

Trading Sand for Water – A 20-Acre Borrow Pit Became a Floodplain Lake

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The Friends of the Lower Wisconsin River (FLOW) Science Committee recently stumbled upon a borrow pit lake (Figure 1) after nearly two decades of sampling oxbow lakes across the Lower Wisconsin River floodplain. Borrow pits are formed from the excavation of earthen materials used for either construction or fill elsewhere. We learned the floodplain lake was created on marginal farmland in 1991 as a source of sand for a highway construction project and was designed for wetland mitigation. A Wisconsin Department of Transportation (WDOT) hydrogeological assessment of the site offered the only information we could find

on the waterbody. The lake even lacked a waterbody identification code assigned to most public waters. We wanted to learn more about the mystery lake.

The lake is located within the Lower Wisconsin State Riverway (LWSR) in southwest Wisconsin's unglaciated Driftless Area (Figure 2). The 92-mile stretch of river from the Prairie du Sac dam to the confluence with the Mississippi River is also a RAMSAR Wetland of International Importance. These designations reflect the ecological importance of a large, braided channel river along with the numerous adjoining oxbow lakes and other wetlands. Ninety-

eight native fish species are found within the State Riverway along with rare mussels and rare aquatic insects.

We decided to study the artificial lake for a couple of reasons. Most importantly, we wanted to know why the borrow pit lake appear healthy while oxbow lake water quality had declined across the LWSR (Figure 3). Secondly, we also wanted to explore whether creating artificial lakes is in the public interest, particularly in a high-quality river floodplain.

The oxbow lake eutrophication came in the form of dense mats of duckweeds and filamentous algae (Figure 4), collectively described as free-floating



Figure 1. Drone photograph of the borrow pit lake with clean groundwater recharge area known as Blackhawk Ridge in the background. Photo by Richard Wedepohl.



Figure 2. Overview map showing location of Lower Wisconsin State Riverway and borrow pit



Figure 3. Borrow pit lake looking south demonstrating somewhat linear channel similar to the natural cutoff channel oxbow lakes within the LWSR. Photo by Dave Marshall

plants (FFP). Dense FFP mats often degrade water quality and habitat and threaten many types of aquatic life. Anoxia beneath extensive FFP mats is a common problem. Under the right conditions, FFP dominance can become an alternative stable state (Scheffer et al. 2003).

The FFP dominance in most of the LWSR oxbow lakes coincided with a significant change in agriculture across the Pleistocene sand terrace that adjoins the LWSR. Large-scale irrigated corn and soybean plantings gradually replaced smaller terrace

farms. These cropping patterns rapidly expanded across Wisconsin during the early part of the 21st Century. Applied nitrogen fertilizers nearly doubled from 2004 to 2014 (Matson 2017).

The hydrology of most LWSR oxbow lakes is dominated by groundwater discharges. Groundwater discharges are so significant that some of the oxbows function as classic spring lakes, lacking inlets but having navigable outlets to the river. Based on our well monitoring data, groundwater discharges to many LWSR oxbow lakes now contain NO₃-N concentrations two to three times higher than the Drinking Water Standard (10 mg/l) while total phosphorus concentrations are significantly lower (< 40 ug/l or <0.04 mg/l TP). Research over the past few decades has demonstrated that eutrophication is not just about phosphorus. For instance, increased nitrogen has been a significant eutrophication driver along the East Coast (Howarth and Marino 2006). Nitrogen is often the limiting nutrient in FFP dominated Mississippi River floodplain lakes (Giblin et al. 2013).

The borrow pit study

In 2022, the FLOW Science Committee decided to take a closer look at the unnamed borrow pit lake. Although it is not a natural oxbow lake, it displayed all the original environmental characteristics of the natural LWSR oxbow lakes before the increasing trend of



Figure 4. Photo of duckweed growth covering Jones Slough oxbow.

FFP dominance occurred. The borrow pit is also a seepage lake with groundwater as the primary water source. Our team (Figure 5) split study responsibilities focusing on aquatic plants, monthly water quality sampling and fish surveys.

Plant survey

On July 14, 2022, two FLOW Science Committee members teamed with the Wisconsin Department of Natural Resources (WDNR) to conduct an aquatic plant point intercept survey. A pole rake was used to sample 70 sites across the borrow pit lake. The maximum depth of the lake was four feet (1.2 m) and plants were found at 67 sites. We found 11 plant species in the lake compared to a median of 8.5 species in Driftless Area and Mississippi River region floodplain lakes (DMR). Borrow pit plant data analysis indicated the average coefficient of conservatism was 6.6 compared with a mean value of 5 for DMR lakes. Conservatism estimates the likelihood of plants occurring within a relatively



Figure 5. Some of the borrow pit lake study team with the borrow pit lake in the background. Left to right: Retired WDNR Lakes Program Specialist and FLOW Board member Susan Graham, FLOW Board member Dave Kruger, FLOW President Timm Zumm, FLOW Board member Patrick Michaels, and WDNR Water Resources Biologist and FLOW Science Committee Chair Jean Unmuth. Photo by Dave Marshall

unaltered state (Nichols 1999). The borrow pit lake had a Floristic Quality Index (FQI) value of 18.7, which is above both the median (14.3) and upper quartile (18.1) for DMR lakes. *Chara vulgaris* (common stonewort) was the most abundant plant followed by creeping bladderwort (*Utricularia gibba*) and white waterlily (*Nymphaea odorata*) (Figure 6). Duckweeds and non-native aquatic plants were not detected during the survey.

Fish electroshocking surveys

We waded around the shoreline while towing a small DC electroshocker to sample fish in June and July 2022. We identified seven species during the surveys: bluegill sunfish (*Lepomis macrochirus*), green sunfish (*Lepomis cyanellus*), largemouth bass (*Micropterus salmoides*), northern pike (*Esox lucius*), American grass pickerel (*Esox americanus*), Central mudminnow (*Umbra limi*) and starhead topminnow (*Fundulus dispar*). Regarding the first six species, we found no stocking records and their origins remain unclear. All six species may have migrated into the seepage lake during high river stages. In particular, green sunfish, American grass pickerel and mudminnows are not typically stocked in Wisconsin. We had introduced the state endangered starhead topminnows into the borrow pit in 2021.

We raised the fish as part of a conservation aquaculture rescue effort to establish populations out of harm's way given the ongoing pollution of LWSR oxbow lakes (Lyons et al. 2021; Marshall et al. 2021; Lyons et al. 2022). The LWSR has the largest population of this endangered fish in the state but their status along the river is now less secure. We stocked most of the endangered fish upstream of the dam but had nearly 600 left over to stock the borrow pit. This year we observed overwinter survival and reproduction at most of our stocking sites, including the borrow pit lake.

Water quality sampling

We collected monthly water samples from the borrow pit from June through September and found stable conditions. Dissolved oxygen levels remained within the range of 7 mg/l to 12 mg/l. Specific conductance ranged from 417 to 496 uS/cm. pH ranged from 8.0 to 8.2. Alkalinity

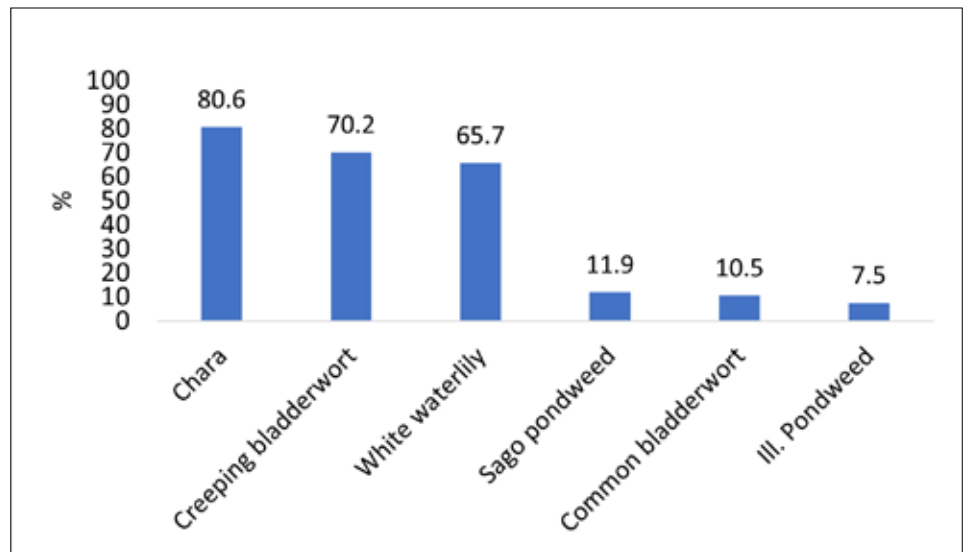


Figure 6. Summary of Borrow Pit Point Intercept Aquatic Plant Survey – Percent Frequency of Occurrence

ranged from 208 to 248 mg/l. $\text{NO}_3\text{-N}$ + $\text{NO}_2\text{-N}$ concentrations were below detection at the State Laboratory of Hygiene. Relatively low Total Kjeldahl Nitrogen (TKN) levels were found as was total phosphorus (Figure 7).

Why is the borrow pit lake's water cleaner than most LWSR oxbow lakes?

Many of the oxbow lakes lie adjacent to glacial outwash terraces, where nitrogen applications on croplands increased significantly over the past decade. In contrast, the borrow pit seepage lake lies down-gradient from

Blackhawk Ridge, a publicly owned woodland where uncontaminated groundwater recharge occurs. Whereas the groundwater beneath the agricultural terraces is often contaminated with $\text{NO}_3\text{-N}$ concentrations two to three times the Drinking Water Standard, private well data upgradient of the borrow pit did not exceed 1.8 mg/l $\text{NO}_3\text{-N}$ (UW Stevens Point). The borrow pit lake's physical features and hydrology resemble most LWSR oxbow lakes, but the primary difference proved to be uncontaminated groundwater.

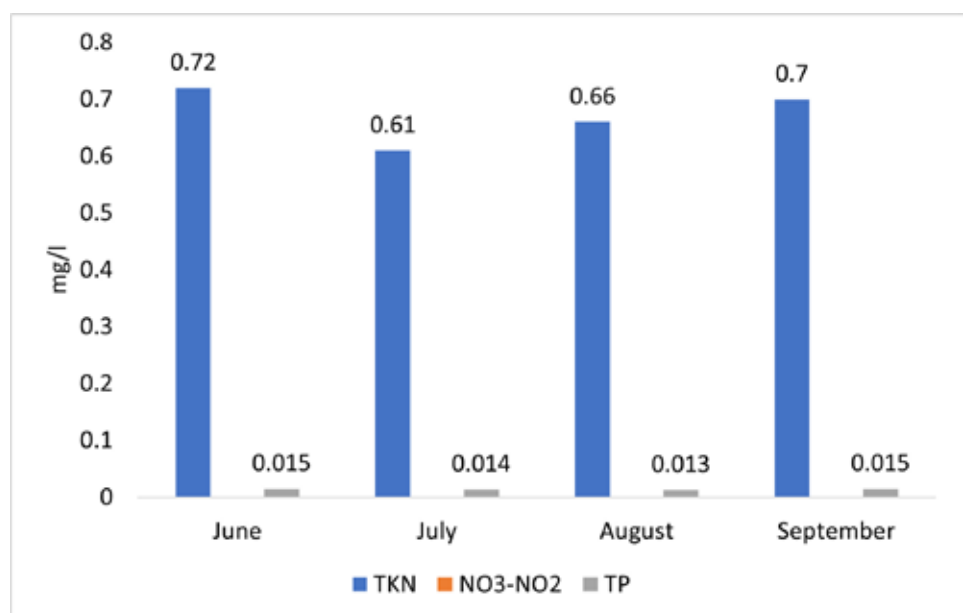


Figure 7. Borrow Pit N and P data.

Are borrow pits in the public interest?

Our brief study suggests that this borrow pit expanded important LWSR habitat that is declining elsewhere. A floodplain lake, now surrounded by public land, was created where marginal farmland existed. It can now serve as a reference site since most other LWSR floodplain lakes became degraded. The 1991 wetland mitigation did not result in an overly deep waterbody since most of the natural LWSR oxbow lakes are 8 feet (2.4 m) deep. The mitigation could be enhanced by increasing biodiversity, including perhaps introducing additional fish species found in the natural oxbow lakes. Given that current agricultural practices will not likely change soon, strategically placed shallow borrow pits, where groundwater is not contaminated, may be beneficial. Borrow pits may improve off-channel habitats along other rivers where oxbows were lost or degraded due to sedimentation, a common problem in southern Wisconsin (Knox 2006). In these aggraded floodplains deeper excavations will be needed to reach groundwater.

Acknowledgements

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About FLOW

FLOW is a 501c3 nonprofit conservation organization established to help preserve the unique historic and ecological features of the Lower Wisconsin River, a shared mission with the Lower Wisconsin State Riverway Board and WDNR. The Science Committee has become somewhat of a WDNR afterlife for many of us geezer retirees.

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Richard Wedepohl is a retired environmental engineer who worked for the Wisconsin Department of Natural Resources for 33 years. For 20 years he was the DNR's Lake Management Coordinator. In a later capacity he was responsible for developing non-point source water appraisals and best land management practices for priority watershed projects. Since retiring he's been providing consultation and design services for numerous lake and reservoir restoration projects. Richard is a Past President of North American Lake Management Society.



Dave Marshall retired from Wisconsin DNR in 2006 after a 30-year career in the Water Resources Management and Fisheries Habitat Protection programs. He has since worked as a lake management consultant and specializes in littoral zone fish population surveys and conservation aquaculture techniques designed to restore rare fish populations. Dave is currently on the FLOW Board and a member of the Science Committee.



Jean Unmuth has an MS degree from UW Stevens Point Fisheries and Water Resources. She retired from Wisconsin DNR after decades of work as a fisheries researcher and later Water Resources Specialist. She is currently the Chair of the FLOW Science Committee.



Sue Graham was a lake water quality biologist in various positions for Wisconsin Department of Natural Resources (WDNR) for 31 years. Much of her time was spent helping people understand lake processes so they could collaboratively design protection and restoration measures. She assisted with the department's lake and invasive species grant funding program, in addition to the aquatic plant management policy and permitting program. Since retirement, she has spent many happy hours backpacking, and swimming and paddling lakes and streams. 🐾

