High River Discharge Impacts on Total Nitrogen and Total Phosphorus in Missisquoi Bay

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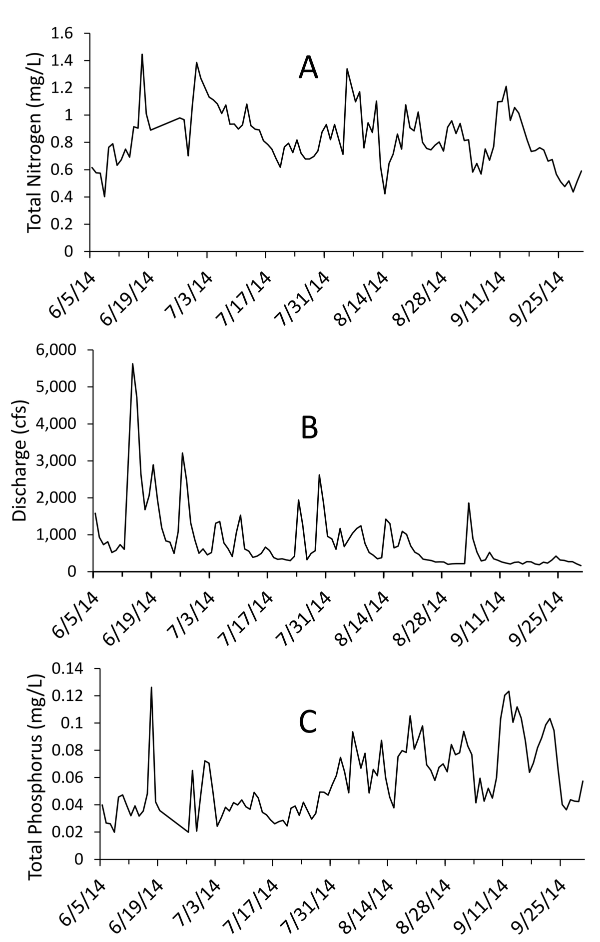
Background

- Nonpoint sources of nitrogen and phosphorus in surface waters may increase primary production and cause cyanobacteria blooms in aquatic systems (Carpenter *et al.* 1998).
- Cyanobacteria blooms can disrupt aquatic ecosystems by causing increased pH and turbidity, decreased dissolved oxygen, and by increasing the likelihood of fish kills (Smith *et al.* 1999).
- Missisquoi Bay is a eutrophic system that has had frequent cyanobacteria blooms during the summer months (McCarthy *et al.* 2013).
- Missisquoi River is a major tributary to the Missisquoi Bay and delivers most of the nutrients (McCarthy *et al*. 2013).
- There are multiple branches of the Missisquoi River delta leading into Missisquoi Bay. Little research has been conducted to determine which of these branches has the highest level of discharge, or how the proximity to the river mouth affects lake TN and TP concentrations.

Research Questions

- Which branch of the Missisquoi River carries the most discharge into Missisquoi Bay?
- Does higher discharge from the Missisquoi River affect TN and TP concentrations in the surface water of Missisquoi Bay?
- Are TN and TP concentrations near the Missisquoi River delta showing greater responses to storm events than areas further away?
- Are there seasonal differences of TN and TP concentrations?

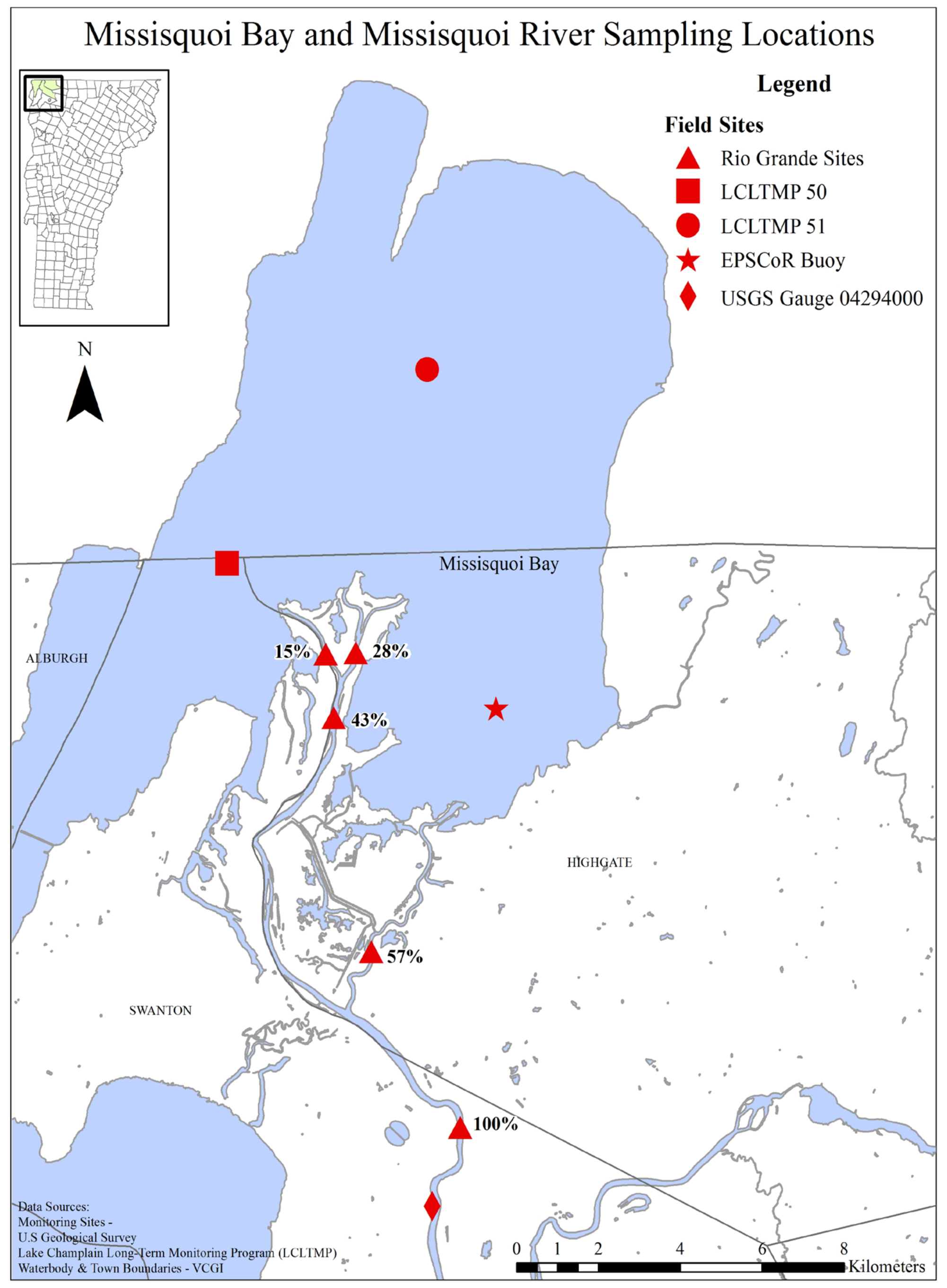
Comparing Discharge to High-Frequency Nutrient Measurements



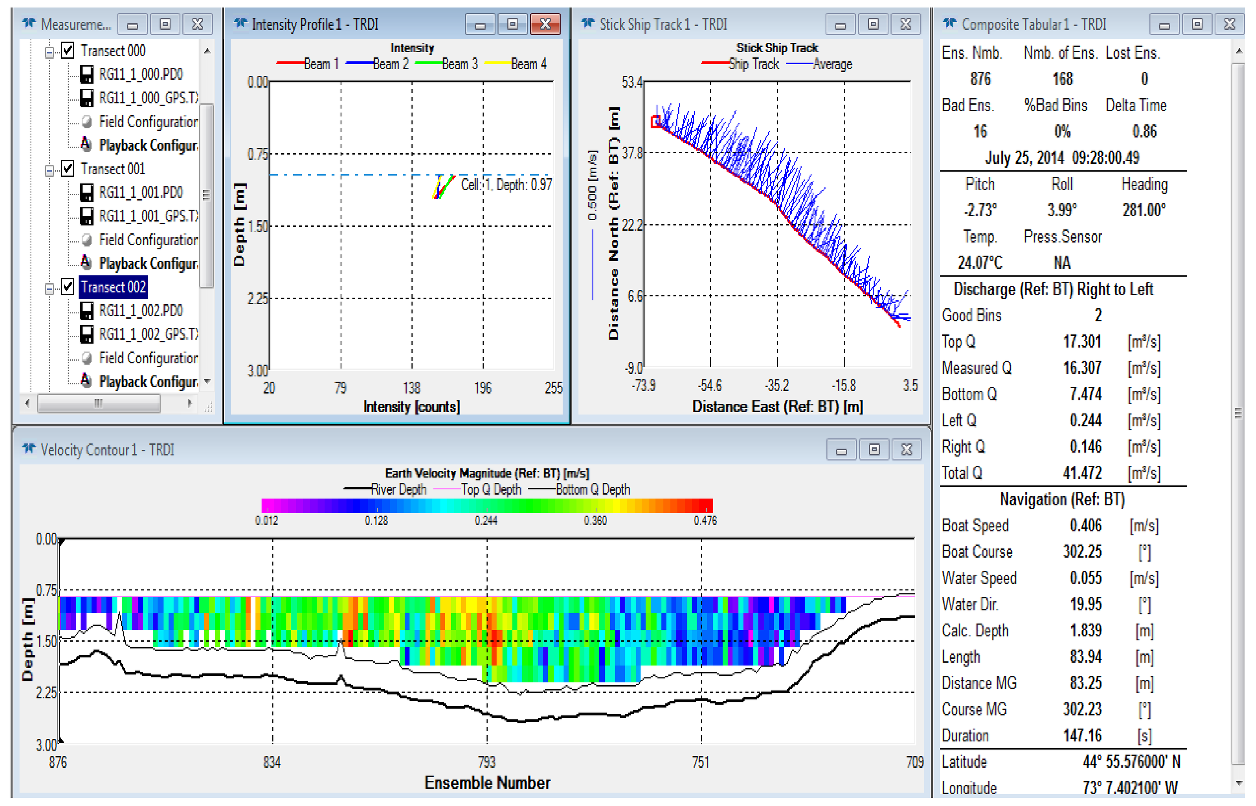
- Daily changes of TN and TP were determined using high frequency data collected from ISCO samplers during 2014 and compared to Missisquoi River discharge rates.
- TN and TP values were collected 0.5 meters from the surface of the water column.
- Changes in TN and TP responded to peaks in storm events, but these responses were not consistent.

Figure 1. Daily surface water column changes of TN (A) and TP (C) obtained from our ISCO samplers. Discharge estimates (B) were acquired from USGS gauge station 04294000.

Where Does Missisquoi River Drain Into the Bay?



- The amount of water coming out of different branches of the Missisquoi River may affect our interpretations of long-term monitoring data, residence time, and the results obtained from our model.
- On July 25, 2014, we mounted a Rio Grande Acoustic Doppler Current Profiler (ADCP) to a boat and measured discharge rates at the major branch points of the Missisquoi River Delta
- We conducted four transects with the Rio Grande ADCP at each location. Final estimates of discharge were calculated from a cumulative average of all four transects.
- Our first sample location was down river from the USGS gauge station and accounted for 100% of the discharge into the Missisquoi River. Our discharge estimate was 1512 (cfs), while the USGS gauge station read 1520 (cfs).
- Discharge at all other sites was expressed as a percentage of our first sample location.



Conclusions

- Most of the water from the Missisquoi River enters the south-east portion of Missisquoi Bay, near the EPSCoR buoy.
- Changes in TN and TP show unpredictable responses to storm events from long-term data sets. Additional sampling efforts should be conducted and incorporated into long-term data sets.
- Sampling locations for TN and TP in Missisquoi Bay show little to no variation in surface water TN and TP concentrations after high discharge events. Other locations of the water column should also be analyzed, as there could be meaningful relationships happening at different depths.
- Higher concentrations of TN and TP are observed in late season, as compared to the early season long-term data.

How Does Missisquoi Bay Respond to Storm Events?

- We categorized major discharge events of the Missisquoi River from May-August during 1993-2014 using daily discharge averages from USGS station 04294000.
- High discharge events were classified as early season (May-June) or late season (July-August).
- Changes of TN and TP in Missisquoi Bay were calculated by subtracting post-storm concentrations from pre-storm concentrations. TN and TP values were obtained from Lake Champlain Long-Term Monitoring Program (LCLTMP) sampling stations 50 and 51.

- Long-term observations of changes in TN and TP from each sampling station did not show a consistent response to major discharge events.

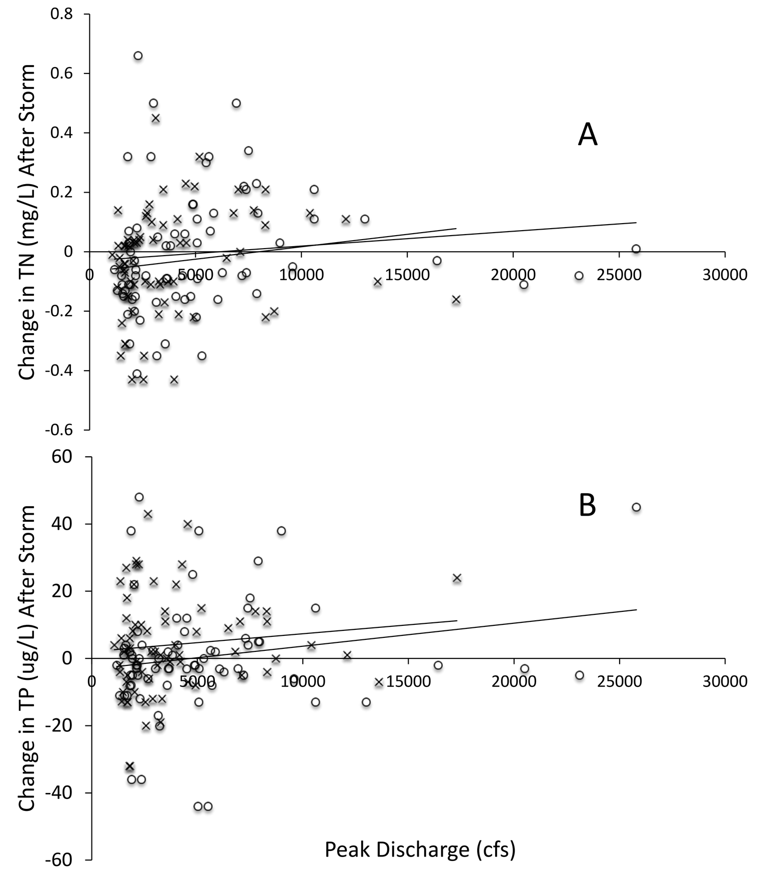
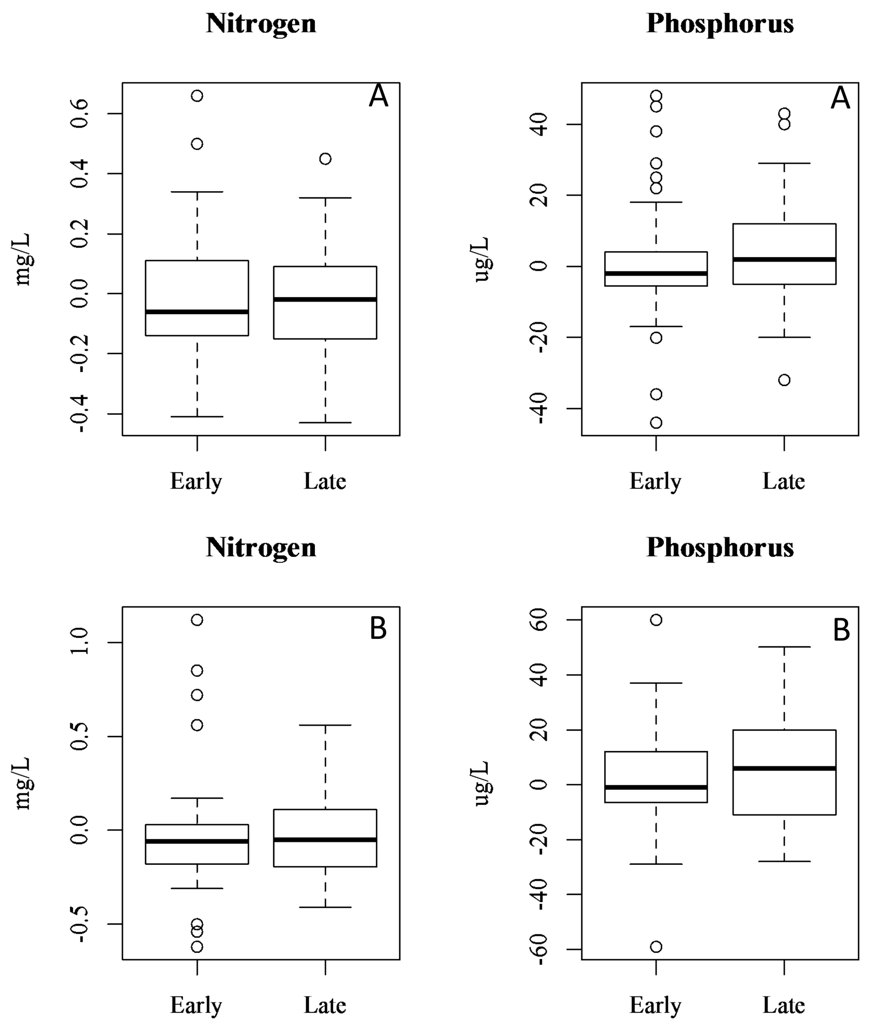


Figure 2. Changes of TN (A) and TP (B) after high discharge events during 1992-2014 from sampling station 50. Storm events were categorized by early season, May-June (o), and late season, July-August (x).



- Storms appeared to have stronger impacts on change of TN and TP later in the season at each sampling station.
- Distance from the Missisquoi River delta did not seem to influence TN and TP values when compared across sampling sites.

Figure 3. Variation of TN and TP changes after storm events from early season, May-June, and late season, July-August from sampling stations 50 (A) and 51 (B). Values for station 50 are from 1992-2014 and 2006-2014 for station 51.

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