PALEOECOLOGICAL STUDY OF EAGLE SPRING LAKE, WAUKESHA COUNTY

Paul Garrison
Wisconsin Department of Natural Resources
MAY 2006

Introduction

In an attempt to determine if the deposition of marl (calcium carbonate, $CaCO_3$) has increased during the last 2 decades with the invasion of Eurasian Water Milfoil a sediment core study was conducted. This study was conducted by collecting sediment cores at 5 locations from Eagle Spring Lake on May 24, 2005. All of the cores were analyzed for changes in water content, organic matter, and calcium carbonate. A radiochemical analysis was performed on one core to determine changes in the sedimentation rate during the last 150 years. It was anticipated that increased marl deposition would be indicated by higher concentrations of $CaCO_3$ in the upper sediments as well as increased $CaCO_3$ deposition rate since 1980.

Figure 1 shows the five locations where the cores were collected. The water depth at all of the sites was 5 to 6 feet (Table 1). The radiochemical analysis was performed on the core from site Es-5. This analysis was used to date the core and measure the sedimentation rate. The core was dated using the lead-210 method. This is a naturally occurring radionuclide that is derived from particles which fall into the lake from the atmosphere. Since this element decays at a known rate we are able to use it to determine the lake's sedimentation rate and to date the core sections for the last 130-150 years. The model employed for the dating analysis was the constant rate of supply model.

Table 1. Location and water depths of the coring sites.

Core	Water Depth (ft)	Latitude	Longitude
Es-1	6	N 42˚51.244’	W 88˚26.360’
Es-2	6	N 42˚51.491’	W 88˚26.410’
Es-3	5	N 42˚51.413’	W 88˚26.648’
Es-4	5	N 42˚51.061’	W 88˚26.567’
Es-5	6	N 42˚50.958’	W 88˚26.290’

Results

Profiles for organic matter at all five core sites are shown in Figure 2. Organic matter content was measured by weight loss when heated at 550˚C. Technically this is known as loss on ignition (LOI) but it is organic matter that is burned. Prior to the construction of the dam, the lake was a marsh and this

Figure 1. Location of coring sites.

is reflected in the high concentration of organic matter at the bottom of the cores. With the raising of the water level, marsh plants, e.g. cattails, were no longer prevalent and the amount of organic matter deposited was reduced. Since the dam was constructed around 1850, we know the approximate date when the lake was converted from a marsh to a lake. The change in organic matter in the cores allows us to estimate the average sedimentation rate at the core sites for the last 150 years (Table 2). The sedimentation rate varies throughout the lake basin with the highest rates occurring in the northern part of the lake at sites Es-2 and Es-3. The lowest rate occurs at site Es-4. At all of the sites the concentration of organic matter is unchanged since the water level was raised.

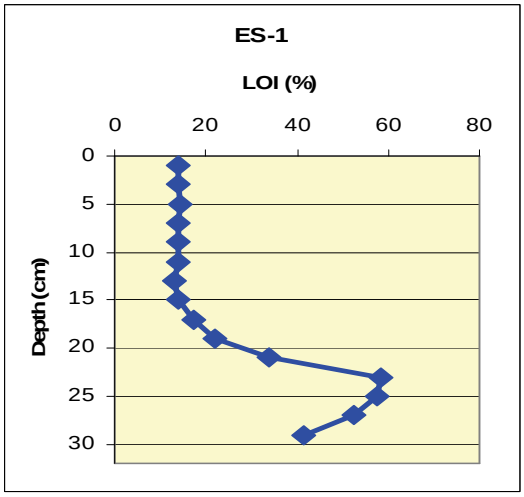
Table 2. Depth of peat and average linear sedimentation rate since the mid-1800s.

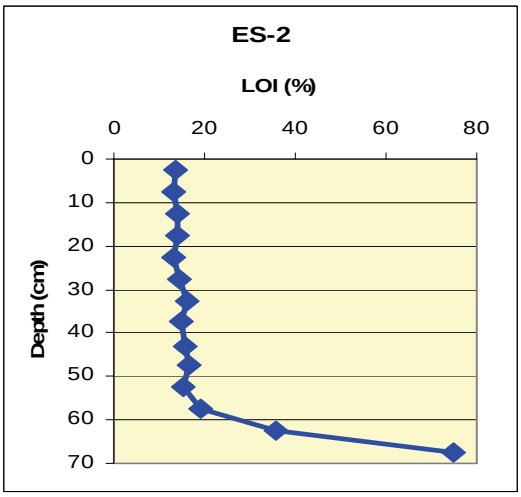
Core	Depth of Peat (cm)	Linear Sedimentation Rate (cm yr^{-1})
Es-1	21	0.14
Es-2	62	0.40
Es-3	70	0.45
Es-4	8	0.05
Es-5	26	0.17

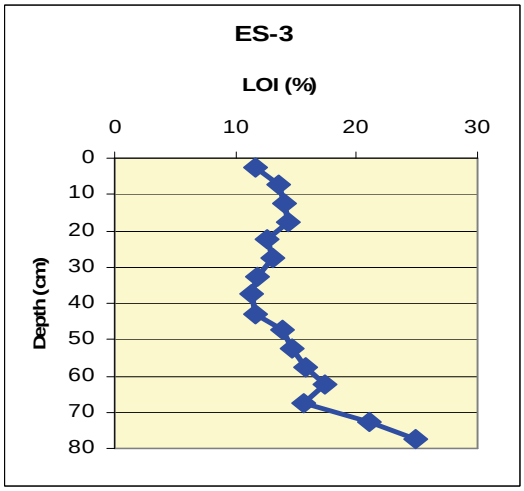
The change in the profiles of marl (calcium carbonate, $CaCO_3$) are not as consistent between the cores as with organic matter. The cores from sites Es-1, Es-4, and Es-5 clearly show the transition from a marsh environment to the lake with the raising of the water level (Figure 3). The cores from these sites show a significant increase in $CaCO_3$ following the placement of the dam. The cores from sites Es-2 and Es-3 show little change in the concentration of $CaCO_3$ throughout the cores. At these sites there apparently was a high rate of marl deposition even when the basin was a marsh.

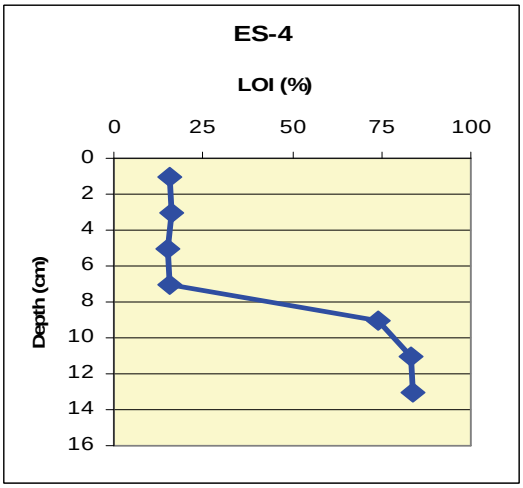
Most important for this study is that $CaCO_3$ concentration is unchanged in the upper part of all of the cores. This indicates that with the invasion of the Eurasian Water Milfoil (EWM) there has not been a significant increase in the amount of marl deposition in relation to other measured variables, e.g. organic matter and clastic material.

Although the relative concentration of marl has not changed at any of the coring sites, there may have been a change in the deposition rate of marl with the arrival of EWM. This was measured at one site, Es-5 with the radiochemical analysis. This analysis determines both the sedimentation rate during the last 150 years as well as estimates dates for each of the sediment layers. Figure 4 shows that since the creation of the lake there has been a steady increase in the bulk sedimentation rate. For the period 1900-1980 the average rate was 0.025 g cm^{-2} yr^{-1}. Starting around the mid-1980s the rate significantly increased and the average bulk sedimentation rate for the last 20 years was 0.061 g cm^{-2}









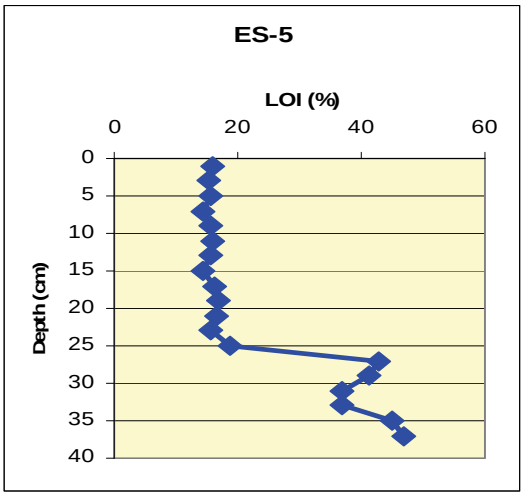


Figure 2. Profiles of organic matter (LOI) for the five core sites. The large decline in organic matter reflects the raising of the water level and the conversion from a marsh to a lake which occurred in the mid-1800s.

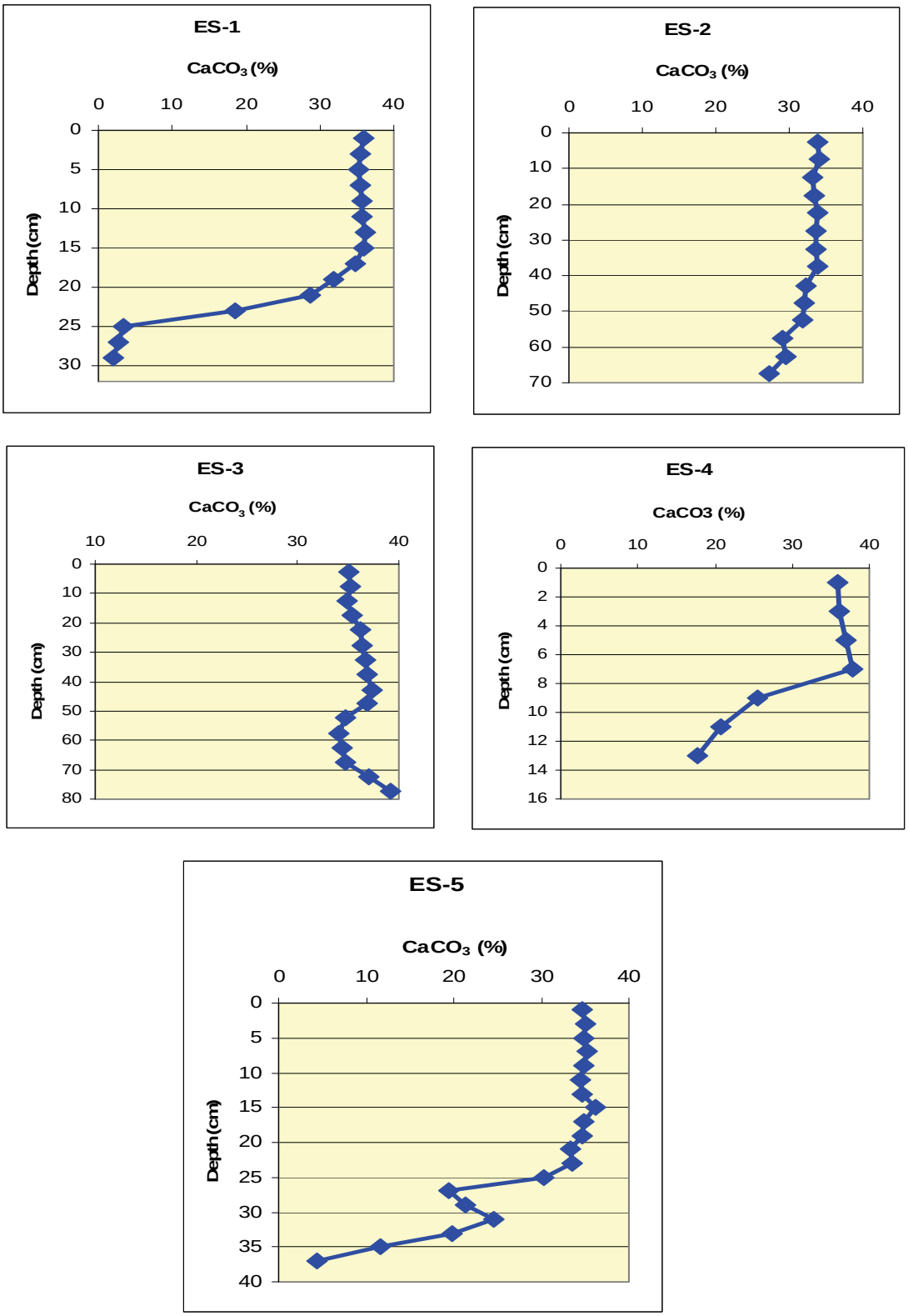


Figure 3. Profiles of calcium carbonate ($CaCO_3$) for the five core sites. The large increase in $CaCO_3$ at cores Es-1, Es-4 and Es-5 reflects the raising of the water level and the conversion from a marsh to a lake which occurred in the mid-1800s.

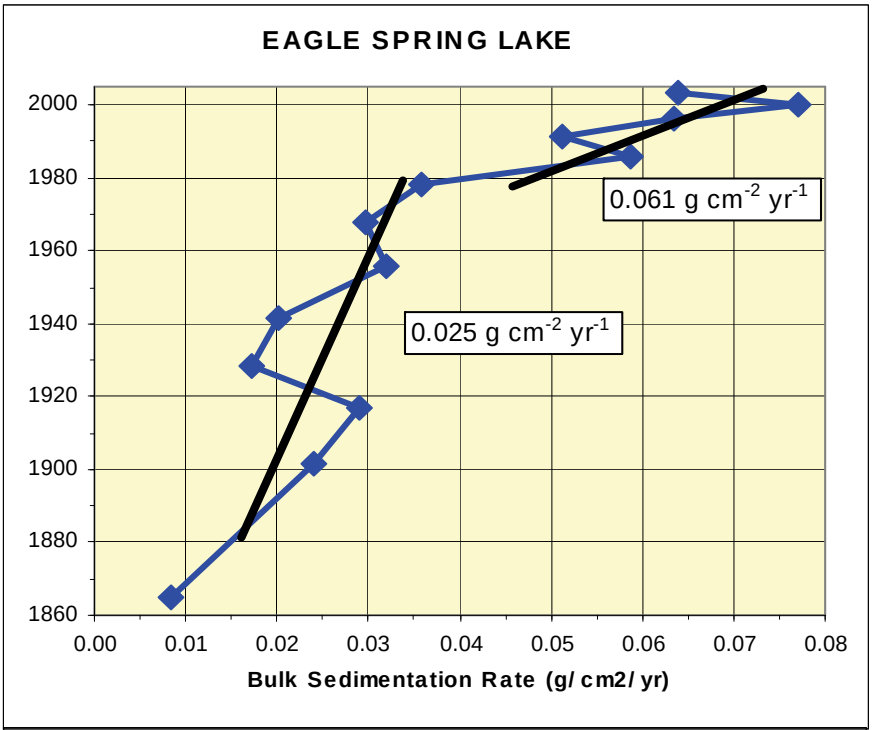


Figure 4. Bulk sedimentation rate at site Es-5. The average sedimentation rate increased by nearly 2.5 times after 1980. This was due to increased deposition of marl, organics, and noncombustible material.

yr^{-1}. This is an increase in the sedimentation rate of almost 2.5 times. This increase is not the result of just increased marl deposition. The deposition rate of organic matter as well as noncombustible material (clastics) also increased during this time interval (Figure 5). The increased sedimentation since 1980 could be the result of: 1) either the EWM trapped more sediment at this site or 2)there has

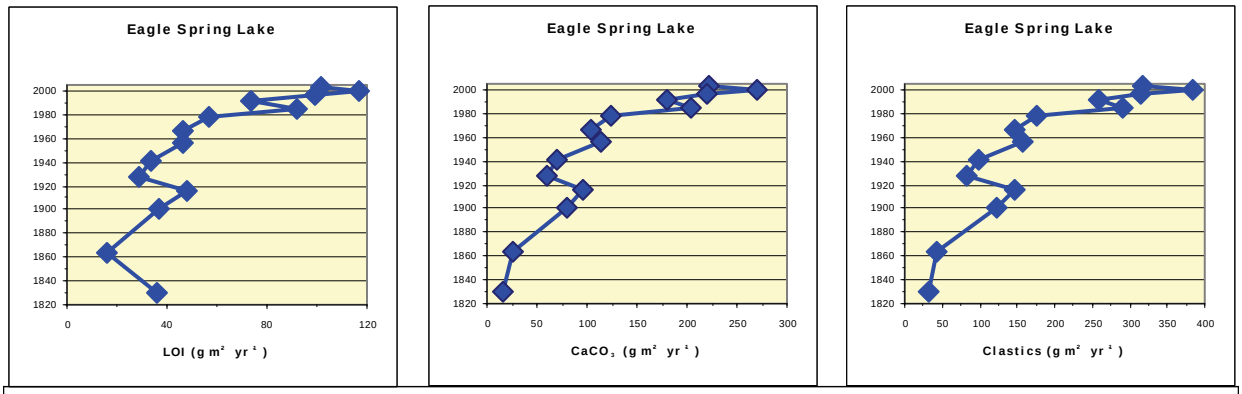


Figure 5. Changes in the deposition rates of organic matter (LOI), marl ($CaCO_3$), and noncombustible elements (clastics). The deposition rate of all of these materials significantly increased after 1980.

been significant changes in the lake's watershed which resulted in increased delivery of sediment and

nutrients to the lake. The increased nutrients would allow increased growth of algae and plants which would increase marl and organic deposition. The increased sediment runoff would be reflected in an increase in the deposition of clastic material. Since none of the other sites show an increase in $CaCO_3$ in the upper part of the cores, it is likely that the mechanism for increased deposition at site Es-5 is also occurring at those sites. This means that there likely is increased sedimentation throughout much of the lake but it is not solely the result of increased marl deposition. If this were the case the concentration of $CaCO_3$ would increase in the upper part of those cores. Instead it appears that the increased deposition of sediment during the last 20 years is the result of an increase in marl, organic matter, and clastic material.

Summary

1. The sediment core study found that the rate of infilling of the lake varies throughout the lake. The area in the northern part of the lake (Es-2, Es-3) have the highest rate while western area (Es-4) is the lowest. All of the cores penetrated to a depth that encompassed the time period since the lake was created by the placement of the dam which raised the waterlevel.
2. The concentration of marl ($CaCO_3$) is unchanged in the upper part of all of the cores. This means that marl deposition has not increased during the last 100+ years in relation to other materials, e.g. organic matter and clastics.
3. The lake's bulk sedimentation rate steadily increased from the mid-1800s until about 1980. After 1980, the rate significantly increased by about 2.5 times. The increase in the rate was because of increased deposition of marl, organic matter, and clastic materials at similar rates.
4. It appears that at the time of the invasion of Eurasian Water Milfoil (EWM), mid-1980s, there was a significant change in the deposition of material in the lake. Circumstantial evidence indicates this could be related to the EWM. It may be that the EWM has a higher production rate than native plants. This would result in increased marl and organic matter deposition. The increase in clastic deposition may be because the dense plant beds trap more sediments.