Effects of Substrate and Water Depth on Lotus *Nelumbo lutea* and Wild Rice *Zizania aquatica* Frequency in Mississippi River Lower Pool 4, 1998-2015

**Valerie Gehn* | Faculty Mentor Dr. Tali Lee and Supervisor Megan Moore**

*Department of Biology • University of Wisconsin-Eau Claire, *GEHNVA@UWEC.edu*

**Introduction and Background**

Observational data indicate Lake Pepin is gradually filling in, increasing sedimentation in Lower Pool 4, a 15-mile stretch of river extending from the bottom of Lake Pepin to Lock and Dam No. 4 at Alma, WI. Lake Pepin acts as an enormous filter, slowing water and allowing sediment to drop out. Vegetation levels and water clarity rise dramatically below the lake, especially during low-flow years. High-flow years, such as the Great Floods of 1993 and 2001, result in extremely low vegetation levels due to limited sunlight and the inability of plants to establish a root system in deep and turbid water. Historically, high water levels invariably drown out wild rice and are linked to poor yields.

Locations in our sampling area that have historically been lotus beds appear to be shifting toward emergent-type vegetation such as wild rice. From 1998-2010, wild rice had nearly disappeared in lower Pool 4. A threshold level of plants was able to establish a solid root system during recent low flow years and the population now appears to be thriving.

This study examined the frequency of lotus and wild rice in lower pool 4 backwater and side channels from 1998-2015, which until now have not been systematically studied. It was hypothesized that over time, frequency of lotus decreased and frequency of wild rice increased. It was our objective to verify the hypothesis and place these frequency changes in the context of water depth and substrate type.

**Methods**

- Sites were located via GPS throughout pool 4 during peak vegetation biomass
- Stratified random sampling was conducted of aquatic vegetation to estimate pool-wide abundance and distribution
- Plants present (visually and sampled) were identified
- Coordinates were recorded and substrate type was determined

- A specialized rake with 0.1 meter increments marked on the handle was used to sample plants and measure depth at six marked points around the hull of the boat

Lotus (*Nelumbo lutea*)

Wild Rice (*Zizania aquatica*)

Lotus (*Nelumbo lutea*)

**Results and Discussion**

**Figure I.** Percent Frequency of Lotus (NELU) and Wild Rice (ZIAQ) in lower pool backwater and side channels from 1998-2015. Percent Frequency was calculated as (# of sites with species “Y” present in Lower Pool)/(# sites sampled in Lower Pool). There was not sufficient sample to use in 2003.

Since 2010, the frequency of wild rice has been increasing and the frequency of lotus has remained fairly steady.

**Figure II.** Percent frequency of species in sites of each substrate type (a 95% CI). N Frequency was calculated as [(# sites w/ species in each substrate type)/(# sites sampled in Lower Pool)].

Lotus displays strong preference for fertile, river-deposited alluvial substrate classes (silt/clay and mostly silt with sand). Wild rice displays even stronger preference for the alluvial substrates and cannot grow in hard clay.

Wild rice is known to grow in a wide range of soil types, but does best in soft alluvial organic soil. Roots can easily grow in this nutrient-dense silt common in backwater and side channels of the river.

**Figure III.** No major change in substrate type has occurred over time, suggesting change in substrate is not a factor significantly influencing the increase in wild rice.

**Figure IV.** Presence or absence of NELU and ZIAQ in 2015 BWC-L and SC-L sites as a function of average depth (m). Green marks represent means ± 95% CI. For NELU at t=2.36, p=0.10. For ZIAQ at t=1.98, p=0.08.

Because wild rice appears to prefer shallower depths, it could be gaining a slight advantage over lotus during low-flow years or as river sediments continue in the region.

Water levels from Lock and Dams 3 and 4 have declined in recent years. This is the most plausible explanation for the observed increase in wild rice frequency, because water depth has been found to be the most important factor influencing a wild rice crop. Ideal depth during a plant’s life cycle is about 0.3-0.6m. If the water is either too deep or too shallow, or sudden fluctuations in depth greater than 25 cm occur, production is severely affected. An increase in depth of 0.3 m from preceding years could nearly eliminate a wild rice crop.

**Conclusion**

Many factors impact the composition of aquatic plant communities. Although lotus and wild rice display preference for rich, alluvial substrate types, substrate composition or the river has not drastically changed and is not a plausible factor for the large increase in wild rice frequency.

The observed effect of water depth on species frequency in this section of the Mississippi helps to explain the observed shift in species over time, providing a better understanding of aquatic plant community changes and improving predictions of the future for these species in the Mississippi River.

**Special Thanks to**

- Dr. Tali Lee for her constant guidance and patience as I developed my research and analytical skills.
- Megan Hanks, DNR aquatic biologist, vegetation specialist, and internship supervisor, for exceptional training in the field of aquatic biology.
- The Long Term Resource Monitoring Program team at Lake City DNR, for opening up to me the world of field research.
- Lake City DNR, for opening up to me the world of field research.

**Sources**