Vermont EPSCoR

Experimental Program to Stimulate Competitive Research

Understanding Drivers of Water Quality and Eutrophication in the Lake Champlain Basin: RACC and NEWRnet Progress and Context

Andrew Schroth

Talk Outline

Research Introduction

Environmental Monitoring Infrastructure

Missisquoi Bay Studies

Lake Champlain-Wide Studies

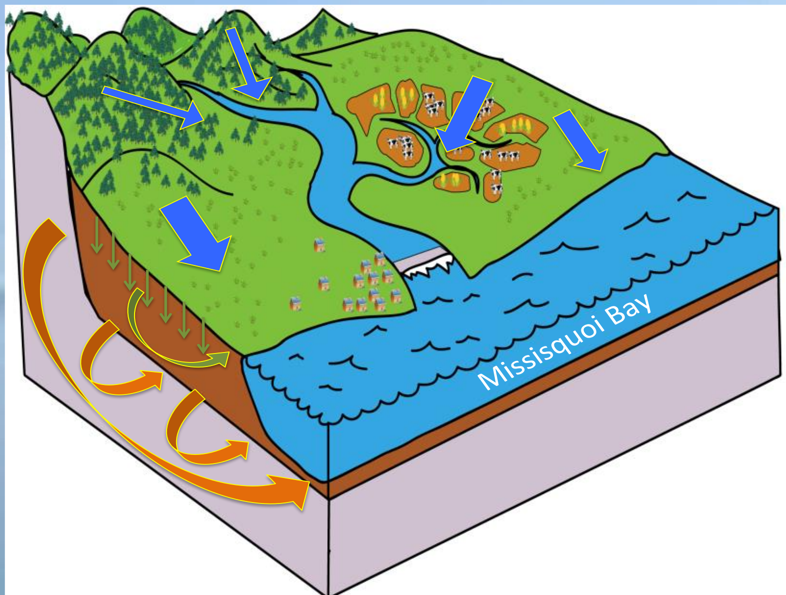
Research on Adaptation to Climate Change Question 1

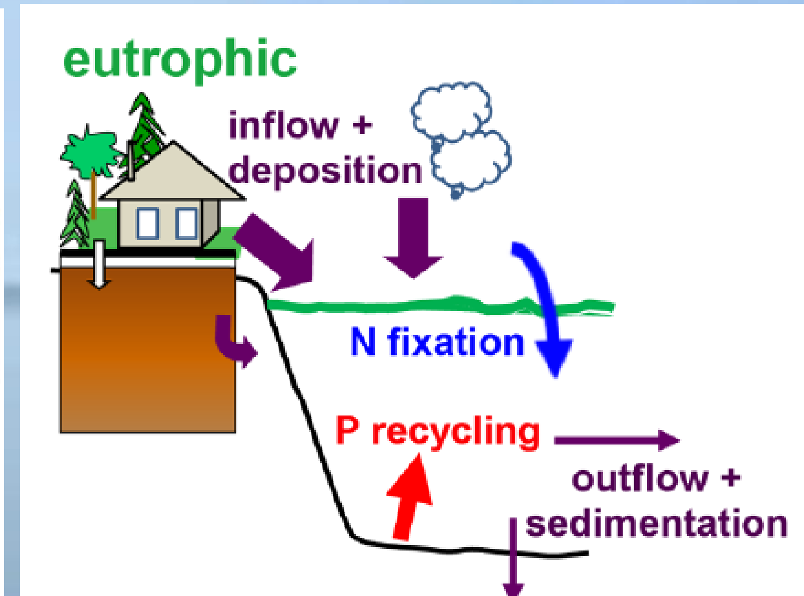
- Q1: What is the relative importance of endogenous (in-lake) processes versus exogenous (to-lake) processes to eutrophication and harmful algal blooms?

Internal

External

Integrated Research Approach



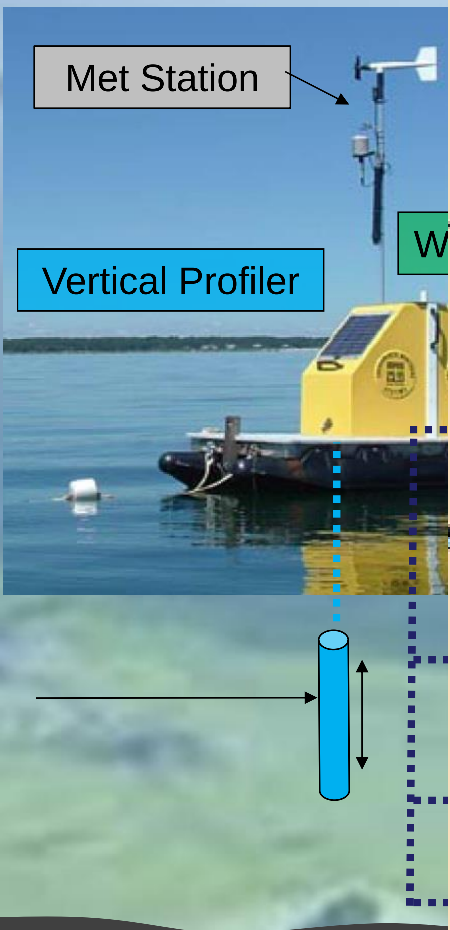


- What are the important sources of nutrients & sediment to the lake?
- How do land use, seasonality and climate affect the nature and strength of these sources?
- How are nutrients and sediments transformed and cycled within the lake over time and space?
- How do the loadings of these materials and hydrodynamics affect lake processes and ecosystems?

What we have accomplished?

Missisquoi Bay Advanced Environmental Observatory

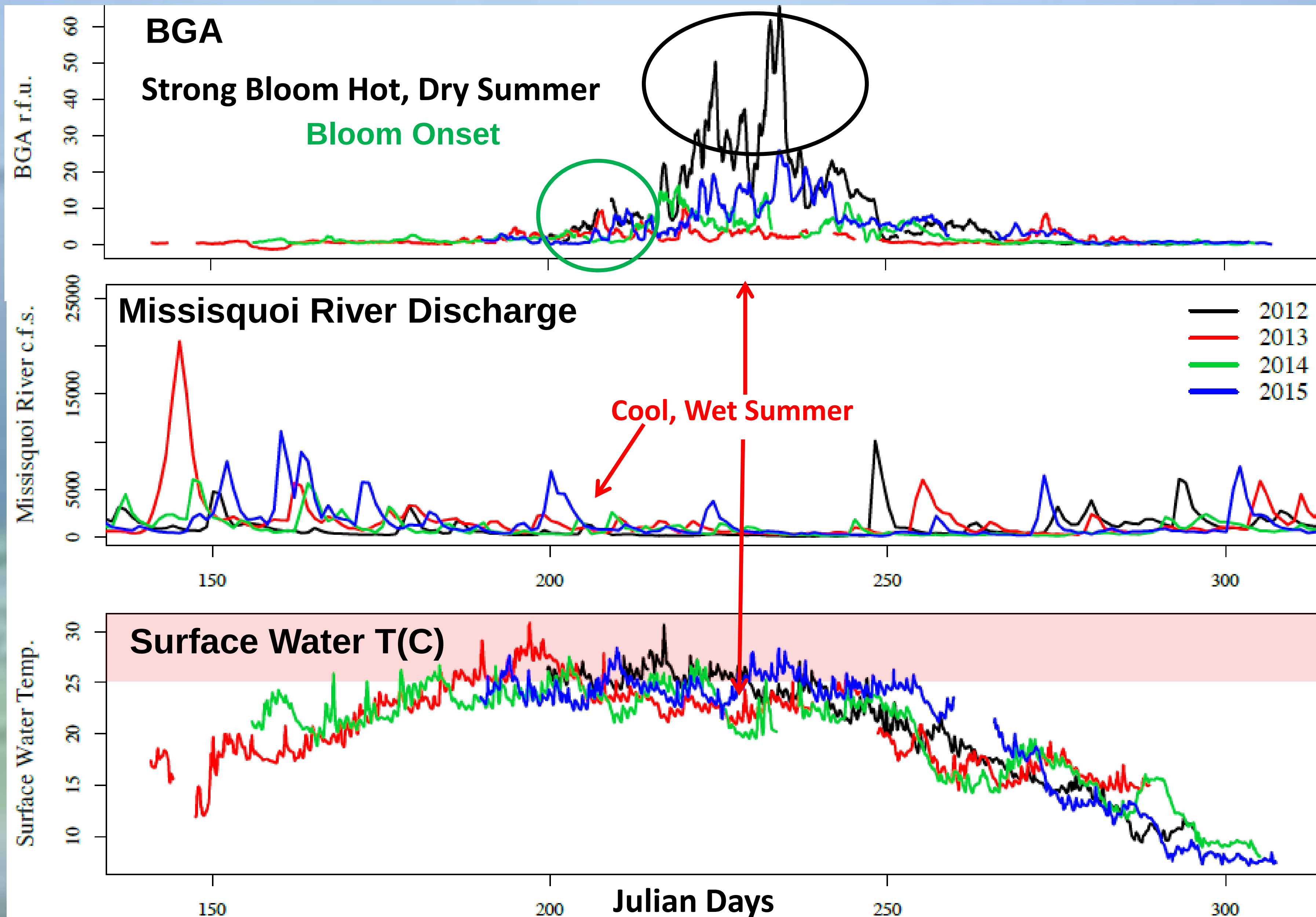
UVM Biogeochemica



Middlebury ydrodynamics

Continuous Monitoring Since 2012

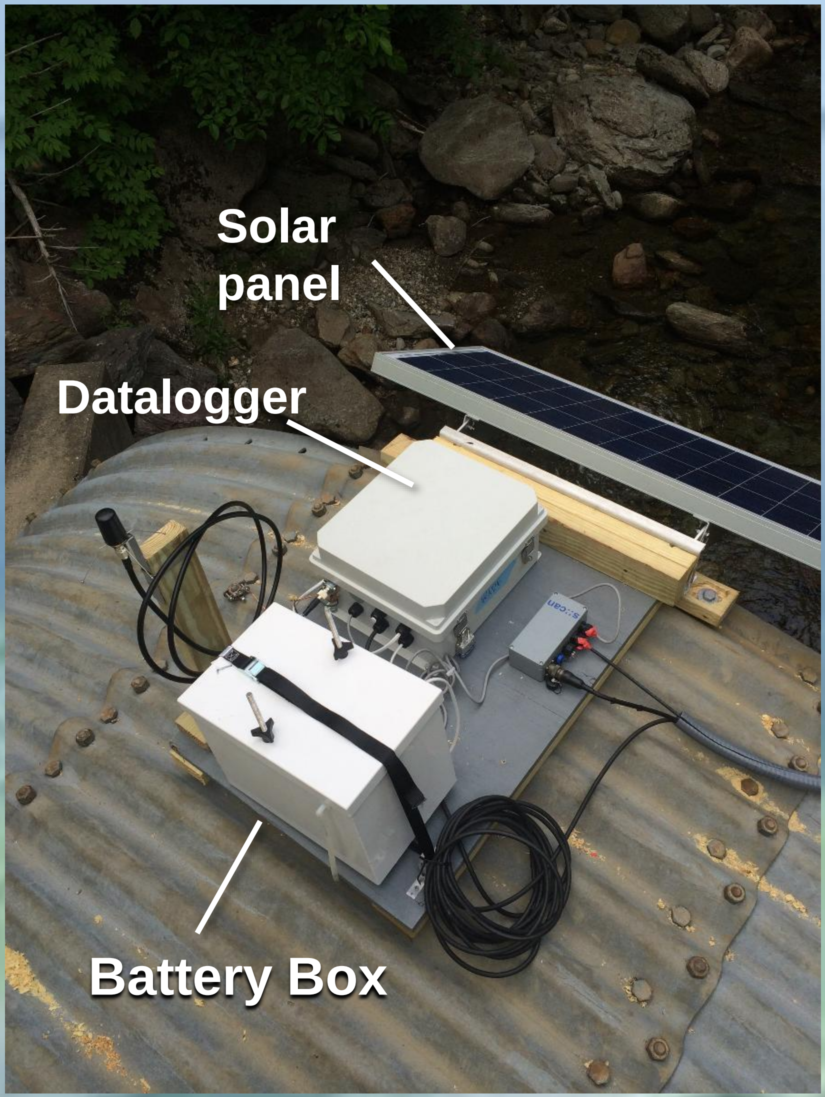
New high-frequency data reveals dramatic inter-annual variability in internal/external drivers and ecosystem response

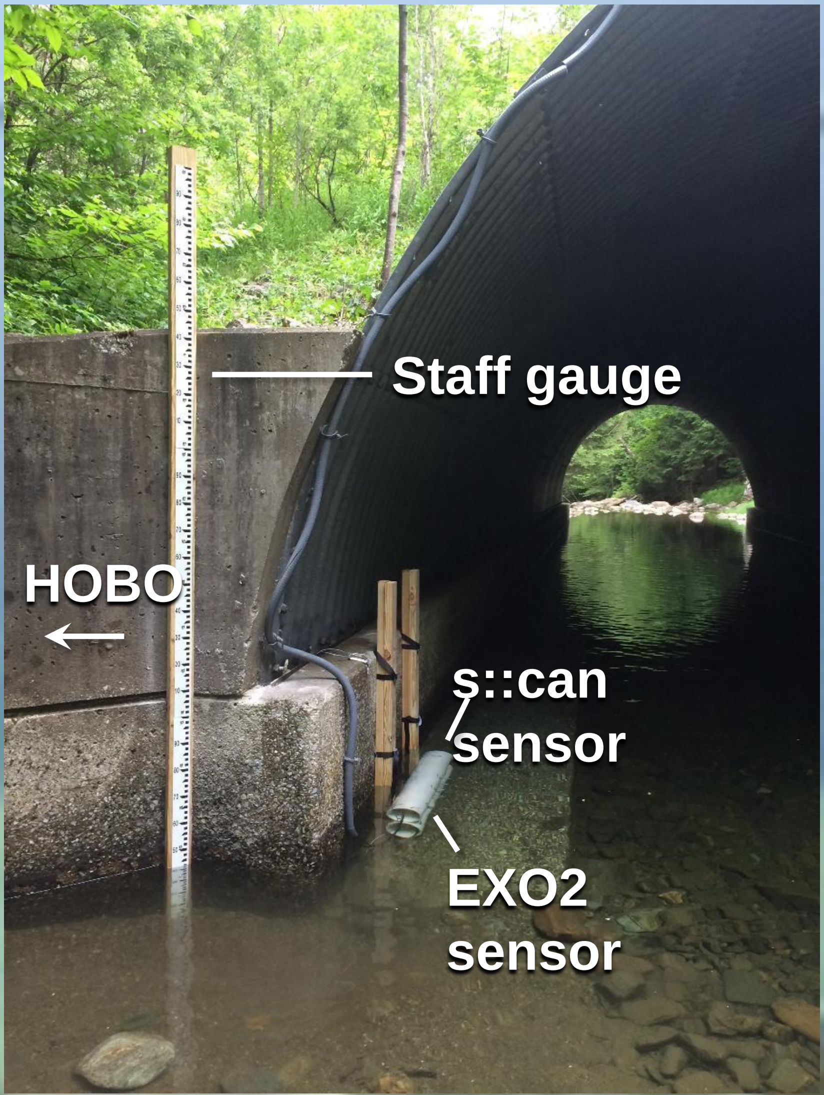


NEWRnet Sensor Network

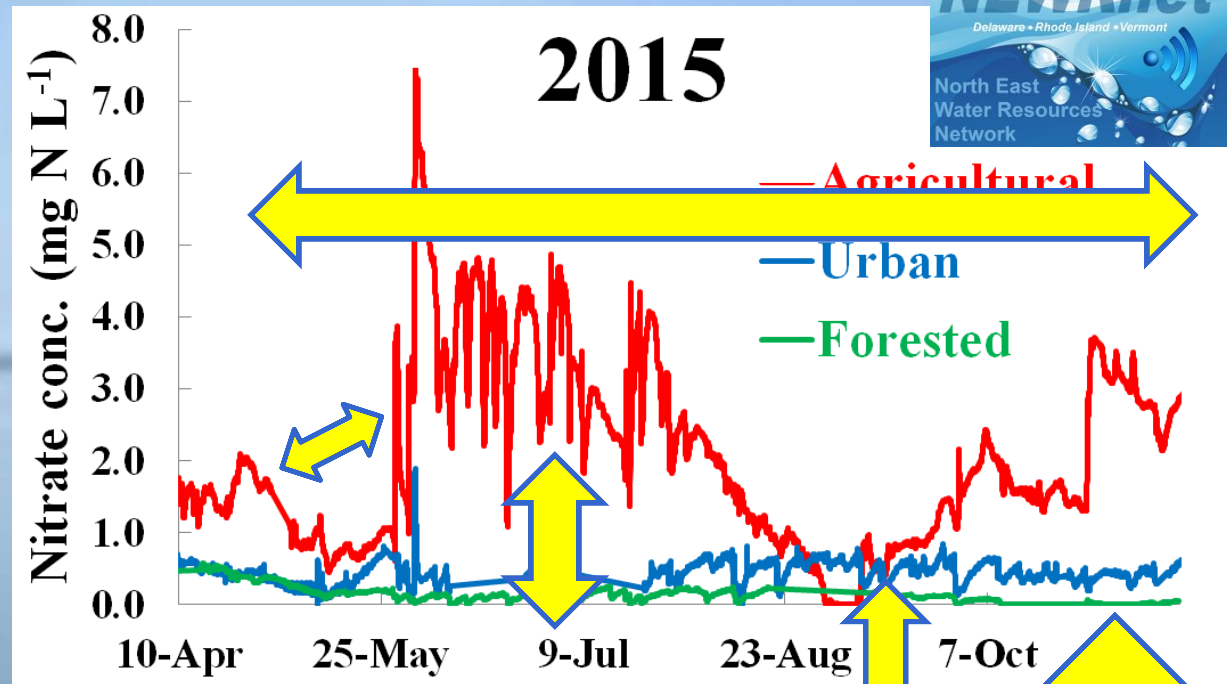
How do land use, seasonality and climate affect the nature and strength of these sources?

NEWRnet Field Installations



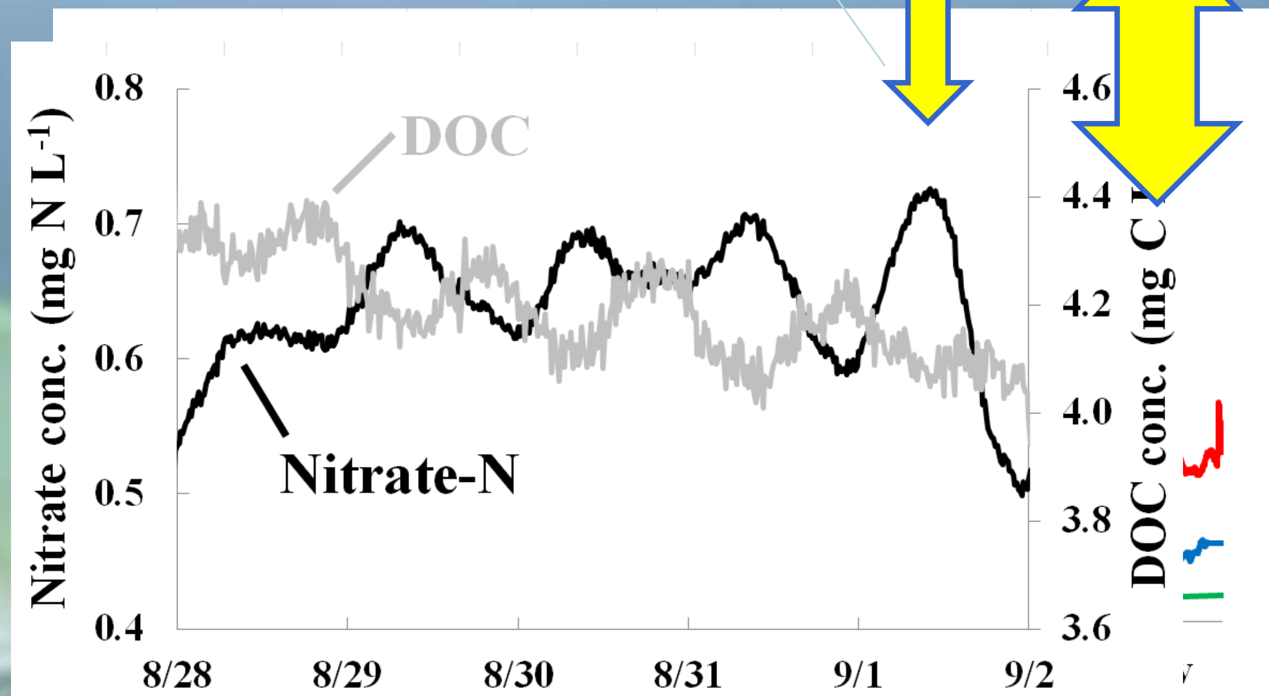


Example NEWRnet Sensor Data



Study:

- Landcover Effects
- Seasonal Dynamics
- Event Variability
- Inter-Annual Variability (in all of the above)
- Diurnal Cycling



Research Highlights and Next Steps

Journal of Environmental Quality — TECHNICAL REPORTS
SURFACE WATER QUALITY

Characterization of Organic Phosphorus Form and Bioavailability in Lake Sediments using ^{31}P Nuclear Magnetic Resonance and Enzymatic Hydrolysis

Courtney D. Giles,* Lydia G. Lee, Barbara J. Cade-Menun, Jane E. Hill, Peter D. F. Isles, Andrew W. Schroth, and Gregory K. Druschel

Journal of Great Lakes Research 41 (2015) 818–829
Contents lists available at ScienceDirect
ELSEVIER — Journal of Great Lakes Research — IAGLR
journal homepage: www.elsevier.com/locate/jglr

Dynamic internal drivers of a historically severe cyanobacteria bloom in Lake Champlain revealed through comprehensive monitoring

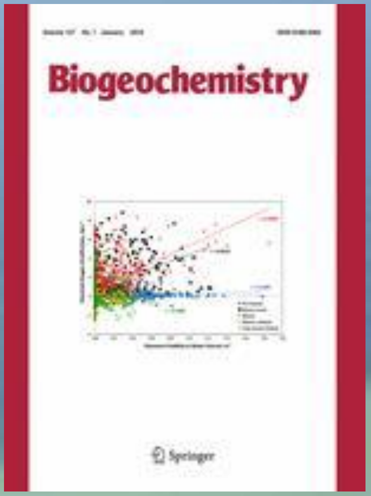
CrossMark

Peter D.F. Isles [a,b,*], Courtney D. Giles [b], Trevor A. Gearhart [b,c], Yaoyang Xu [b], Greg K. Druschel [b,d], Andrew W. Schroth [b,e]

Freshwater Biology
Freshwater Biology (2015) doi:10.1111/fwb.12615

Quantile regression improves models of lake eutrophication with implications for ecosystem-specific management

YAOYANG XU*, ANDREW W. SCHROTH*,†, PETER D. F. ISLES*,‡ AND DONNA M. RIZZO*,§



Environmental Science & Technology — Article
pubs.acs.org/est

1 **Dynamic Coupling of Iron, Manganese, and Phosphorus Behavior in**
2 **Water and Sediment of Shallow Ice-Covered Eutrophic Lakes**

3 Andrew W. Schroth,[*,†,‡] Courtney D. Giles,[‡] Peter D.F. Isles,[‡,§] Yaoyang Xu,[‡] Zachary Perzan,[∥]
4 and Gregory K. Druschel[⊥]

LIMNOLOGY and OCEANOGRAPHY: METHODS — ASLO
Limnol. Oceanogr.: Methods 13, 2015, 237–249
doi: 10.1002/lom3.10021

Developing a 21st Century framework for lake-specific eutrophication assessment using quantile regression

Yaoyang Xu,*[1] Andrew W. Schroth,[2] Donna M. Rizzo[3]

Journal of Great Lakes Research 41 (2015) 818–829

ELSEVIER

Contents lists available at ScienceDirect

Journal of Great Lakes Research

journal homepage: www.elsevier.com/locate/jglr

IAGLR

Dynamic internal drivers of a historically severe cyanobacteria bloom in Lake Champlain revealed through comprehensive monitoring

CrossMark

Peter D.F. Isles [a,b,*], Courtney D. Giles [b], Trevor A. Gearhart [b,c], Yaoyang Xu [b], Greg K. Druschel [b,d], Andrew W. Schroth [b,e]

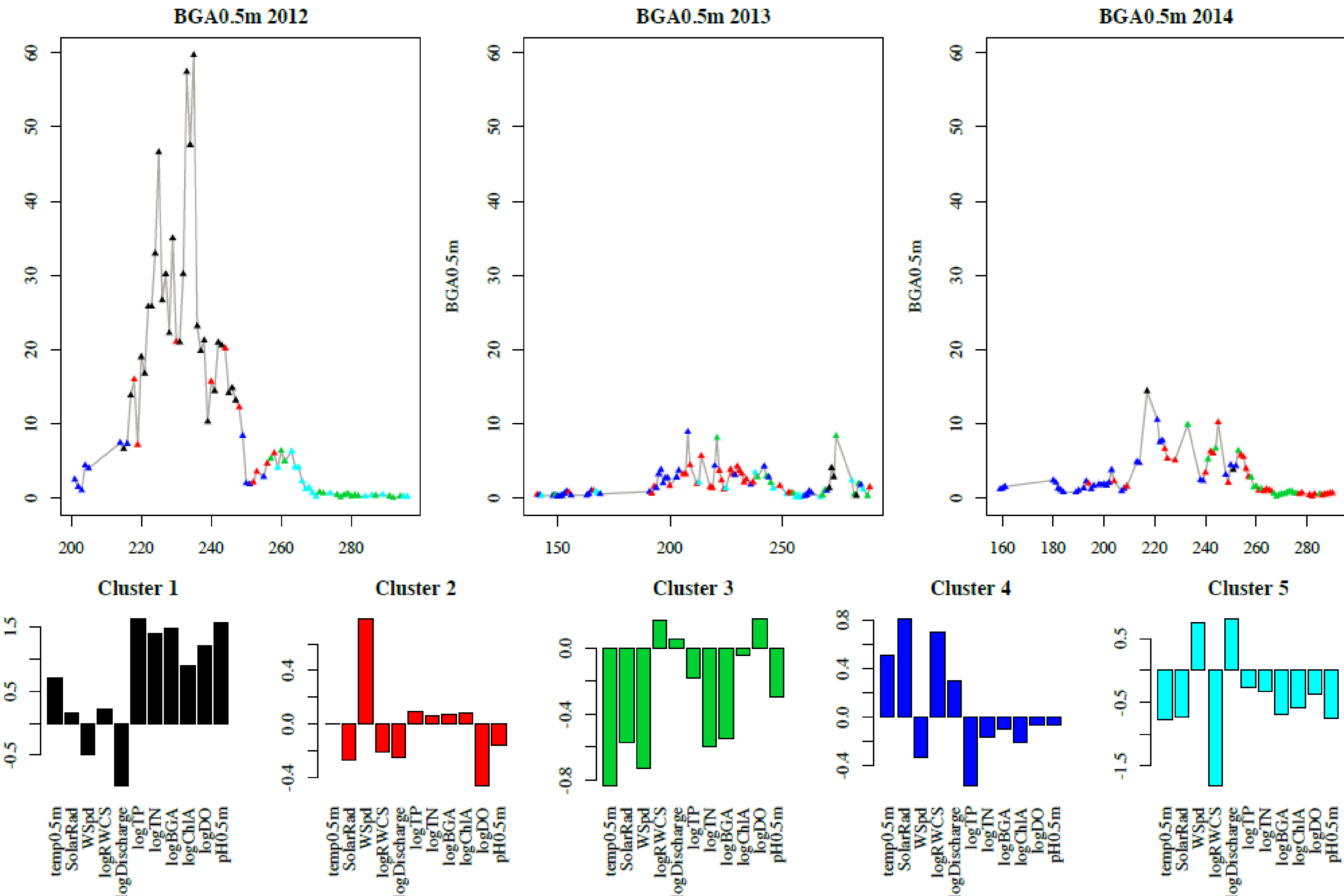
Key Points:

2012 was a historically severe bloom year due to sustained warmth and water column stability.

Limiting resources vary in systematic progression over time and promote cyanobacterial dominance until system changes due to a storm event.

Next Steps: Comparable analysis of bloom drivers and resource limitation across all years of monitoring(inter-annual variability in these drivers, systematic understanding of how they interact over time)

Statistical *Analyses of Entire RACC Time Series*



Journal of Environmental Quality
TECHNICAL REPORTS
SURFACE WATER QUALITY

Characterization of Organic Phosphorus Form and Bioavailability in Lake Sediments using ^{31}P Nuclear Magnetic Resonance and Enzymatic Hydrolysis

Courtney D. Giles,* Lydia G. Lee, Barbara J. Cade-Menun, Jane E. Hill, Peter D. F. Isles, Andrew W. Schroth, and Gregory K. Druschel

Key Points:

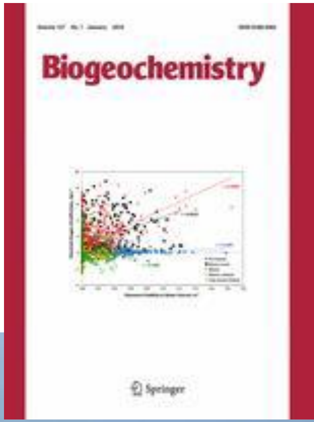
Organic P speciation and bioavailability in sediment differs under bloom vs non-bloom water column.

Suggests a poorly-constrained feedback between blooms and internal P loading.

Next Steps (Courtney):

Relate Organic P speciation and bioavailibility to water column biology, chemistr and hydrodynamics

The mobility of phosphorus, iron, and manganese through the sediment–water continuum of a shallow eutrophic freshwater lake under stratified and mixed water-column conditions



Courtney D. Giles · Peter D. F. Isles · Tom Manley · Yaoyang Xu · Gregory K. Druschel · Andrew W. Schroth

Key Points:

Water column stability, as controlled by wind and diurnal thermal stratification, is the critical driver of internal release of P, Mn and Fe

Fluctuations in WCS impact the onset, severity and duration of the bloom in 2013 by controlling internal P loading.

Next Steps(DJ):

Comparable analysis of this relationship across years where bloom severity and weather differ.

Comparison with hyper-eutrophic SP that is not impacted by a large river.

Environmental Science & Technology
Article
pubs.acs.org/est

Dynamic Coupling of Iron, Manganese, and Phosphorus Behavior in Water and Sediment of Shallow Ice-Covered Eutrophic Lakes

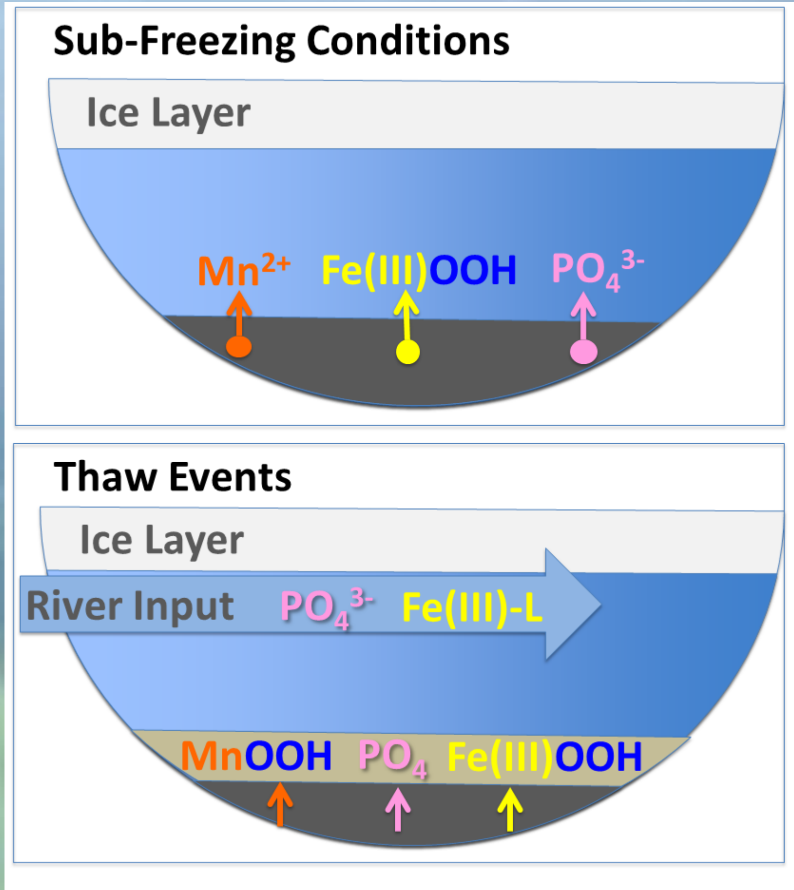
Andrew W. Schroth,[*,†,‡] Courtney D. Giles,[‡] Peter D.F. Isles,[‡,§] Yaoyang Xu,[‡] Zachary Perzan,[∥] and Gregory K. Druschel[⊥]

Key Points: Under ice period concentrates reactive Fe, Mn, and P in bottom water and near surface sediments.

Thaw events have unique chemical signature and impact

Next Steps(DJ/Andrew/Jason): Comparable analysis of this relationship with 2015(historic persistent cold) and across systems of different productivity/configuration (SP).

Focus on thaw events of different magnitude/provenance



Alteration of essential fatty acids in secondary consumers across a gradient of cyanobacteria

Trevor A. Gearhart[1], Katie Ritchie[2,5], Evan Nathan[3,6], Jason D. Stockwell[4], and Jana Kraft[2]

Hydrobiologia (Under Review)

Key Points:

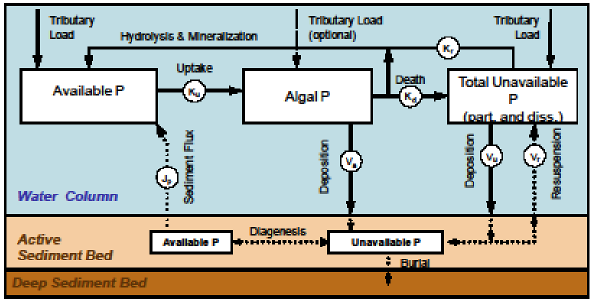
Fish in eutrophic systems show depressed levels of nutritious fatty acids.

These shifts in FA composition present potential health and reproductive consequences.

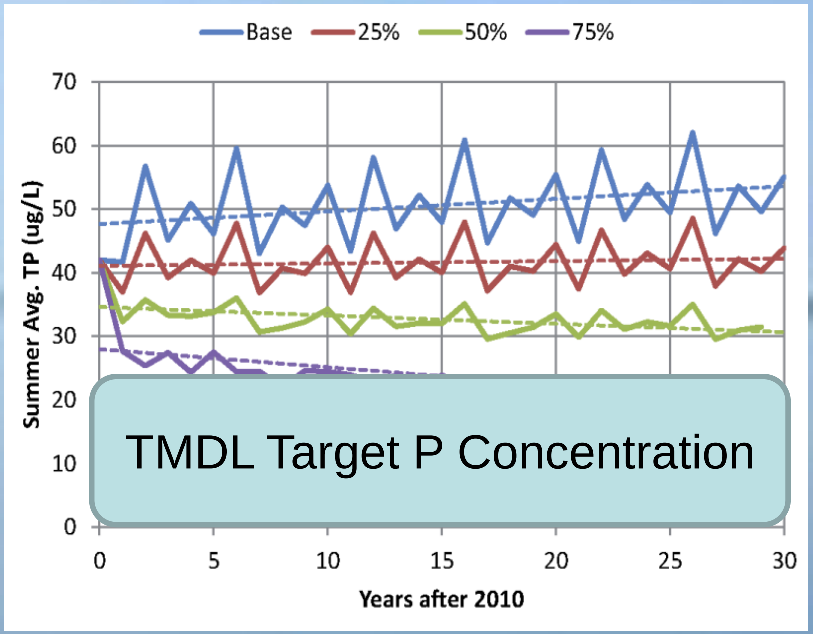
Next Steps:

Determine threshold levels for duration and extent of essential fatty acid deficiency and extent of physiological consequences

Data Drives Process-Based Modeling



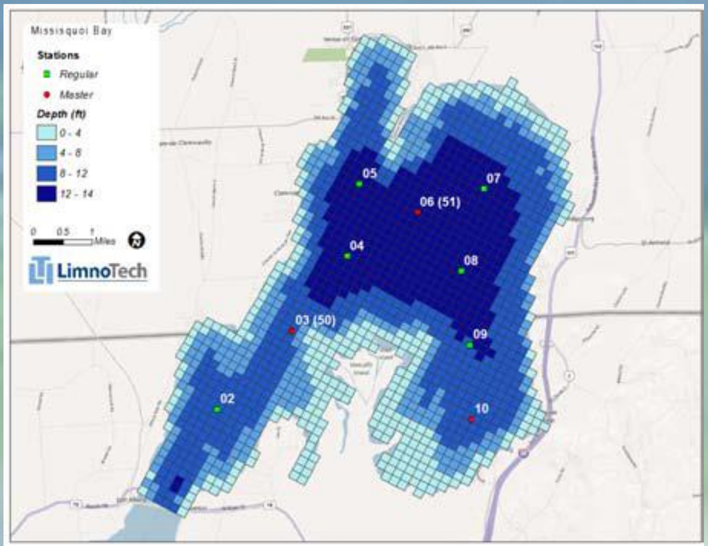
Pete's IAM talk

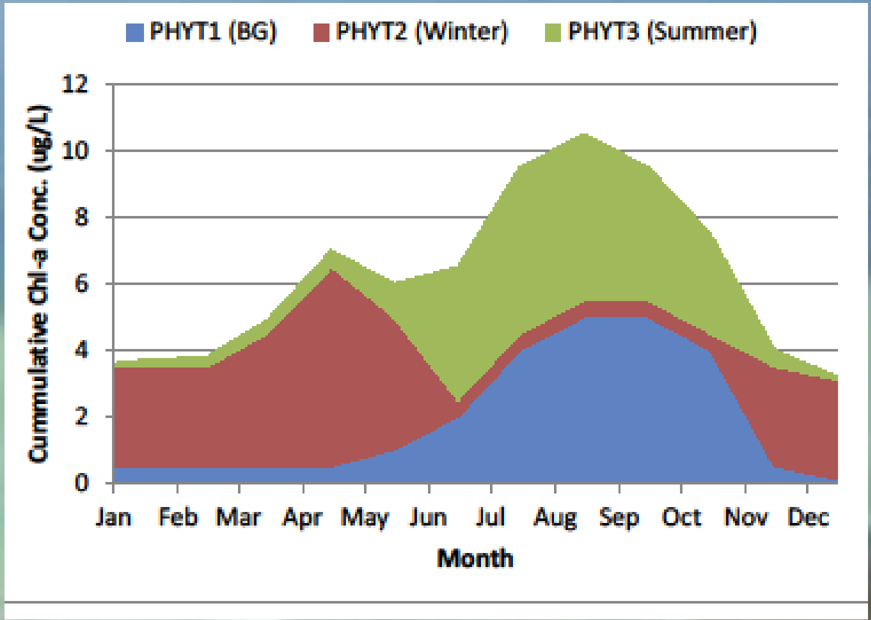


Model Scenarios

Climate Change

Human Management Decisions





Freshwater Biology

Freshwater Biology (2015) doi:10.1111/fwb.12615

Quantile regression improves models of lake eutrophication with implications for ecosystem-specific management

YAOYANG XU*, ANDREW W. SCHROTH*,†, PETER D. F. ISLES*,‡ AND DONNA M. RIZZO*,§

LIMNOLOGY and OCEANOGRAPHY: METHODS

ASLO

Limnol. Oceanogr.: Methods 13, 2015, 237–249

doi: 10.1002/lom3.10021

Developing a 21st Century framework for lake-specific eutrophication assessment using quantile regression

Yaoyang Xu,*[1] Andrew W. Schroth,[2] Donna M. Rizzo[3]

Key Points: Develop water quality and ecological metrics that are useful for management and detecting impacts of climate/landuse change across diverse environments of LC.

Focus on using big data to develop ecosystem specific metrics and management targets.

Next Steps: Use this dataset to understand impacts of climate change and nutrient loading over time across diverse environments of LC (**Pete's Q1 Slam Talk**)