Carbon storage in boreal and temperate Québec lakes

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Introduction

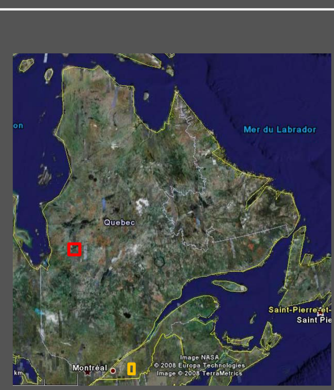
One of the black boxes of the carbon cycle in lakes is the sediment. In this project, we focus more closely on total carbon accumulation in lakes sediments. The first challenge is to accurately estimate organic sediment mass in lakes, and the second is to explore the patterns of carbon storage and accumulation rate using general properties of lakes and watersheds.

Objectives

- Construct empirical models of carbon storage based on general lake properties (catchment area, lake area, water depth).
- Compare two groups of lakes in two different regions of Québec.

Study sites

15 lakes in Eastern Townships (45° 15’; 72° 15’) and 13 lakes in Eastmain region (52° 05’; 75° 40’) that include a gradient of lake size, water depth, and catchment area



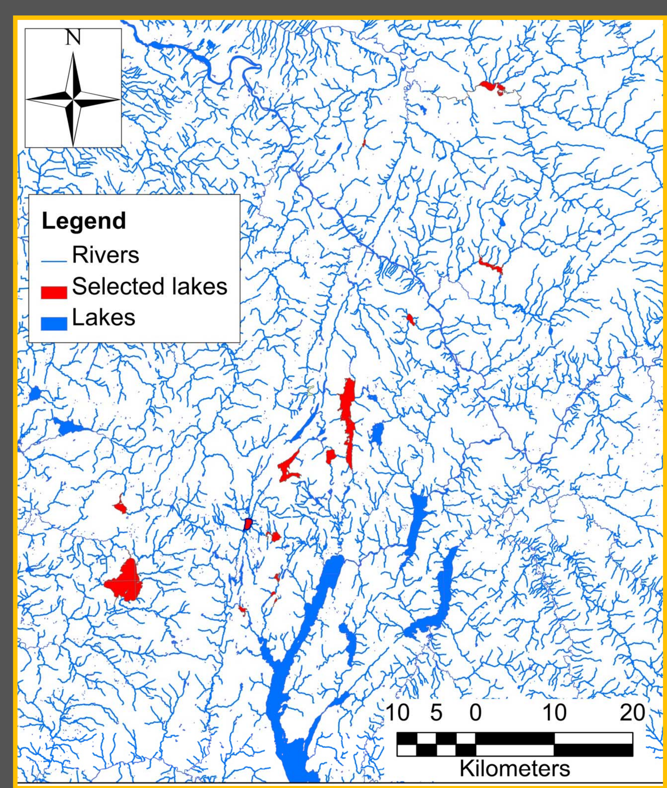


Figure 2. Map of selected lakes of Eastern Township region

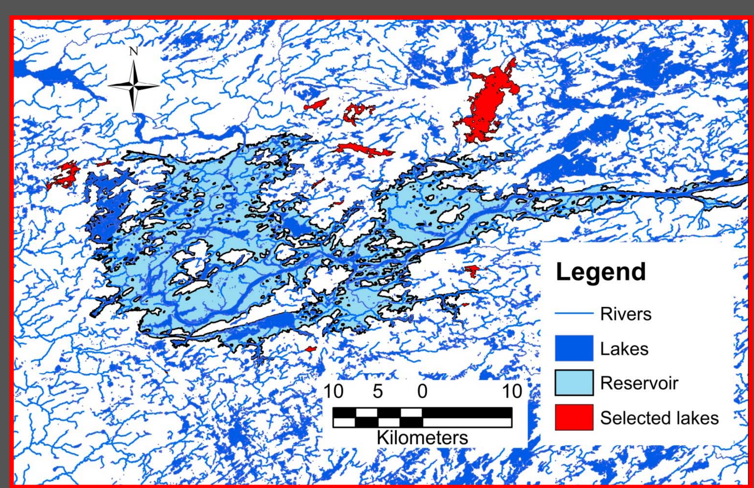


Figure 1. Map of selected lakes of Eastmain region

Methods

Mapping of sediment thickness was done in each lake with a *zig zag* pattern, using a Sub-bottom profiling BSS+3 system from Specialty devices Inc. Two waves were analysed: the 208 Hz frequency for the water-sediment interface and the 24 Hz for the bottom of the organic sediment. With these results a 3D nearest neighbour interpolation was made using ArcGIS 9.0 to calculate the entire volume of sediment in each lake basin.

The carbon content of surface Kajak Brinkshurst cores, taken at the center of each lake, was estimated with the loss on ignition technique. A mean carbon accumulation value was derived from a 1 cm^3 sample taken every 4 cm in each core. The overall carbon mass storage in each lake was calculated using the carbon content of cores and was interpolated to the complete sediment basin.

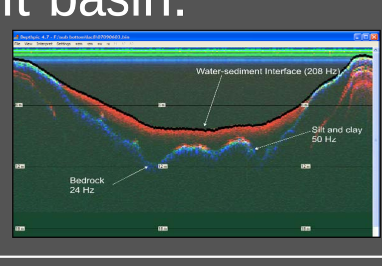


Figure 3. Sub-bottom profiler profile.

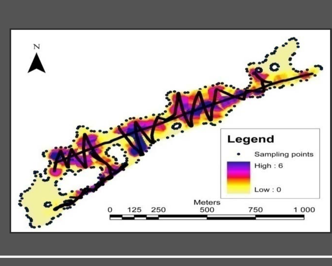


Figure 4. Map of sediment thickness.

Results

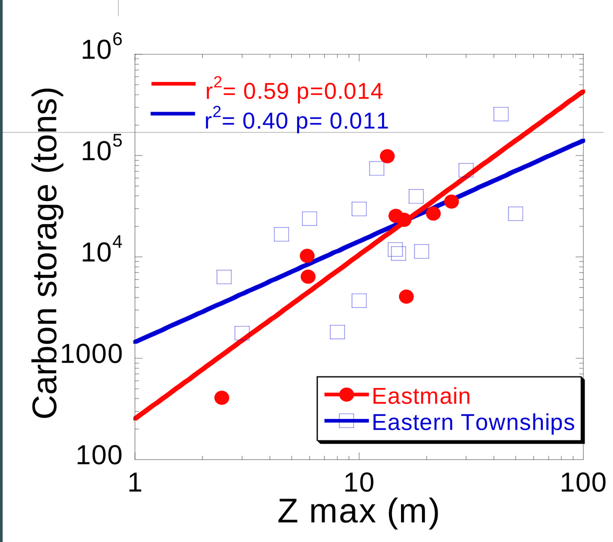


Figure 5. Maximum water depth vs. Carbon storage

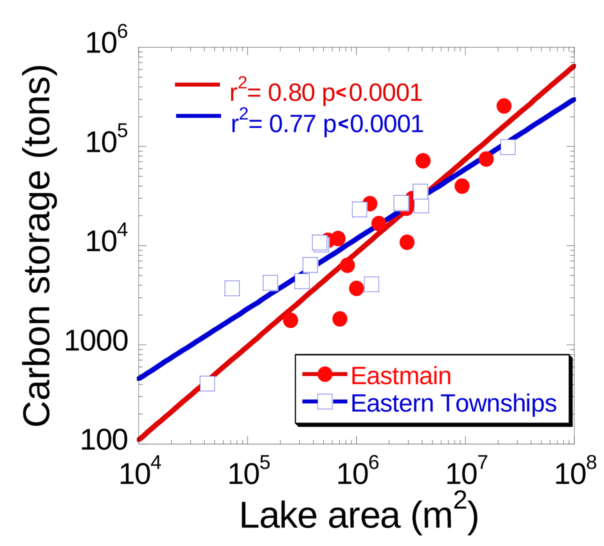


Figure 6. Lake area vs. Carbon storage

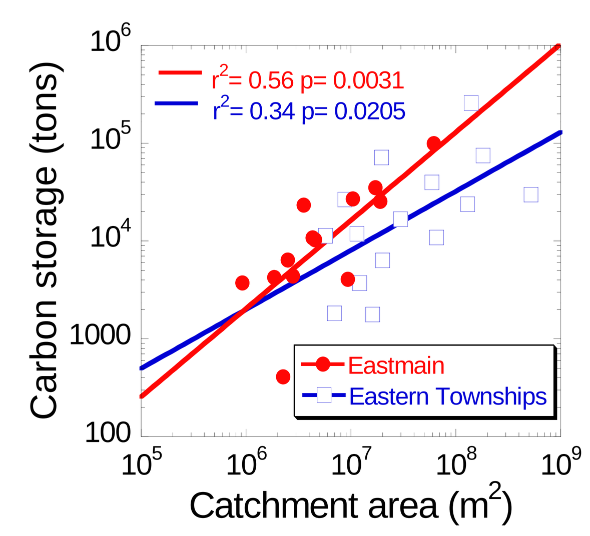


Figure 7. Catchment area vs. Carbon storage

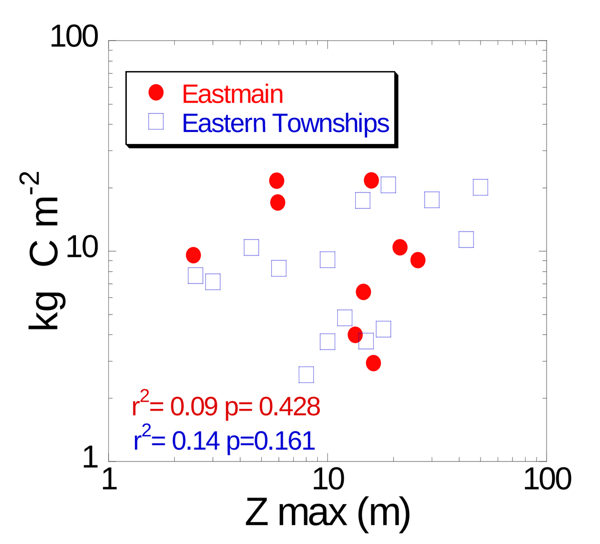


Figure 8. Maximum water depth vs. Carbon areal stock

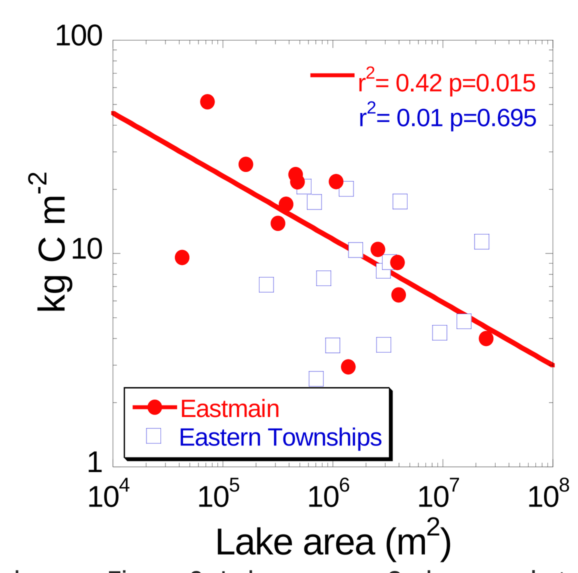


Figure 9. Lake area vs. Carbon areal stock

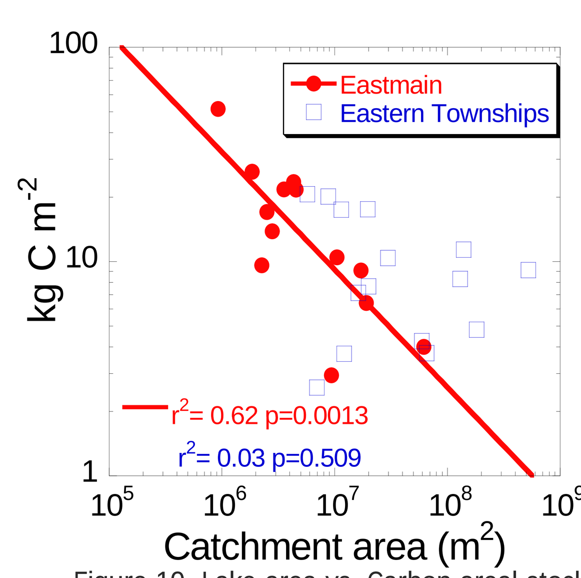


Figure 10. Lake area vs. Carbon areal stock

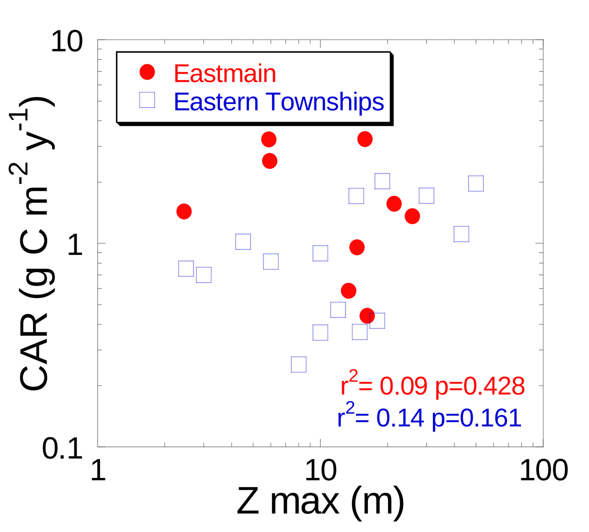


Figure 11. Maximum water depth vs. Carbon Accumulation Rate

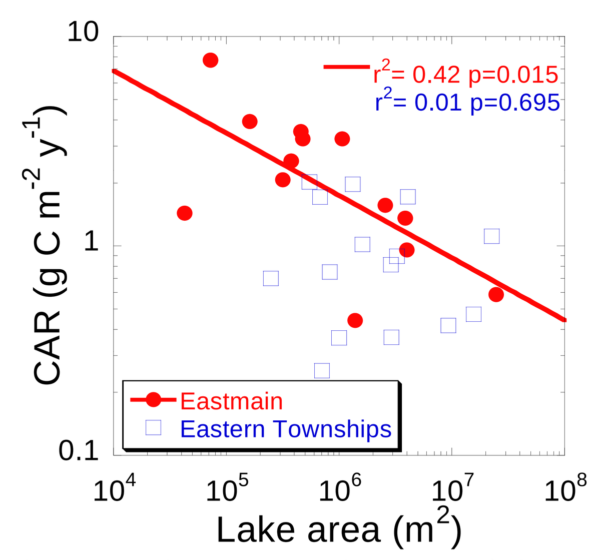


Figure 12. Lake area vs. Carbon Accumulation Rate

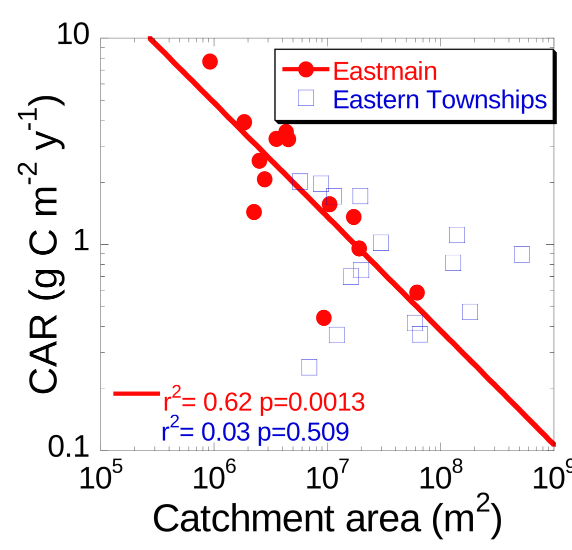


Figure 13. Catchment area vs. Carbon Accumulation Rate

- Total carbon storage in sediments had a strong relationship with lake and catchment area.
- Carbon areal stock in the Eastmain region had a strong relationship with catchment area, but Eastern Townships lakes did not follow this pattern.
- The regional accumulation rate of lakes in the Eastern Townships was lower than that of lakes in the Eastmain region.

Conclusions

- Total lake carbon storage is predictable from lake area in both regions.
- The areal carbon storage in the Eastmain region is strongly related to lake area and catchment area, but these relationships are much weaker in the Eastern Townships.
- The carbon accumulation rate in lakes in the Eastmain region was strongly related to lake area and catchment area but these relationships disappeared in Eastern Townships.
- Lakes in the two different regions share the same range of total carbon storage and areal carbon stock but the accumulation rates of carbon tend to be lower in the Eastern Townships region.

Acknowledgements

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