Surveys of Grant County Floodplain Lakes

Lakes Planning Grant Study

Whites Slough

RIVER ALLIANCE of Wisconsin

We Save Rivers

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Summary

As part of two small-scale Lakes Planning Grants, 7 floodplain lakes were sampled along the Lower Wisconsin State Riverway during the summer of 2010. Information collected during the surveys included water chemistry, water transparency, nearshore fish species, and aquatic plants. Seventeen fish species were identified in the floodplain lakes including the State Endangered starhead topminnow, State Special Concern lake chub sucker, and State Special Concern pirate perch. Starhead topminnows and pirate perch were found in 3 of the 7 floodplain lakes and the lake chubsucker was found in four lakes. While the unexpected rare fish species collections likely reflected a dearth of sampling in the past, additional sources of information suggest that the water quality had improved in recent years and their habitats expanded. The oxbows also supported numerous popular sport fishes including juvenile bluegill sunfish and largemouth bass. In addition to nearshore fish population surveys, habitat conditions were noted and aquatic plant specimens were submitted to the University of Wisconsin Madison Herbarium.

A continuum of floodplain aquatic habitats varied with the relative contributions of upland groundwater flow and alluvial groundwater flow. Change can be considered a constant within the floodplain lakes as river stages altered water chemistry and habitat conditions. The flooding that occurred in 2010 demonstrated how floodplain habitats can drastically change. The backwater fish populations appear to be adapted to periodic environmental stressors, but additional stressors such as groundwater contamination and polluted runoff can threaten the environmentally sensitive ecosystems.

Annual phosphorus loadings were difficult to estimate since river flooding can result in either a net gain or loss depending on a given event. Flooding events are a force of nature, and not manageable, but are an important function that sustains the oxbows. Strong floods can scour the braided channel oxbows since these linear flood channels can pass high water velocities. Land uses can be managed to reduce nutrient loads and protect groundwater; factors that can have significant direct and indirect effects on fisheries and water quality. In general, the study demonstrated that the floodplain lakes are environmentally sensitive habitats within the State Riverway and are important for sustaining ecological diversity along the State Riverway.

Recommendations

1. Lower Wisconsin State Riverway partners should consider management options that are needed to protect the environmentally sensitive floodplain lakes.
2. Establishing buffer zones could benefit floodplain lakes that are vulnerable to upland groundwater contamination and runoff pollution.
3. The Lower Wisconsin River is currently classified an Exceptional Resource Water (ERW) and encompasses the floodplain lakes. However, given that these important resources are environmentally sensitive, WDNR should classify these waterbodies as Outstanding Resource Waters (ORW).
4. Conservation easements may be useful in areas where nutrient management problems can be linked to high nitrate levels in wells and springs.
5. This study certainly doesn't finalize floodplain lake research or provide a complete floodplain lake dataset. Many other sloughs in Grant County had not been sampled. Consider examining water quality trends in a few key cutoff channel oxbows over a range of river stages.
6. Avoid channel armoring that can alter natural fluvial processes and floodplain connectivity.

Introduction

While most glacial lakes and impoundments in southern Wisconsin have been the focus of lake monitoring, planning and management, another entire class of lakes has been largely ignored. Scores of cutoff channel oxbows and other floodplain waterbodies provide important habitats for aquatic communities within transitional zones linking the Lower Wisconsin River with the Driftless Area uplands. The Lower Wisconsin State Riverway is one of the most biologically diverse large river systems in the United States. The high diversity of species reflects a relatively natural floodplain that includes cutoff channel oxbows and other floodplain aquatic habitats. Many of the oxbows within the State Riverway are locally popular sportfish destinations, yet very little is known about these mysterious lakes.

Prior to the more recent surveys, information on floodplain lakes was limited to brief descriptions in "Surface Water Resources of Grant County" (1971). In that publication, there is no discussion of standard lake metrics such as Trophic State Index (TSI), specific management recommendations or identification of nongame or rare fish populations. Yet most of the information in that report had not been updated.

In response to the dearth of information on these ecologically important oxbows, the River Alliance of Wisconsin applied for and received two small-scale Lakes Planning Grants to collect information needed to better understand these unique ecosystems and develop management recommendations. The surveys were designed to collect the following information: TSI and other water chemical parameters, nearshore fish populations, habitats including aquatic plants, local watershed areas and upland land uses that may affect water quality.

Methods

At each lake, surface water samples were collected for total phosphorus, color, and chlorophyll at the deepest location of each lake. A Garmin 76 was used to log all sampling locations. A YSI Model 52 meter was used to measure dissolved oxygen and temperature. A YSI Model 63 meter was used to measure pH and specific conductivity. Calibration of the instruments followed manufacturer recommendations including the 2 point calibration for pH. Back-up systems for pH included a LaMotte meter and ExStik conductivity probe. The water quality sampling was performed from May through September 2010. Secchi transparency tube measurements replaced standard secchi since the lakes are typically shallow. Water samples were analyzed at the State Lab of Hygiene (SLOH). Total phosphorus, chlorophyll, and color were tested at the State Lab of Hygiene. Notes on habitat quality were compiled for each floodplain lake. Aquatic plant specimens were collected and submitted to the University of Wisconsin Madison Herbarium. Photographs routinely captured aquatic plant and shoreline habitat conditions at each lake. The amounts of metaphyton (duckweeds and filamentous algae) were estimated using a 0.25^2 meter quadrat as another indicator of eutrophication and nutrient enrichment. Metaphyton cover estimates ranged from 0, 1 (1 - 20%) to 5 (> 80%). Metaphyton density estimates included 0 (none present), 1 (thin layer) and 2 (high density mat). Metaphyton estimates were developed to examine the level of water quality impairments in Mississippi River backwaters (Sullivan 2008) and are useful for additional eutrophication analysis of Lower Wisconsin State Riverway floodplain lakes.

Nearshore fish population sampling included small mesh dipnetting, small mesh seining and towed DC electro-shocker. All specimens were immediately released after field identification and enumeration except where immature specimens required further review. The fish surveys were designed to sample populations of nongame species and juvenile stages of sportfish. The surveys were indicators of ecological diversity and distribution of fishes that inhabit nearshore areas. This type of survey does not evaluate the growth rates, size structures or densities of sport fish populations.

Upland land uses and upland watersheds were estimated using Map Tech Terrain Navigator and WDNR WebView where applicable. WILMS watershed phosphorus loading module estimated phosphorus loading from local watersheds. This information represented only an initial screening and does not account for alluvial groundwater inputs during floods or event related scour and deposition. The Trophic State Index (TSI) was calculated for phosphorus and chlorophyll concentrations in each lake using these calculations: phosphorus TSI = 14.42 ln (ug/l) + 4.15, chlorophyll TSI = 34.8 + 7.56 ln (ug/l). The range is 0-100 with values > 50 reflecting eutrophic conditions. The TSI values do not reflect rooted plant suppression or alleopathic effects on planktonic algae. Figure 1- 3 display the 2010 Grant County survey areas.

Figure 1: Map of Whites Slough, Poffenrath Slough and Jones Slough sampling sites

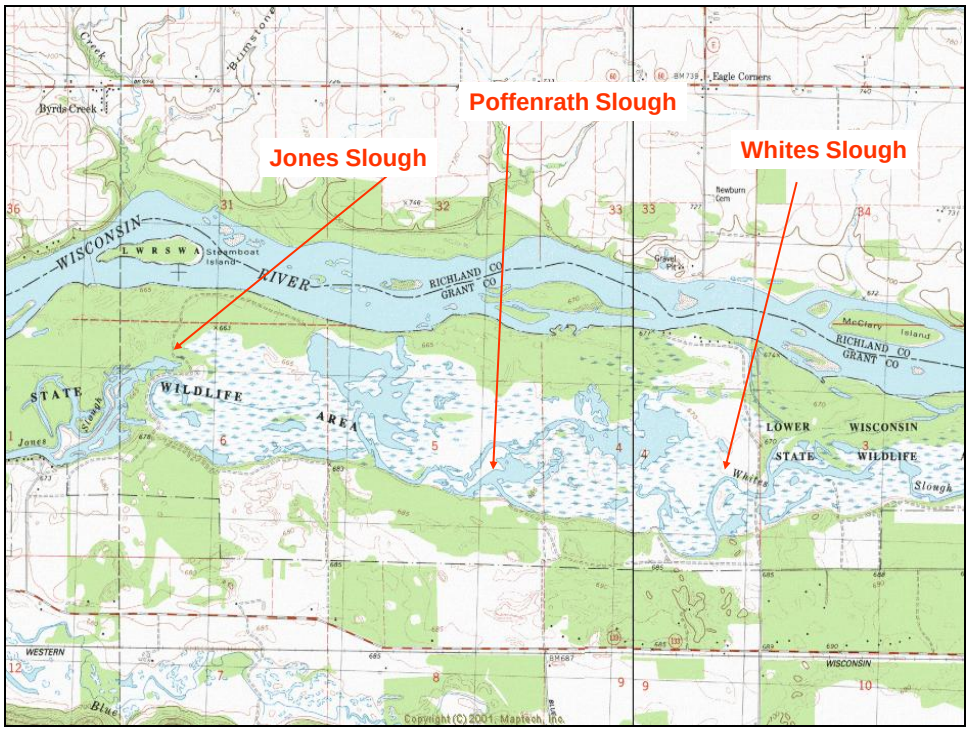


Figure 2: Map of Bullhead Slough and Woodman Lake sampling sites

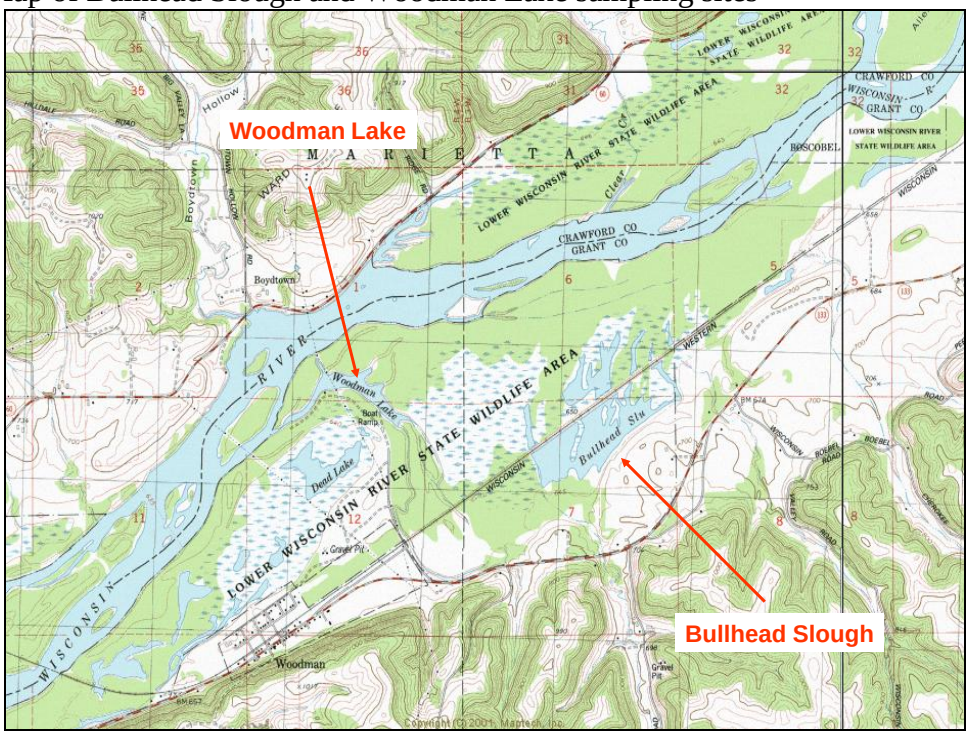
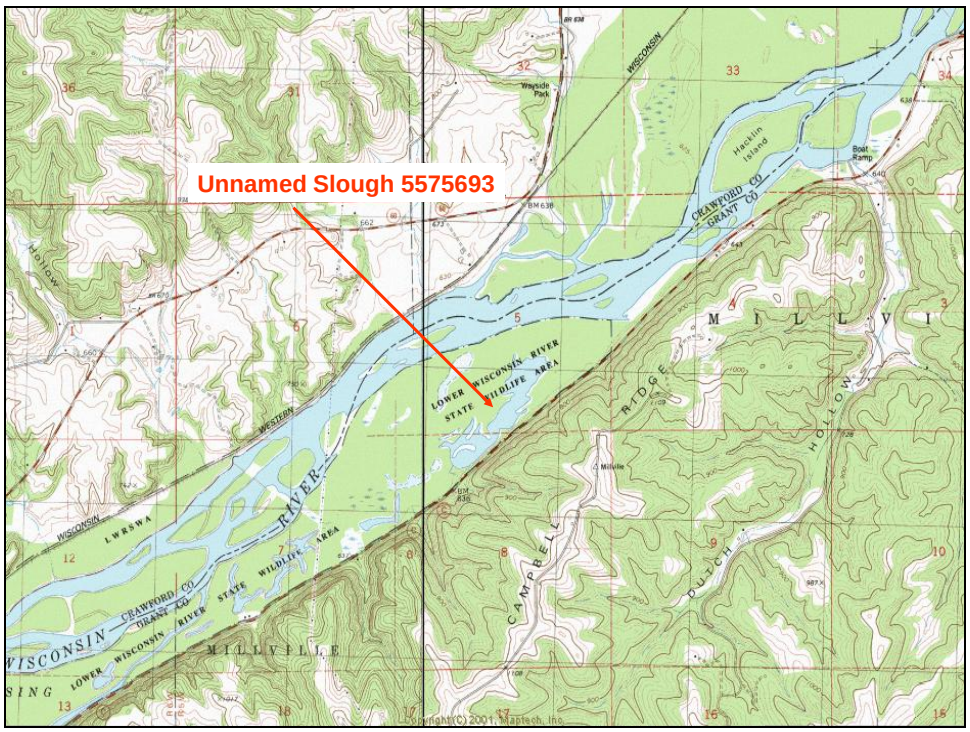


Figure 3: Map of Unnamed slough 5573319 sampling site



Findings

The results of the surveys demonstrated that the conditions in floodplain lakes were highly variable and reflected diversity of habitats along the Lower Wisconsin State Riverway. Lakes on the east side of the county displayed the best water quality. Whites Slough, Poffenrath Slough and Jones Slough had mean TSI values of 59, 47.5 and 47.5 respectively. These lakes also were also the clearest (secchi tube measurements of 120 each, Figure 5). Jones Slough and Poffenrath Slough also had relatively low color measurements that likely reflected greater inputs of upland groundwater. Whites Slough displayed more complex characteristics. The lake was highly stained (typically indicating alluvial groundwater inputs) while the very cold bottom water temperature that suggested upland spring flow. 2010 was not a normal year for sampling since summer river flooding occurred throughout most of July and August. Water quality sampling results did not represent typical summer conditions since the Wisconsin River flows exceeded roughly 3X the daily median rate. Seventeen species of fish were found in the seven floodplain lakes. With the exception of Bullhead Slough, the Lower Wisconsin State Riverway floodplain lakes were not impaired with dense metaphyton growths that occur along the Mississippi River.

Whites Slough (WBIC 1214900) is a six acre cutoff channel oxbow lake that is located about one mile west of Muscoda. The wilderness setting of this slough demonstrates one of the many Lower Wisconsin State Riverway attractions. It was previously considered a winterkill lake with periodic gamefish populations that enter during floods (Smith and Ball 1971). Likely sources of water include river flooding, alluvial groundwater and perhaps upland groundwater based on

cold bottom temperatures (10.7 C). The local watershed consists primarily of wetlands (90 ha) and croplands (223 ha) with an estimated annual phosphorus loading of 232 kg P/yr.

Whites Slough was sampled on August 18th 2010. Relatively low dissolved oxygen was detected with only 3.6 mg/l at the surface and 1 mg/l or less below 0.5 meters (Figure 4). The highly stained oxbow (color level = 70 su, Figure 7) supported a diverse aquatic plant community including white water lily, spatterdock, Elodea, leafy pondweed, flatstem pondweed, common bladderwort, coontail, duckweeds, pickerelweed, arrowhead, and wild rice. While duckweeds were present in the lake, the level of metaphyton was undetectable with cover and density scores of 0 each (Figure 8). The chlorophyll concentration was relatively low at 4.47 ug/l (TSI = 48) while the total phosphorus concentration was significantly higher at 93 ug/l (TSI = 70). The disparity in TSI values may have reflected aquatic plant suppression of phytoplankton. The standard secchi reading (1.1 m or TSI = 59) likely reflected the stained water rather than phytoplankton bloom. Comparative phosphorus and TSI values appear in Figure 6. Fish were collected with both dip nets and electroshocker. A typical floodplain fish community was revealed in Whites Slough including grass pickerel, mudminnow, golden shiner, lake chubsucker, pirate perch, pumpkinseed sunfish, and bluegill. In 2008 the oxbow was briefly dip netted and starhead topminnows were found at that time.

Figure 4: Whites Slough dissolved oxygen and temperature profiles

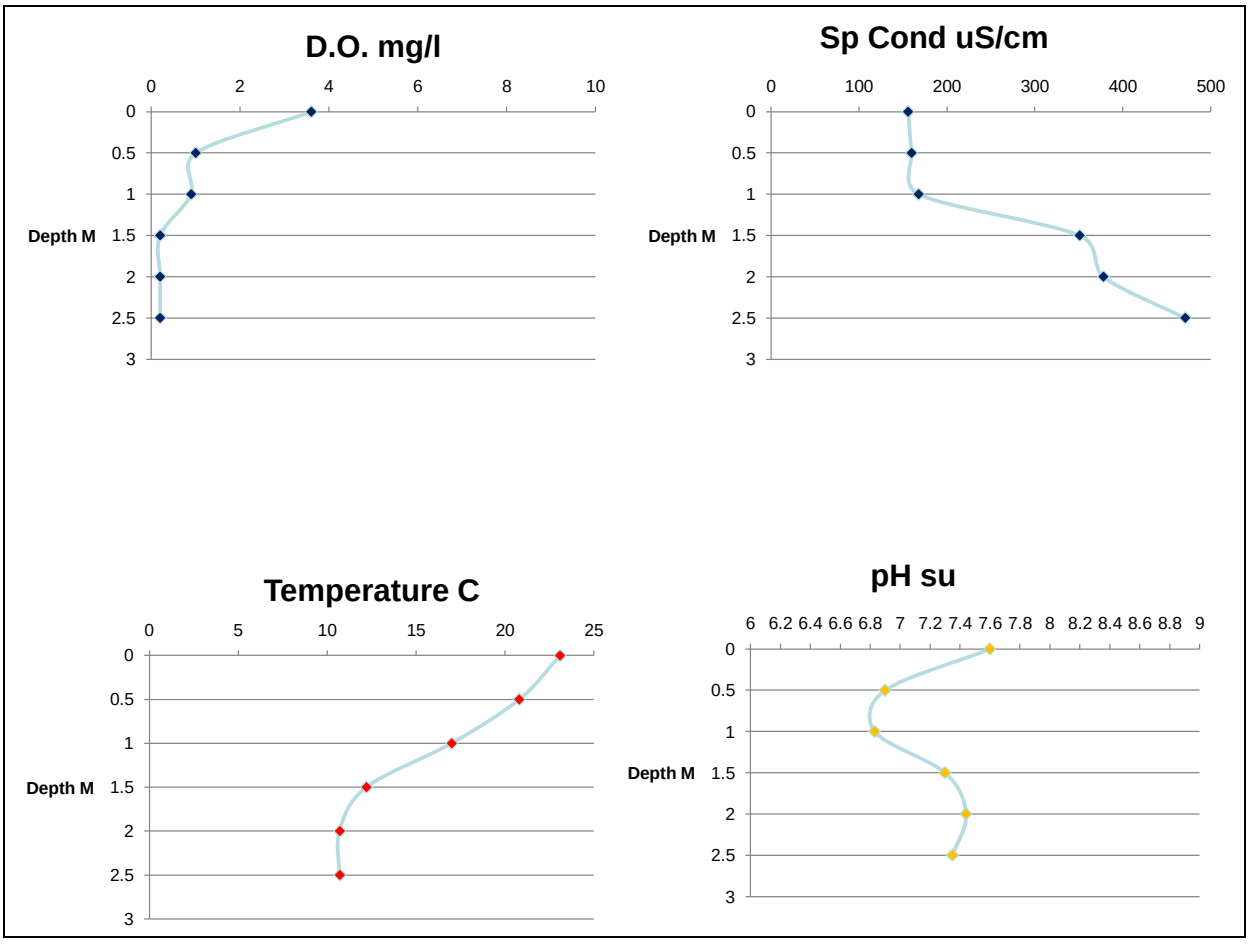


Figure 5: Comparative secchi tube transparency (* heavy metaphyton cover)

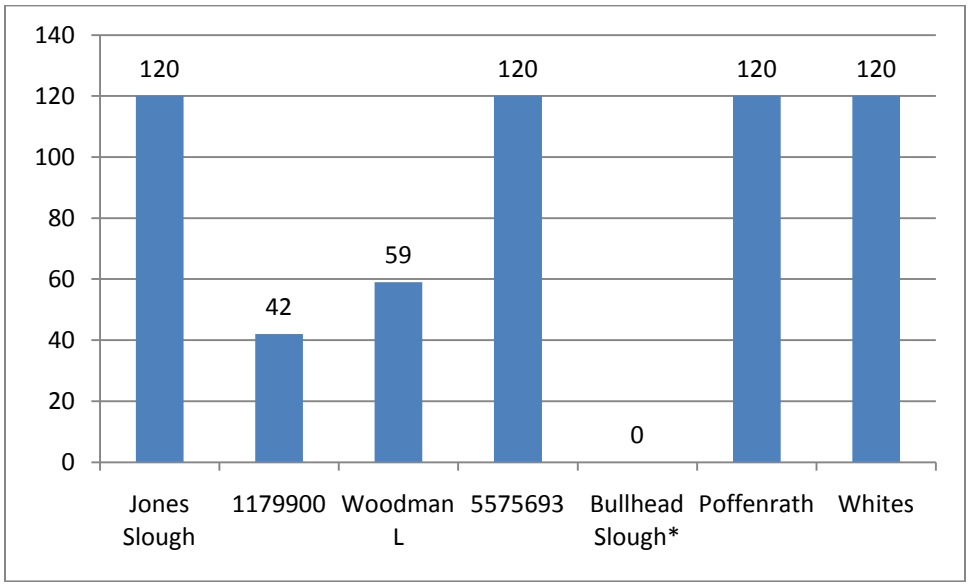
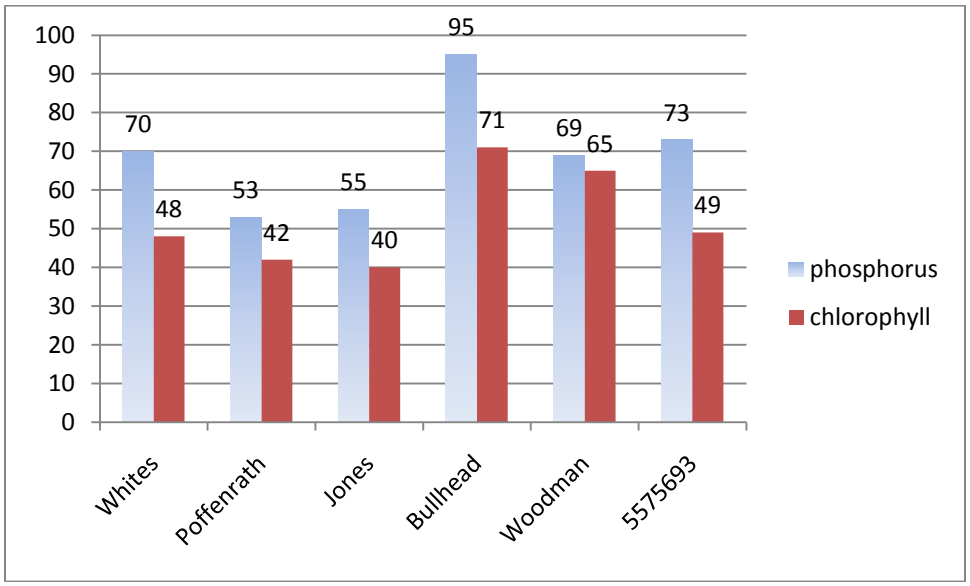


Figure 6: Comparative TSI values for phosphorus and chlorophyll



Poffenrath Slough (WBIC 1214900) is a 10 acre cutoff channel oxbow located about two miles east of Blue River. Upland groundwater appears to be the primary water source. The local watershed includes farmland (89 ha) and wetlands (81 ha) that immediately surround the lake. The estimated annual phosphorus loading is 97 kg P/yr from the local watershed. The chlorophyll concentration was 2.66 ug/l (TSI = 42) and total phosphorus concentration was 30 ug/l (TSI = 53). Aquatic plant suppression of phytoplankton may have been the reason for the relatively lower chlorophyll TSI. Aquatic plants in the lake included white water lily, large-leaf pondweed, flat-stem pondweed, coontail, duckweeds and wild rice. Metaphyton was present in the lake with a cover and densities ranks of 1 each. The overall habitat was rated "high" and several rare fish species were found in the lake; starhead topminnow, lake chubsucker and pirate perch. Other fish species collected were grass pickerel, mudminnow and bluegill.

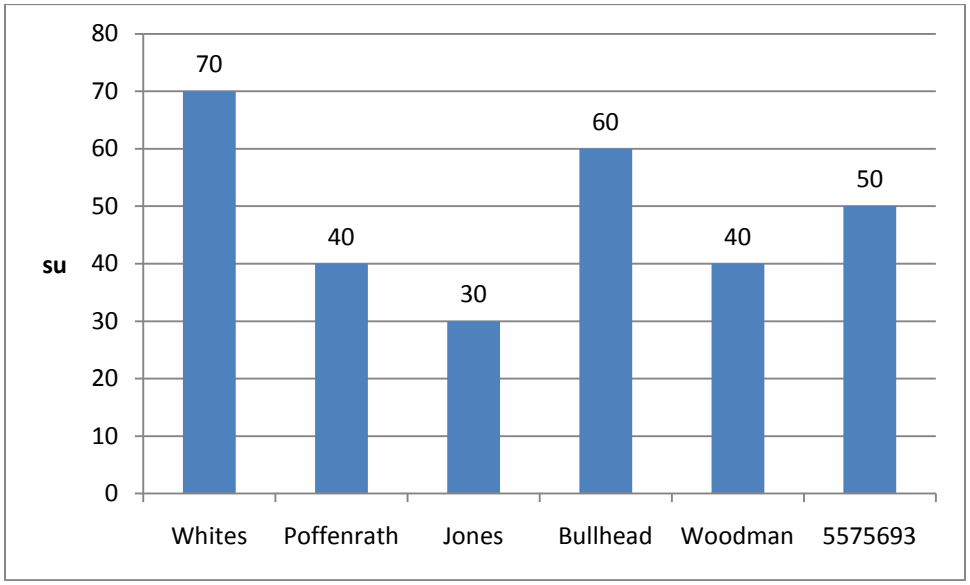
Poffenrath Slough

Jones Slough (WBIC 1210900) is a 13 acre cutoff channel oxbow that is located about one mile northeast of Blue River. The oxbow receives upland groundwater and flow from Fish Trap Lake that is managed with an earthen berm. A number of seasonal residences lie on the south side of the oxbow. In the 1990s, property owners and WDNR managers were concerned about a mysterious orange turbidity in the water. After an investigation, WDNR Water Resources staff determined Fish Trap Lake had released anoxic water containing high levels of iron through the

bottom withdrawal structure. The soluble iron quickly precipitated into particulates as water was oxygenated at the outlet of the discharge pipe. The iron particulates and associated iron bacteria caused the orange color in Jones Slough. In recent years and when the oxbow was sampled for this project, water from Fish Trap Lake had bypassed the bottom withdrawal structure and the water was clear instead of orange.

The local watershed surrounding Jones Slough is about 264 ha including farms (152 ha), wetlands (108 ha) and residential (4 ha) that contributes an estimated annual phosphorus loading of 168 kg P/yr. Jones Slough was sampled on July 13, 2010. The chlorophyll concentration was 2.05 ug/l (TSI = 40) and total phosphorus concentration was relatively higher at 35 ug/l (TSI = 55). The standard secchi reading was greater than the sampling depth (1.5 m = <TSI 54). Metaphyton was scarce and lower than detection using the quadrat sampler. Aquatic plants in the lake included white water lily, Elodea, leafy pondweed, Eurasian watermilfoil and coontail. Fish were sampled with both electroshocker and dip nets. We found grass pickerel, golden shiner, lake chubsucker, starhead topminnow, green sunfish, warmouth sunfish, bluegill and black crappie near the public boat ramp.

Figure 7: Comparative color levels



Bullhead Slough (WBIC 1205300) could be considered a deep water marsh that is located about one mile northeast of Woodman. A railroad grade creates an impoundment that partially separates Bullhead Slough from the river floodplain. It is uncertain if the grade had altered the hydrology of the marsh but it is one of the most eutrophic waterbodies along the Lower Wisconsin State Riverway. When it was recently sampled in 2008, a thin layer of duckweed (metaphyton) covered the marsh. A few starhead topminnows were dip netted in a small open water area where a spring entered from the south. In 2010, Bullhead Slough water levels were higher the slough was covered with a much heavier layer of duckweed. Neither starhead topminnows nor other fish could be found since dissolved oxygen level was 0 mg/l. The anoxia

in the marsh generated strong septic odors as well. This was the only major floodplain waterbody along the Lower Wisconsin State Riverway that displayed severe water quality problems frequently found along the Mississippi River. The specific causes for the hypereutrophic conditions in Bullhead Slough are unknown but further investigations should be conducted to determine if the railroad grade had significantly changed the hydrology. Bullhead Slough is ultimately connected to Woodman Lake. From Bullhead Slough, a river of anoxic water flowed into Woodman Lake. The organic loading to Woodman Lake is a concern given the value of Woodman Lake for the Lower Wisconsin State Riverway and should be investigated further.

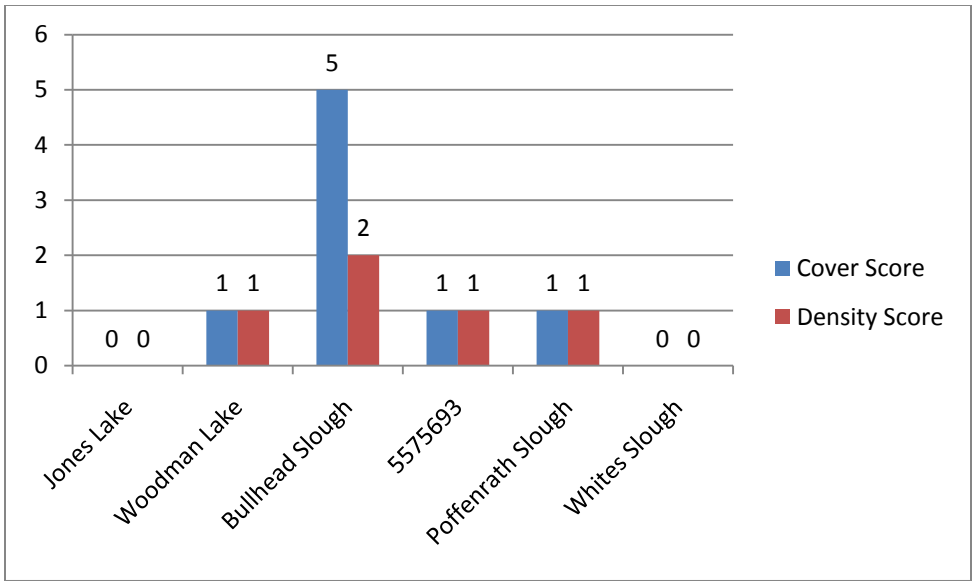
The local watershed is about 1245 ha including woods (622 ha), farms (510 ha) and wetlands (114 ha) that contribute an estimated 583 kg P/yr.

Dense metaphyton covering Bullhead Slough

Unnamed Slough (43o 07.05' – 90o 45.407') is a small river connected slough that was sampled on July 15, 2010 during a canoe trip with River Alliance staff, WDNR, Friends of the Lower Wisconsin Riverway, volunteers and UHI. We seined a variety of fish species including grass pickerel, spotfin shiners, lake chubsuckers, brook silversides, bluegill, largemouth bass and black

crappies. Aquatic plant species included Elodea, leafy pondweed, Eurasian watermilfoil and coontail.

Figure 8: Metaphyton cover and density ratings



Woodman Lake (WBIC) is a 21 acre cutoff channel oxbow that is permanently connected to the Lower Wisconsin River. A town ordinance prohibits gas motors on the lake. The local watershed is approximately 262 ha including wetlands (105 ha), woods (78 ha), farms (64 ha) and grassland (14 ha) with an estimated annual phosphorus loading of 86 kg P/yr. The estimated annual phosphorus load was probably exceeded given the nutrient loading from Bullhead Slough in 2010. The lake was sampled on July 15th and high chlorophyll (57.1 ug/l) and phosphorus (121 ug/l) may have reflected organic loading from Bullhead Slough. More sampling is needed to determine baseline conditions in the lake. The TSI values were comparable at 65 and 69 respectively.

Aquatic plants were relatively scarce in Woodman Lake but white water lily, Elodea, Eurasian watermilfoil and coontail were observed in low densities. Metaphyton was present but relatively low in density and cover. Fish were sampled on two occasions and included grass pickerel, mudminnow, golden shiner, young of year buffalo, tadpole madtom, brook silverside, green sunfish, bluegill, orange spotted sunfish, largemouth bass, and Iowa darter.

Unnamed slough (WBIC 5575693, Figure 3 map) is located in the Town of Millville along CTH C. It was sampled on August 4, 2010, and like all of the surveys, river flow was higher than normal. The unnamed cutoff channel oxbow functioned temporarily as a flowing side channel at that time. The slough lies adjacent to a steep bluff and the elevation change would suggest upland groundwater inputs. Since the slough elevation was higher than normal along with temporary riverine flow, upland groundwater could not be detected. The local watershed is about 131 ha including wetlands (45 ha) and ridgeline woods (86 ha) for an estimated annual phosphorus load of 91 kg P/yr.

River current was clearly evident in the slough. The chlorophyll concentration in the mixed water was 6.16 ug/l (TSI = 49) and total phosphorus concentration was 121 ug/l (TSI = 73). While the slough did support abundant aquatic plants, the likely reason for the TSI disparity was probably linked to flood water nutrient inputs and the short residence time in the slough under these conditions. Metaphyton (duckweeds) was evident in the moving water with modest cover and density scores of 1 each. Aquatic plants in the slough included white water lily, Elodea, coontail, long-leaf pondweed, arrowhead, pickerelweed and duckweeds. Fish were sampled with dip nets and electroshocking gear. Sampling was difficult since high water reduced wadeable habitats with drop-offs next to shore. At any rate, we collected typical Lower Wisconsin State Riverway slough fish including grass pickerel, mudminnow, pirate perch, starhead topminnow, warmouth sunfish, bluegill, and largemouth.

Unnamed slough 5575693

Discussion

The lakes planning grant study revealed diverse floodplain lakes along the Lower Wisconsin State Riverway in Grant County. These habitats sustain the high biodiversity and provide

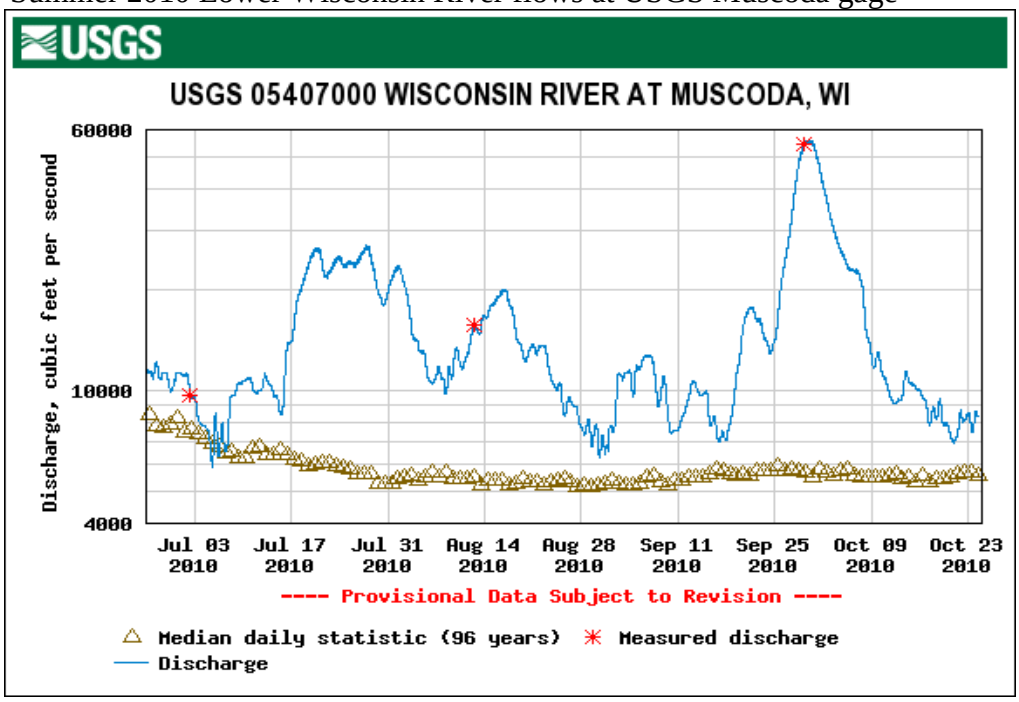
important ecological functions linked to the main river channel. Some of the braided channel oxbows along the Lower Wisconsin State Riverway are continuously connected to the main river channel and support a blend of riverine and lake fish populations. These habitats also provide important nursery habitat for immature river fish (Amoros 2001, Amoros and Bornette 2002, Killgore and Miller 1995). Other oxbows are isolated from the river channel except under floodwater conditions. In many other river systems, these unique habitats had been destroyed by dams as the diverse oxbows become permanently flooded. The impoundments along the Mississippi River may be a reason why metaphyton growths are excessive and damaging to water quality as hydrology is permanently changed. Altered hydrology may be a reason for poor water quality in Bullhead Slough.

Upland groundwater plays an important role in the survival of many fish species (Amoros 2001). There are some indications that habitat linked to water quality and upland groundwater may have improved over the years. Long term United States Geological Survey data indicate rising groundwater levels and increasing tributary lowflow rates in the Driftless Area (Gebert and Krug 1996, Potter 1991). These changes were linked to improved agricultural land use practices. Increased sustained tributary flow rates to the floodplain lakes may have improved habitat fish species in recent years. Flooding would then be the likely dispersal mechanism for fish to become established in favorable habitats.

Other factors likely contributed to improved floodplain lake and stream habitats. First, thanks to the Clean Water Act upper river pollutant loads declined precipitously since the early 1980's. By the early 1980s, implementation of the Clean Water Act and the Wisconsin Pollutant Discharge Elimination System resulted in a 95% reduction in Biochemical Oxygen Demand from point sources in the upper Wisconsin River. Floodplain habitats are now exposed to cleaner water during seasonal flood events. And river flooding was certainly evident in 2010 (Figure 9).

While river floodplain conditions likely improved over the years, threats in the forms of polluted runoff and contaminated groundwater are a concern. The entire floodplain is designated highly susceptible to groundwater contamination, including high nitrates. Research has demonstrated that aquatic life can more susceptible to high nitrates than human infants (Camargo et al. 2005). Pfieffer et al. (2006) demonstrated the higher nitrate concentrations can occur in cutoff channel oxbows that receive substantial upland groundwater flow. Poffenrath Slough and Jones Slough are examples of environmentally sensitive floodplain lakes that should be protected from groundwater contamination.

Figure 9: Summer 2010 Lower Wisconsin River flows at USGS Muscoda gage



At the mouth of the Big Green River, a swollen spring-pond overflowed into the Wisconsin River. This was one of many examples in 2010 where fish distribution can be affected by flooding.

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Appendix A: Field and SLOH Water Quality Data

Waterbody	WBIC	Date	Trans Tube	D.O. mg/l	Temp C	pH su	Sp Cond
Jones Slough	1210900	7/13/2010	120	6.7	22.8	7.7	282
Un slough	1179900	7/15/2010	42	8.5	25.5	7.75	341
Woodman L	1205000	7/15/2010	59	14.1	27.9	8.4	303
Un slough	5575693	8/4/2010	120	3.4	26.2	7.9	270
Bullhead Slough	1205300	8/4/2010		0	25.9	7.04	321
Poffenrath	1214600	8/18/2010	120	9	22.9	7.84	333
Whites	1214900	8/18/2010	120	3.6	23.1	7.6	156

Waterbody	WBIC	Chlorophylla	Tot Phos	Color
Jones Slough	1210900	2.05	0.035	30
Woodman L	1205000	57.1	0.088	40
Un slough	5575693	6.16	0.121	50
Bullhead Slough	1205300	113	0.562	60
Poffenrath	1214600	2.66	0.03	40
Whites	1214900	5.47	0.093	70

Appendix B: Fisheries Distribution

spp	Whites	Poffenrath	Jones	Bullhead	1179900	Woodman	5575693
Grass pickerel	X	X	X		X	X	X
mudminnow	X	X				X	X
Golden shiner	X		X			X	
Spotfin shiner					X		
Buffalo yoy							
Lake chubsucker	X	X	X		X	X	
Tadpole madtom						X	
Pirate perch	X	X					X
Starhead topminnow		X	X				X
Brook silverside					X	X	
Green sunfish			X			X	
Pumpkinseed	X						
Warmouth			X				X
Bluegill	X	X	X		X	X	X
Orange spotted sunfish						X	
Largemouth bass			X		X	X	
Black crappie			X		X		
Iowa darter						X	

Appendix C: Aquatic plant collections

spp	Whites	Poffenrath	Jones	Bullhead	1179900	Woodman	5575693
White water lily	X	X	X			X	X
Spatterdock	X						
Elodea	X		X		X	X	X
Leafy pw	X		X		X		
Large-leaf pw		X					
Long-leaf pw							X
Flatstem pw	X	X					
CLP							
EWM			X		X		
Common bladderwort	X						
Coontail	X	X	X		X	X	X
Duckweeds	X	X		X		X	X
Pickerelweed	X						X
Arrowhead	X						X
Wild rice	X	X					

Appendix D: Field Notes

Waterbody	WBIC	Date	Substrate	Plants	Floating plants	Woody debris	Rock	Overall Habitat
Jones Slough	1210900	7/13/2010	sand	Medium	Low	Medium	Low	Medium
Un slough	1179900	7/15/2010	sand	Low	Absent	Low	Absent	Medium
Woodman L	1205000	7/15/2010	sand	Low	Low	Medium	Absent	Medium
Un slough	5575693	8/4/2010	clay/sand	Low	Low	Medium	Absent	Medium
Bullhead Slough	1205300	8/4/2010	silt	Low	Absent	Medium	Absent	Low
Poffenrath	1214600	8/18/2010	silt/sand	Low	Low	Low	Absent	High
Whites	1214900	8/18/2010	silt	High	High	Low	Absent	Medium

Waterbody	WBIC	Date	Upland g.w.	Ob color
Jones Slough	1210900	7/13/2010	no	clear
Un slough	1179900	7/15/2010	yes	turbid
Woodman L	1205000	7/15/2010	?	turbid
Un slough	5575693	8/4/2010	?	clear
Bullhead Slough	1205300	8/4/2010	?	stained
Poffenrath	1214600	8/18/2010	yes	clear
Whites	1214900	8/18/2010	?	Stained/clear