ARE AQUATIC MACROPHYTES A SIGNIFICANT SOURCE OF ORGANIC MATTER TO LAKE ECOSYSTEMS?

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Introduction:

Aquatic macrophytes of Cougar Lake (the SIUE campus lake, Fig. 1) currently consist mostly of large beds of *Myriophyllum spicatum* (Eurasian water milfoil, a well-known invasive species, Fig 2). Cougar Lake had very few aquatic macrophytes before 2002 when Large Mouth Bass (*Lepomis macrochirus*) were introduced into the lake. At the same time, aquatic macrophytes began to spread throughout the lake. There are two possible reasons why this happened. One is that the aquatic macrophytes were contaminants in the water containing the bass when it was released into the lake. The other is that the aquatic macrophytes were always present but were unable to compete with the phytoplankton until bass were stocked in the lake. When the bass were introduced into the lake they may have indirectly influenced the phytoplankton by reducing the number of zooplanktivorus fish. The subsequent reduction in phytoplankton might have given *Myriophyllum* a chance to spread (Ottensmeier 2005).

Figure 1: Cougar Lake

Figure 2: *Myriophyllum spicatum*

Stable Isotopes of Carbon

Carbon has two major isotopes ^{12}C and ^{13}C. Terrestrial C3 plants and aquatic plants discriminate against ^{13}C for photosynthesis (Wang et al. 1998). C4 plants do not discriminate as strongly against $\delta^{13}C$ (Table 1). Although aquatic plants are C3 plants , they use ^{13}C for photosynthesis when the availability of inorganic carbon is limited. Because they live in dense beds, carbon is frequently limiting. Under these conditions they produce organic matter with $\delta^{13}C$ similar to C4 plants. Phytoplankton, on the other hand, discriminate very strongly between isotopes of carbon because they do not reduce inorganic carbon to limiting levels. Thus phytoplankton have lower $\delta^{13}C$ values. The difference in $\delta^{13}C$ between phytoplankton and aquatic macrophytes allows me to track sources of organic matter to the lake sediment (Ottensmier 2005).

My hypothesis is that the increase in aquatic macrophytes should lead to an increase in $\delta^{13}C$ in the lake sediment. The shallow water sediments where aquatic macrophytes are abundant should have an increased $\delta^{13}C$. The data collected in 2007 can be compared to data collected by Chu Guo (2001). His samples were collected before the recent expansion of macrophytes in the lake.

Source	$\delta^{13}C$	Reference
C3 Plants	-20 to -35	Wang *et al.* 1998
CAM Plants	Between C3 and C4	Wang *et al.* 1998
C4 Plants	-9 to -17	Wang *et al.* 1998
Atmospheric CO_2	-8	Wang *et al.* 1998

Table 1: δ13C Values for common substances

Materials and Methods:

Samples were taken from Cougar Lake during Fall 2006 and Spring 2007. All of the samples were taken from a boat at depths ranging from 0.5 m to 11.5 m. The depths for each sample were determined by using both an electronic depth sounder and by using a lead. The samples were taken close to samples that had been made by Chu Guo (2002). Both sets of samples were located using a Garmin GPS V geographic positioning unit with an accuracy of 15 m. Figure 3 shows the locations of my samples and Chu Guo's samples. Samples were taken using an Ekman Dredge. The sediment was then placed into a whirl pack bag and frozen to be saved for later use. In the lab an aliquot of the sample was dried over night 75˚C. Once dry, the samples were ground using a hand grinder. The grinder was washed after each sample to ensure that the samples would not be contaminated. The ground sample was poured into a 1 mL plastic vial using a funnel to ensure that very little of the sample was lost. The vials were put into beakers and set into an evaporating chamber above 12M HCl to remove carbonate from the sample. The samples were dried then sent to Cornell Isotope Labs for analysis.

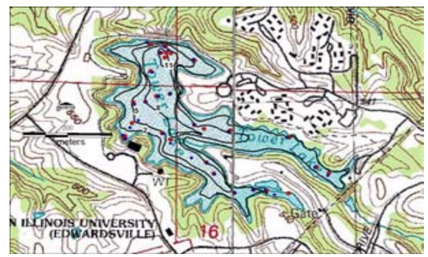


Figure 3: Map of location of 2001 samples and 2007 samples
2001 Samples
2007 samples

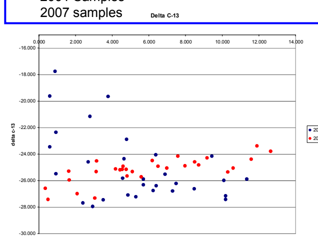


Figure 4: Plot of δ13C versus depth in Cougar Lake.

Results:

The data show a decrease in $\delta^{13}C$ from shallow depths to the deepest part of the lake (Fig. 4). This result is in direct contrast to the data collected in 2001 by Chu Guo (2001) which suggests a slight increase in $\delta^{13}C$ from shallow samples to the deepest samples from the lake (Fig. 4). The areas located closest to the shore from the 2007 samples showed higher $\delta^{13}C$ (Fig 5) whereas the 2001 samples showed little difference in $\delta^{13}C$ throughout the lake (Fig. 6).

Discussion:

The hypothesis was that $\delta^{13}C$ concentration would increase as a direct result of increased aquatic macrophytes in the lake. The 2001 samples were taken prior to the overwhelming growth of aquatic macrophytes. The samples varied very little with depth in the 2001 dataset. The 2007 samples were taken after Large Mouth Bass were introduced and after the aquatic macrophytes spread throughout the lake. The data indicate that the $\delta^{13}C$ was highest in areas that would have large mats of aquatic macrophytes consisting mostly of *Myriophyllum spicatum.* The graph of the 2007 samples vs, the 2001 samples implies that there is a big difference in the sample sets. The biggest difference in the data was observed in depths under 4m. The results strongly suggest that the increase in $\delta^{13}C$ concentration is directly associated with the increase of aquatic macrophytes in the lake. The strongest evidence was found when the samples were mapped. The map showed a strong correlation in $\delta^{13}C$ concentration with aquatic macrophytes.

Figure 5: Map of 2007 samples
$\delta^{13}C$ between - 24 and - 28
$\delta^{13}C$ between - 16 and - 24

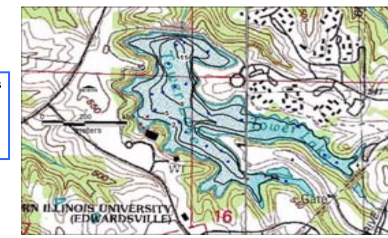
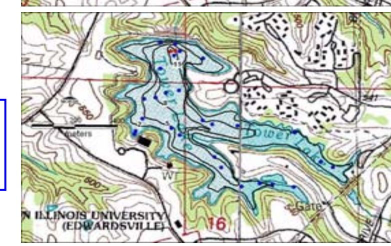


Figure 6: Map of 2001 samples
$\delta^{13}C$ between - 24 and - 28
$\delta^{13}C$ between - 16 and - 24



Conclusion:

The data strongly support the hypothesis that the increase of $\delta^{13}C$ in shallow water sediment is due to an increase in aquatic macrophytes.

Acknowledgements:

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