# Using Sediment Cores to Determine the Recent History of a Mississippi Backwater Lake

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### Introduction

River Lake in Dakota County, MN is a backwater lake connected to the Mississippi River. Such floodplain lakes are essential for flood control and maintaining water quality. They also provide habitat for various plant and animal species, as well as flyways for migrating waterfowl (Bayley 1995). In addition, they are often used for activities such as hunting, fishing, and boating. These important ecosystem functions and opportunities for recreation result in clear economic benefits (Schneider 2000). Despite their widespread importance, much remains unknown about these backwater lakes, but palaeolimnological study can offer a deeper insight.

A study done in 2009 by Engstrom et al. analyzed sediment cores taken from Lake Pepin, a natural impoundment of the Mississippi River. They concluded that Lake Pepin has experienced a dramatic increase in sediment and phosphorus loading since European settlement (Engstrom et al. 2009). Their methods and techniques will serve as a basic guide for our purposes, though only a few of the analyses will be conducted: loss on ignition, magnetic susceptibility, total phosphorus, and cesium-137 dating. By comparing our data to that of the Pepin study we will be able to address our questions regarding River Lake.

## **Research Questions**

- 1. How much sediment has accumulated at our coring site in River Lake since European settlement and how does it compare to that of Lake Pepin?
- 2. How is this sediment accumulation influenced by the Mississippi River?



Via Google Earth





Recreation Area's boundaries



The author conducting fieldwork and lab work

### Methods/Materials

- One piston and four overlapping Livingstone cores were collected from River Lake in June and July of 2010.
- Cores were taken to the Limnological Research Center (LRC) at the University of Minnesota, where a Geotek Standard MSCL-S instrument measured the magnetic mineral content of the sediment to determine the magnetic susceptibility. A DMT CoreScan Color instrument was used to image the cores.
- A 3-gram sample of each interval was used for loss on ignition analysis. Each subsample was burned at 105° overnight, and at 550° and 1000° for one hour. This analysis yields the organic, inorganic, and carbonate content of the sediment.
- Three depth intervals were analyzed for cesium-137 to identify the depositional peak associated with the 1963-64 peak in atmospheric nuclear testing. Freeze-dried samples are measured for cesium-137 at 667 keV using a highresolution germanium diode gamma detector and multichannel analyzer.
- Forty-two core increments were analyzed for total Phosphorus following the procedures in Engstrom (2005) and Engstrom and Wright (1984). Total P was measured as the ortho-P extracted by sequential digestion with 30% hydrogen peroxide, followed by 0.5 M HCl.

## **Results/Conclusions**

Cesium-137 was not found at the 100 cm interval, but was detected in the 50 cm interval. The amount of cesium found was large enough to be considered near the 1963-64 peak. From this, it can be roughly estimated that since 1960, River Lake has had an average sediment accumulation rate of approximately 1 cm per year. In comparison to Lake Pepin, whose cesuim-137 peak was located over a meter down core (Engstrom et al. 2009), River Lake has accumulated less sediment over the past 50 years.

The Magnetic Susceptibility profile for River Lake (Figure 1) shows a prominent peak at 225 cm. This sharp increase is an indication of increased erosion, likely due to widespread land clearance (Sandgren and Snowball 2001). A similar peak in the Lake Pepin sediments was dated to be about 1830 (Engstrom et al. 2009), suggesting the peak in River Lake to represent European settlement. These magnetic features are seen at about the same depth in both lakes, indicating that both have accumulated about the same amount of sediment in the last 200 years. The different depth of the cesium-137 peaks in the two lakes suggest that River Lake has accumulated its sediment at a more consistent rate, and thus functions as an important sediment trap for the Mississippi River.

Loss on Ignition analysis (Figure 2) shows the sediment composition of River Lake to be fairly unchanging, with the highest percentage being inorganic material. This trend is also present in the Lake Pepin LOI profile (Engstrom et al. 2009). The consistently high percentage of inorganic material in River Lake and its similarity to Lake Pepin indicates that much of the sediment accumulation in River Lake is coming from the Mississippi River. There is no indication that River Lake has been isolated from the main channel of the Mississippi River over the period of study.

The total phosphorus (TP) concentration in River Lake (Figure 3) has remained fairly constant, only fluctuating between .2 and .5mg/g. In contrast, Lake Pepin's total phosphorus concentration, which peaked at 1.6mg/g around 1960 (Engstrom et al. 2009).

## **Conclusions**

- 1. Our preliminary dating model indicates that at our coring site River Lake has accumulated roughly the same amount of sediment as Lake Pepin since European settlement. However, the sediment accumulation rate in River Lake appears to be more consistent than Lake Pepin over the time period; this suggests that it is continuing to act as a sediment trap for the Mississippi River.
- 2. The high inorganic content in River Lake's sediment, along with the similarities between the Lake Pepin and River Lake profiles, shows the Mississippi River has had a strong influence on River Lake. There is no indication of an interruption in this influence over the time period of study.
- 3. Unlike Lake Pepin, the TP concentration in the sediment has remained relatively constant.

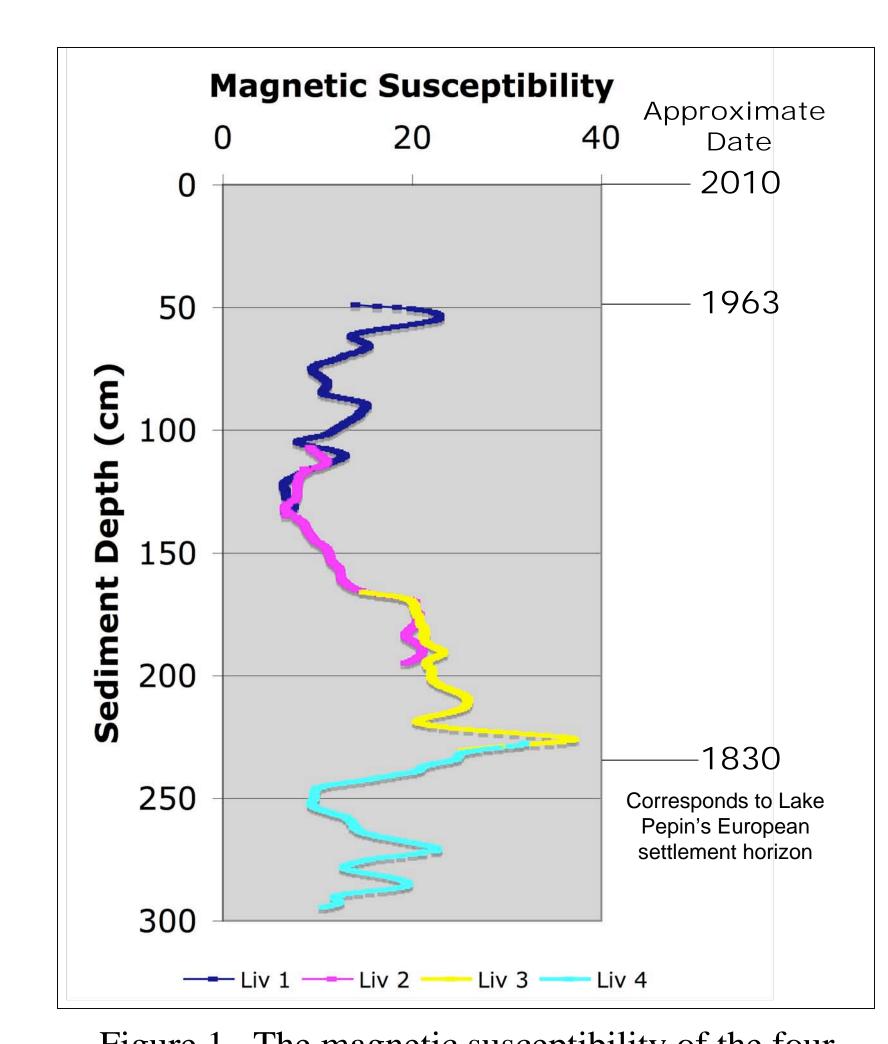


Figure 1. The magnetic susceptibility of the four Livingstone cores and the approximate age of the River Lake sediment

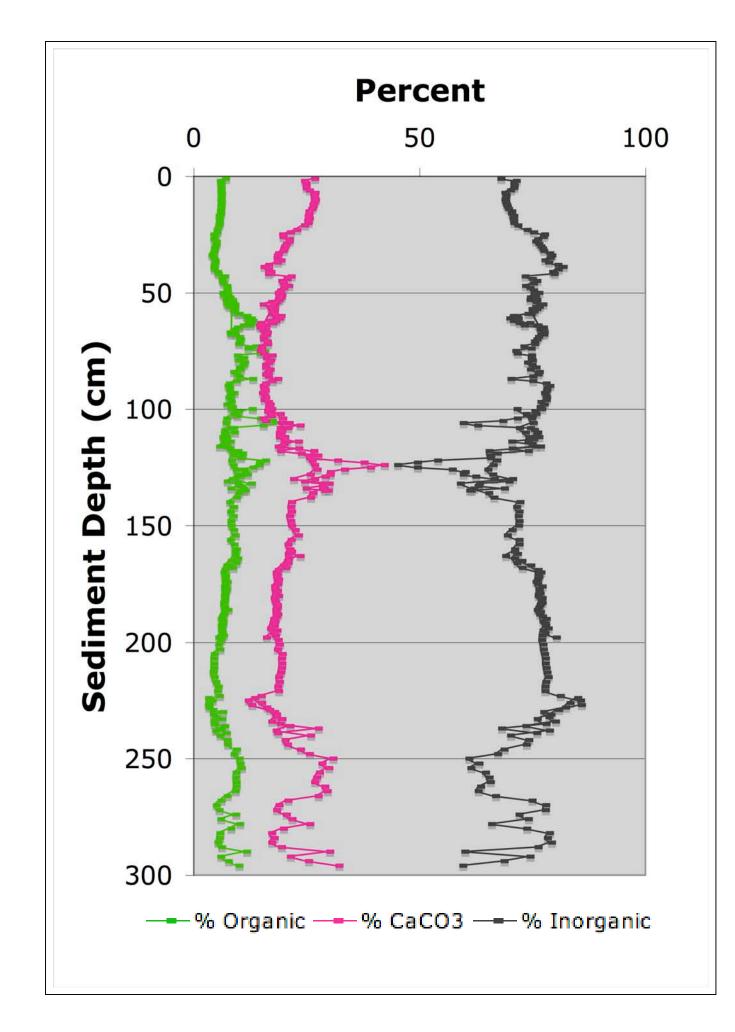


Figure 2. The organic, carbonate, and inorganic content of the River Lake sediment

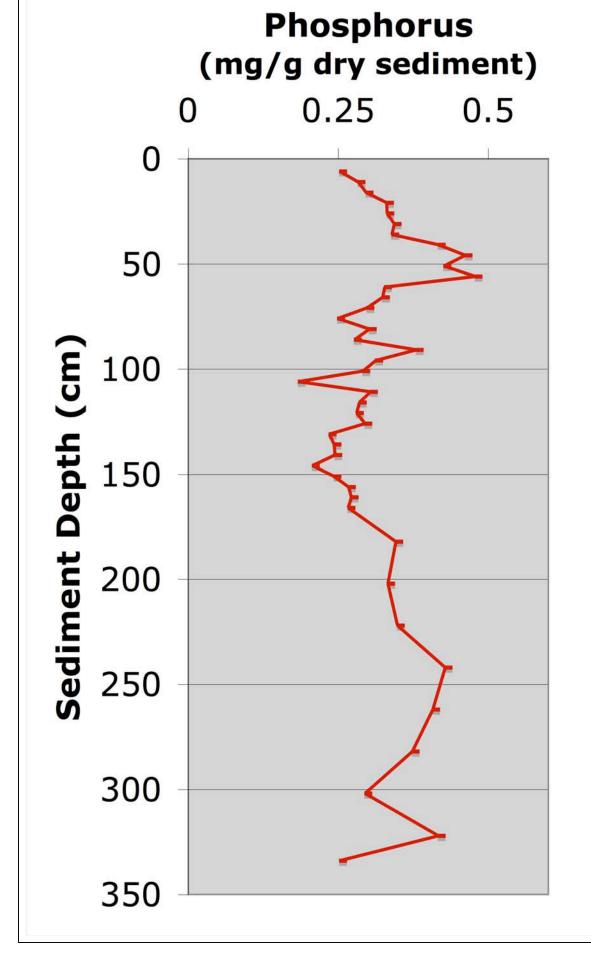


Figure 3. Total phosphorus concentrations of the River Lake sediment versus the sediment depth

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