

BACKGROUND

- Missisquoi Bay is a shallow (<5 m), eutrophic bay in the northern extent of Lake Champlain (Figure 1).
- Internal and external nutrient loading both have an adverse effect on the water quality of Missisquoi Bay.
- During the summer months, periods of low oxygen in sediments can cause an increase in the release of phosphate (PO_4^{3-}) bound to sediment metals (Fe, Mn).
- The spatial distribution of reactive P and metals in Missisquoi Bay sediments is not well understood.

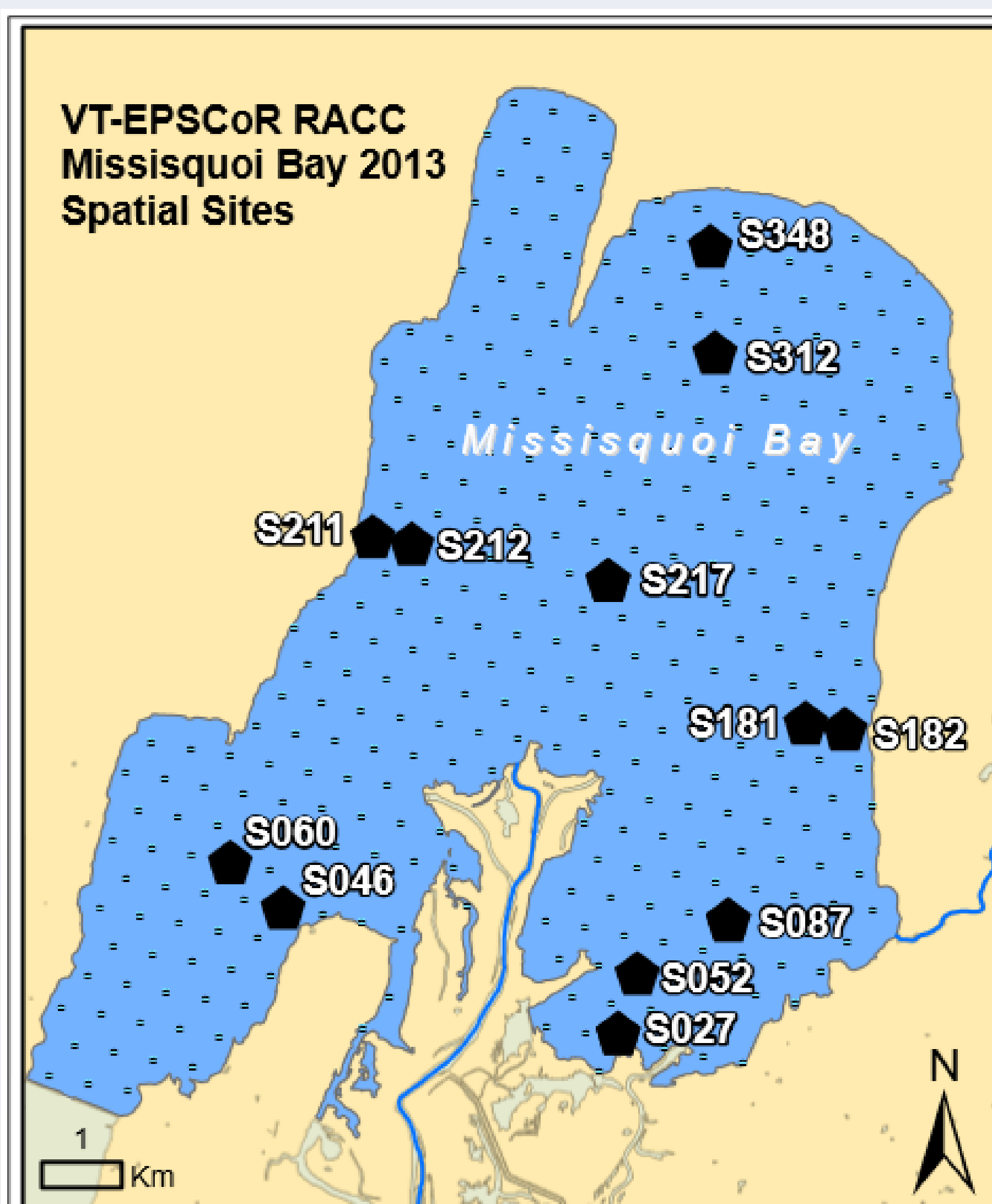


Figure 1. Sites where the spatial sediment samples were collected in Missisquoi Bay (Lake Champlain).

HYPOTHESES

- The amount of reactive P bound to sediments will vary across sites in Missisquoi Bay.
- Changes in the concentration of sediment reactive P can be used to understand the internal loading of P from sediments in Missisquoi Bay.

OBJECTIVES

- Assess sediment P and metals (Fe, Mn) content and composition at spatial sampling locations in Missisquoi Bay.
- Identify areas within Missisquoi Bay with the greatest potential for internal loading of P from sediments.

METHODOLOGY

Sediment Core Collection and Processing

Time-series: Two sediment cores were collected every two weeks at Main Site (S087) from June – October 2013.

Spatial study: Sediment cores collected from 12 locations in Missisquoi Bay in June, July, August, September 2013.



Figure 2. RACC Buoy on Missisquoi Bay at the 'Main Site' S087

Figure 3. Using the extruder to separate and collect sediment.

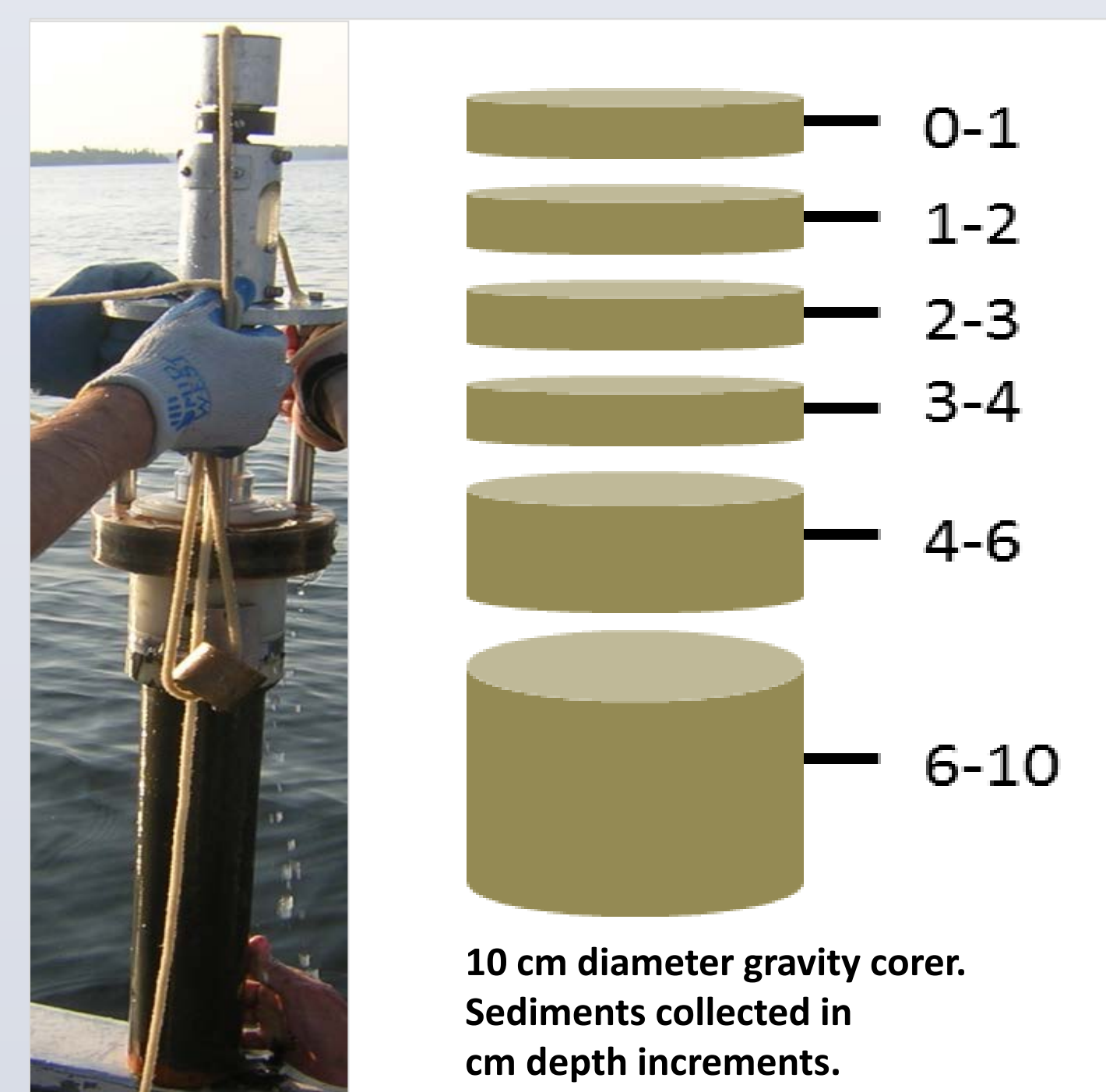


Figure 4. Diagram of sediment core sections

Moisture Content

Sediments were weighed wet and then dried for 48 h at 60°C. Dry masses were used to calculate % moisture.

Reactive P and Metals

The Ascorbic acid solution was prepared by concocting together 20g sodium citrate, 20g sodium bicarbonate, and 8g ascorbic acid to 400mL deionized water. Freeze-dried sediments (0.2-0.3 g) were extracted in 1.5 mL of solution for 24 h with constant shaking (400 rpm; Anschutz et al, 2000). The mixture was centrifuged at 14,000 rpm, and 1 mL of supernatant was diluted 10-fold for analysis by Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES).

RESULTS

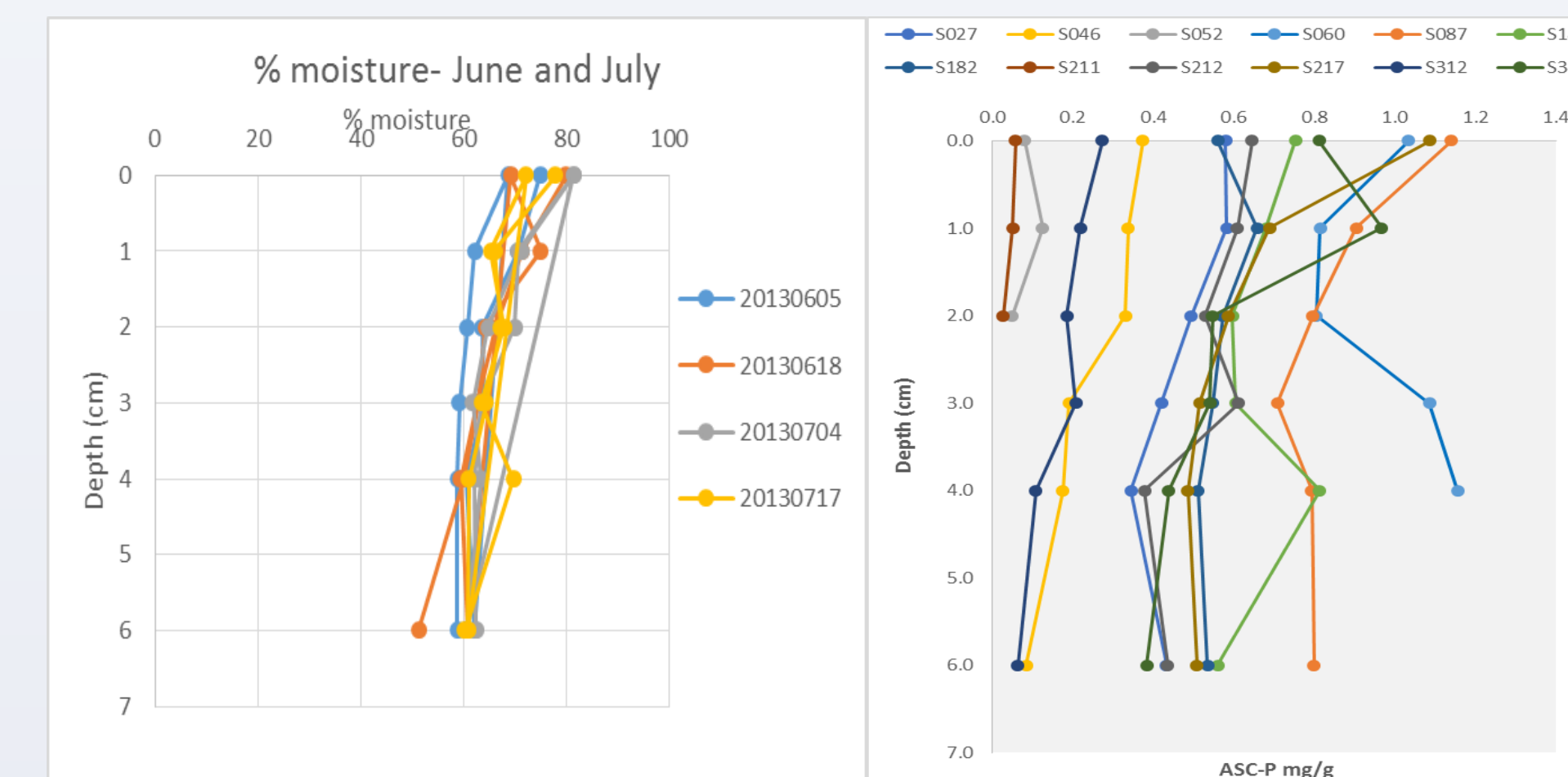


Figure 5. Percent moisture in sediment profiles taken at the Missisquoi Bay site S087 every 2 weeks in 2013

Figure 6. The concentration of reactive P at different depths of sediment through ascorbic acid analysis.

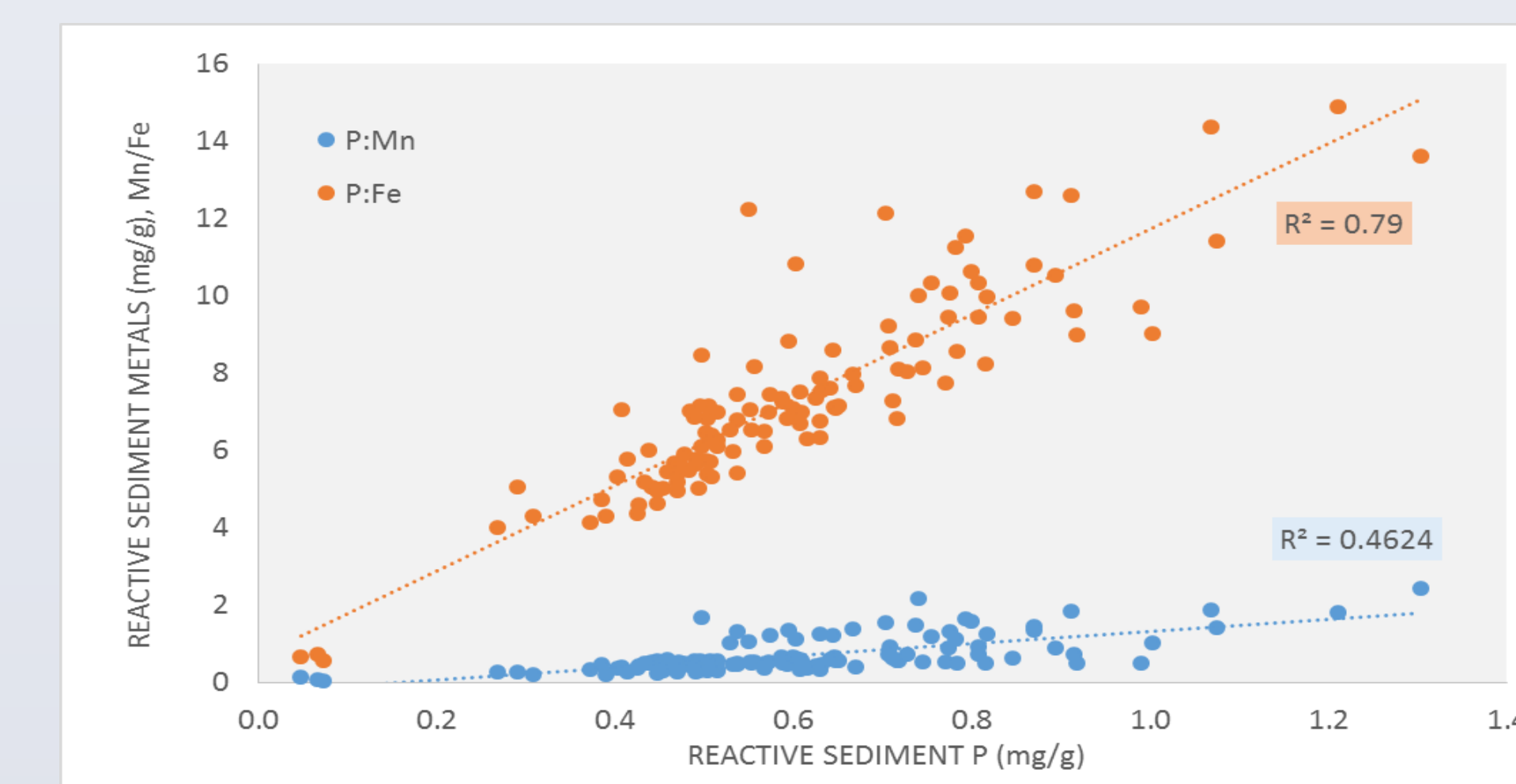


Figure 7. Correlations of Phosphorus with Manganese and Iron in ascorbic acid extractions. In ascorbic acid, phosphorus concentrations were highly correlated with Fe ($R^2 = 0.79$) and Mn ($R^2 = 0.46$).

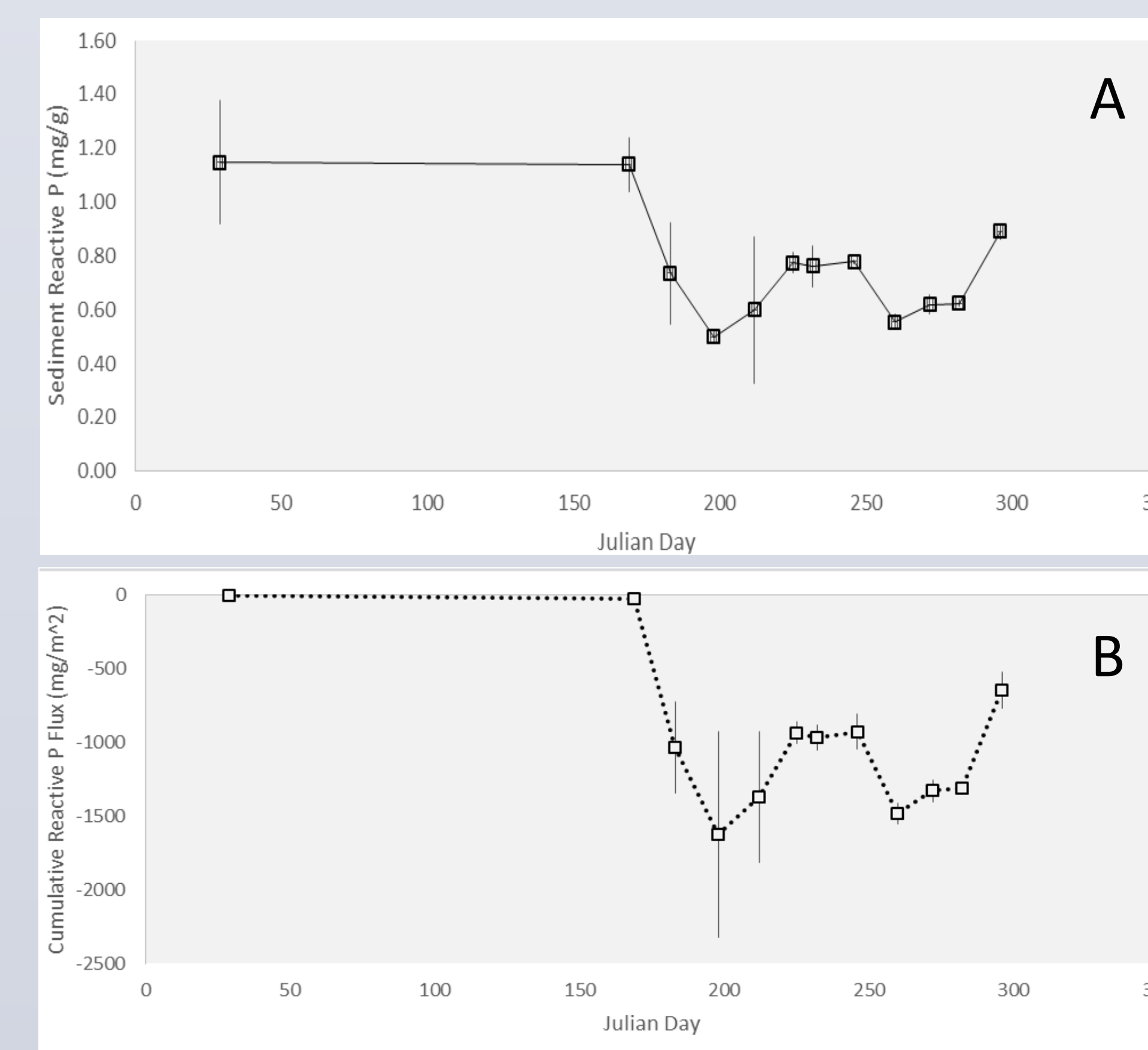


Figure 8. An estimation of sediment reactive P flux. We used the change in reactive P concentration in the 0-1 cm of sediments (A) to estimate the cumulative sediment P flux from the upper mm of sediment, across a m^2 area (B).

CONCLUSIONS

- Percent moisture ranged from 52% - 80% in the Missisquoi Bay sediment collected from Site S087(main site).
- Reactive P was generally higher in deeper sediments than near the surface layers (0-1 cm). The release of reactive phosphorus into the water column may be influenced by the redox state of the sediments, sediment particle size, pH, and temperature, all of which may vary spatially within the bay.
- Reactive P was highly correlated with Fe and Mn, suggesting that these metals control the movement of reactive P in sediments. When an oxidized surface layer is present, substantial amounts of phosphates can be retained in the sediment though they are transported on Fe_2O_3 .
- On average, site S087 had the highest reactive P in surface sediments compared to other sites. It was also determined that the greatest depletion of reactive P in sediments occurred in August 2013
- The depletion of reactive P in the 0-1 cm depth at S087 was equivalent to a sediment P flux rate of $108 \text{ mg m}^{-2} \text{ d}^{-1}$ by July 2013.

ON-GOING INVESTIGATIONS

- Spatial analysis of sediment P and metals flux in Missisquoi Bay in 2013.
- Relationships between sediment flux and water column characteristics.
- Characterization of sediment organic P bioavailability at main and spatial site sediments collected in 2013.

ACKNOWLEDGEMENTS

I would like to thank the Vermont EPSCoR/RACC program for giving to me this amazing opportunity to understand our environmental system in a way I never thought possible. Taking part in a research program that will make people understand the changes occurring in the lake ecosystem was a unique experience, and I hope others will be able to benefit from this program.

REFERENCES

Dennis G, Cooke et al. (1993); Martin Søndergaard et al. (2003); Dennis Trolle et al. (2009); C. P. Slomp et al. (1998).

AFFILIATIONS

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