Sediment Movement, Characteristics, and Macroinvertebrate Distribution in Missisquoi Bay

Ellen Taylor, Middlebury College

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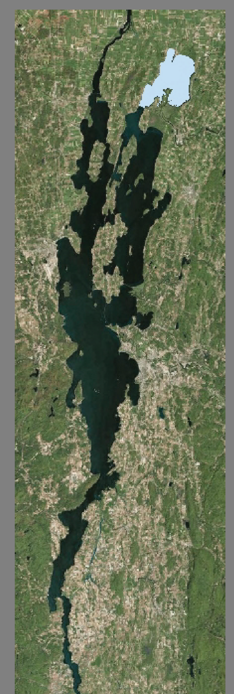


Introduction

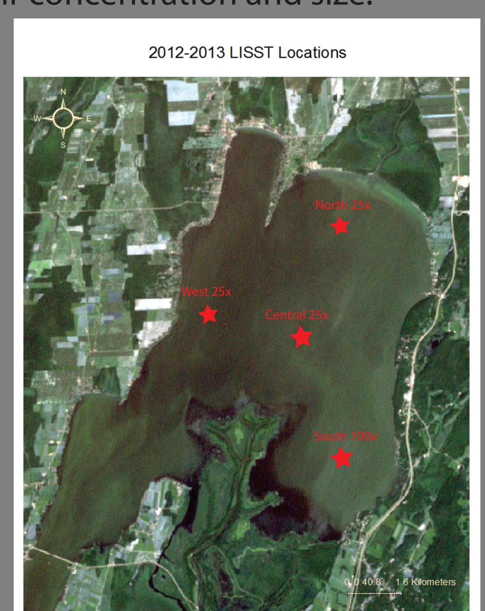
This work continues a project that begain in the summer 2012, combining existing data sets from Missisquoi Bay to better understand sediment properties and movement. Missisquoi Bay is highly eutrophic due to inflow of phosphorus and other nutrients carried by rivers from the surrounding agricultural area (Beaudin et al., 2007). Eutrophication has negative impacts on water quality, leading to algal blooms that can be dangerous to human health. Therefore, it is important to understand where the phosphorus and other nutrients go once they enter the bay. Data from LISST, ADCP, STA, and biological sampling have been combined to create maps of the bay to further that goal.

Data Inventory

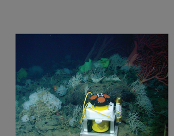
LISST Data

LISST instrument. Image from http://www.sequoiasci.com/product/lisst-100x/.

-LISST (Laser In Situ Scattering and Transmissometry) instruments were mounted on cement platforms at the bottom of the lake.
-LISSTs record how laser light is scattered and absorbed by the particles in the water, giving their concentration and size.



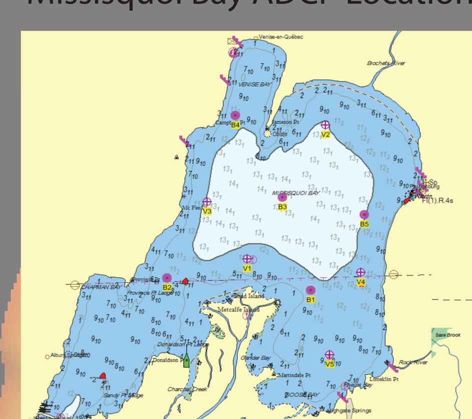
ADCP Data



ADCP deployed on the Davidson Seamount in the Pacific Ocea. Image from http://www.mbari.org/news/news_releases/2006/davidson-newimag-

-ADCP (Acoustic Doppler Current Profiler) tracks water velocity throughout the water column by measuring the Doppler effect of sound waves scattered by particles floating in the water.
- This data, in combination with the LISST data, allows correlations to be drawn between water velocity and the amount of material suspended in the water column.

Missisquoi Bay ADCP Locations



Multibeam Data

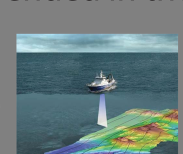
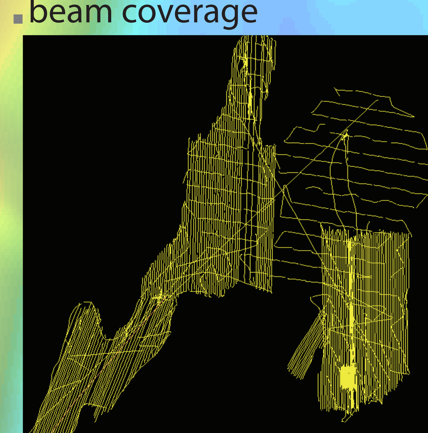


Image from Simon Nathan. "Geological exploration -studying the sea floor and earthquates,' TeAra -The Encyclopedia of New Zealand, updated 21-Sep-12 URL RL: http://www.TeAra.govt.nz/en/-photograph/8209/surveying-the-sea-floor

-A multibeam system provides detailed information on bottom topography using acoustic sound pulses.
-The system used for this survey used 512 individual beams of sound swath mapping the lake bottom.
-Acoustic backscatterance recorded by the multibeam also usedto create acoustic classification maps of the bottom that can hopefully be correlated with bottom type (e.g., weeds, gravel, sand, bedrock, clay, mussels, etc).

Ship tracks showing multi-beam coverage



Macroinvertebrate and STA Data

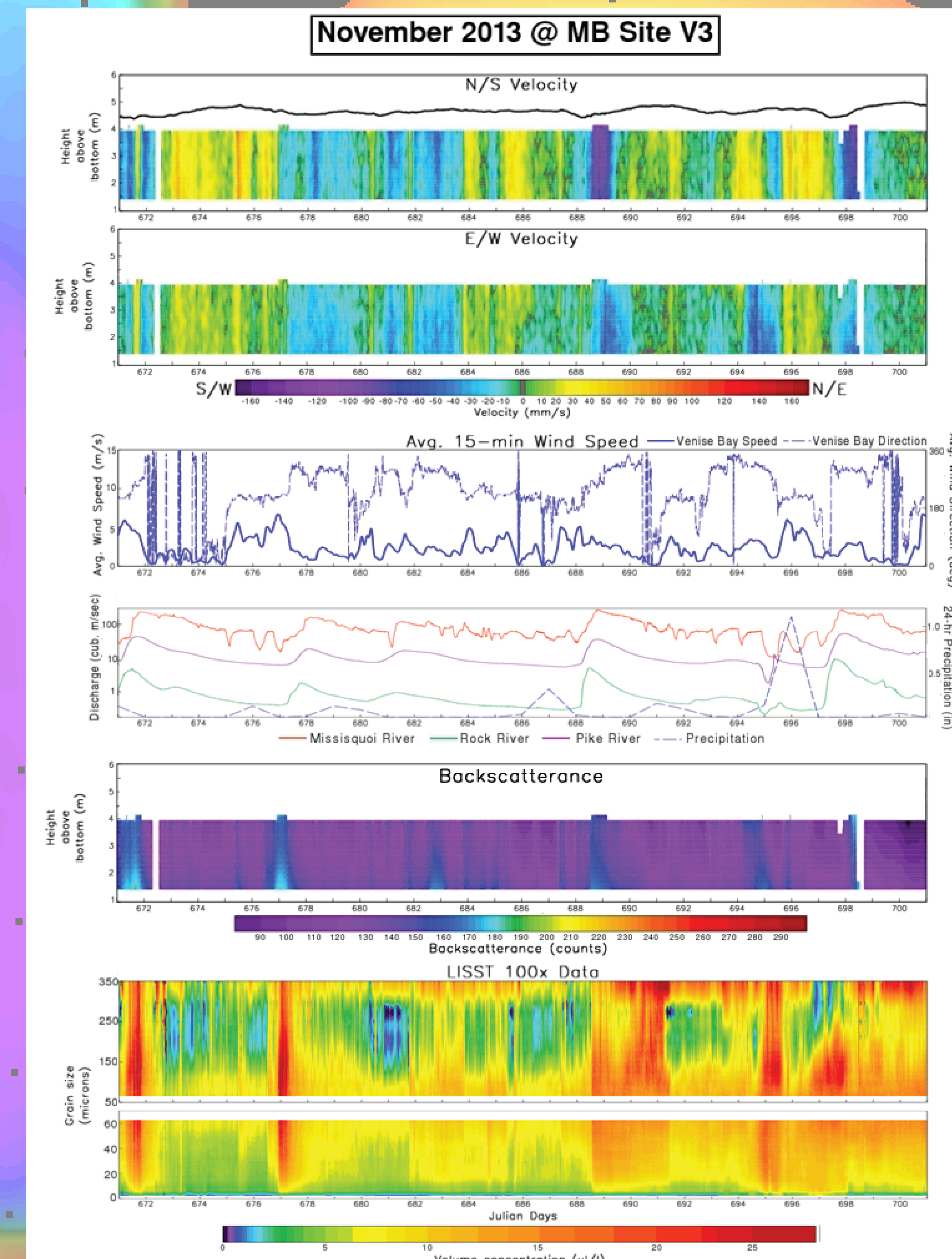
Macroinvertebrate sampling, Summer 2013. Image by Declan McCabe.

-Macroinvertebrate distribution determined by the interaction of many factors, including sediment and water chemistry, sediment structure, and presence of underwater plants.
-Each variable's role in macroinvertebrate distribution is not well understood.
-Understanding how these factors affect macroinvertebrate distribution may allow us to use these animals as indicators of pollution and other human changes to the lake environment.
-For example, *Hexagenia sp.* (mayflies) are intolerant of acidic conditions and chemically contaminated sites, and so are useful indicators of those conditions (Klemm et al. 1990, Reynoldson et al., 2001).
-Macroinvertebrate data used in this project gathered Summer 2013 along with sediment samples, giving a total of 368 macroinvertebrate/sediment samples. A teaspoon of sediment was removed from each sample for sediment trend analysis (STA).

Analysis

LISST and ADCP Data

-First screened for bad data, then graphed with the ADCP data for continuous periods in which all instruments were simultaneously collecting data.
-Image to the right is a representative example of the LISST data integrated with the Missisquoi Bay data sets.
-Top plot shows the N/S velocity of the water in the bay, followed by the E/W water velocity, wind speed, backscatterance from particles suspended in the water, river input and finally the LISST data.
-Sheds light on how the many different factors interacting in the lake may influence sediment movement.

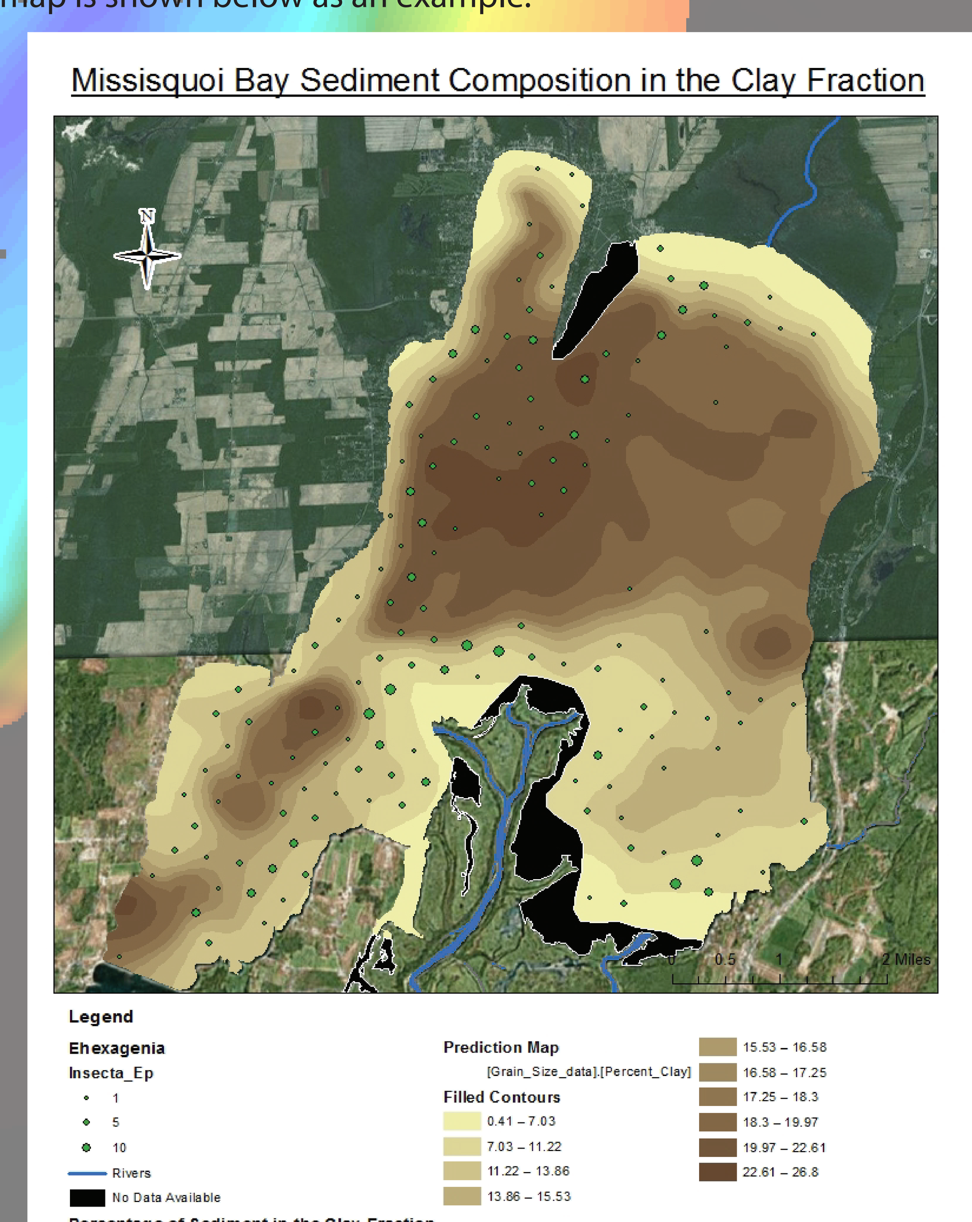


Multibeam Data

-Backscatterance data cleaning and processing performed using Questertangent (QT) Swathview software.
-Data first cleaned of acoustic interference created by boat movment, then classified based on its acoustic signature.
-After many iterations of the software, ten classes were selected to create the acoustic classification map because these classes showed the most detail without splintering the data into classes too small to reveal regional patterns.
-Map was then interpolated using the QT Clams program to create the map you see in the Results and Discussion section. Each color represents an acoustically unique unit.

Macroinvertebrate and STA Data

-Sediment samples processed using the Horiba grain size analyser.
-Invertebrate species were identified to the lowest possible taxonomic level.
-Stepwise multiple regression was run on the data in SPSS to identify correlations between sediment properties and macroinvertebrate distribution.
-Macrinvertebrate species distribution then mapped in ArcMap and compared to maps created from the STA data. One such map is shown below as an example.

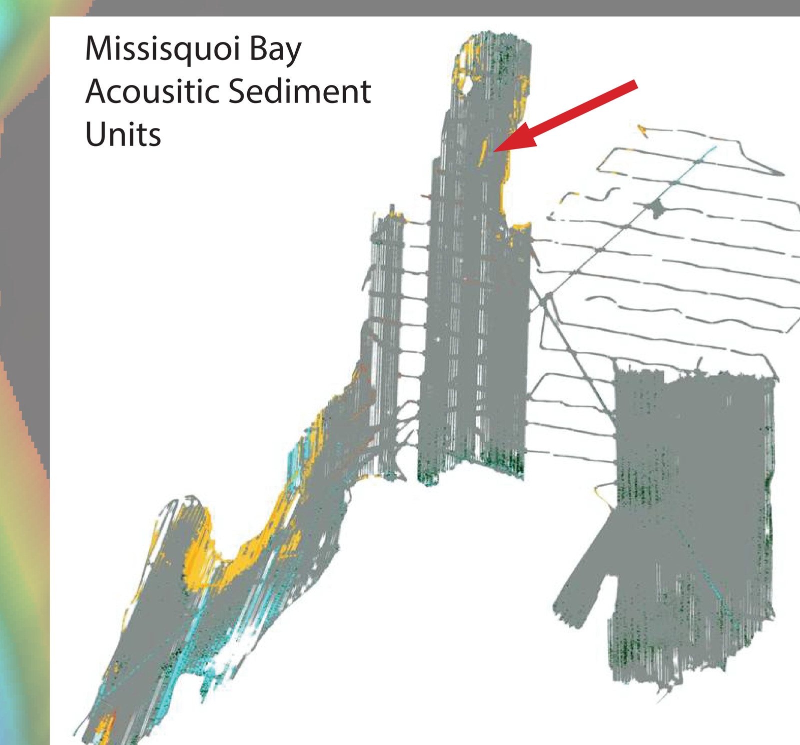


Results and Discussion

LISST and ADCP Data

- Integrated data set images shed light on how the many different factors interacting in the lake may influence sediment movement.
-Increases in the volume concentration of particles in the water was observed to correlate with several phenmena:
  - -increased wind speed
  - -increased current velocity
  - -increased precipitation

Multibeam Data



-Map created by QT acoustic classification was compared to the maps created from the STA survey, showing Percent Clay, Percent Sand, Percent Silt, Bulk Density.
-Units identified by QT did not correlate with any of these maps.
-From observations made on the boat, blue and dark green speckled areas may represent underwater vegetation.
-Questertangent did identify a recently observed shoal in the northern arm of the bay (see red arrow), showing that the material making up this shoal is different from the surrounding material, perhaps a rock outcrop.

Macroinvertebrate and STA Data

-Regression models created in SPSS did not indicate significant correlations between sediment properties and macroinvertebrate species distribution.
-Map to the left (see Macroinvertebrate and STA Data) illustrates one of the few associations observed: that *Ephemeroidea hexagenia*, a mayfly, seem to be associated with areas with a small percentage of sediment in the clay fraction.

Conclusions

-Weather events affect the concentration of particles in the bay and therefore may affect the movement of nutrients in Missisquoi Bay.
- Acoustic classification cannot yet be used to identify the sediment characteristics of the lake bottom. Further study is required tie acoustic classifications to specific physical properties
-Sediment particle size may affect the distribution of some macroinvertebrates, but does not seem to be the primary control on species distribution. Further work on what factors control macroinvertebrate distribution is needed.

Works Cited

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Acknowledgements

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