Surveys of Richland County Floodplain Lakes

Lakes Planning Grant Study

Smith Lake

Richland County Land Conservation Department

October 2010

Prepared by
David W. Marshall
Underwater Habitat Investigations LLC

Project Coordinator: Cathy Cooper, County Conservationist

Survey participants: Ken Anderson, Merel Black, Cathy Cooper, Rob Cooper, Jamesa Marshall, Kent Marshall, Dave Marshall (UHI consultant), Caleb Olson, Jerrod Parker, Jean Unmuth (WDNR).

Summary

As part of a large-scale Lakes Planning Grant, 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. Twenty-eight fish species were identified in the floodplain lakes including the State Endangered starhead topminnow, State Special Concern lake chub sucker, State Special Concern weed shiner, State Special Concern pirate perch, and State Special Concern mud darter. The latter three are Natural Heritage Inventory species that WDNR Bureau of Endangered Resources identified for informational needs. Starhead topminnows were found at 1 of the 7 floodplain lakes. While the rare fish species collections likely reflect a dearth of sampling efforts 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, habitats were assessed and aquatic plant specimens were submitted to the University of Wisconsin Madison Herbarium.

A continuum of floodplain aquatic habitats exists that vary 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 alter 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 habitats.

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 controllable, 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. Upland 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 spring fed floodplain lakes are environmentally sensitive water resources within the State Riverway but are important for sustaining healthy fish populations.

Recommendations

1. Lower Wisconsin State Riverway partners (including Richland County Land Conservation Department, Lower Wisconsin State Riverway Board and WDNR) should consider management options that are needed to protect the environmentally sensitive floodplain lakes.
2. Establishing buffer zones could benefit floodplain lakes 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 and unique, 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. Consider examining water quality trends in a few key cutoff channel oxbows over a range of river stages.

Introduction

While most glacial lakes and impoundments in southern Wisconsin have been the focus of lake monitoring, planning and management, an entire class of lakes has been largely ignored. Scores of cutoff channel oxbows and other floodplain waterbodies provide important habitats for aquatic communities within a transitional area 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 Richland County" (1970). 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 Richland County Land Conservation Department applied for and received a State Lakes Planning Grant 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.

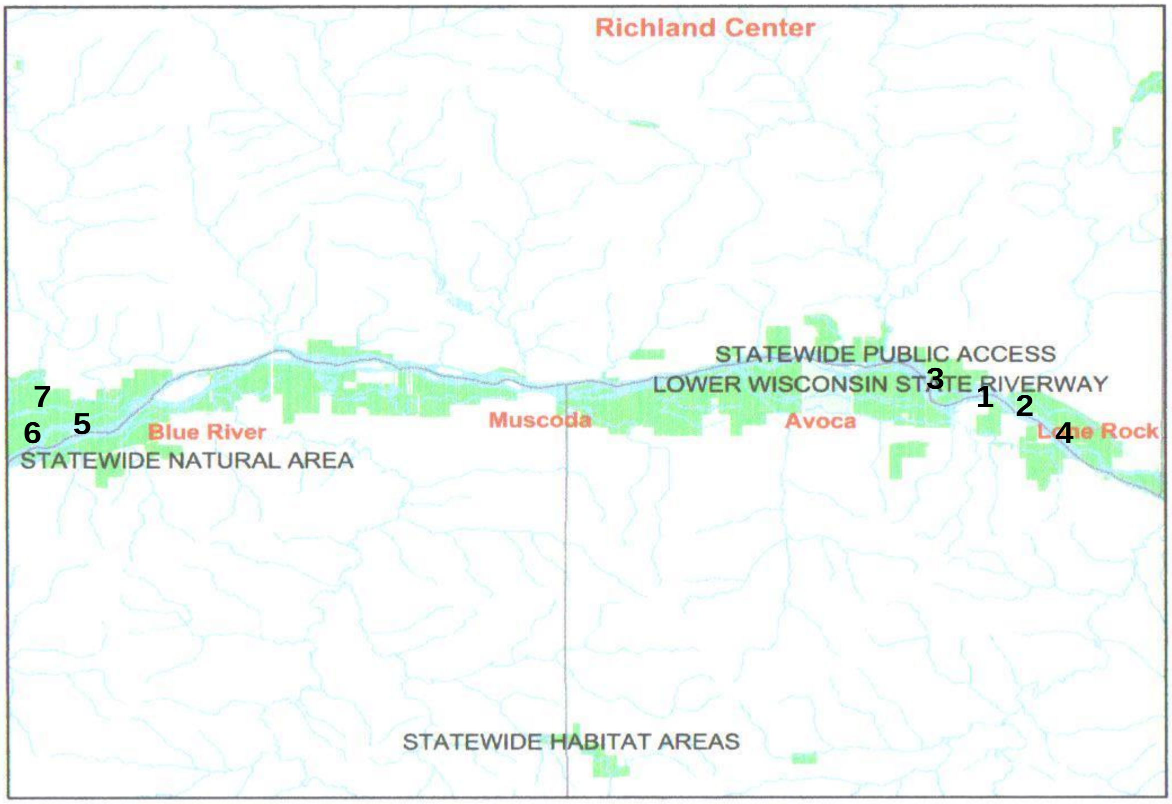
Methods

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 record 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 often 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 (heavy 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 displays the 2010 Richland County survey areas.

Figure 1: Map of project area sampling sites



Findings

The results of the surveys demonstrate that the conditions in floodplain lakes were highly variable and reflect diversity of habitats along the Lower Wisconsin State Riverway. Lakes on the east side of the county displayed the best water quality. Cruson Slough, Smith Lake and Long Lake had mean TSI values of 51.5, 52 and 51 respectively. These lakes also were also the clearest (secchi tube measurements of 120, 120 and 100, Figure 5). Smith Lake and Long Lake had the lowest color measurements that likely reflected greater inputs of upland groundwater. Upland groundwater was most evident in Smith Lake with cold water temperatures just below the surface. 2010 was not a normal year for sampling since summer river flooding occurred throughout most of July and August. Water quality sampling results for Lower Lake and Garner Lake probably did not represent typical summer conditions since these lakes were sampled when Wisconsin River flows exceeded roughly 3X the daily median rate. Twenty-eight species of fish were found in the seven floodplain lakes. In general, the Lower Wisconsin State Riverway floodplain lakes did not display the level of metaphyton impairments that occur along the Mississippi River.

Cruson Slough: No. 1 on map – WBIC 5573731 is located about 1.5 miles west of Lone Rock. The 20 acre floodplain lake stage is artificially high due to an earthen berm that was constructed in 1968. The water control structure was designed to increase surface area during low water periods. Cruson is located entirely within public lands of the Lower Wisconsin State Riverway and is connected to Smith Lake that lies to the east.

Cruson Slough

The combined Cruson Slough – Smith Lake Watershed is approximately 220 ha and is mostly wetland (~95%). A much smaller urban area drains to Smith Lake. Extensive upland and alluvial aquifers, along with periodic river flooding, are more likely greater factors that influence water quality in the lakes. The local watershed contributes only about 26 kg P/yr to the lakes and may represent a relatively modest source of nutrients compared to groundwater inputs and river flooding.

Water quality sampling was conducted on July 12, 2010 when river flows were roughly 10,000 cubic feet per second (cfs) at the Muscoda USGS gage or about 4,000 cfs above the daily median. The chlorophyll concentration in Cruson Slough was relatively low (4.24 ug/l or TSI = 48) compared with the phosphorus concentration (33 ug/l or TSI = 55). The higher phosphorus TSI may have reflected aquatic plant suppression of algal productivity (chlorophyll a). Comparative results for phosphorus and chlorophyll TSI values for all seven lakes appear in Figure 2. While the clarity was good in Cruson Slough (secchi tube = 120 cm), the laboratory color measurement was 50 su and reflected stained water. Comparative color measurements appear in Figure 3.

Cruson Slough supported a diverse aquatic plant community including spatterdock, white water lily, sago pondweed, large-leaf pondweed, leafy pondweed, Elodea, water stargrass, flat-stem pondweed, curly-leaf pondweed, Eurasian watermilfoil, coontail, wild celery and duckweeds. The duckweeds were primarily found in low densities near shore and the metaphyton cover score was 0 (comparative results in Figure 4).

The combination of nearshore woody debris and diverse aquatic plant community provided good habitat (rated high) for both rare and common sport fish. Fish surveys were performed on May 20th and July 12th. The nearshore fish community included mudminnows, grass pickerel, tadpole madtom, yellow bullhead, pirate perch, starhead topminnow, brook silverside, warmouth sunfish, bluegill, largemouth bass, black crappie, mud darter and Iowa darter. Until about 1947, common carp were commercially seined (Ball et al 1970). There is no evidence of a carp problem now based on both aquatic vegetation and fish community.

Figure 2: Comparative phosphorus and chlorophyll TSI

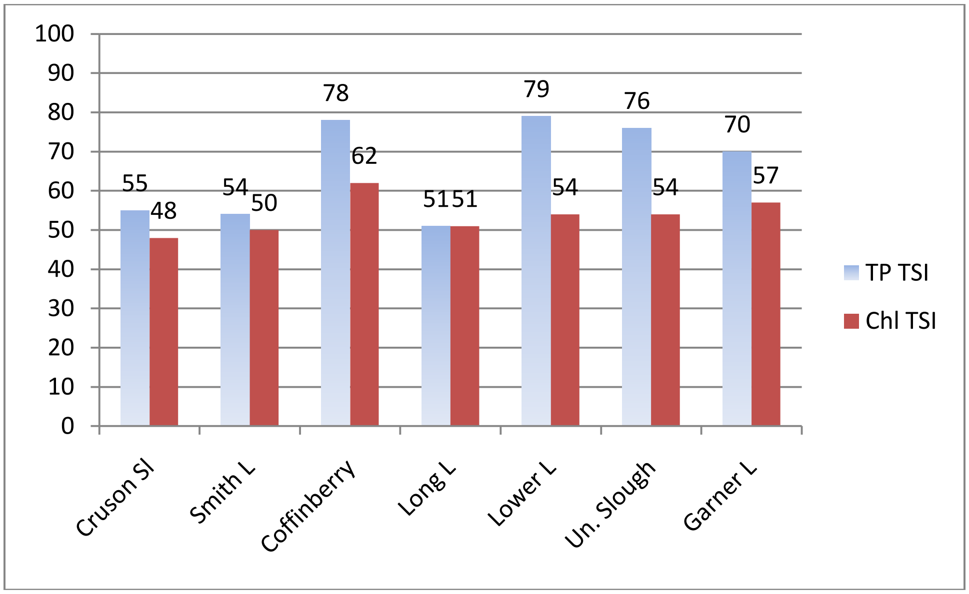


Figure 3: Comparative color measurements (su)

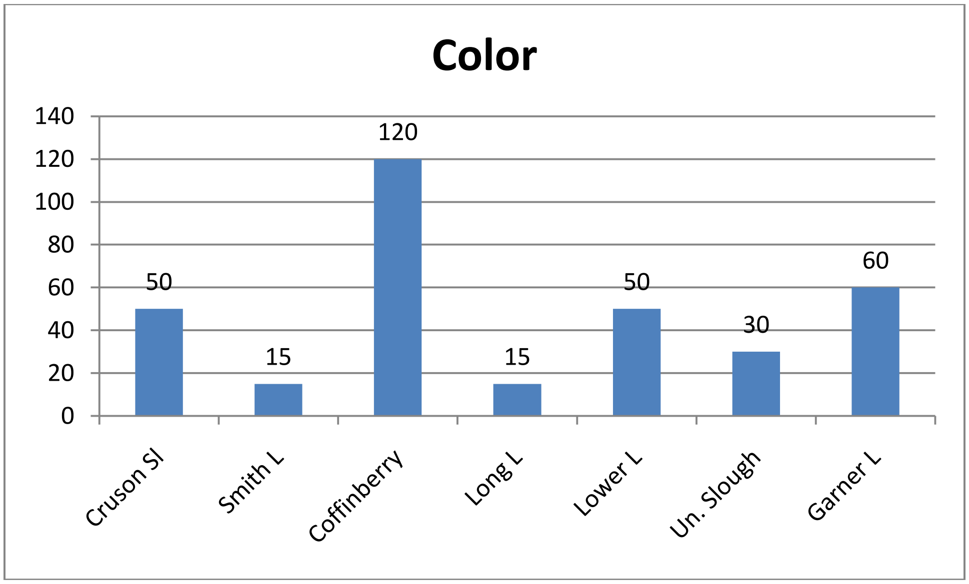
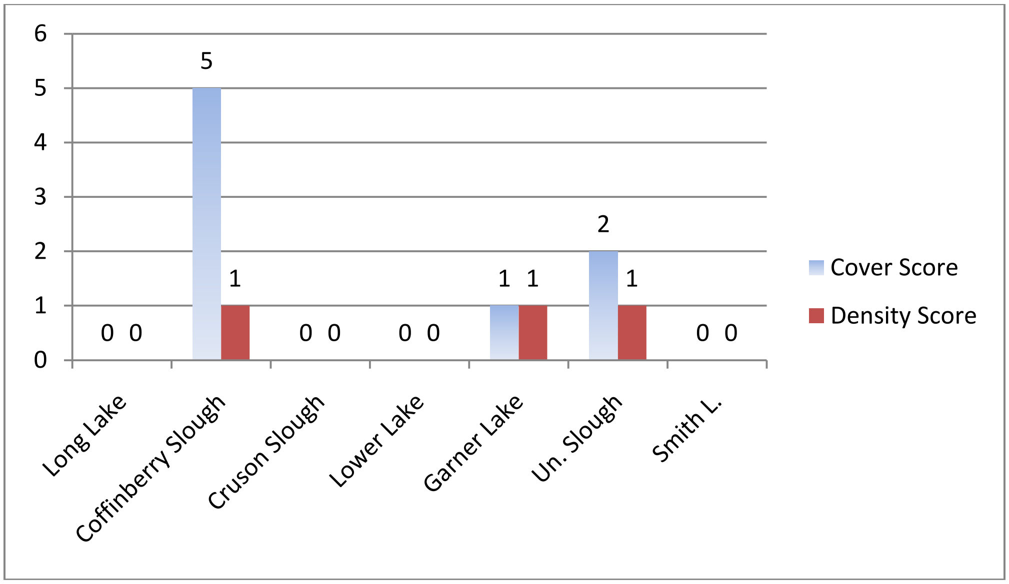


Figure 4: Comparative metaphyton estimates



Smith Lake: No. 2 on map – WBIC 1236400 is located just east of Cruson Slough and is 17 acres in area. Smith Lake is less stained than Cruson Slough, an indicator of greater upland groundwater input. The dissolved oxygen/temperature profile demonstrated the cold upland groundwater inputs into Smith Lake (16 C). Numerous springs had also been identified in the lake during the 1960s. While Cruson Slough and Smith Lake are located in close proximity, the data suggest that Cruson Slough is influenced to a greater extent by alluvial groundwater based on higher color and warmer water temperatures.

Smith Lake was sampled on the same day that Cruson Slough was. Chlorophyll in Smith Lake was 7.74 ug/l (TSI = 50) and phosphorus was 32 ug/l (TSI = 54). Consistent with Cruson Slough, higher phosphorus TSI may have reflected aquatic plant suppression of algae. Metaphyton cover and density ranked 0 since scarce growths of duckweeds and filamentous algae were limited to nearshore areas. A diverse aquatic plant community was found in Smith Lake including white water lily, sago pondweed, Elodea, leafy pondweed, large-leaf pondweed, water stargrass, flat-stem pondweed, curly-lead pondweed, Eurasian watermilfoil, coontail and duckweeds.

Fisheries surveys were performed on May 20th and July 12th 2010. The nearshore fish community included mudminnows, yellow bullheads, pirate perch, green sunfish, bluegill, largemouth bass, mud darters, Iowa darters, lake chubsuckers, warmouth sunfish and black crappies. The diverse nearshore fisheries reflected favorable habitats (rated high) in the form of good water quality, diverse plant community and numerous tree-falls. Carp were historically considered abundant but there is no current evidence that they are common.

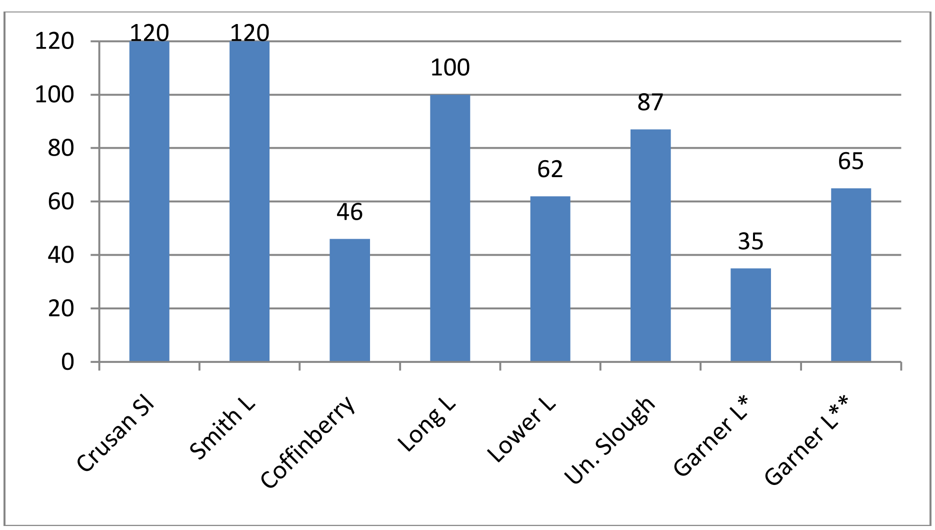
Coffinberry Slough: No. 3 on map – WBIC 5573341 is a 3 acre slough located about 1.5 miles southeast of Gotham. The surrounding land use is about 90 acres of floodplain forest. Coffinberry is a cutoff channel oxbow that is connected to the river at the downstream end. The oxbow characteristics are primarily influenced by river flooding and alluvial groundwater; essentially the river stage. The local watershed contributes a modest phosphorus load (~ 9 kg/yr).

Coffinberry was sampled on July 8th 2010 when the Wisconsin River flow was approximately 10,000 cfs or roughly double the daily median rate. The water was highly stained with a color measurement of 120 su. There was no evidence of upland groundwater inputs. The chlorophyll concentration was 39 ug/l (TSI = 62) and phosphorus concentration was 302 ug/l (TSI = 78). The higher phosphorus TSI may have indicated aquatic plant suppression of algae and/or high short-term phosphorus inputs from the river during the high water period.

Even though the lake was highly stained and light can be reduced under these conditions, a diverse aquatic plant included white water lily, sago pondweed, Elodea, flat-stem pondweed, curly-leaf pondweed, Eurasian watermilfoil, coontail and duckweeds. The duckweeds covered much of the surface area and indicated that the small lake displayed relatively high productivity with a metaphyton cover score of 5 but a density score of just 1. The overall habitat was rated high for fish populations with an abundance of aquatic plants and coarse woody debris near shore. Dissolved oxygen was fairly low at 5.5 mg/l at the surface and just 3.2 mg/l 0.5 meter below the surface. Fish species collected were American grass pickerel, golden shiner, pirate perch and largemouth bass.

Coffinberry Slough was sampled near the outlet to the Wisconsin River in August 2009. Greater numbers and diversity of fish were found at that time and location including bluegills, largemouth bass, grass pickerel, pirate perch, Iowa darters, warmouth sunfish, green sunfish, tadpole madtom, black crappie and yellow perch.

Figure 5: Comparative secchi transparency tube measurements (*High Flow, **Lower Flow)



Coffinberry Slough

Long Lake: No. 4 on map – WBIC 1236600 is located just south of Lone Rock. Most of the cutoff channel oxbow lies in Sauk County but a small portion (about 2 acres) lies in Richland County just west of the Hwy 130 Bridge. Long Lake drains a small medium density urban watershed (~540 acres) with an estimated annual phosphorus load of 109 kg/yr. Long Lake was sampled on July 8th 2010 when river flows were relatively high at around 10,000 cfs. The water was clear and unstained with modest productivity. The clear water reflected upland groundwater inputs, most likely from Sauk County. The chlorophyll concentration was 8.62 ug/l (TSI = 51) and phosphorus concentration was 26 ug/l (TSI = 51). The chlorophyll-phosphorus TSI match may have reflected very low metaphyton (0 cover and 0 density) and low rooted plant density. Three species of aquatic plants were collected: sago pondweed, leafy pondweed and curly-leaf pondweed.

The overall habitat was rated as medium since plants were scarce and so was little shoreline woody debris. Rare fishes were not found at the site but juvenile bluegills and largemouth bass were abundant. Other species found at the site included a juvenile walleye, black crappie, white sucker, brook silverside and bluntnose minnow.

Garner Lake: No. 5 on map – WBIC 1206900 is an eleven acre cutoff channel oxbow located two miles southwest of Port Andrews. The lake receives water from a number of sources including springs, small tributaries, alluvial groundwater and river flows. Garner Lake, Lower Lake and an unnamed marshy slough (WBIC 5573319) are located in the Knapp Creek Watershed. The watershed area is 154 square miles (39,886 ha) with land uses that include woods (45.7%), farms (36.9%), grasslands (9%), and wetlands (6.3%). The local watershed is relatively large and annual phosphorus loading is approximately 17,869 kg/yr.

Garner Lake was sampled three times in 2010. In August, two surveys coincided with very high river flows (15,000 – 17,000 cfs) that had pronounced effects on the lake. Water current in the lake was evident. The chlorophyll concentration was 12.7 ug/l (TSI = 54) and phosphorus concentration was 149 ug/l (TSI = 76). The relatively high phosphorus TSI likely reflected short residence time in the lake and multiple sources of phosphorus. For example, Knapp Creek was also at bankfull and turbid during that period of significant rainfall.

Aquatic plants in the lake included long-leaf pondweed, Elodea, water stargrass, Eurasian watermilfoil, coontail and duckweeds. Modest duckweed cover and density ratings were recorded even though lake flushing had occurred.

High water also limited fish sampling effectiveness in August. Fish species collected at that time included blackstripe topminnow, bluntnose minnow, weed shiner, spotfin shiner, lake chubsucker, brook silverside, bluegill, largemouth bass and emerald shiners. On September 10, when river flow had dropped to around 8,000 cfs, the lake was more accessible (wadeable) and additional species were revealed. Fish species caught in September included grass pickerel, tadpole madtom, yellow bullhead, pirate perch, green sunfish, warmouth sunfish, bluegill, largemouth bass, black crappie, blackstripe topminnow, mud darter, johnny darter and banded darter. Coinciding with a largely different fish community, water clarity improved from 35cm (August secchi tube transparency) to 65 cm (September secchi tube transparency). The changing conditions in Garner Lake reflected how floodplain lakes can be highly variable as the river changes. A few anglers were present during the September survey and they had caught several "lunker" size northern pike; a demonstration how the nearshore surveys do not reflect the condition of sportfish populations.

Lower Lake: No. 6 on map – WBIC 1206800 is connected to Garner Lake to the west. Access to Lower Lake is difficult and canoes or small watercraft is required since the lake is isolated within a large wetland complex away from both roadways and river. On August 10th, the sampling was limited to the outlet of the lake that was behaving as a river with fast current. The chlorophyll concentration was 13.1 ug/l (TSI = 54) and the phosphorus concentration was 175 ug/l (TSI = 79). The relatively high phosphorus concentration was likely influenced by storm related loading and short residence time in the lake.

Aquatic plants were scarce and were limited to coontail and duckweeds. Fish species collected at the outlet of Lower Lake included grass pickerel, spotfin shiner, bluegill, black crappie, johnny darter, emerald shiners and spottail shiners. Another survey is needed to better characterize fish and plant communities when river stage is at normal summer level.

Garner Lake

Unnamed slough: No. 7 on map – WBIC 5573319 is located near Highway 60 and Windward Sq and relatively remote from the river. Access was limited to walk-in through dense brush off Windward Sq. The marshy slough was sampled on August 10th and 16th. The chlorophyll concentration was 23.6 ug/l (TSI = 57) and the phosphorus concentration was 97 ug/l (TSI = 70). The higher phosphorus TSI may have reflected abundant rooted aquatic plants and measureable metaphyton; both suppressing algae. The productive marsh ranked 2 for metaphyton (duckweed) cover and 1 for density. Aquatic plant species collected included spatterdock, coontail, leafy pondweed and duckweeds. Fish species included grass pickerel, mudminnow, golden shiner, black bullhead and green sunfish.

Discussion

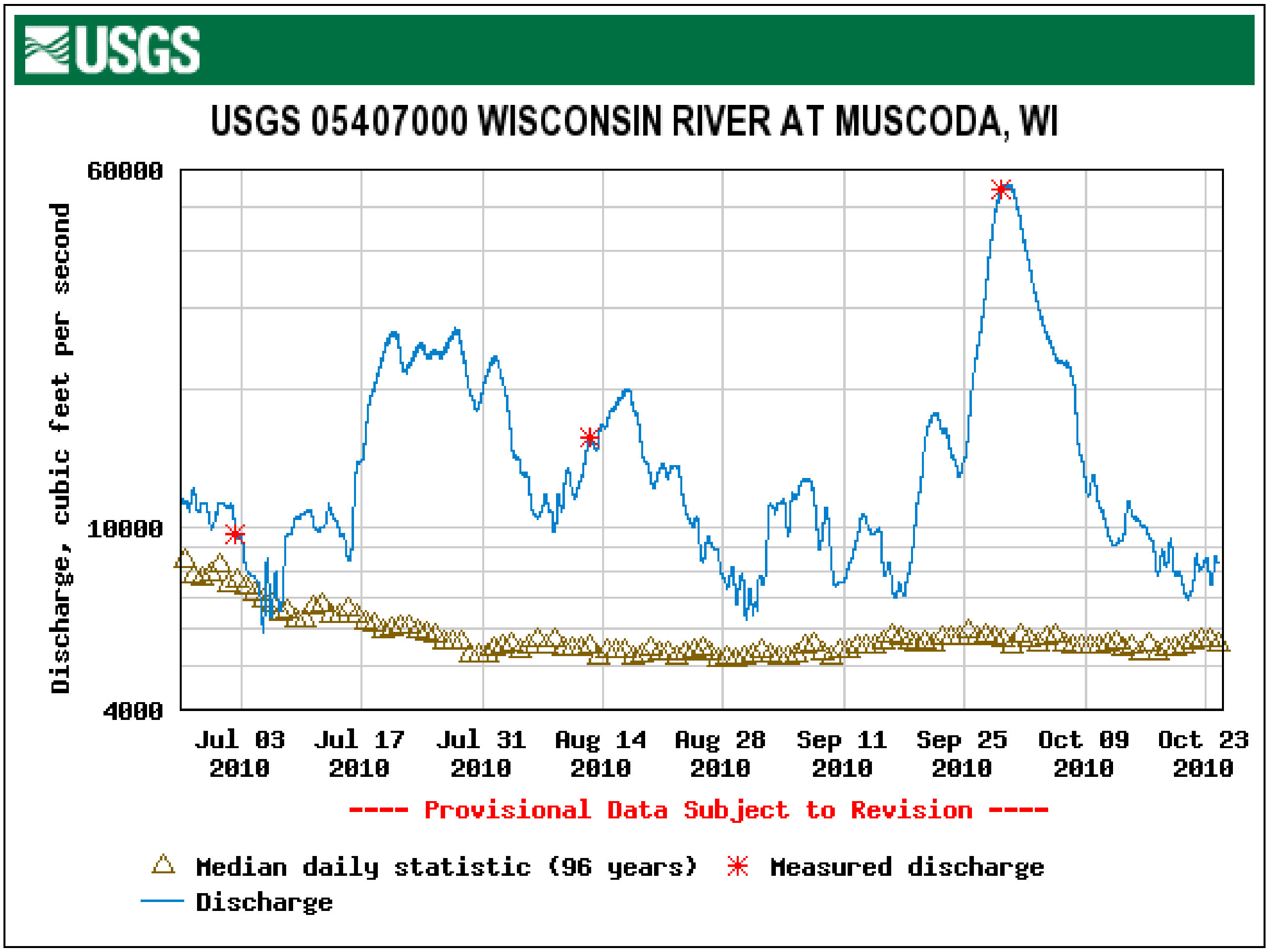
The lakes planning grant study revealed diverse floodplain lakes along the Lower Wisconsin State Riverway in Richland County. These habitats sustain the high biodiversity and provide important ecological functions linked to the main river channel. Some of the braided channel oxbows along the Lower Wisconsin 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.

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 6).

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. Smith Lake is an example of an environmentally sensitive floodplain lake that should be protected from groundwater contamination.

Figure 6: Summer 2010 Lower Wisconsin River flow trend (USGS Muscoda gage)



Most floodplain lakes had been swallowed by the much larger river in late September – early October 2010; perhaps a time of species dispersal?

Amoros, C. 2001. The Concept of Habitat Diversity Between and Within Ecosystems Applied to River Side-Arm Restoration. Environmental Management 28:805-817.

Amoros, C and G. Bornette. 2002. Connectivity and Biocomplexity in Waterbodies of Riverine Floodplains. Freshwater Biology 47:761-776.

Ball, J. R., T. Smith and C.W. Threinen. 1970. Surface Water Resources of Richland County. WDNR Lake and Stream Classification Project.

Camargo, J.A., A. Alonso and A. Salamanca. 2005. Nitrate Toxicity to Aquatic Animals: A Review with New Data for Freshwater Invertebrates. Chemosphere 58:1255-1267.

Gebert, W.A. and W.R. Krug. 1996. Streamflow Trends in Wisconsin’s Driftless Area. Journal of the Water Resources Association. 32:733-744.

Kilgore, K. J. and G.L. Miller. 1995. Larval Fish Dyanmics in Oxbow Lakes with Varying Connections to a Temporate River. United States Army Corps of Engineers Technical Report WRP-SM-11.

Pfieffer, S.M., J.M. Bahr and R.D. Bielfuss. 2006. Identfication of Groundwater Pathways and Denitrification Zones in a Dynamic Floodplain Aquifer. Journal of Hydrology 325:262-272.

Potter, K. W. 1991. Hydrological Impacts of Changing Land Management Practices in a Moderate-Sized Agricultural Catchment. Water Resources Research 27:845-855.

Sullivan, J. 2008. The Use of Metaphyton to Evaluate Nutrient Impairment and Proposed Nutrient Criteria for Wetlands and Backwaters in the Upper Mississippi River. WDNR.

Wisconsin Department of Natural Resources. 2000. Lower Wisconsin River State of the Basin Report: http://www.dnr.state.wi.us/org/gmu/lowerwis/lwbasinplan.html

Appendix A: Field and SLOH Water Quality Data

Waterbody	WBIC	Date	Trans Tube	D.O. mg/l	Temp C	pH su	Sp Cond
Crusan Sl	5573548	7/12/2010	120	7.3	23.2	7.77	265
Smith L	1236400	7/12/2010	120	8.8	19.9	8.85	306
Coffinberry	5573341	7/8/2010	46	5.5	24	7.4	133
Long L	1236600	7/8/2010	100	8.4	24.3	8.63	300
Lower L	1206800	8/10/2010	62	3.1	25.8	7.53	268
Un. Slough	5573319	8/10/2010	87	5	27.1	7.3	279
Garner L	1206900	8/10/2010		4.7	26.7		
Garner L	1206900	8/16/2010	35	4.9	23.8	7.5	221
Garner L	1206900	9/10/2010	65	7.4	18.6	7.9	333

Waterbody	WBIC	Date	Chlorophylla	Tot Phos	Color
Crusan Sl	5573548	7/12/2010	4.24	0.033	50
Smith L	1236400	7/12/2010	7.74	0.032	15
Coffinberry	5573341	7/8/2010	39	0.302	120
Long L	1236600	7/8/2010	8.62	0.026	15
Lower L	1206800	8/10/2010	13.1	0.175	50
Un. Slough	5573319	8/10/2010	23.6	0.097	30
Garner L	1206900	8/10/2010	12.7	0.149	60

Appendix B: Fisheries Distribution

Spp	Cruson	Smith	Coffinberry	Long	Garner	Lower	5573319
Grass pickerel	X		X		X	X	X
Mudminnow	X	X					X
Golden shiner			X				X
Bluntnose minnow					X		
Spotfin shiner				X	X	X	
Emerald shiner					X	X	
Spottail shiner						X	
Weed shiner					X		
Tadpole madtom	X				X		
Bl. Bullhead							X
Y. bullhead	X	X			X		X
Pirate perch	X	X	X		X		
Starhead tm	X						
Blackstripe topminnow					X		
White sucker							
Lake chubsucker		X			X		
Brook silverside	X			X	X		
Gr. sunfish		X			X		x
Warmouth	X	X			X		
Bluegill	X	X		X	X	X	
Bl. Crappie	X			X		X	
LM bass	X	X	X	X	X		
Mud darter		X			X		
Iowa darter	X	X					
Johnny darter					X	x	
Banded darter					X		
Logperch				X			
walleye				X			

Appendix C: Aquatic plants distribution

Spp	Cruson	Smith	Coffinberry	Long	Garner	Lower	5573319
White water lily	X	X	X				
Spatterdock	X						X
Sago pw	X	X	X	X			
Elodea	X	X	X		X		
Leafy pw	X	X	X	X			X
Large-leaf pw	X	X					
Long-leaf pw			X		X		
Water stargrass	X	X	X		X		
Flatstem pw	X	X	X				
CLP	X	X	X				
EWM	X	X	X	X	X		
Coontail	X	X	X		X	X	X
Duckweeds	X	X	X		X	X	X
Wild celery	X						
Slender naiad	X						

Appendix D: Field Notes

Waterbody	WBIC	Date	Upland g.w.	Ob color
Crusan Sl	5573548	7/12/2010	yes	clear/stained
Smith L	1236400	7/12/2010	yes	clear
Coffinberry	5573341	7/8/2010	no	stained
Long L	1236600	7/8/2010	yes	clear
Lower L	1206800	8/10/2010	?	turbid/high water
Un. Slough	5573319	8/10/2010	yes	stained
Garner L	1206900	8/10/2010		turbid/high water
Garner L	1206900	8/16/2010	?	turbid/high water
Garner L	1206900	9/10/2010	yes	anglers w/ n.p.

Waterbody	WBIC	Date	Substrate	Plants	Floating plants	Woody debris	Rock	Overall Habitat
Crusan Sl	5573548	7/12/2010	sand	Medium	Medium	Low	Absent	High
Smith L	1236400	7/12/2010	sand	High	Low	high	Absent	High
Coffinberry	5573341	7/8/2010	sand/silt	Medium	Low	high	Absent	High
Long L	1236600	7/8/2010	sand	Medium	Low	Low	Absent	Medium
Lower L	1206800	8/10/2010	clay/silt	Low	Absent	Low	Absent	Medium
Un. Slough	5573319	8/10/2010	silt	High	High	Low	Absent	Medium
Garner L	1206900	8/10/2010	silt	Medium	Low	Medium	Absent	Medium