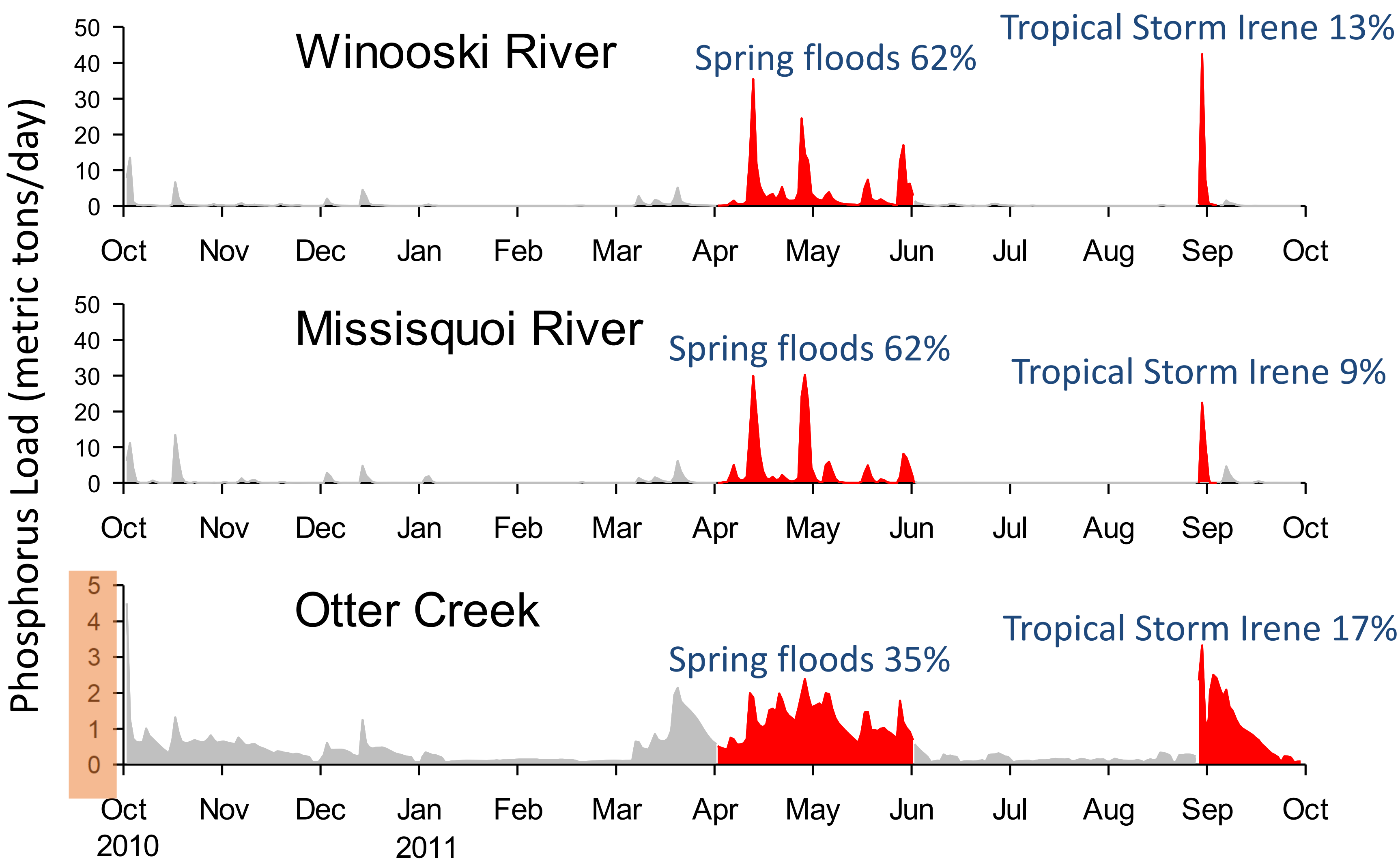
BREE
Basin Resilience to Extreme Events
in the Lake Champlain Basin

Thrust 1:
Goal 1.1a Model stormwater infrastructure


BREE Ecological Research

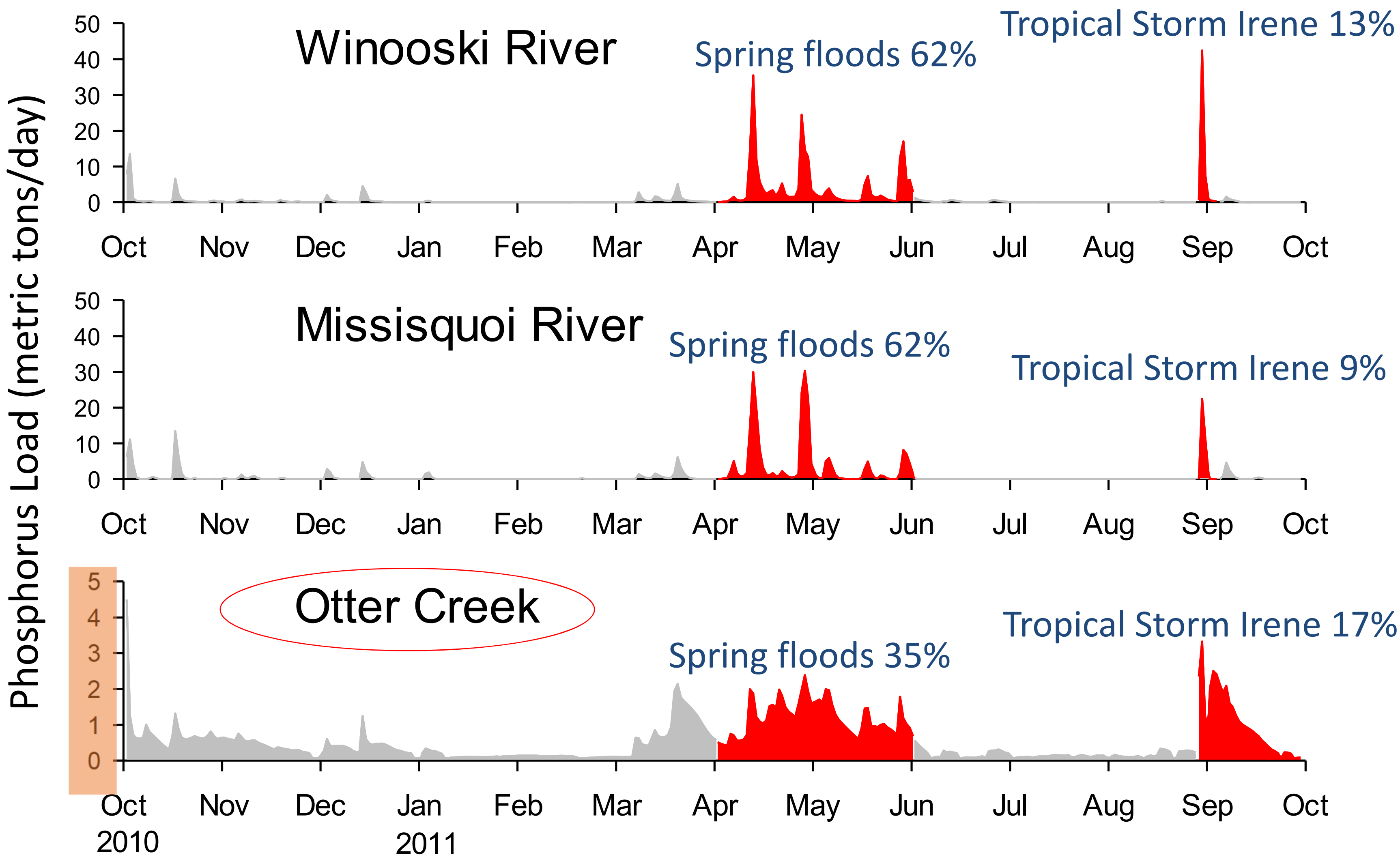
Extreme Events:
Daily P loads from tributaries, 2011



Water Quality Resilience

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

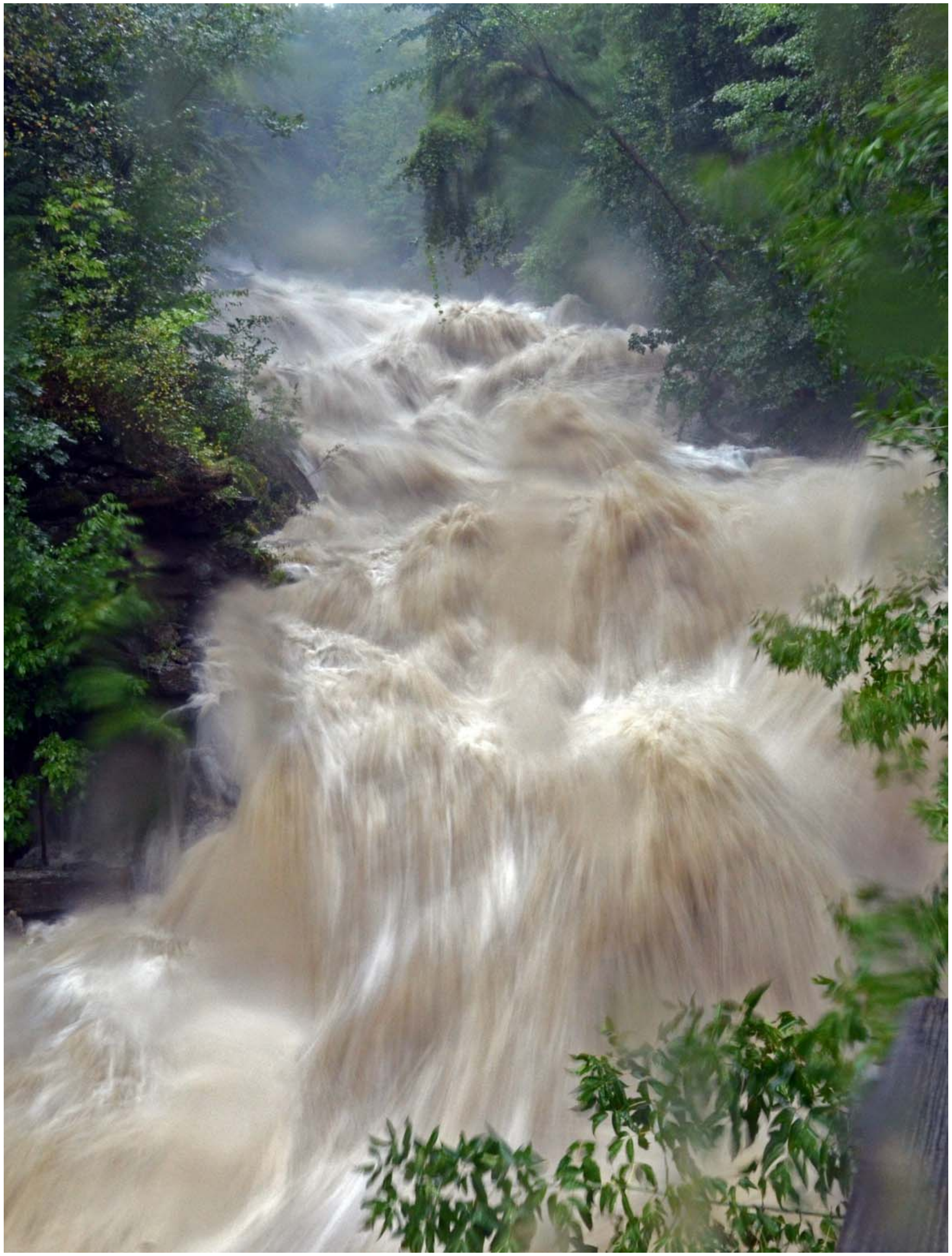
Extreme Events:
Daily P loads from tributaries, 2011



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 waters, watershed soils and streams 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

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

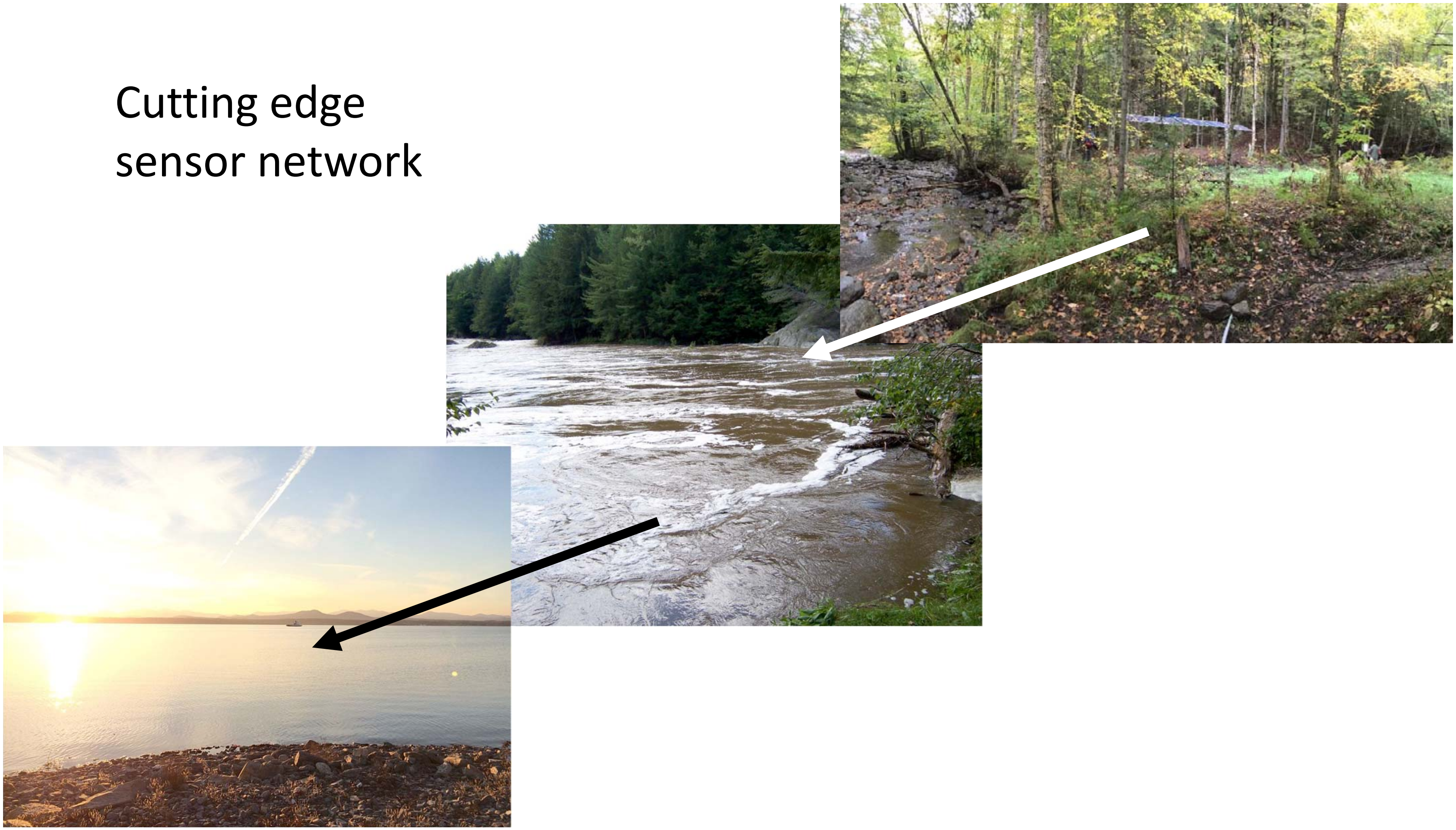
Goal 1.2: Develop new lake model for projecting impacts of climate change & extreme events on water quaility

- Objective 1.2: Develop and calibrate Lake Model

Ecological Research

Resilience to Extreme Events Across Soil-River-Lake Continuum

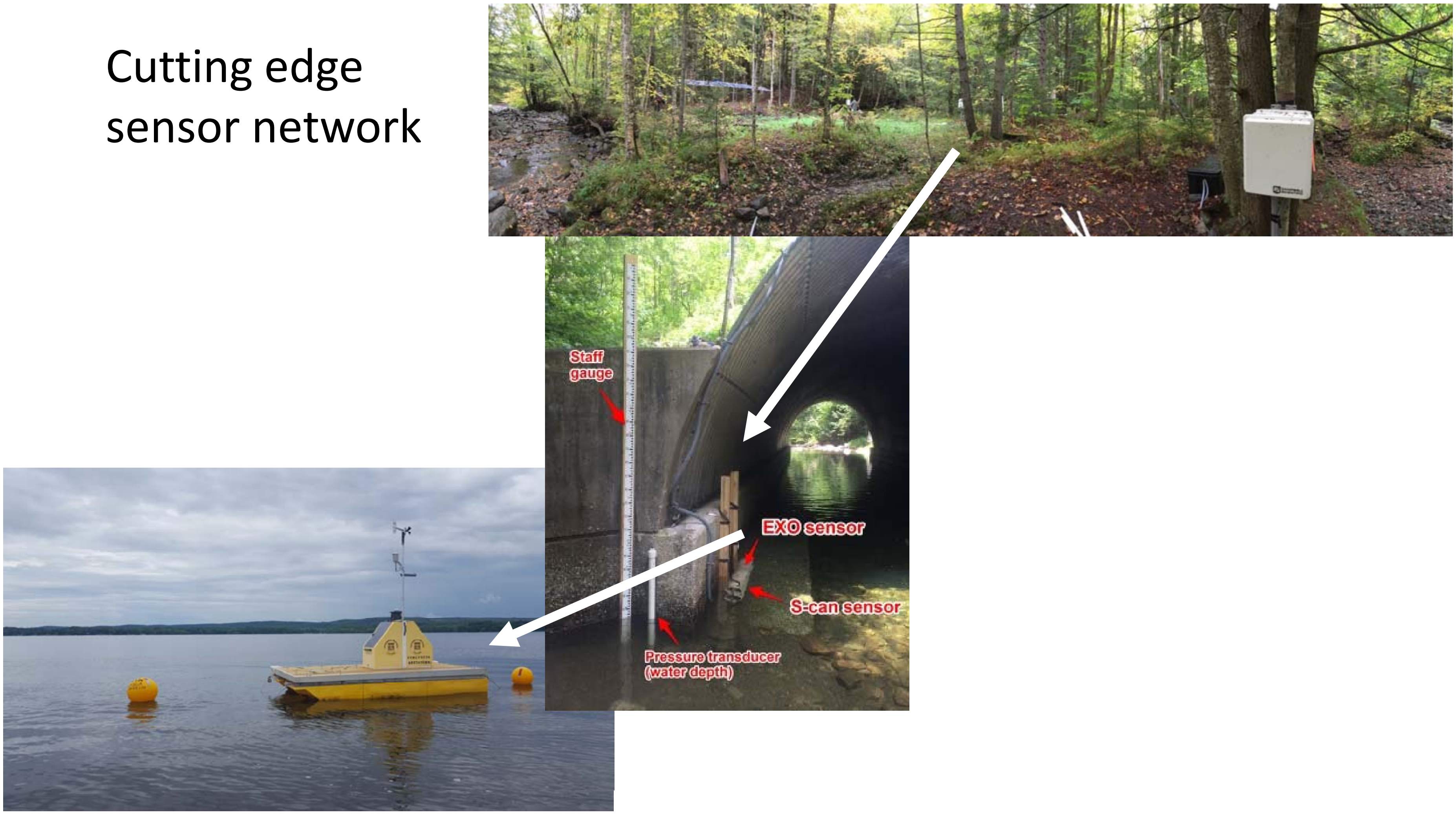
Cutting edge
sensor network



Ecological Research

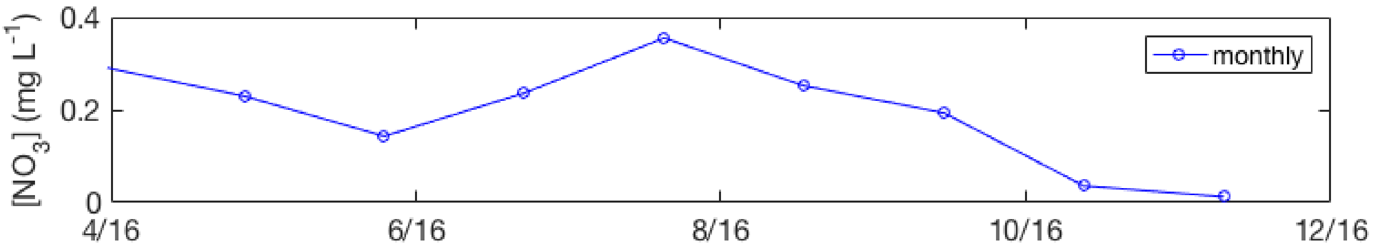
Resilience to Extreme Events Across Soil-River-Lake Continuum

Cutting edge sensor network



Ecological Research

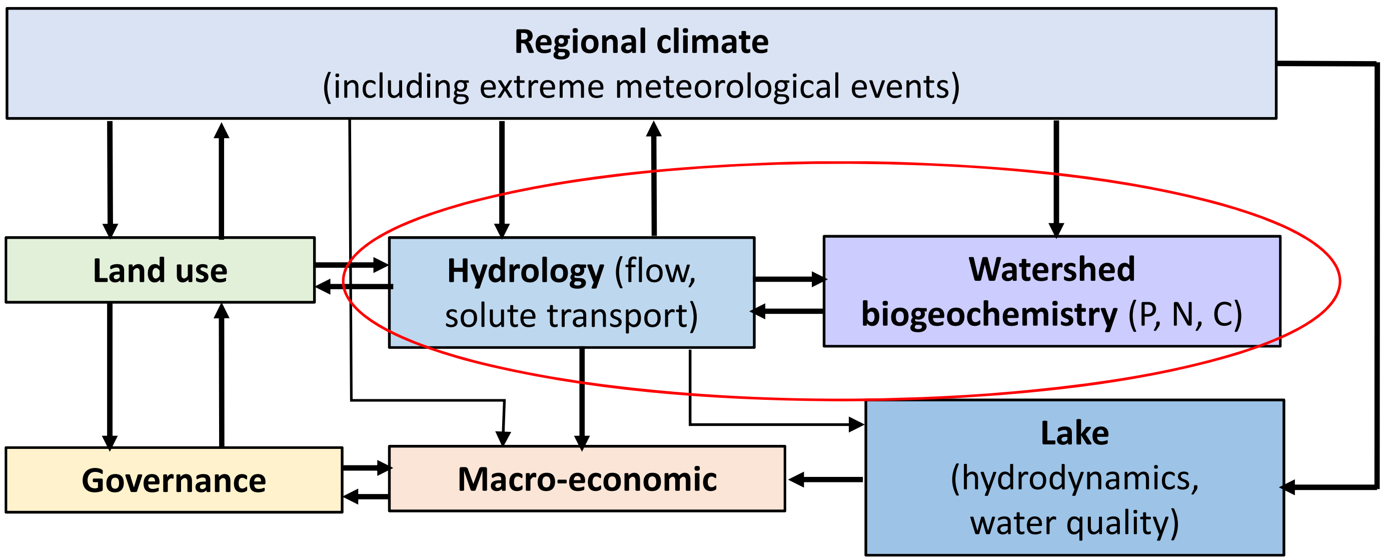
High frequency essential for capturing episodic events



Hydrology & Stormwater

Thrust 1:
Obj. 1.1a Model stormwater infrastructure

Major Features of the BREE Integrated Assessment Model



Slide 15

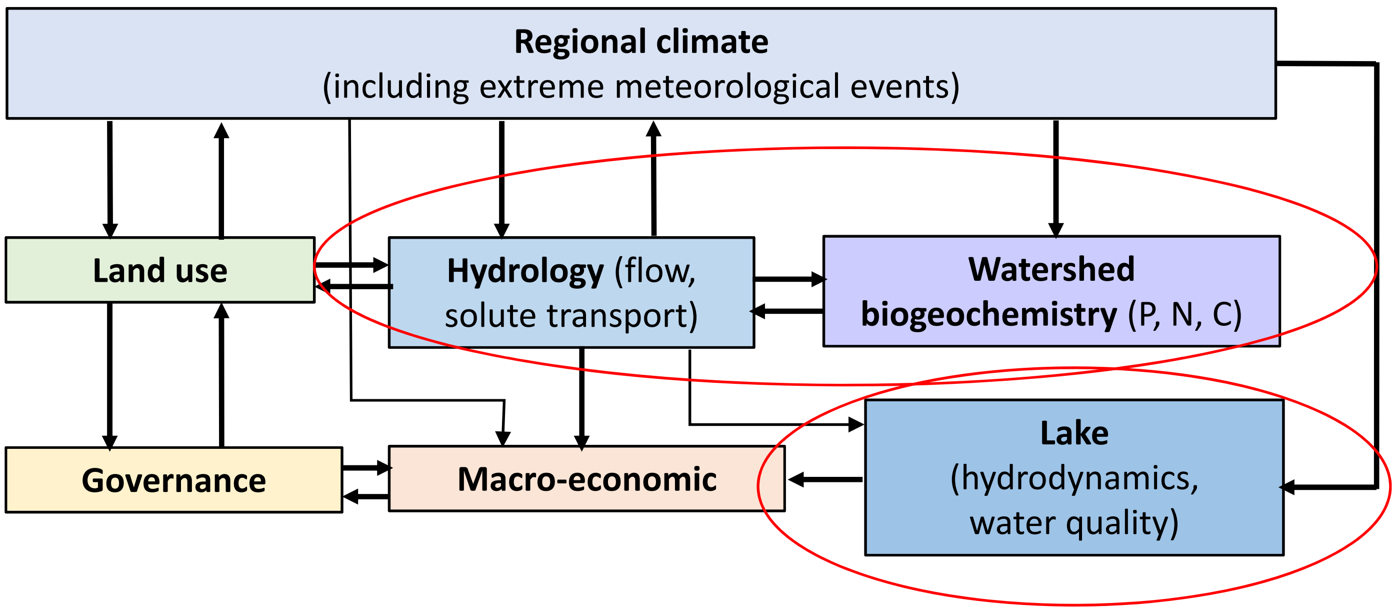
AZ [15]3 For structural uncertainties, it will be useful to engage stakeholders in a discussion, or even have them do an exercise.
Asim Zia, 5/22/2017

Ecological Research

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

- River, riparian and lake sensor network
- Sensor and grab sample data (2017-present)
- Added P cycling to watershed model (Biome-BGC in RHESSys)
- Develop new lake models for Missisquoi and St. Albans Bays

Major Features of the BREE Integrated Assessment Model



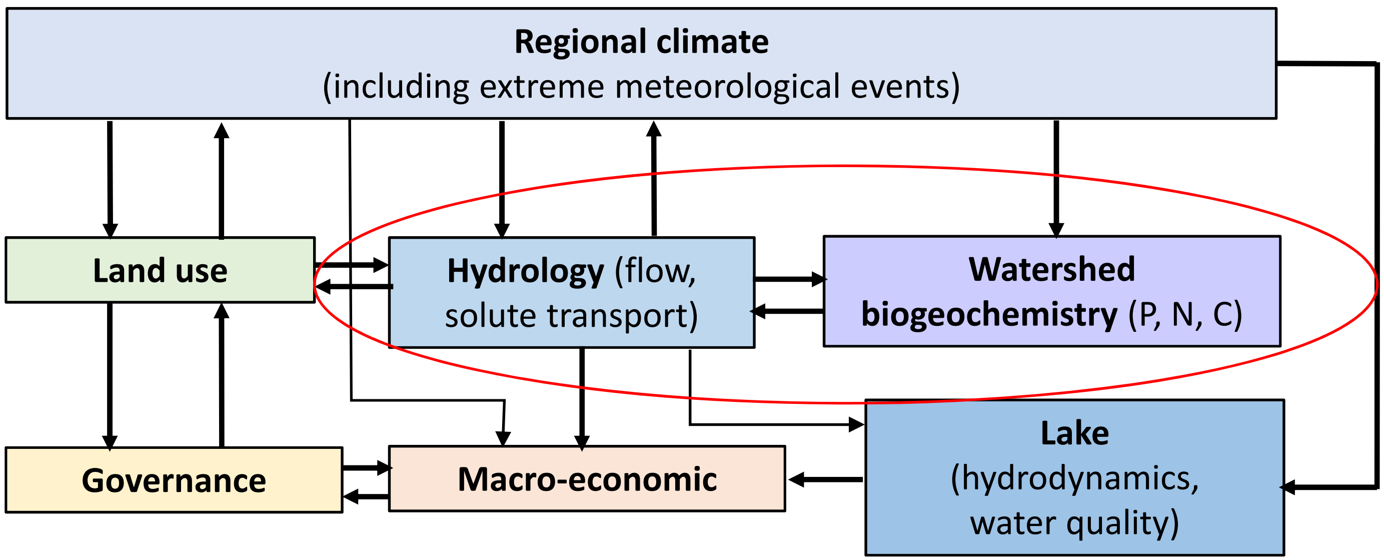
Slide 17

AZ [15]4 For structural uncertainties, it will be useful to engage stakeholders in a discussion, or even have them do an exercise.
Asim Zia, 5/22/2017

Watershed

Thrust 1:
Obj. 1.1b: Model watershed to lake nutrient flows

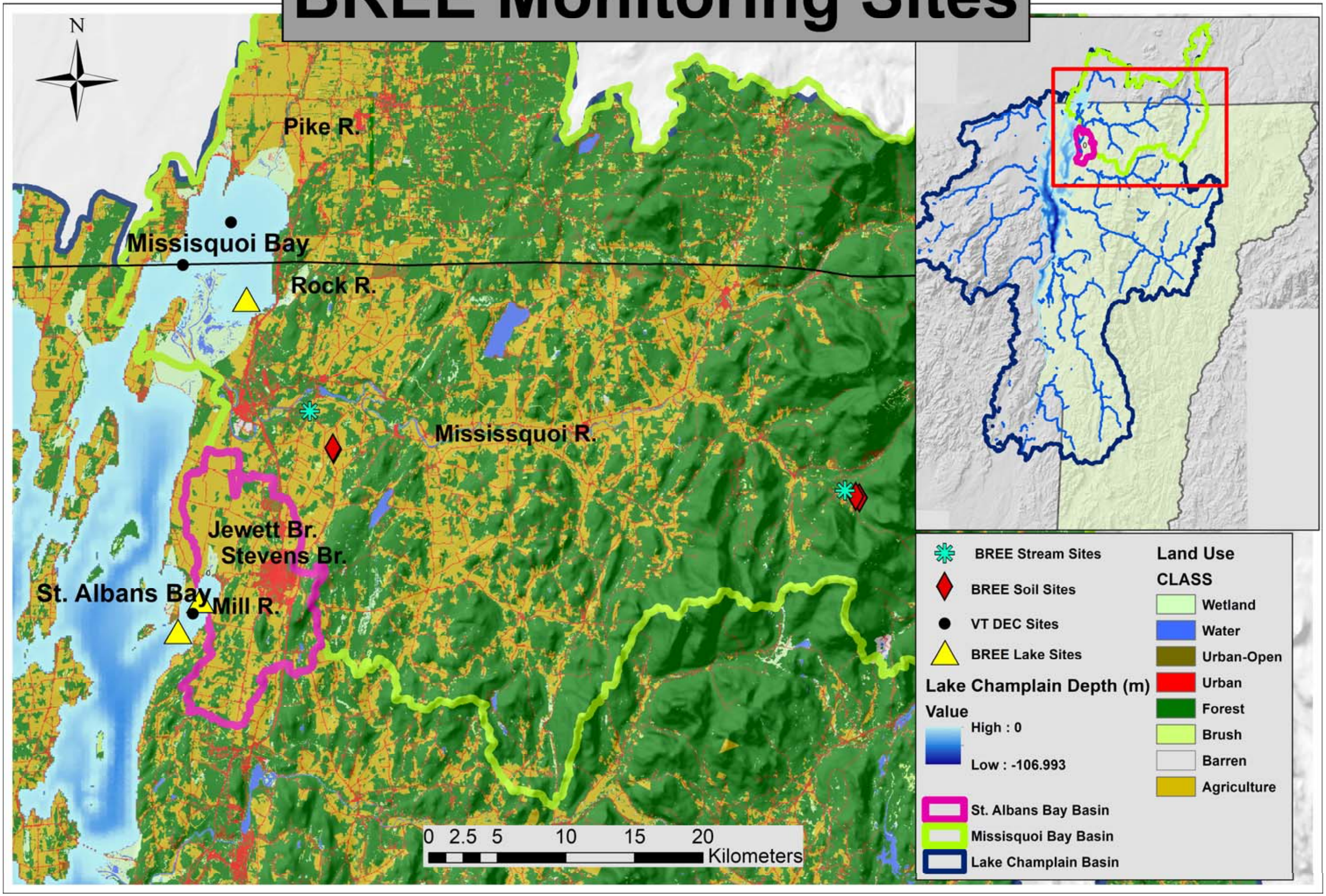
Major Features of the BREE Integrated Assessment Model



Slide 19

AZ [15]5 For structural uncertainties, it will be useful to engage stakeholders in a discussion, or even have them do an exercise.
Asim Zia, 5/22/2017

BREE Monitoring Sites



Yr 1-2 Missisquoi watershed site installations (2016-17)

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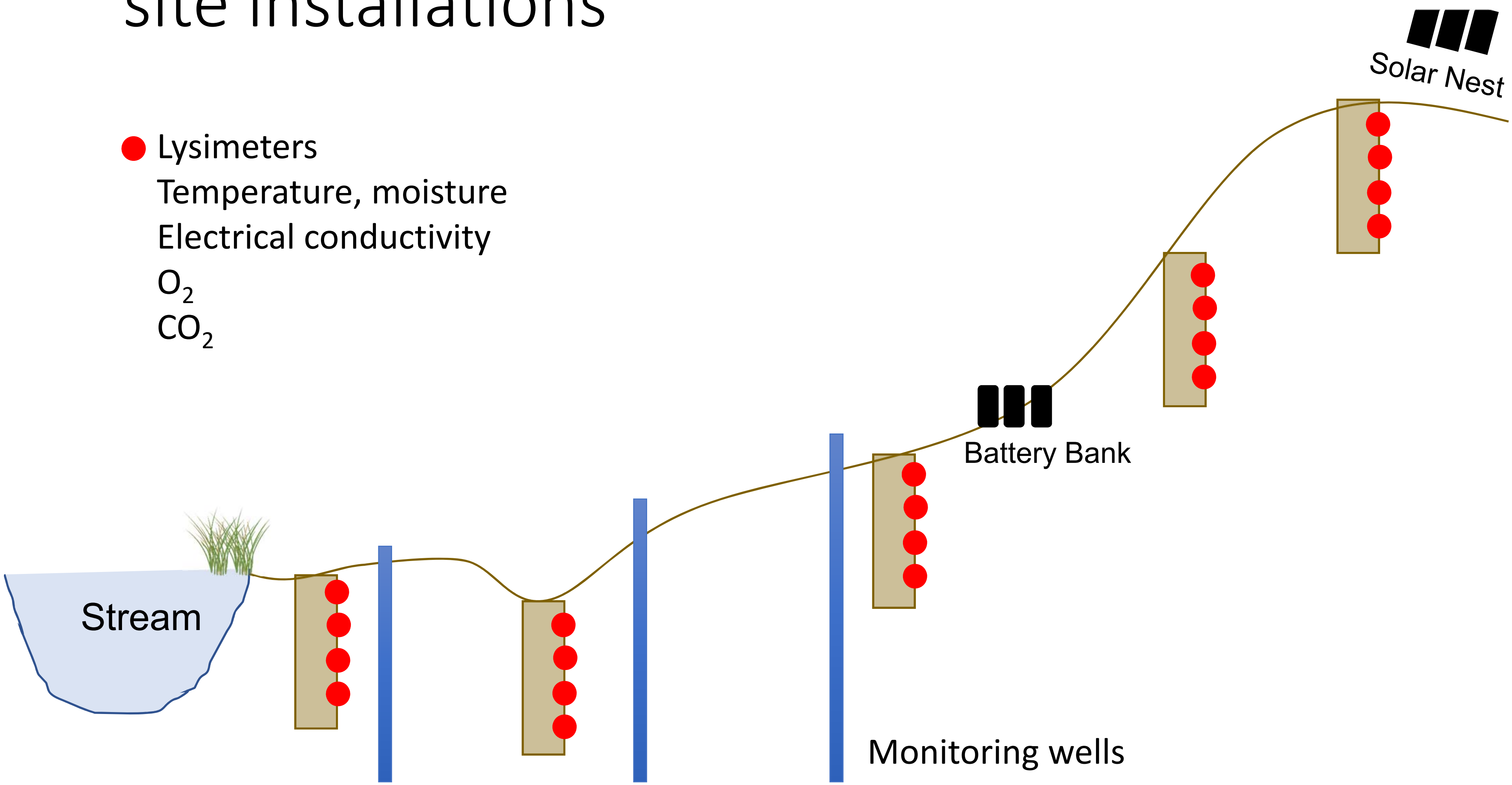
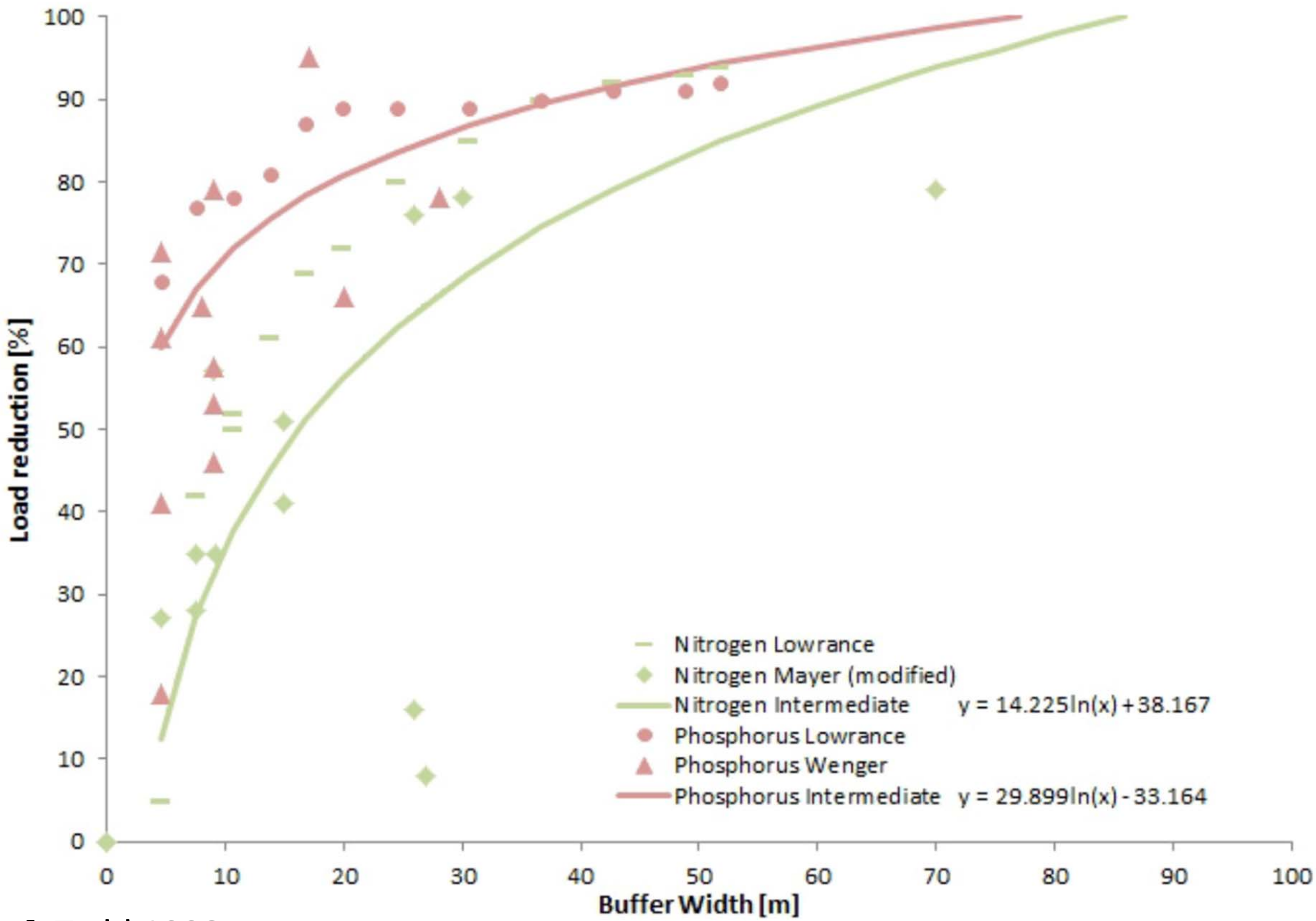
Model watershed to lake nutrient flows

Yr 1-2 Missisquoi watershed site installations



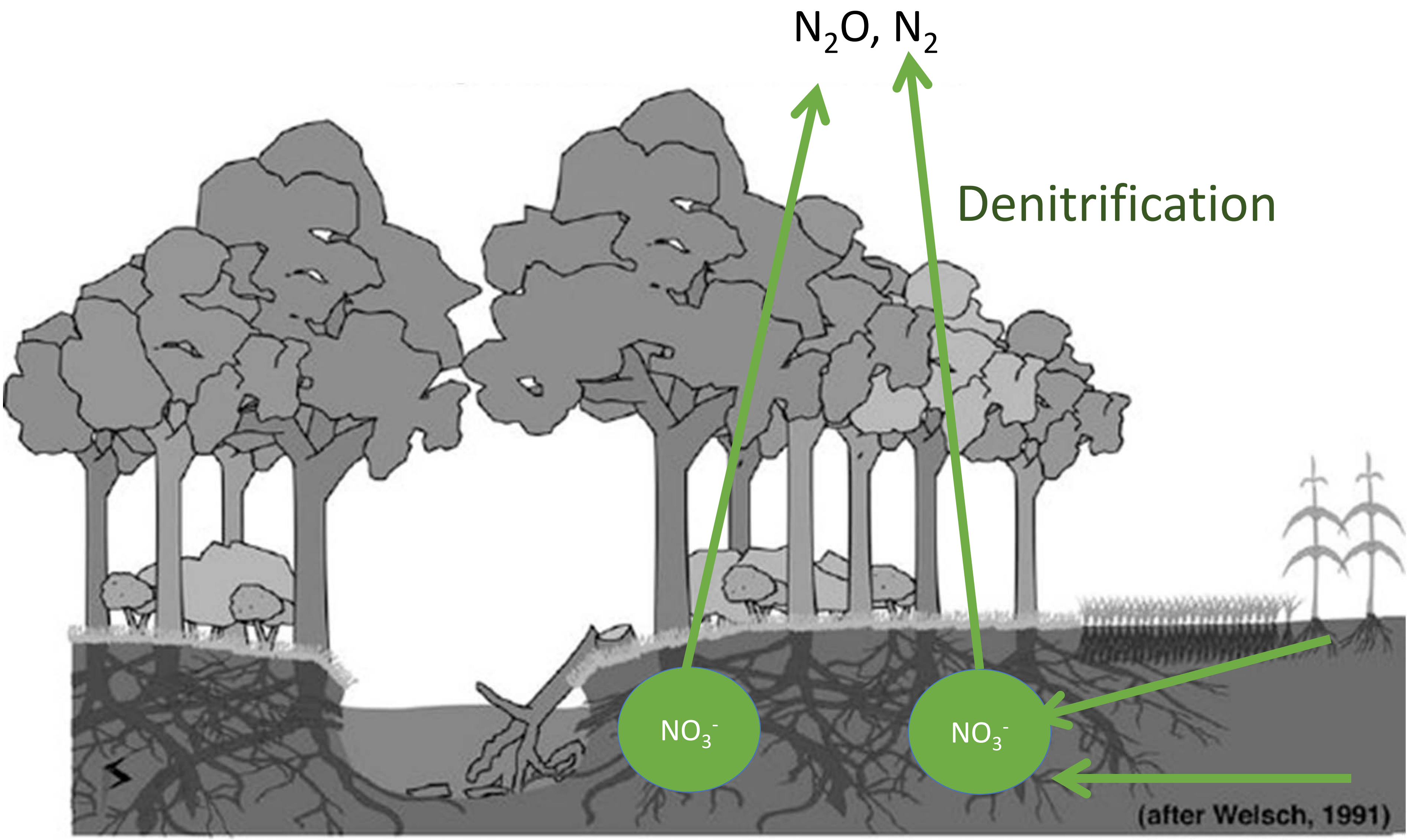
Riparian zones as water "filters"



Palone & Todd 1998

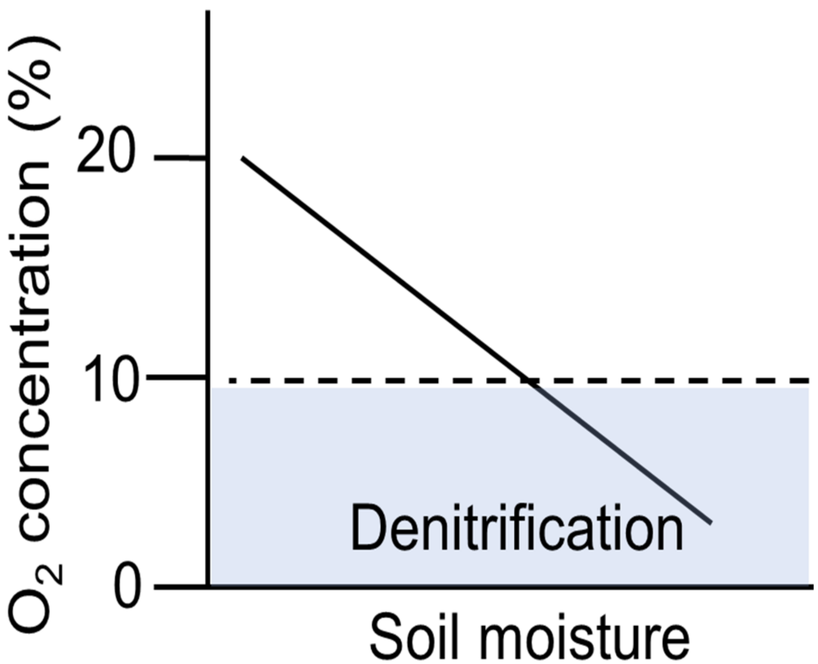
Weissteiner et al. 2013

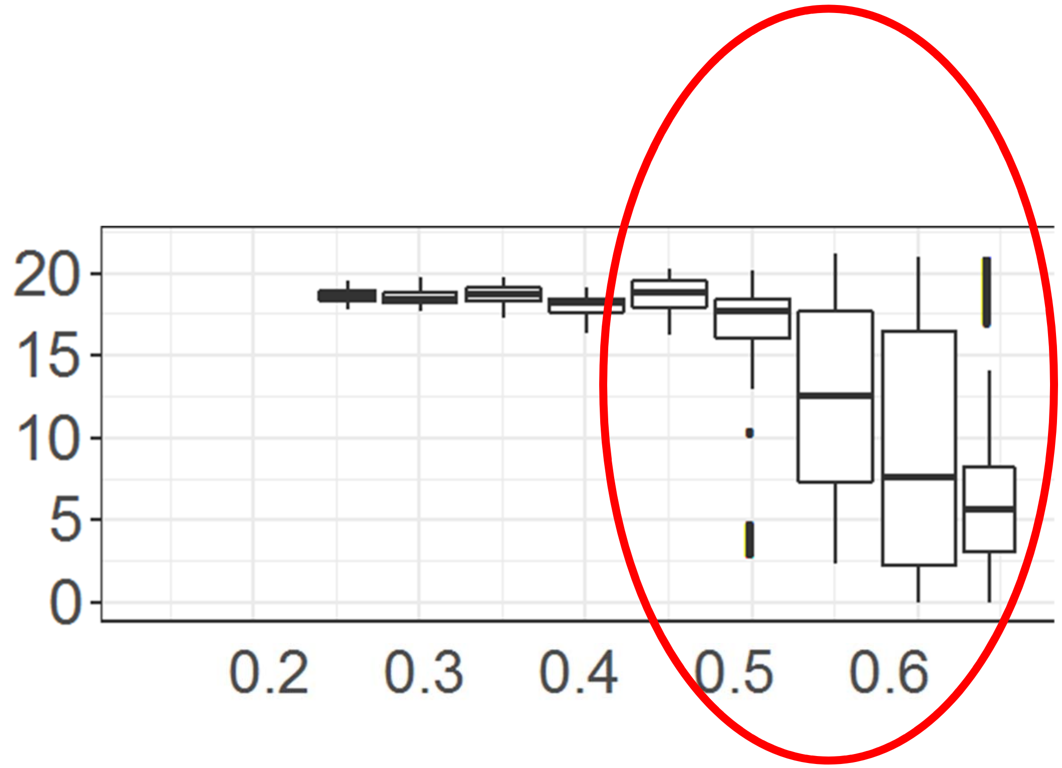
Riparian zones as water "filters"



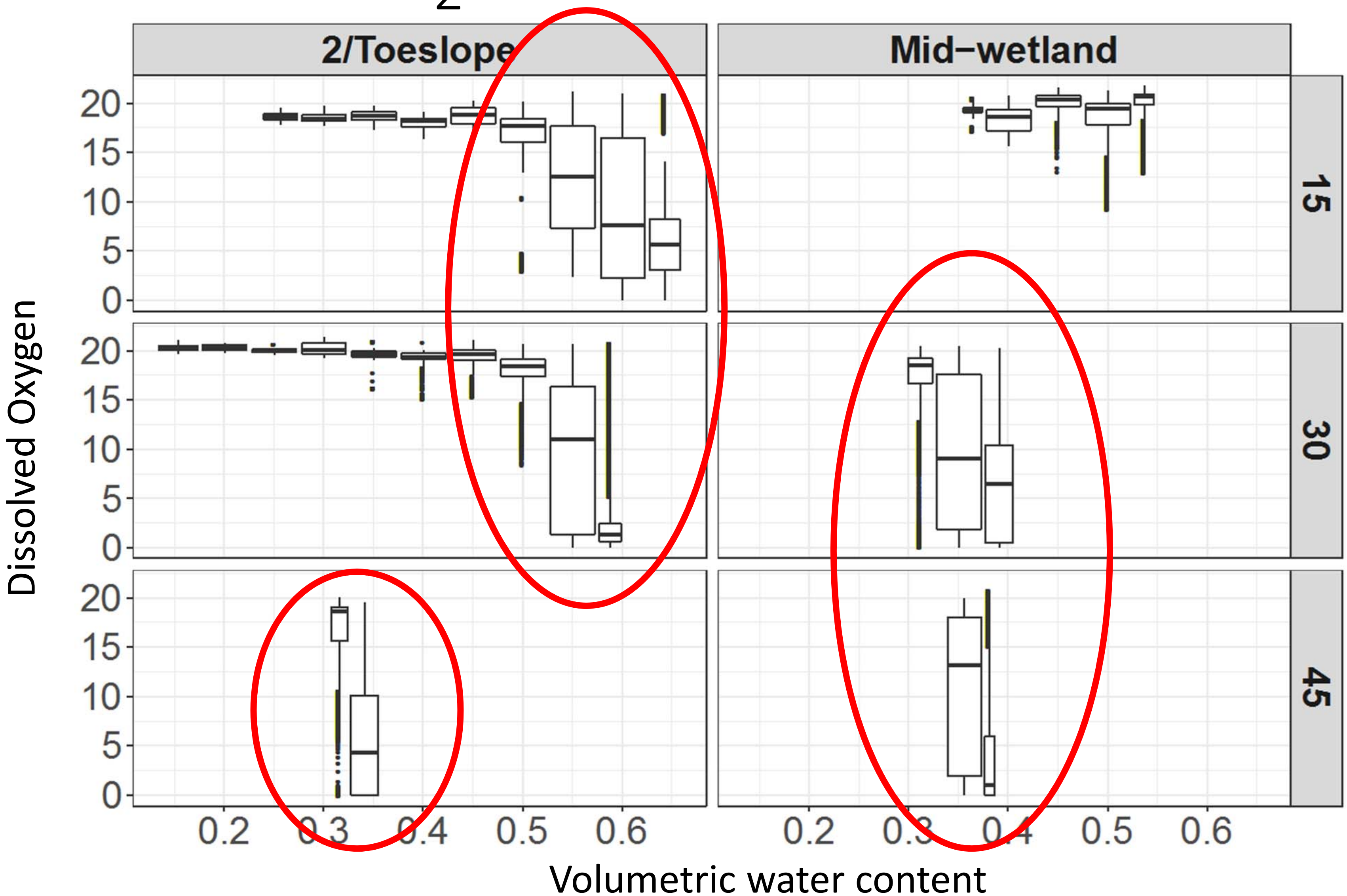
Schultz et al. 2004

Assumption: Reality:





Not so clear cut: dissolved O_2 is variable



Yr 1-2 Missisquoi river sensors

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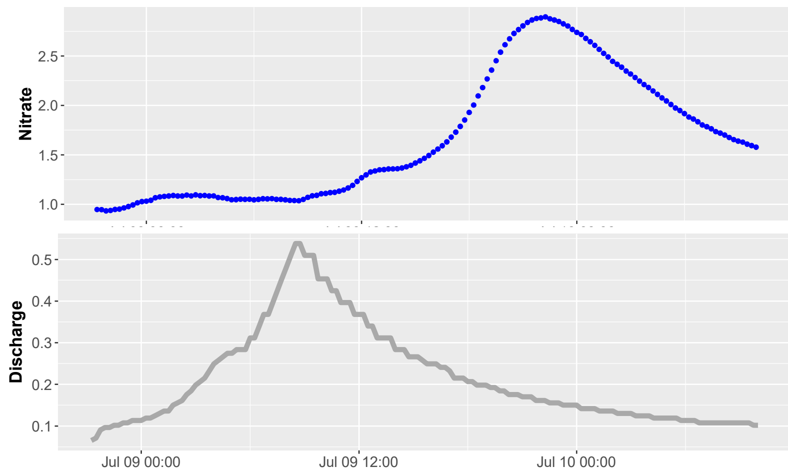
in the Lake Champlain Basin

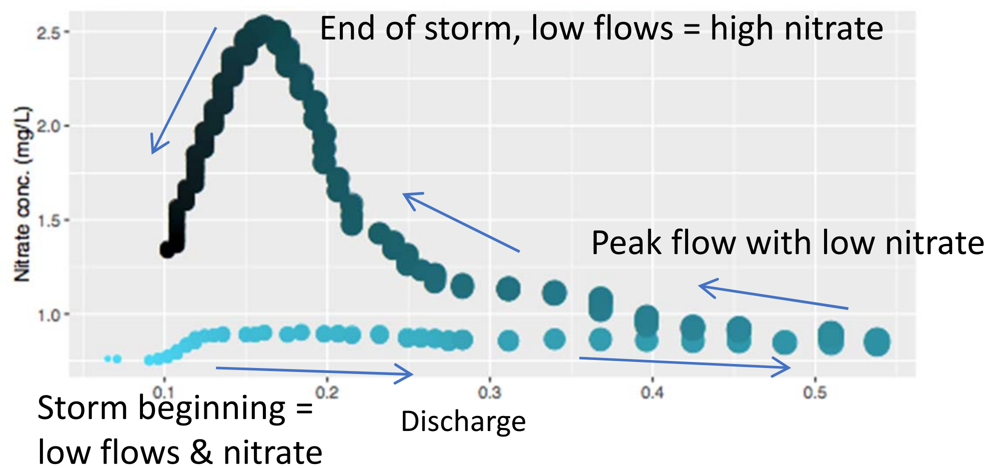
- Flow
- Sensor data:
    - DOC, POC, fDOM
    - NO_3, turbidity (Phosphorus)
    - Temperature, DO, pH, conductivity
- ISCO: nutrients and sediment
    - Targeted Water 'Grab' Sampling

Thrust 1:
Obj. 1.1b: Model watershed to lake nutrient flows

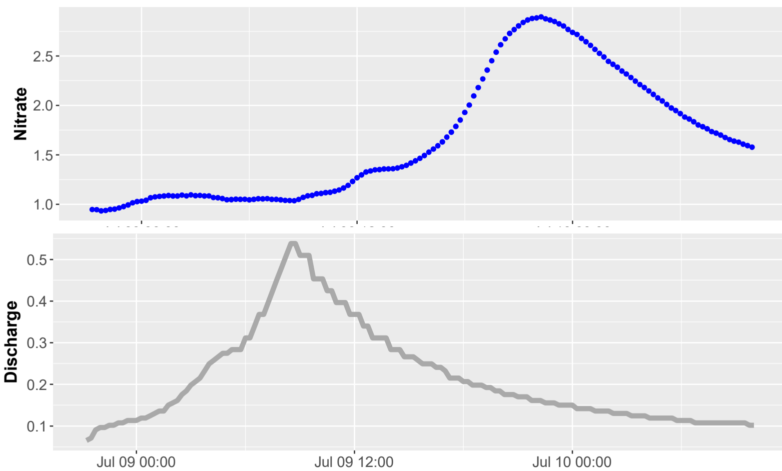
What controls water quality resiliency in the Missisquoi watershed?



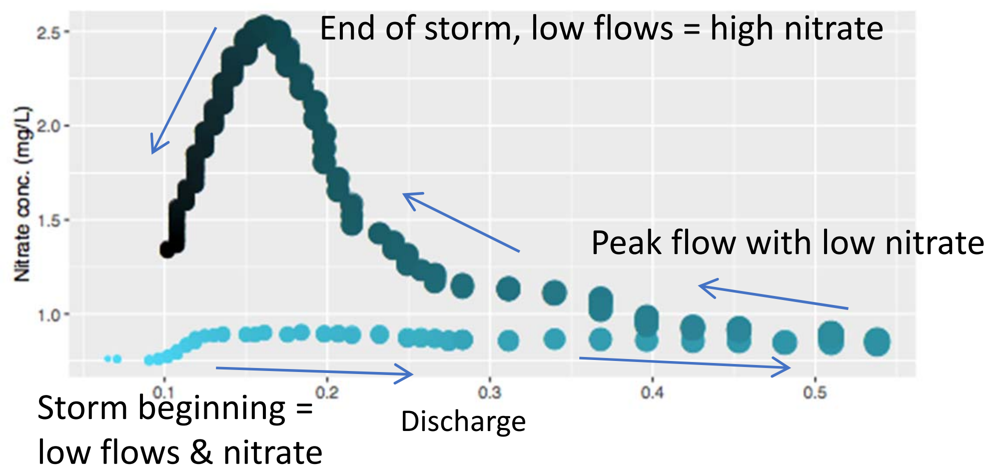
Distant sources, lower connectivity

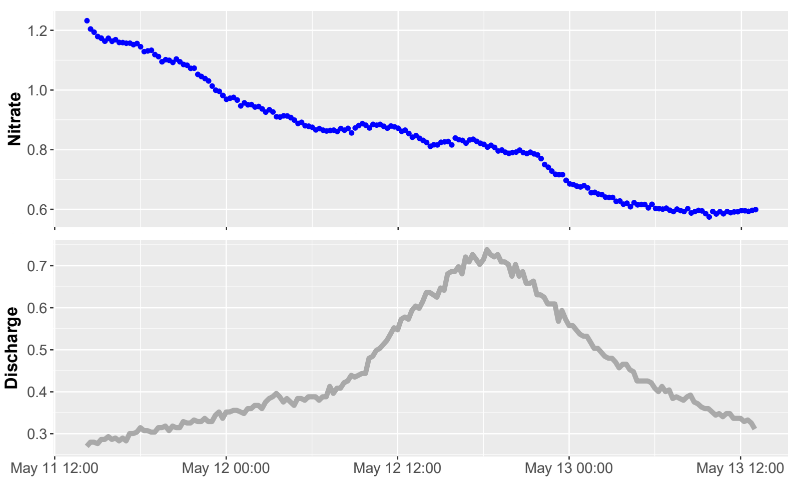


What controls water quality resiliency in the Missisquoi watershed?

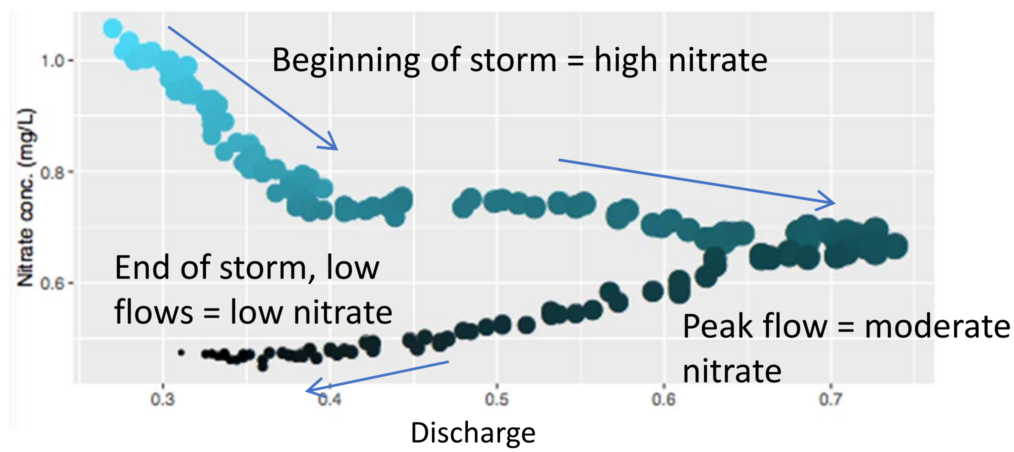


Distant sources, lower connectivity





Nearby sources, higher connectivity



What controls water quality resiliency in the Missisquoi watershed?

Same location

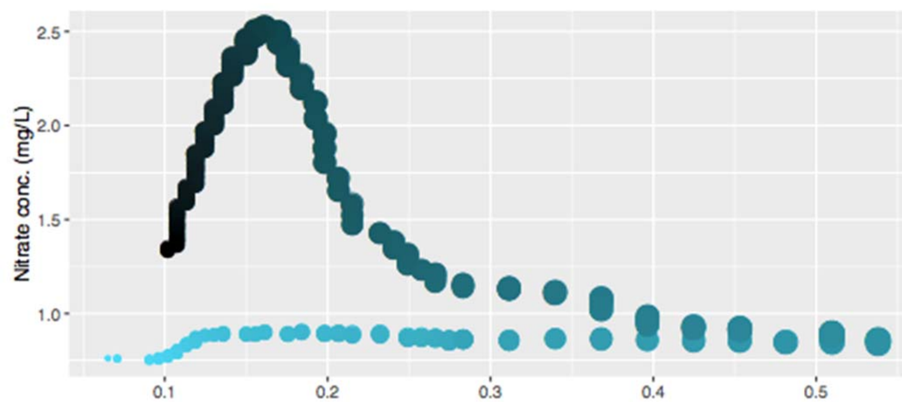
Different dynamics

In watersheds, what

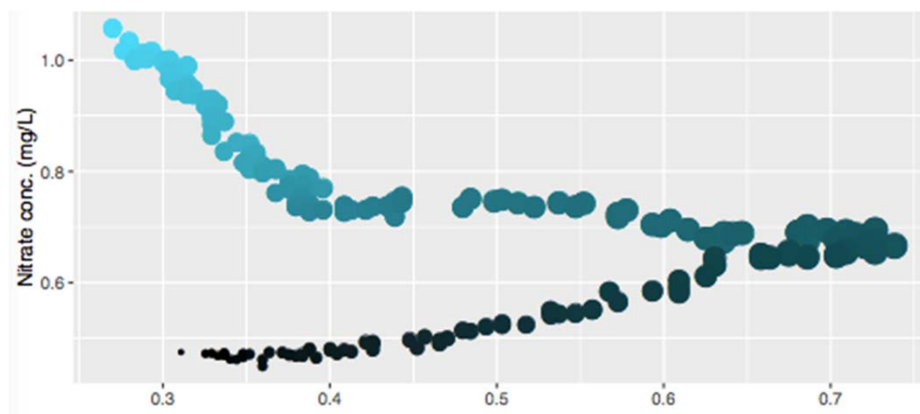
- Conditions
- Properties
- Human activities

account for these differences?

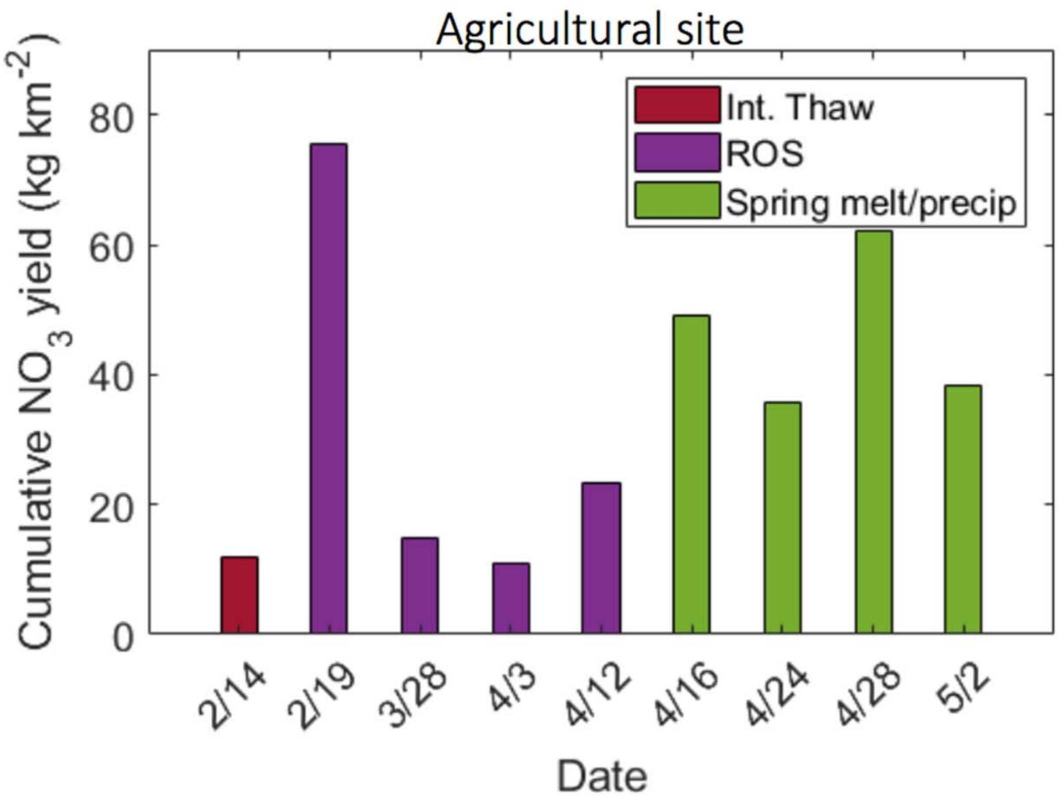
Distant sources, lower connectivity



Nearby sources, higher connectivity

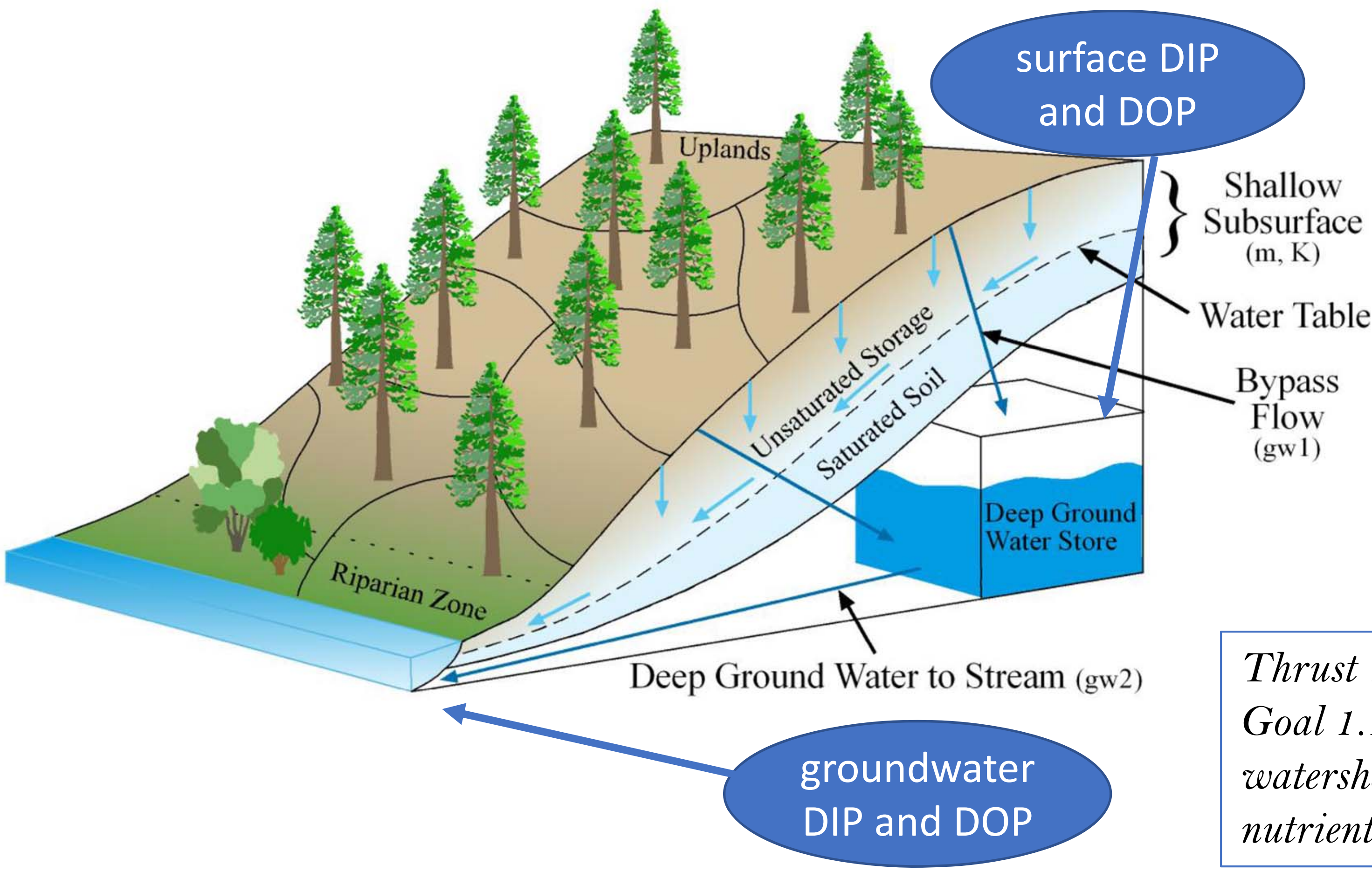


Event-scale NO_3 fluxes



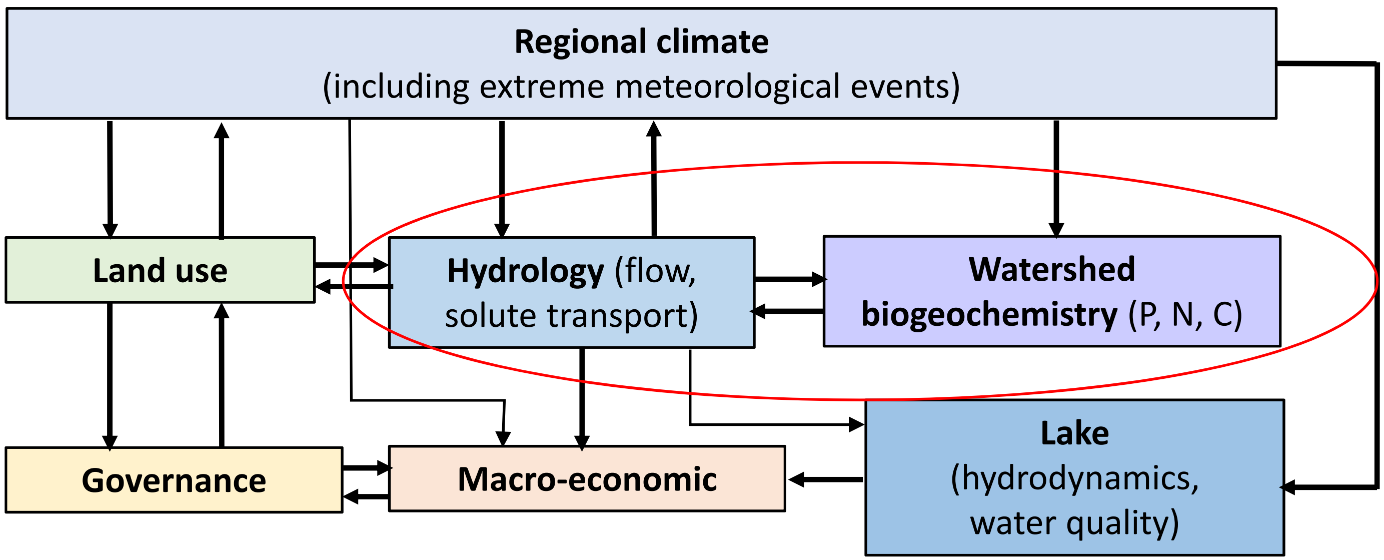
- Largest single event contribution to annual loads occurred during ROS event
- Combined spring events: 55% of measured annual loads
    - ROS: 22% of measured annual loads
    - Spring melt/precip: 31% of measured annual loads

Year 1-2 modeling: P incorporation



Thrust 1:
Goal 1.1b: Model watershed to lake nutrient flows

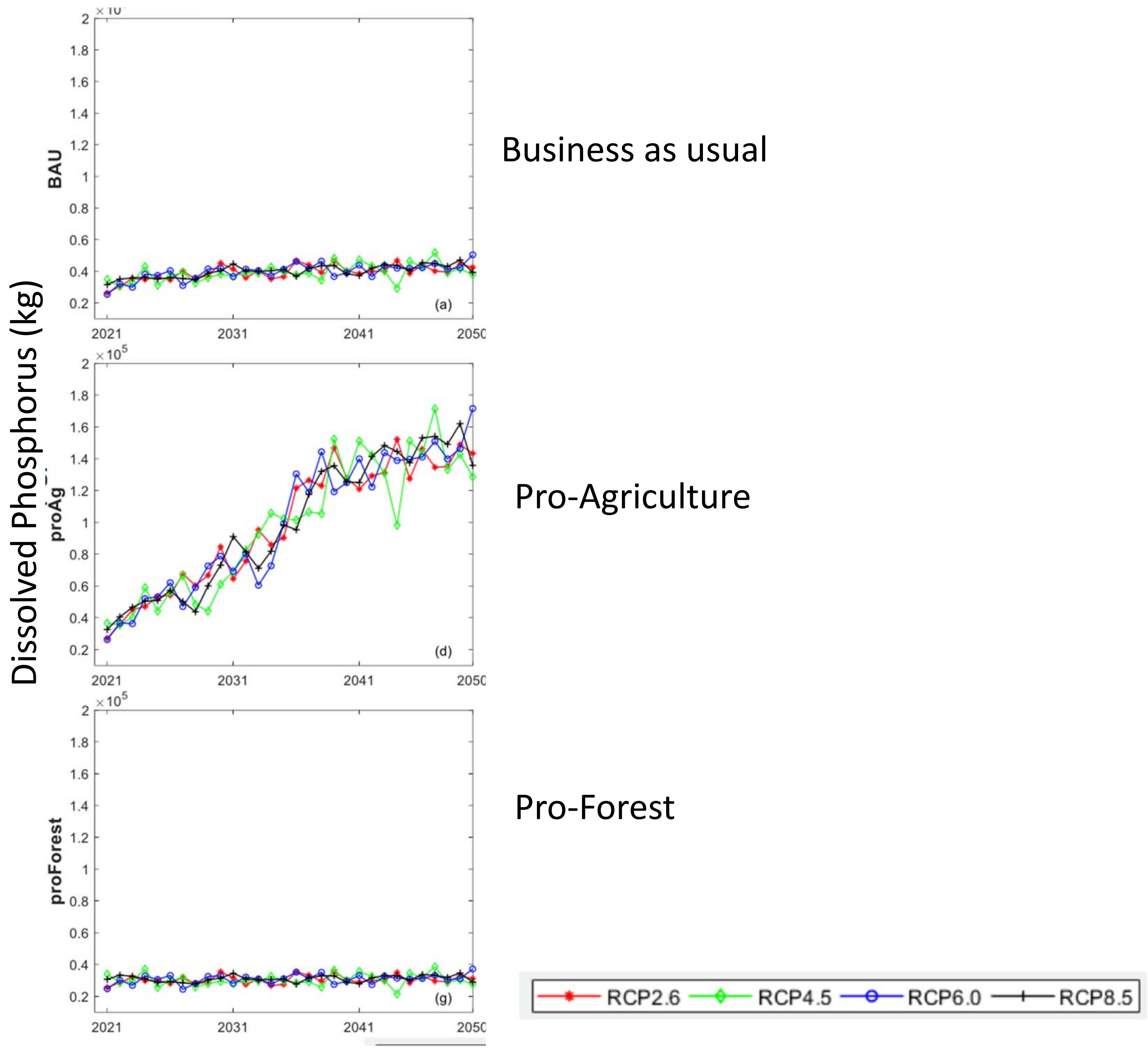
Major Features of the BREE Integrated Assessment Model



Slide 33

AZ [15]1 For structural uncertainties, it will be useful to engage stakeholders in a discussion, or even have them do an exercise.
Asim Zia, 5/22/2017

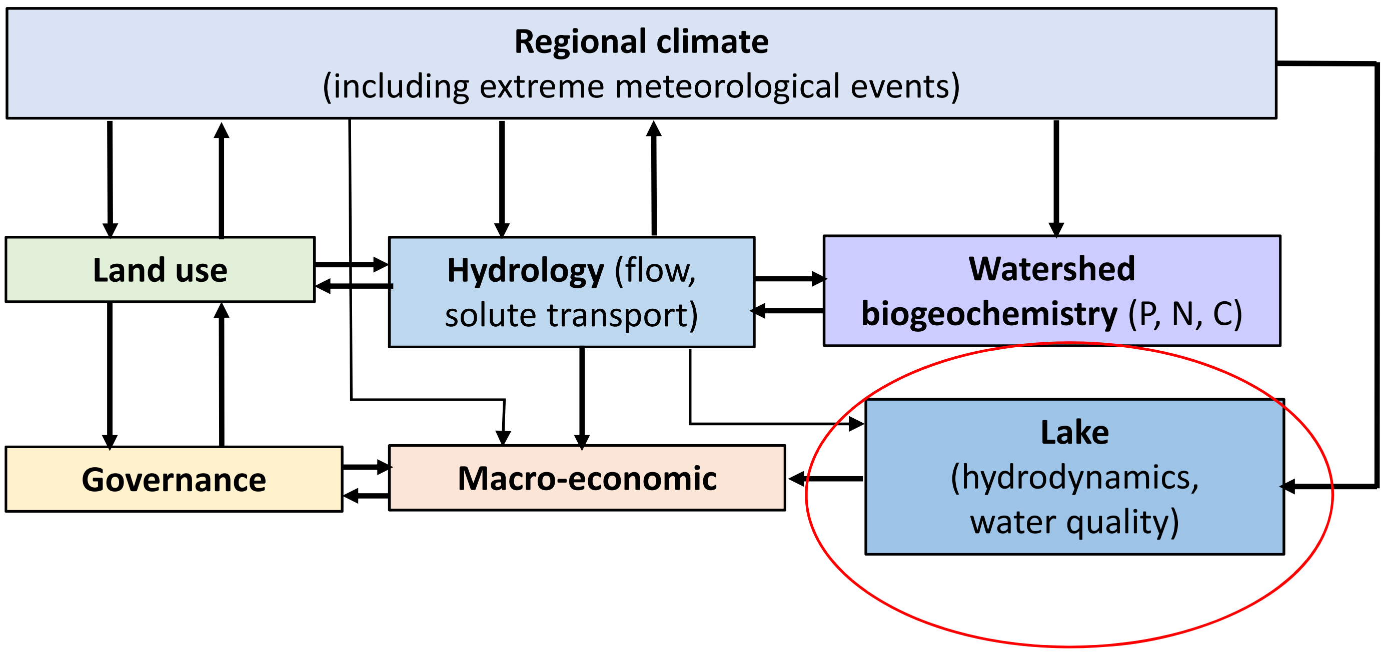
Land use impacts P loads more than climate



Lake

Thrust 1:
Goal 1.2: Develop lake model

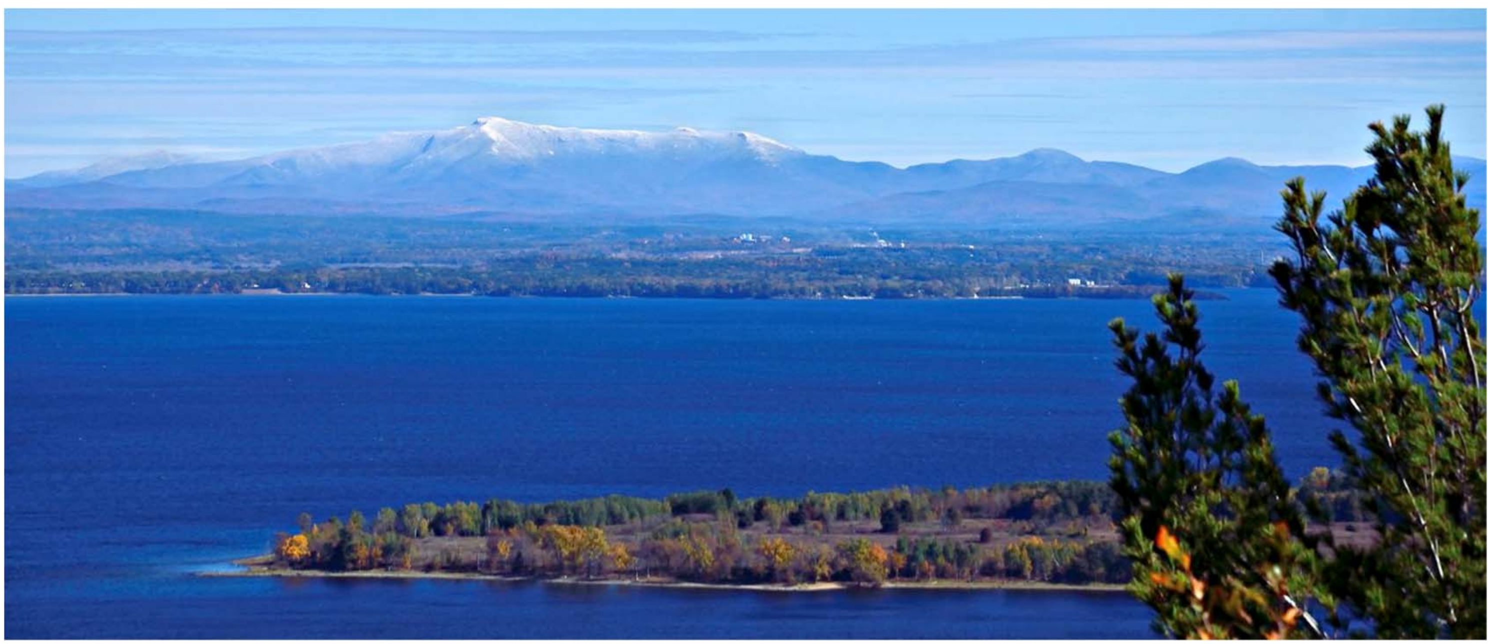
Major Features of the BREE Integrated Assessment Model



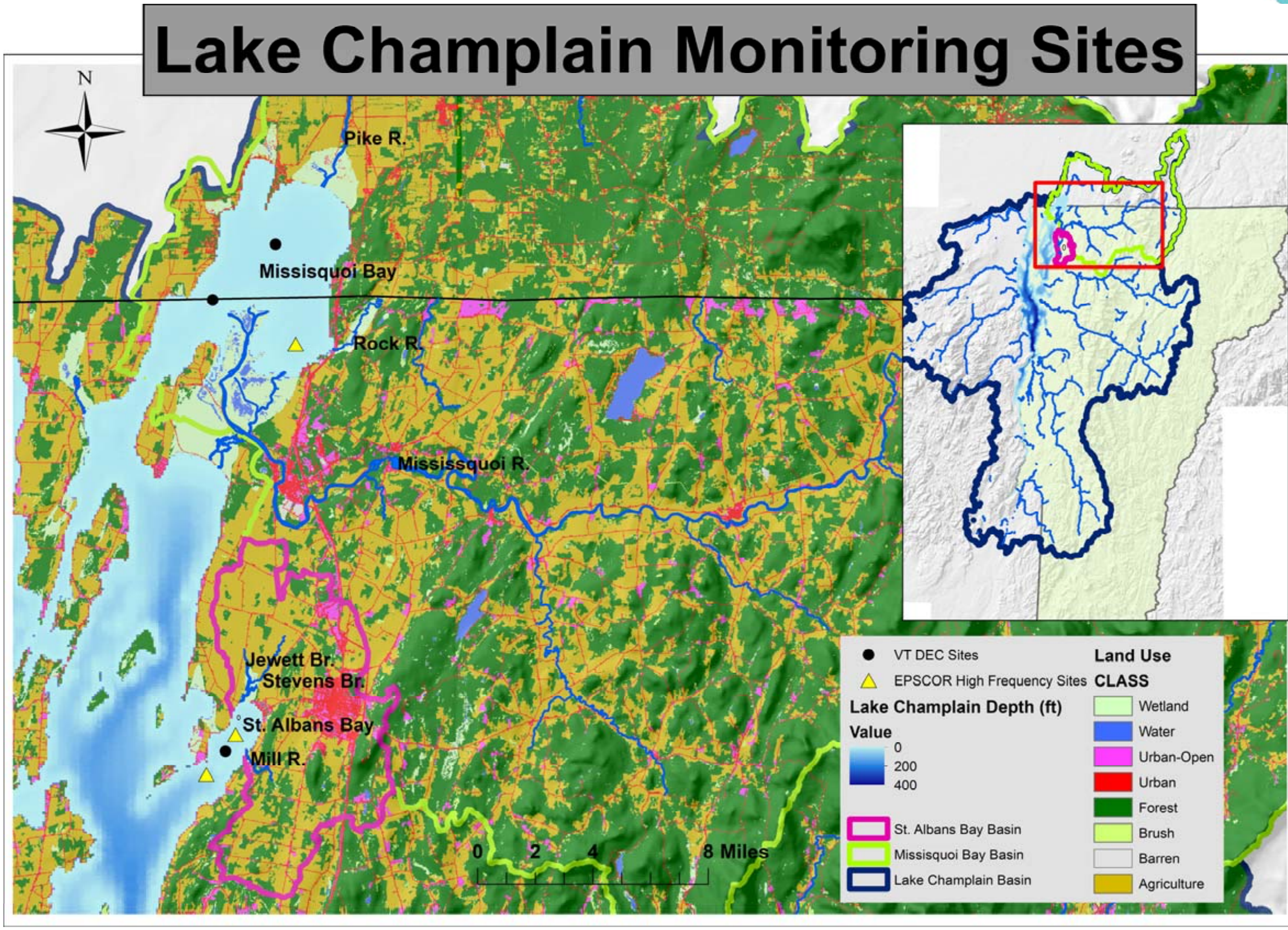
AZ [15]1 For structural uncertainties, it will be useful to engage stakeholders in a discussion, or even have them do an exercise.
Asim Zia, 5/22/2017

Lake Research Objectives
Thrust 1.2 Develop Lake Model

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



Lake Research



Shallow eutrophic systems that differ in terrestrial and open water connectivity

What processes drive water quality response to events?

Year 1-2 Deployment of Saint Albans and Missisquo Bay Advanced Biogeochemical and Hydrodynamic Observatory

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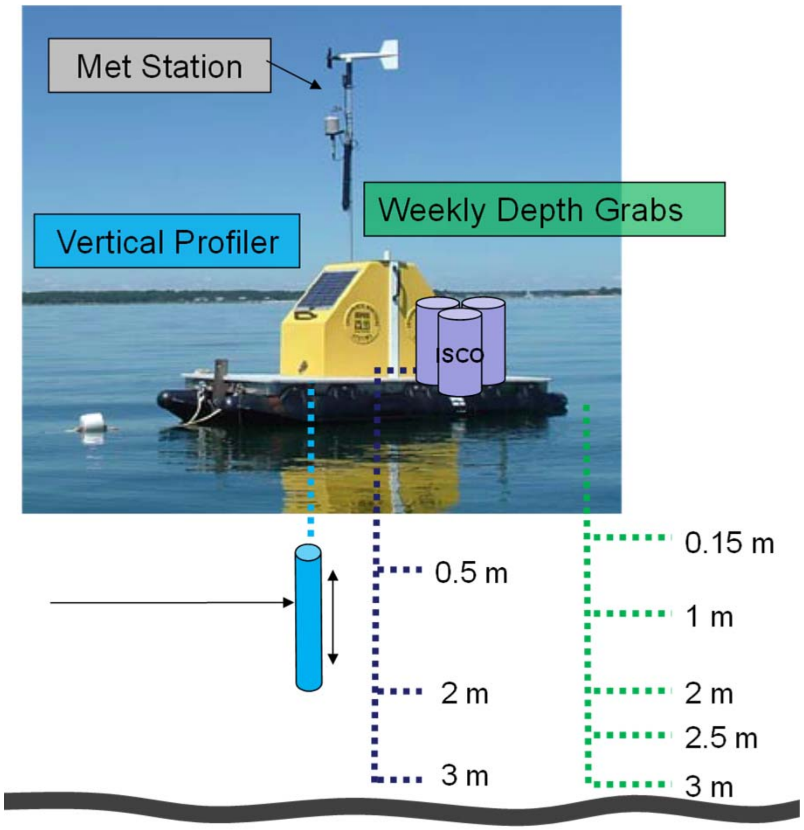


Thrust 1:
Goal 1.2 Develop Lake Model

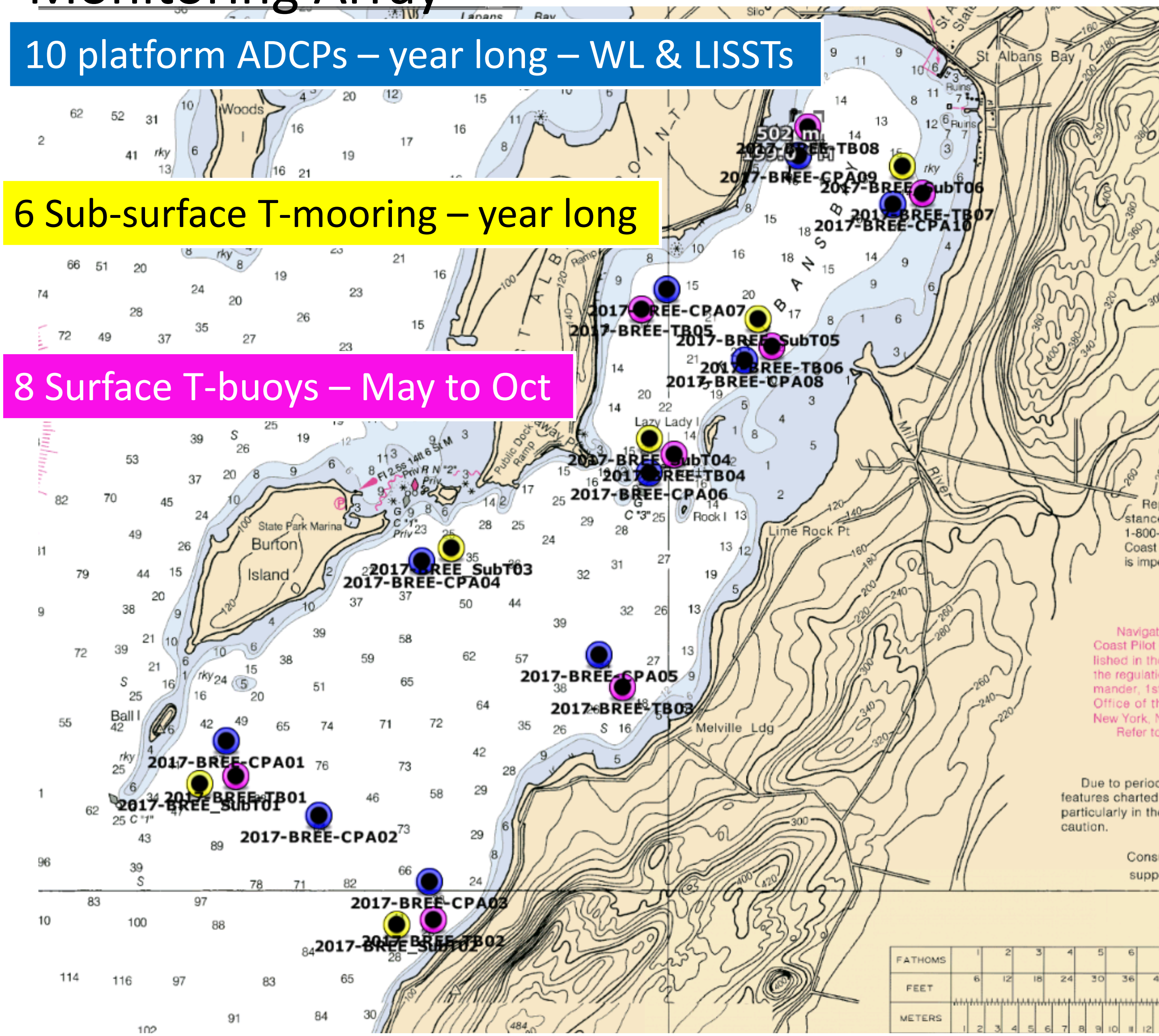
Sensors Measure-ChlA/PC, T, Cond, pH, DO, FDOM, Turbidity every hr. at 0.5 meter depth intervals at 3 Sites

Year 1-2 Saint Albans Hydrodynamic Monitoring Array

10 platform ADCPs – year long – WL & LISSTs

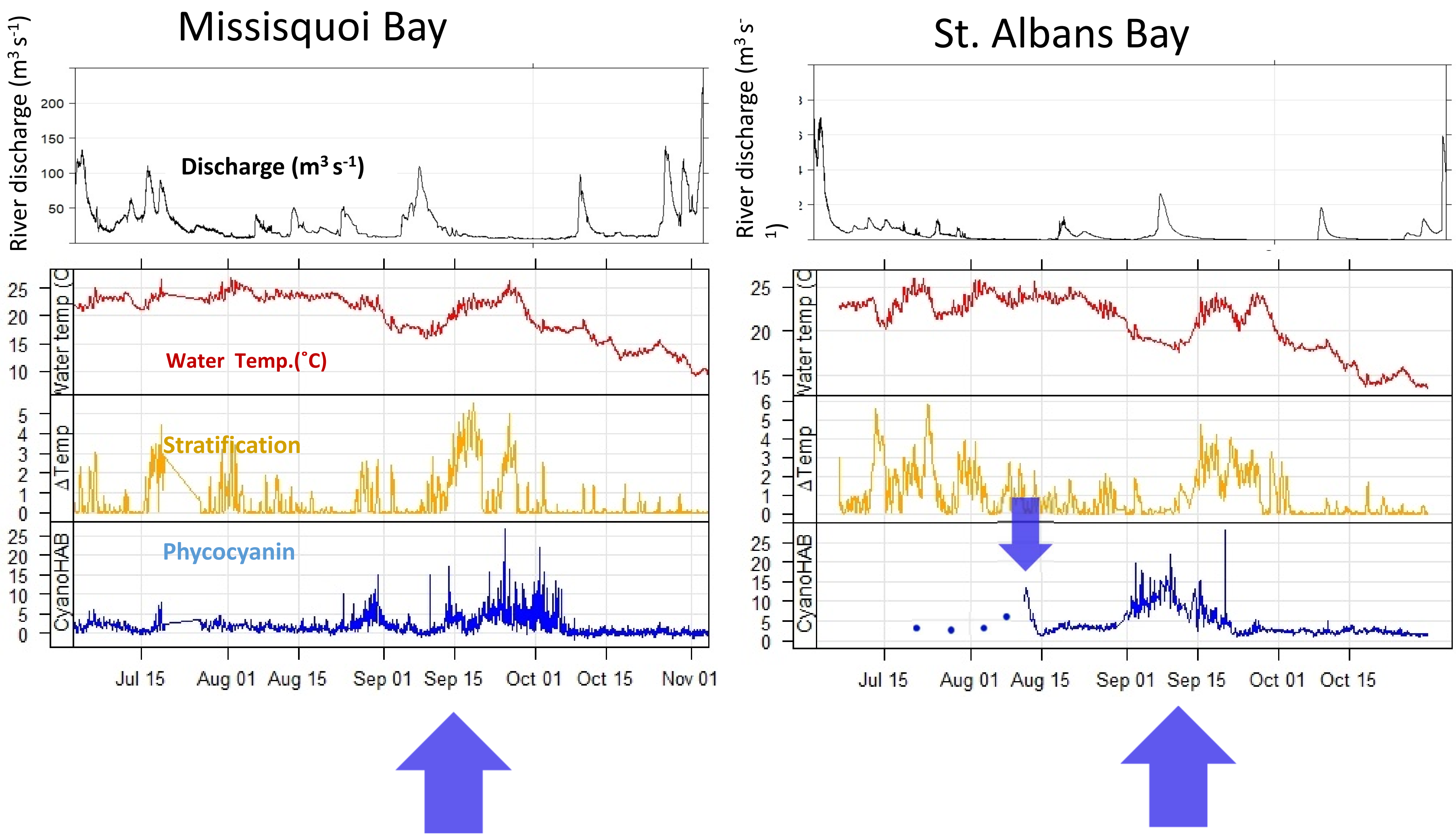
6 Sub-surface T-mooring – year long

8 Surface T-buoys – May to Oct

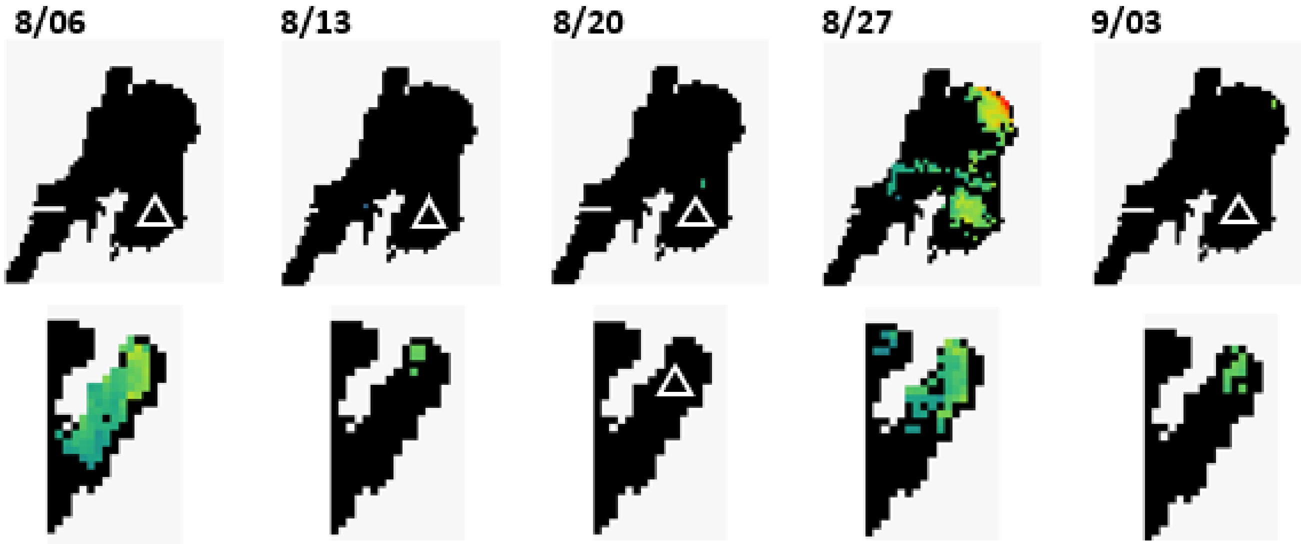


Thrust 1:
Goal 1.2: Model lake

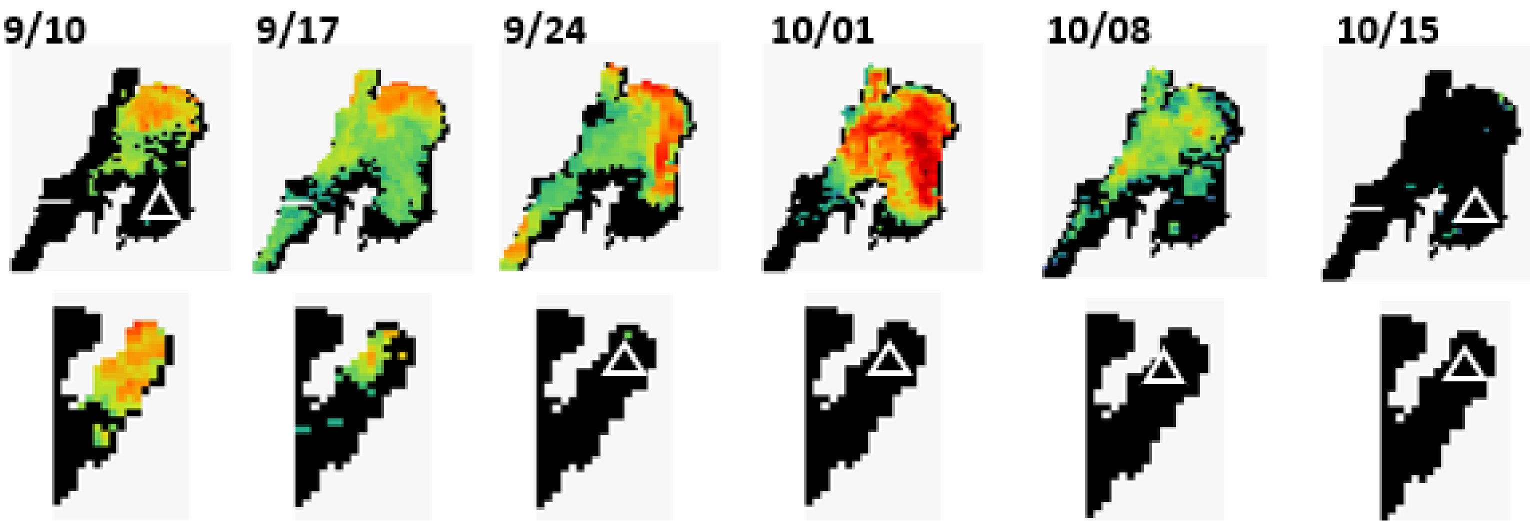
Sensors reveal 2017 blooms were late and had different timing



Satellite mostly confirms 2017 differences, provides spatial context

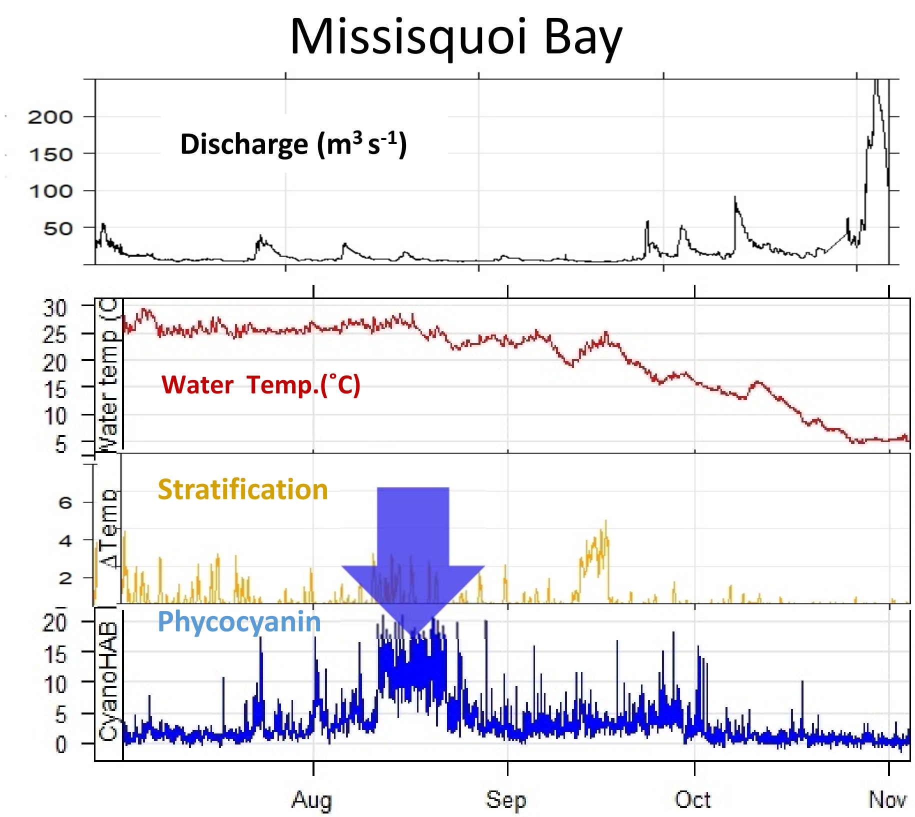


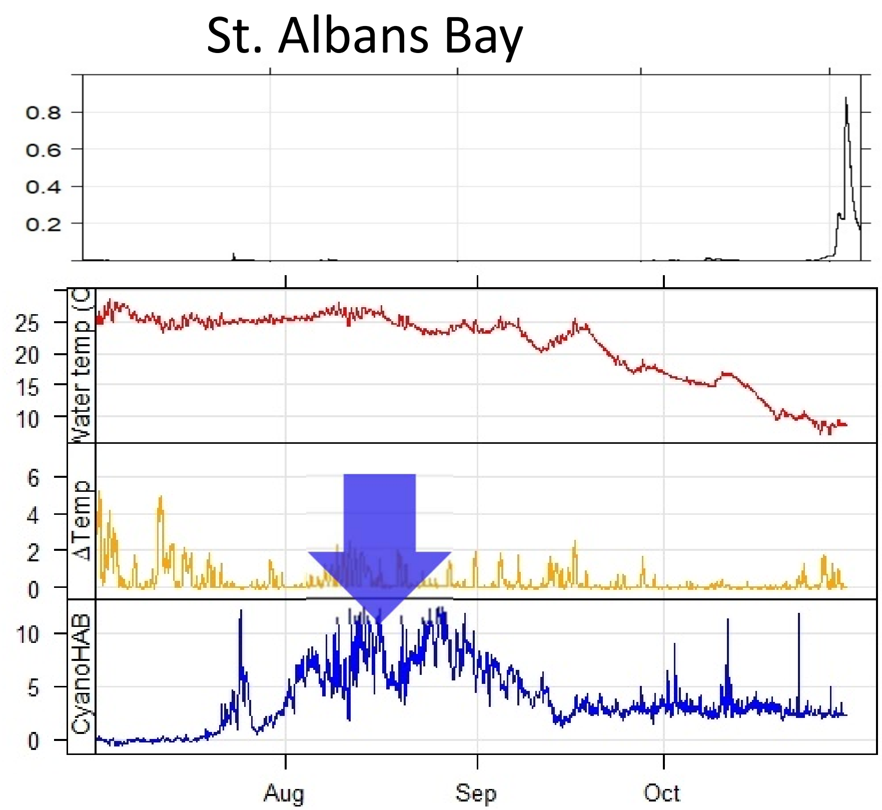
New collaboration with NOAA, early warning system proposal development



***Composite images of weekly maximum values for each pixel**

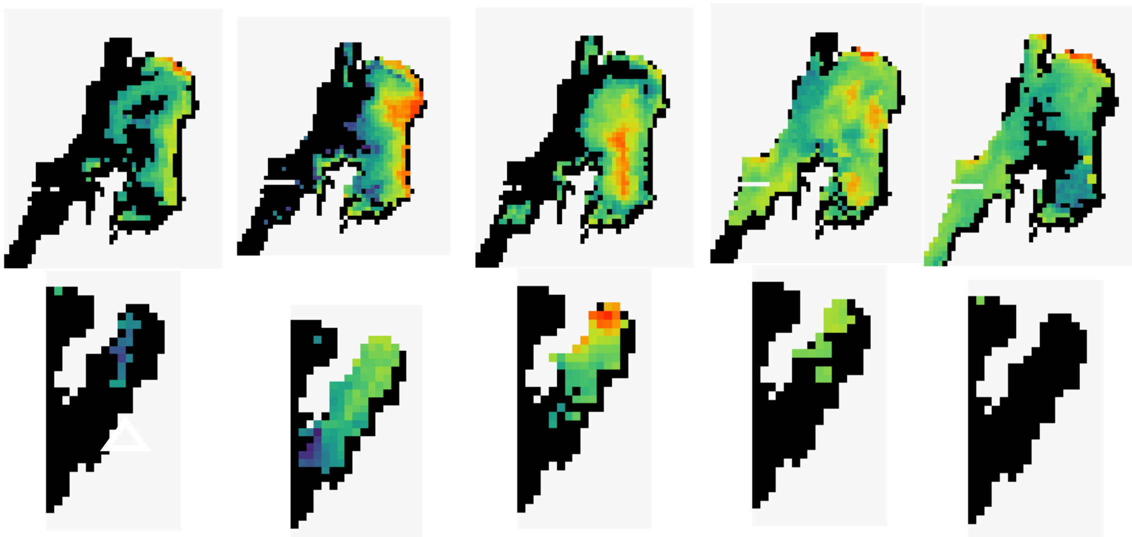
2018 bloom earlier than 2017 and similar timing between bays



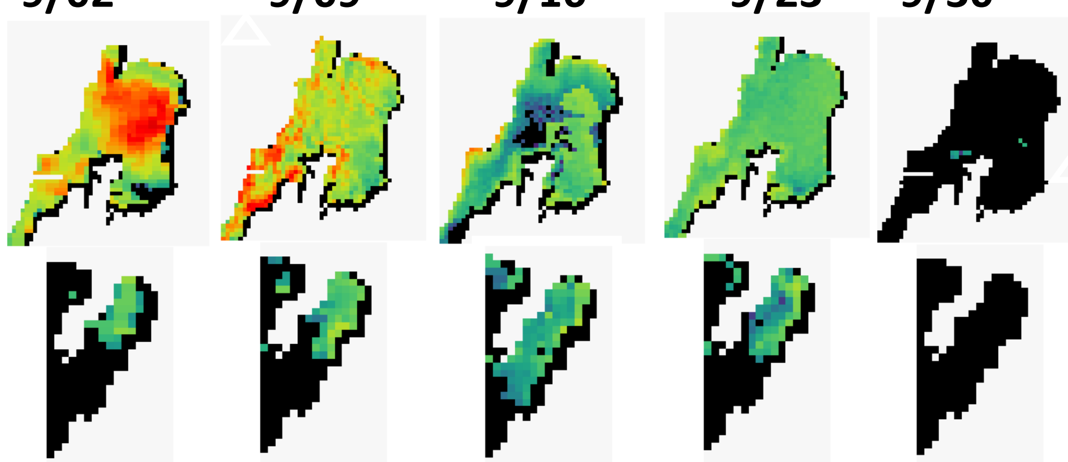


Satellite mostly confirms 2018 similarities, different peaks for MB

7/29 8/05 8/12 8/19 8/26

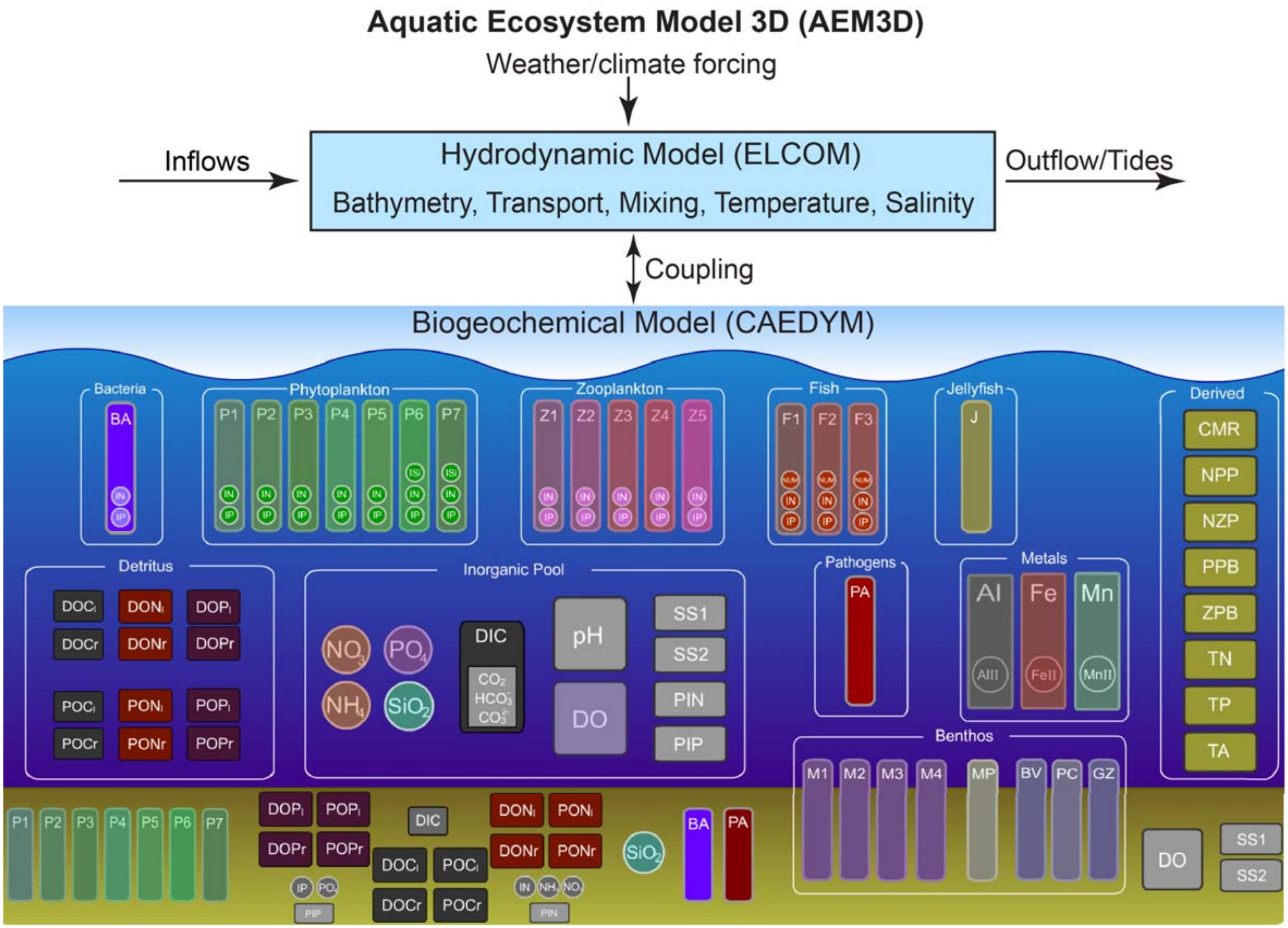


9/02 9/09 9/16 9/23 9/30



***Composite images of weekly maximum values for each pixel**

Lake Modeler Hired, Model Selected and Under Development



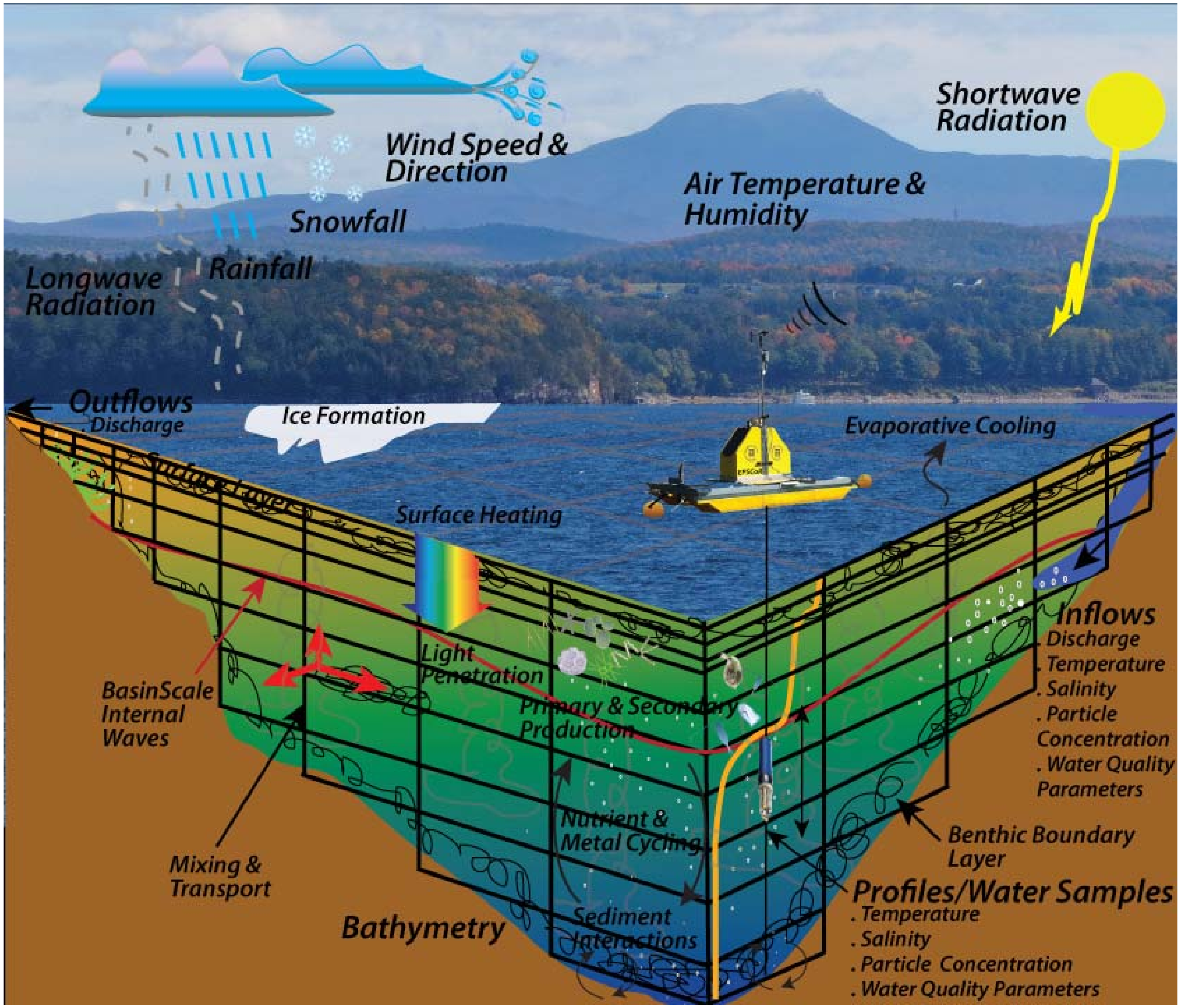
Thrust 1: Ecological Systems
Objective 1.2a: Develop lake model

Lake Model (AEM3D; ELCOM-CAEDYM)
3D coupled Hydrodynamic-Aquatic Ecosystem Model

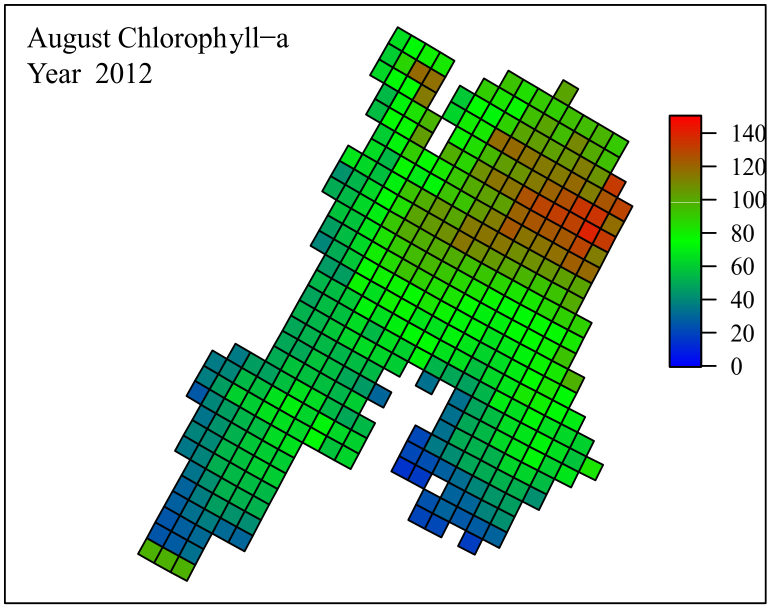
Processes Simulated

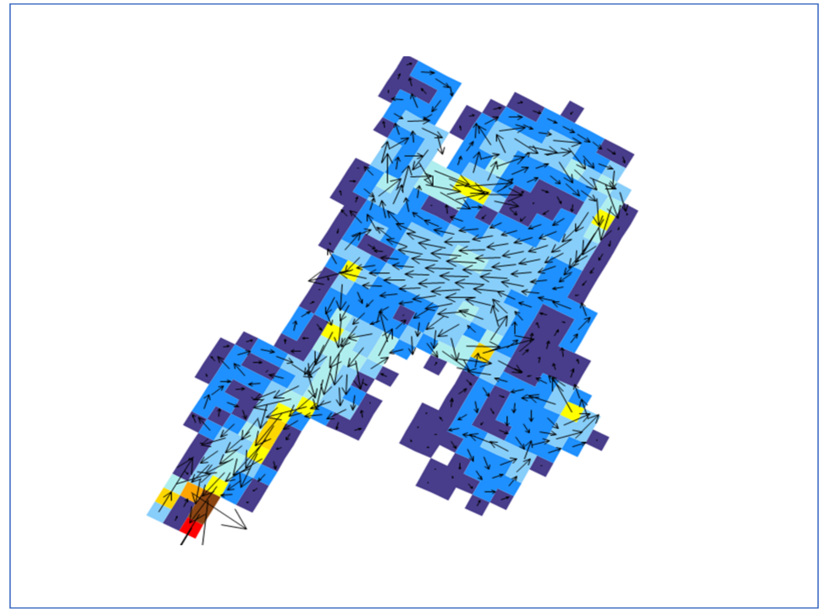
Hydrodynamics: Motions of the water body and the transport and mixing of all simulated constituents due to these motions.

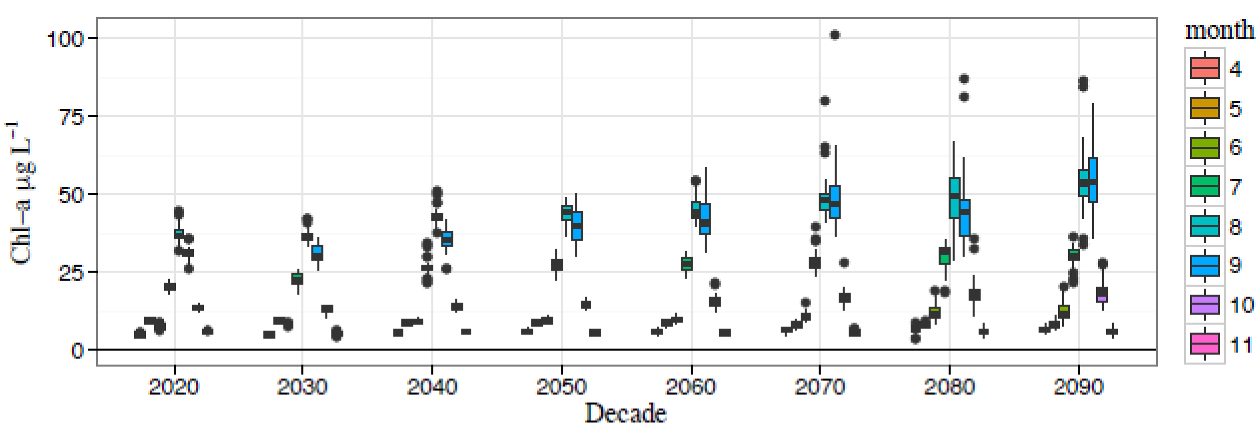
Biogeochemical processes: Primary and secondary production, nutrient and metal cycling and sediment interactions.



Ongoing Lake Modeling: Climate Change, Response to Events, Watershed Management







Thrust 1:
Goal 1.2: Model lake