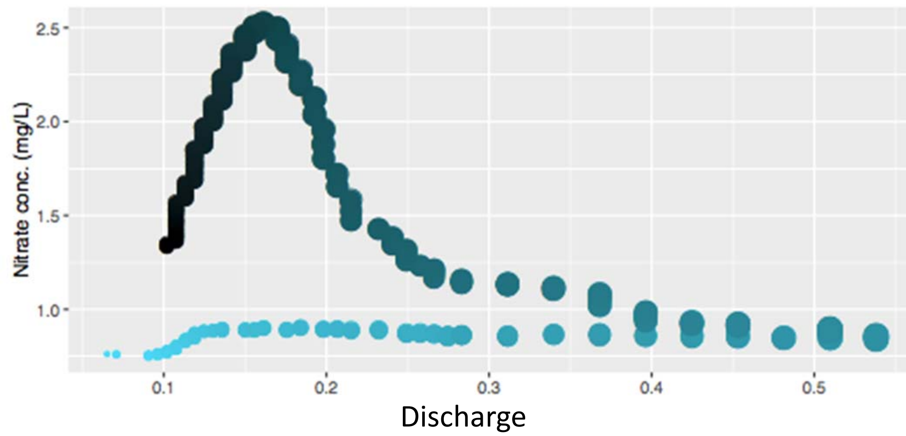
Different dynamics

In watersheds, what

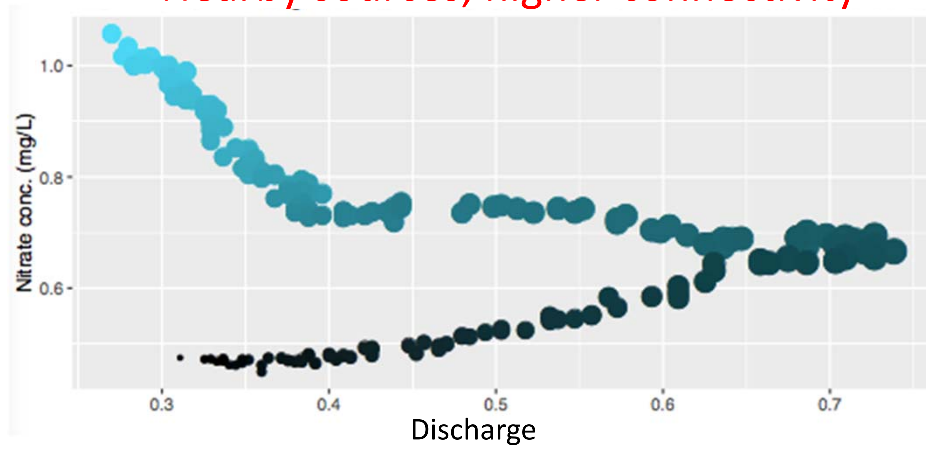
- Conditions
- Properties
- Human activities

account for these differences?

Distant sources, lower connectivity



Nearby sources, higher connectivity



Thrust 1: Ecological Systems

Objective 1.1b: Model watershed to lake nutrient flows

Modeling: P Incorporation

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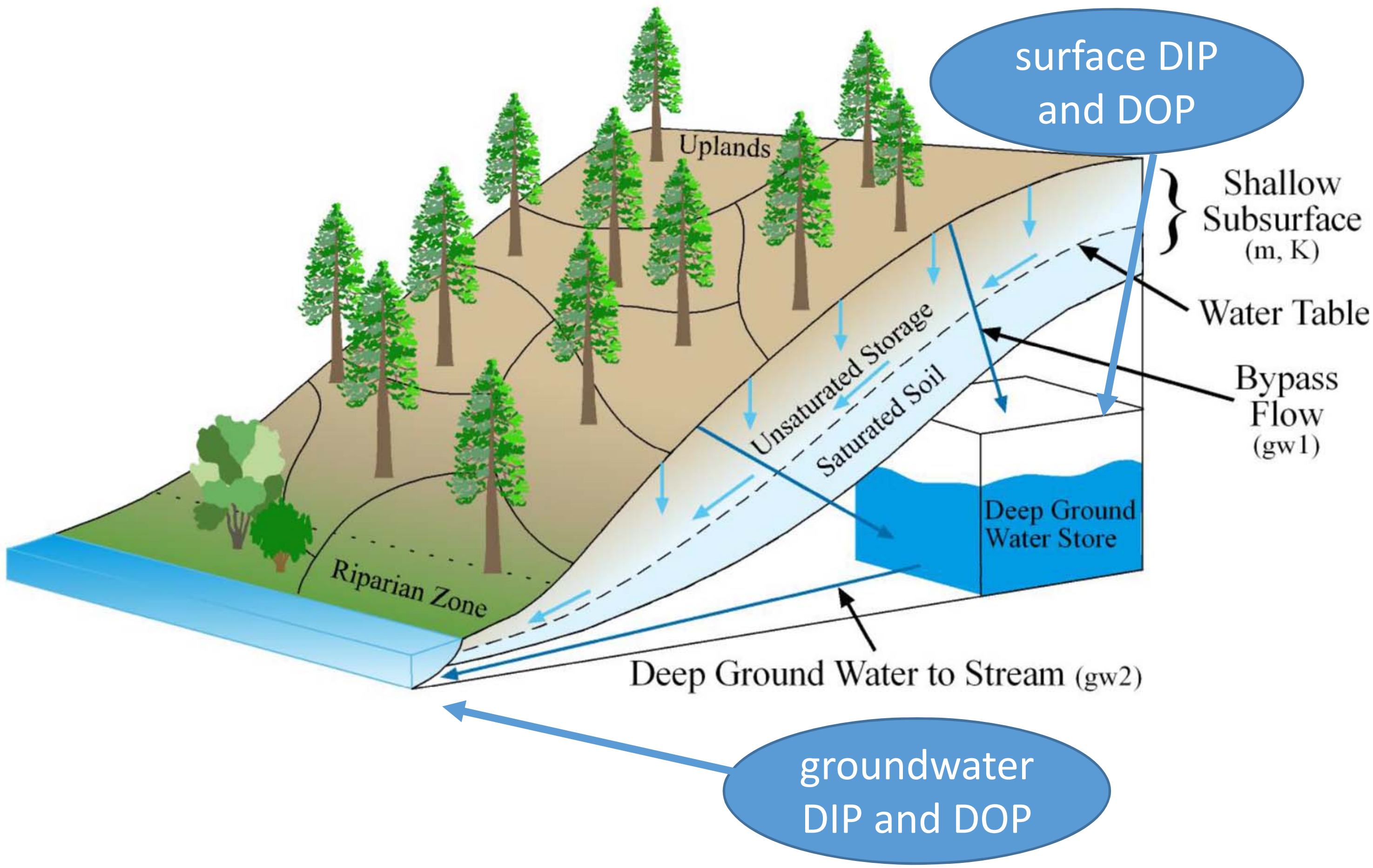

Thrust 1: Ecological Systems
Objective 1.1b: Model watershed to lake nutrient flows

Lake

Thrust 1: Ecological Systems
Objective 1.2a: Develop lake model

Major Features of the BREE Integrated Assessment Model

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Basin Resilience to Extreme Events
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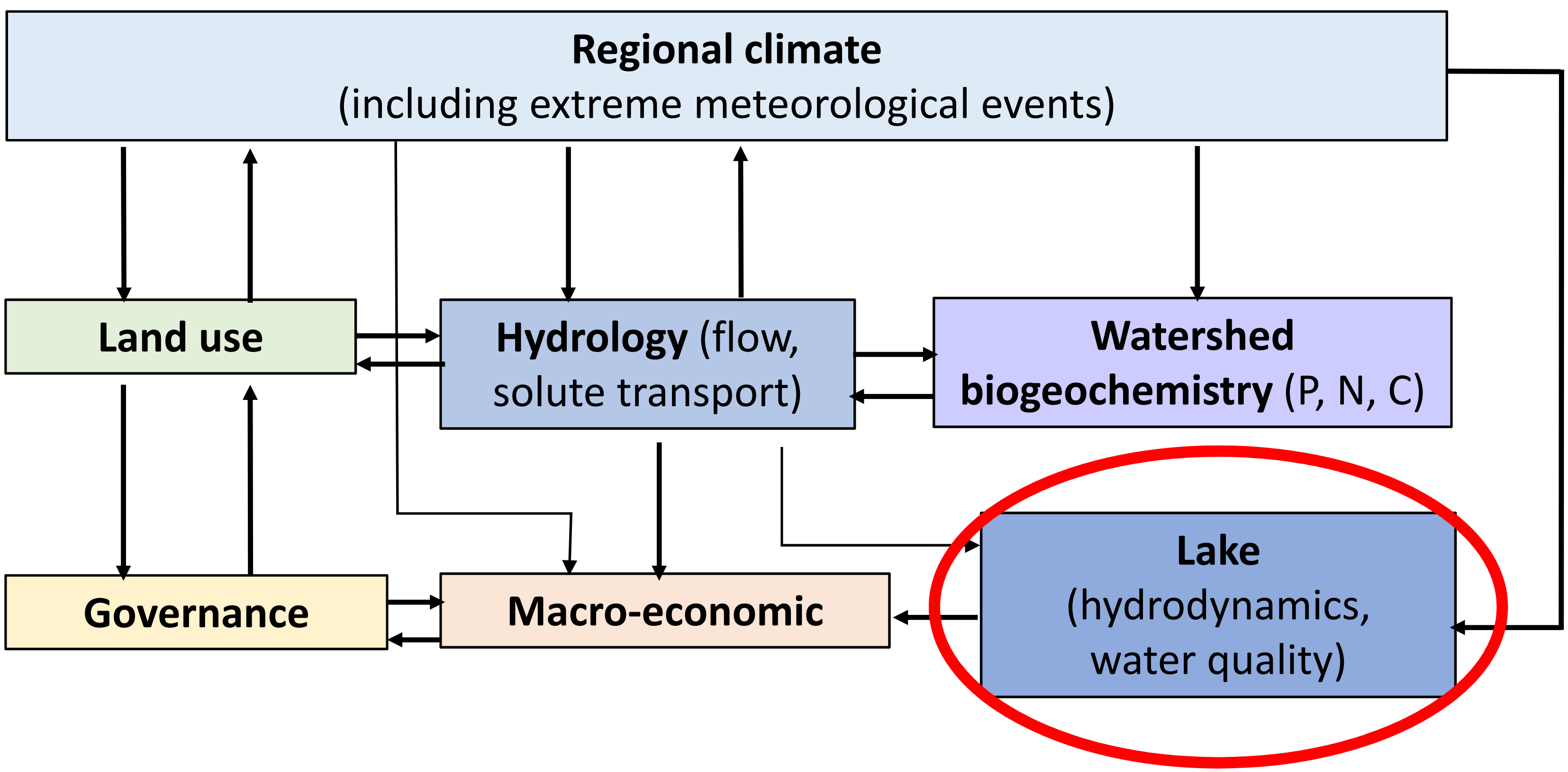
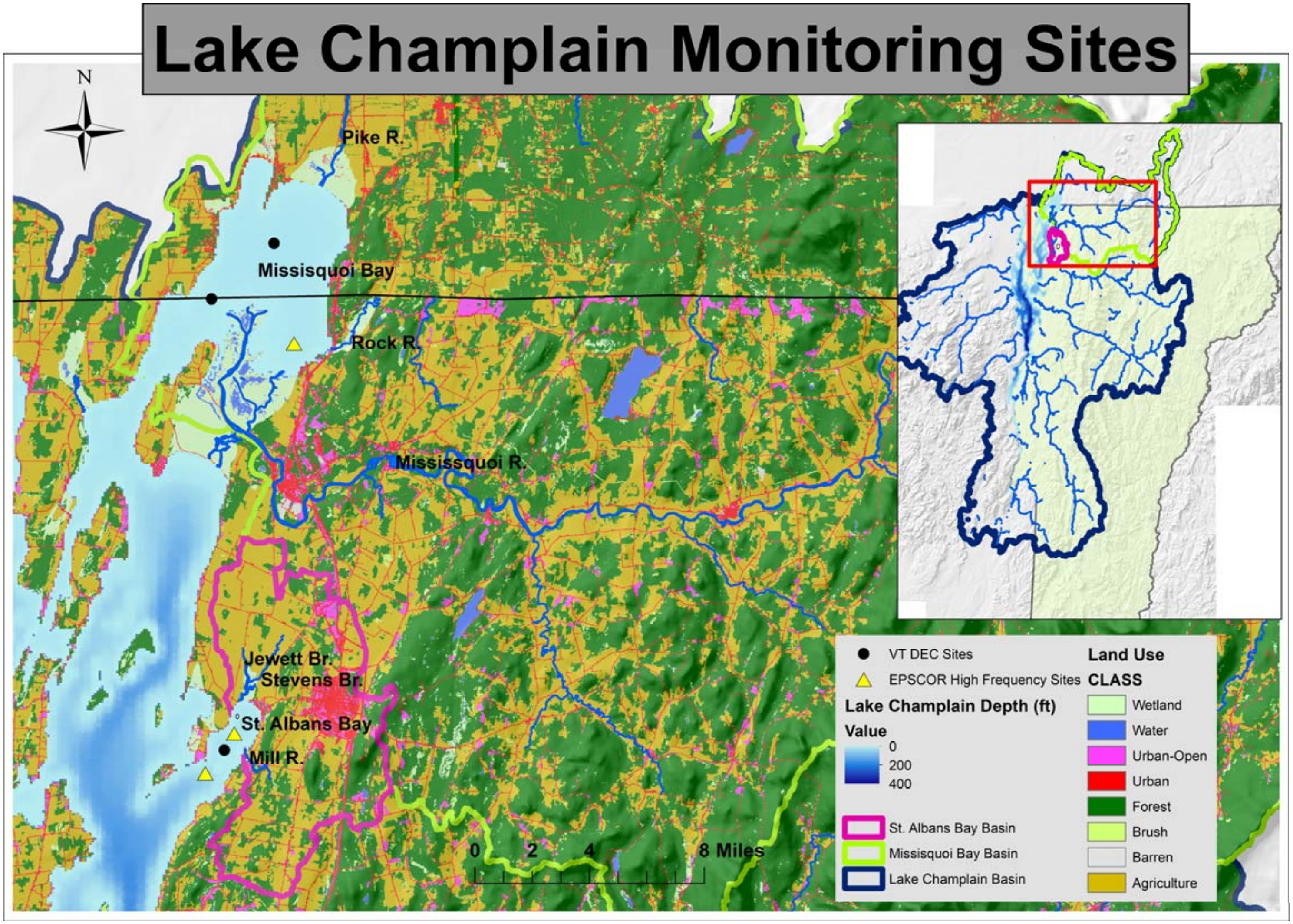


Objective 1.2a: Develop Lake Model

- Model is developed and calibrated with sensor data
  - Monitoring network deployed and maintained
  - Event-based water quality sampling
- Lake model selected and structure developed

Thrust 1: Ecological Systems
Objective 1.2a: Develop lake model

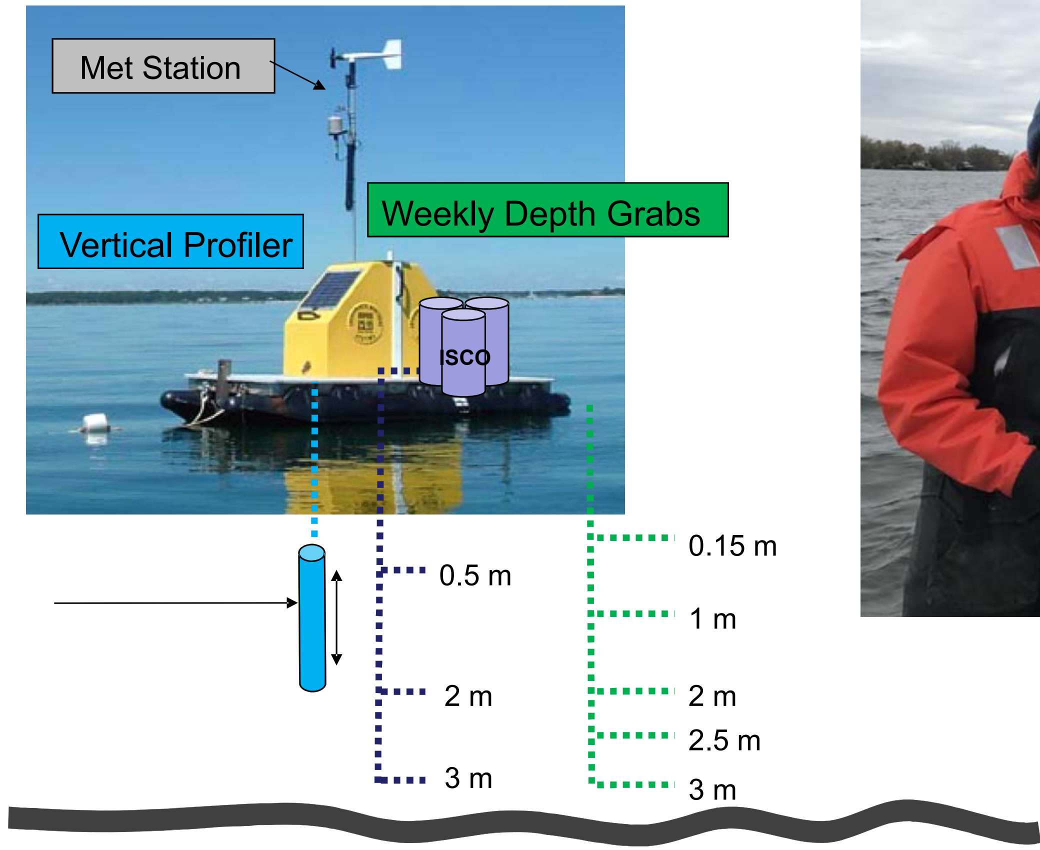
Lake Research



Shallow eutrophic systems that differ in terrestrial and open water connectivity

Thrust 1: Ecological Systems
Objective 1.2a: Develop lake model

Deployment of St. Albans and Missisquoi Bay Advanced Biogeochemical and Hydrodynamic Observatory



Sensors Measure ChlA/PC, T, Cond, pH, DO, FDOM, Turbidity every hr. at 0.5 meter depth intervals at 3 Sites

Thrust 1: Ecological Systems
Objective 1.2a: Develop lake model

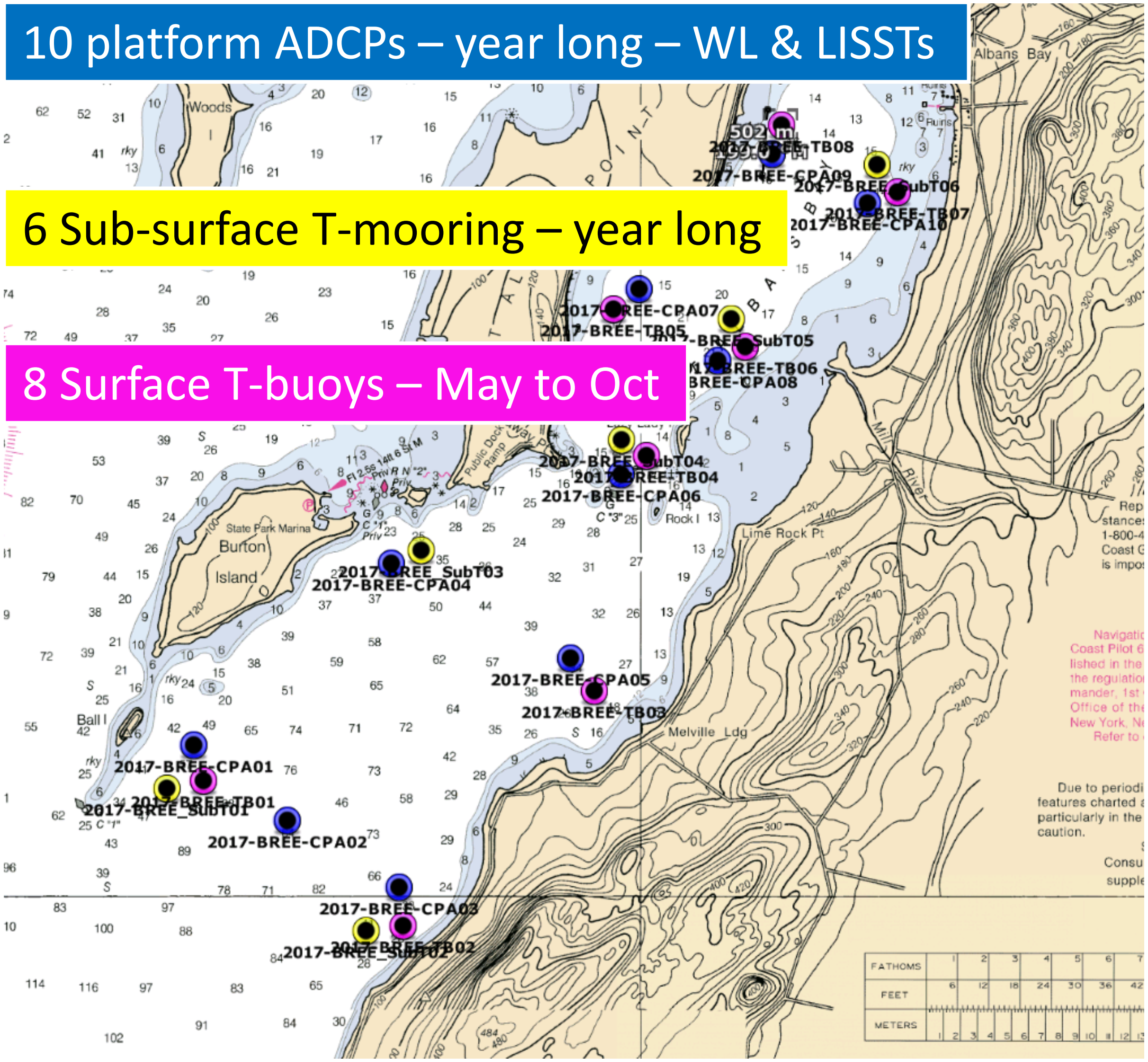
St. Albans Hydrodynamic Monitoring Array

Basin Resilience to Extreme Events in the Lake Champlain Basin

10 platform ADCPs – year long – WL & LISSTs

6 Sub-surface T-mooring – year long

8 Surface T-buoys – May to Oct



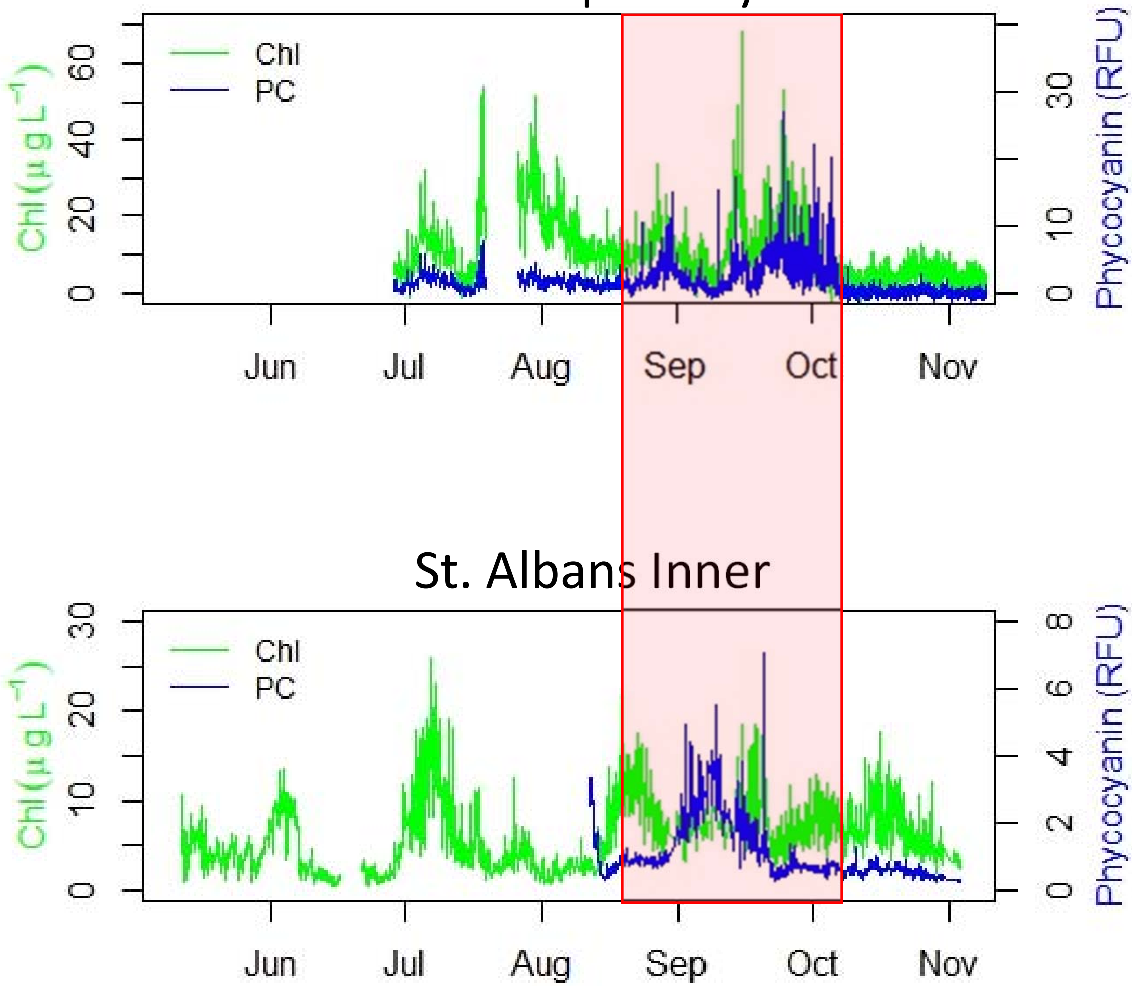
Thrust 1: Ecological Systems

Objective 1.2a: Develop lake model

2017 Late Blooms!

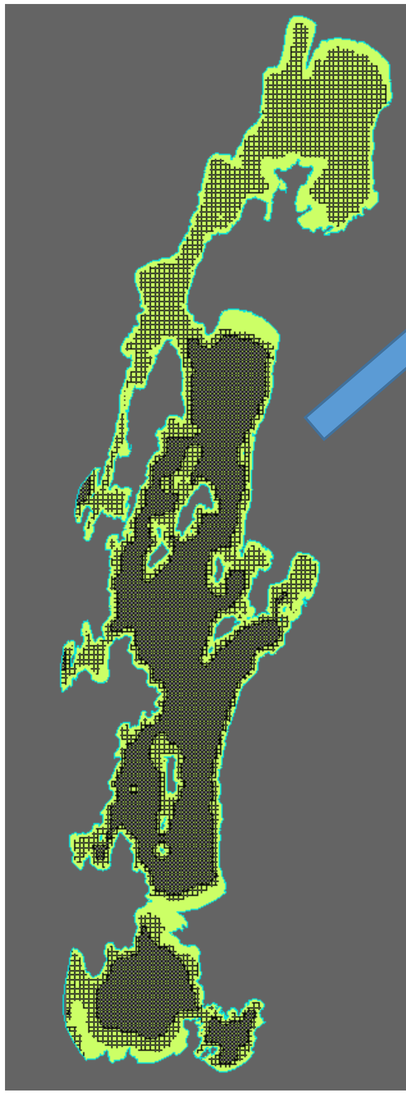
Missisquoi Bay

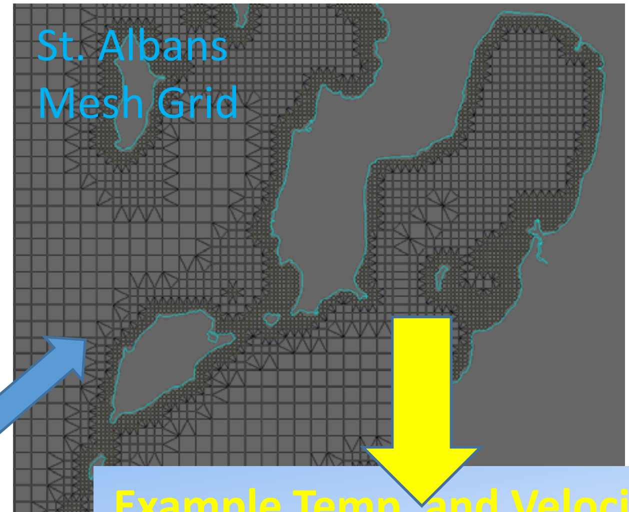
St. Albans Inner

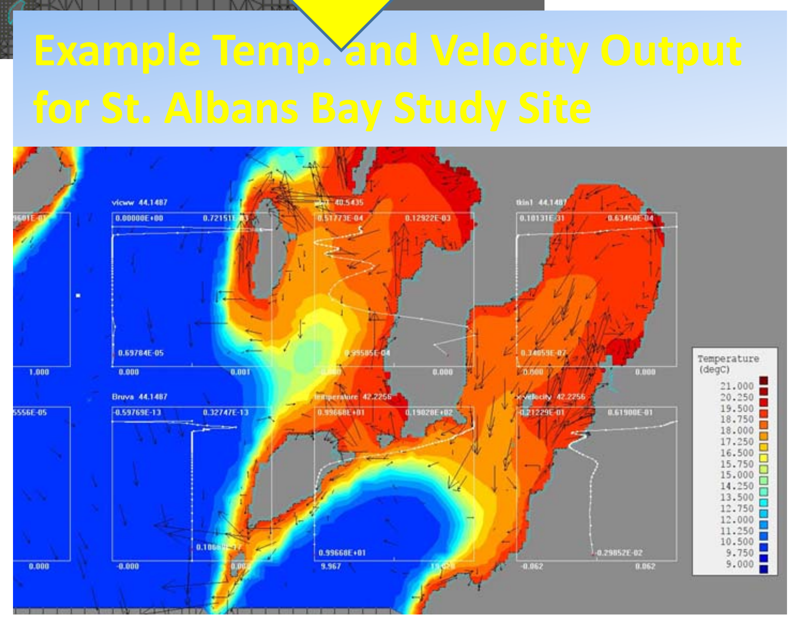


Thrust 1: Ecological Systems
Objective 1.2a: Develop lake model

New Hydrodynamic Deltares Model Flexible Mesh Grid and Initial Output

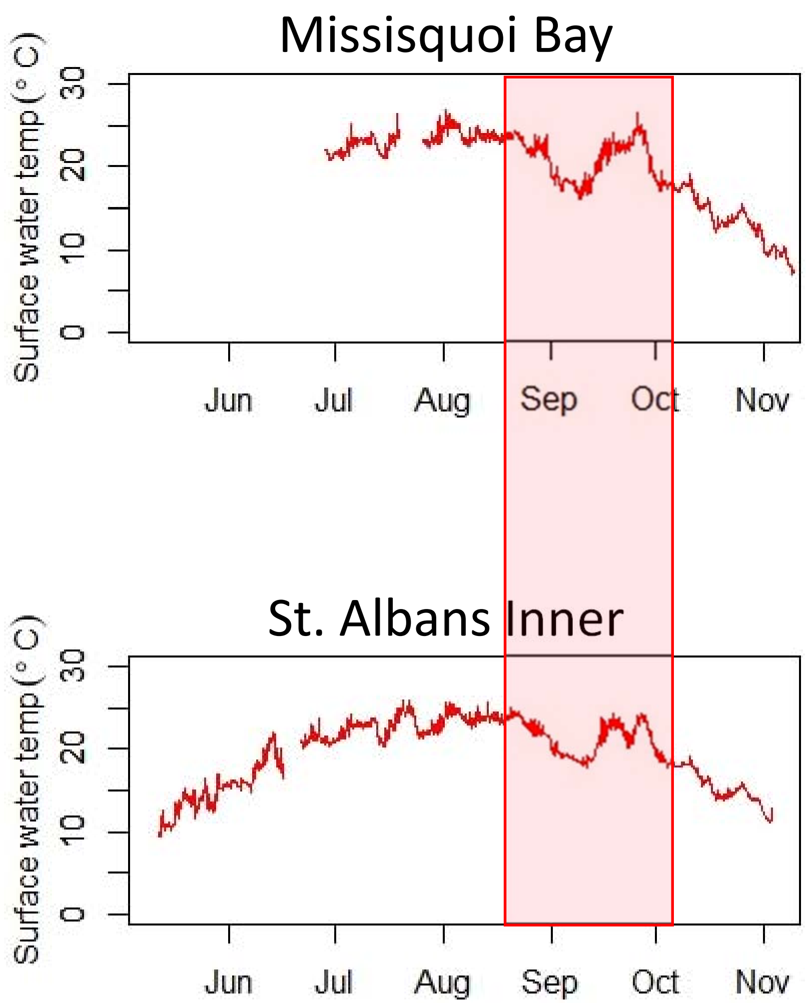






Thrust 1: Ecological Systems
Objective 1.2a: Develop lake model

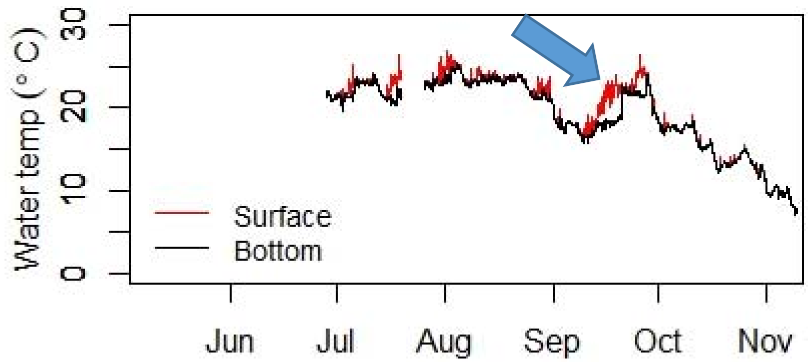
Why Were They Late?
Cool Water Temperatures?

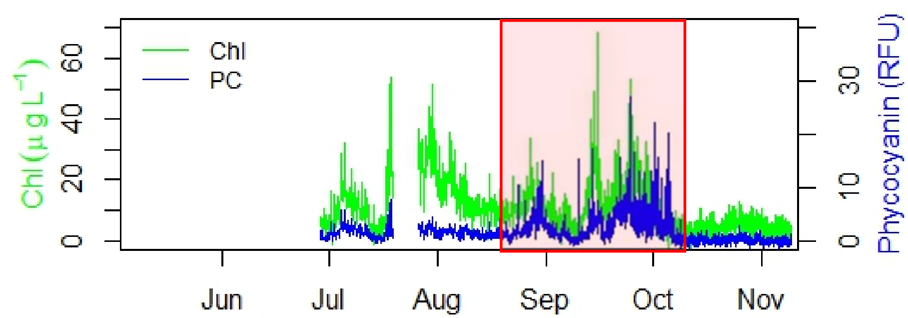


Thrust 1: Ecological Systems
Objective 1.2a: Develop lake model

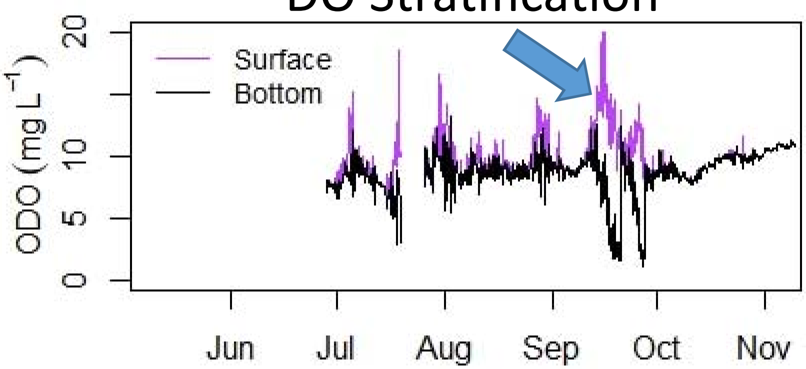
Why Were They Late?
Stormy Summer and Delayed Stratification?

Missisquoi Bay
Thermal Stratification





Missisquoi Bay
DO Stratification



Thrust 1: Ecological Systems
Objective 1.2a: Develop lake model

Why Were They Late?
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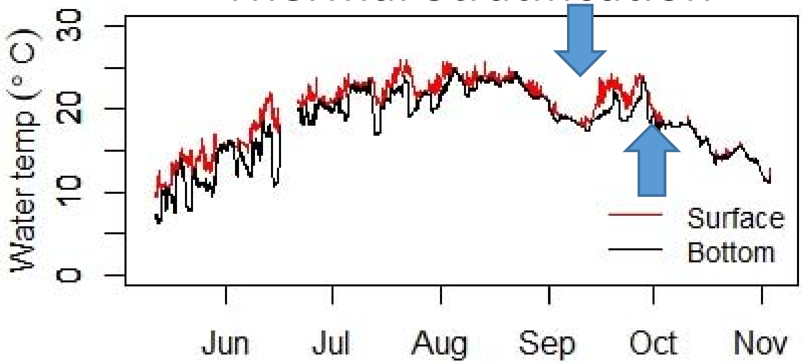
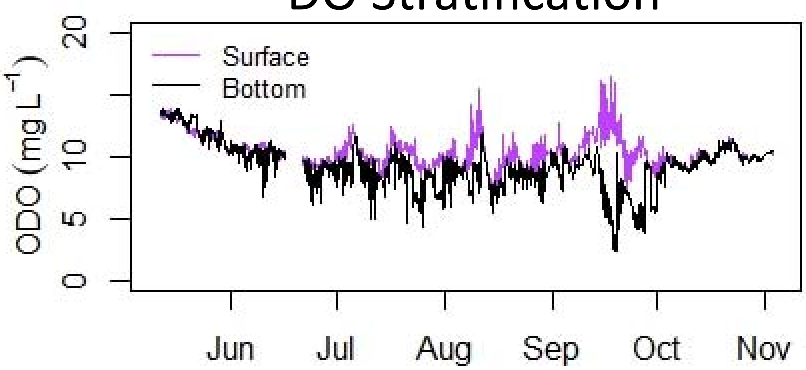
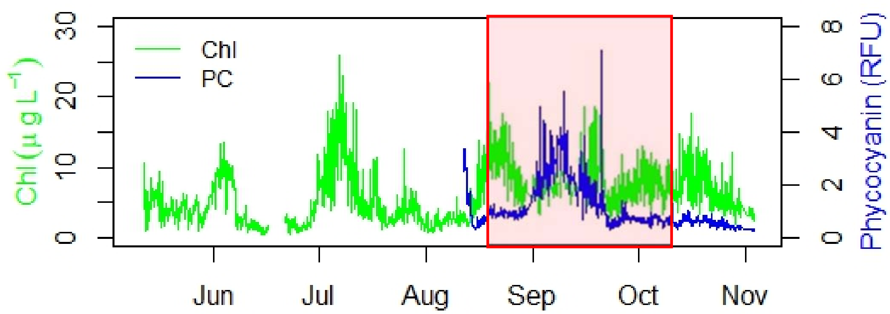
St. Albans Bay
Thermal Stratification



St. Albans Bay
DO Stratification





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