Surveys of Crawford County Floodplain Lakes

Lakes Planning Grant Study

Crawford County Land Conservation Department

CRAWFORD COUNTY
WISCONSIN
GOVERNMENT

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Summary

As part of a large-scale Lakes Planning Grant, 13 floodplain lakes were sampled along the Lower Wisconsin State Riverway, Kickapoo River and Mississippi River during the summer of 2009. Information collected during the surveys included water chemistry, water transparency, nearshore fish species, and aquatic plants. Twenty-six fish species were identified in the floodplain lakes including the State Endangered starhead topminnow, State Special Concern lake chub sucker, State Special Concern pirate perch, and State Special Concern mud darter. The latter two are Natural Heritage Inventory species that WDNR Bureau of Endangered Resources identified for informational needs. Starhead topminnows were found at 4 of the 13 floodplain lakes, entirely along the Lower Wisconsin State Riverway (50% frequency). 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 include bluegill sunfish and largemouth bass. Sixty-eight pressed aquatic plant specimens were submitted to the University of Wisconsin Madison Herbarium.

Three key factors were identified that influenced the abundance or presence of fish populations in braided channel oxbows. First, river flooding and associated alluvial groundwater depths can affect dissolved oxygen levels but are largely uncontrollable. However, river water quality has greatly improved since the 1980s with implementation of the Clean Water Act. Second, upland groundwater flow into the oxbows is very important for sustaining sufficient dissolved oxygen, particularly during periods of stress such as late winter ice cover or warm season floods. Lakes that lacked significant sources of upland groundwater flow had the lowest dissolved oxygen levels. A continuum of floodplain lake habitat exists that vary with the relative contributions of upland groundwater flow and alluvial groundwater flow. Third, upland watershed land uses can affect groundwater quality and flow to the floodplain lakes. The floodplain lakes located adjacent to the uplands typically benefit from upland groundwater flow. These lakes offer the best fisheries habitat but also are more threatened by upland land uses that affect nearshore habitat, groundwater flow and quality, and surface runoff. Upland groundwater discharge did not typically take the form of specific springs but rather appeared as sheet flow detected by chemical sampling in the field or appeared as upland spring fed tributaries.

Annual phosphorus loading estimates are 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 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 has demonstrated that the spring fed floodplain lakes are the most environmentally sensitive water resources within the State Riverway.

Information Sharing

Presentations highlighting the Crawford County floodplain lakes surveys included the "Crawford County Land Conservation Tour" on July 7, 2009, Lower Wisconsin State Riverway Board meeting in Wauzeka October 8, 2009 and Crawford County Land Conservation Committee meeting November 12, 2009. A fact sheet was prepared as a supplement for this report. A spreadsheet containing all of the data was submitted to WDNR fisheries-water resources biologists and researchers.

Recommendations

1. Crawford County Land Conservation Department should work with the Lower Wisconsin State Riverway Board and WDNR to consider management alternatives to protect the environmentally sensitive floodplain lakes.
2. Establishing buffer zones could benefit floodplain lakes by protecting upland groundwater and reducing surface runoff pollution.
3. The Lower Wisconsin River is currently classified an Exceptional Resource Water (ERW) and encompasses the floodplain lakes. However, given that these importance resources are environmentally sensitive, the WDNR should classify these waterbodies as Outstanding Resource Waters (ORW).
4. Conservation easements should be considered 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. Additional floodplain lake surveys are recommended, including the Mississippi River, Kickapoo River and other river floodplains.
6. Consider examining possible reasons for the low dissolved oxygen levels in Garnet Lake.

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 oxbows, braided channel oxbows, delta tributary ponds and beaver ponds provide important habitats for numerous aquatic communities within a transitional area linking rivers with the Driftless Area uplands. Based on a small sampling of oxbows that WDNR completed between 1999 and 2004 and more recently during 2007 and 2008 floodplain lake surveys, the Lower Wisconsin State Riverway supports a unique blend of riverine and lake fish populations and the most abundant populations of rare and endangered species in southern Wisconsin. Many of the oxbows are also locally popular sportfish destinations. Despite the preliminary information suggesting a wealth of biodiversity, very little was 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 Crawford County" (1972). In that publication, there is no discussion of Trophic State Indices (TSI) conditions, specific management recommendations or identification of nongame or rare 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 Crawford 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, alkalinity 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 Yellow Springs Instrument 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 in July and August 2009 and included secchi transparency tube measurements. Most of the floodplain lakes were too shallow for standard secchi measurements. Water samples were analyzed at the State Lab of Hygiene (SLOH). Parameters tested at the state lab included total phosphorus, chlorophyll, alkalinity and color.

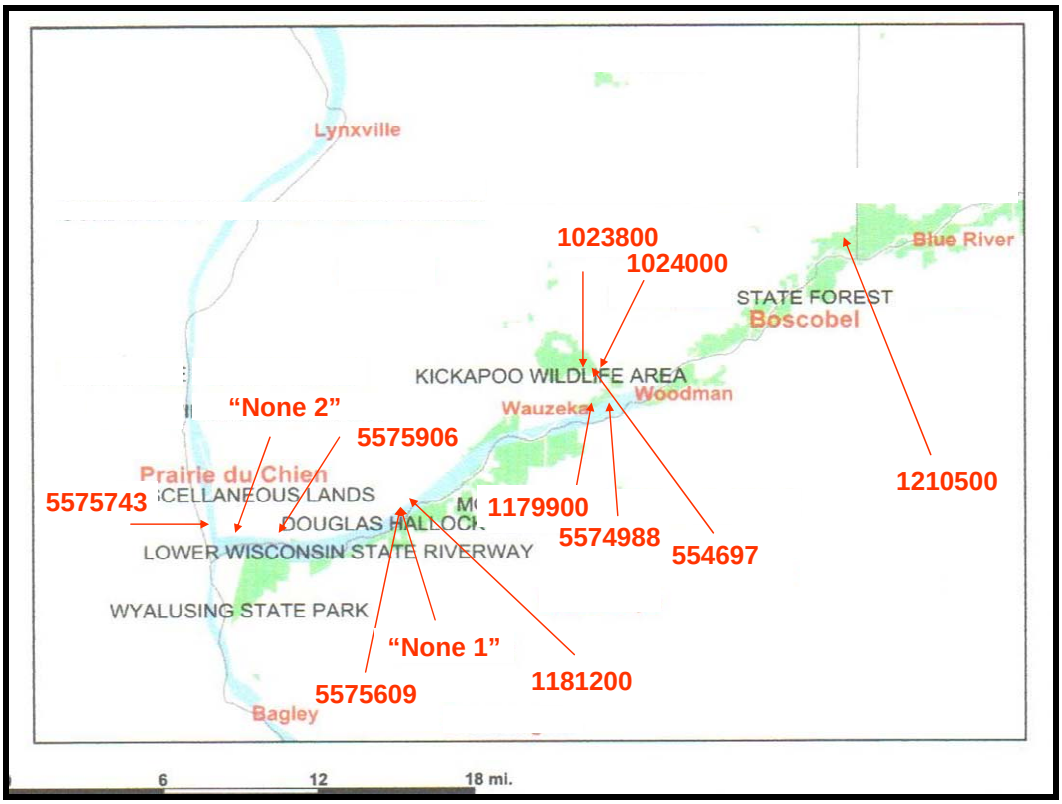
Notes on habitat quality were compiled for each floodplain lake. Aquatic plant specimens were collected and submitted to the University of Wisconsin Madison Herbarium. Photographs routinely captured aquatic plant and shoreline habitat conditions linked to GPS locations.

Nearshore fish population sampling included small mesh dipnetting and 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. Figure 1 displays the entire 2009 Crawford County surveys area.

Upland land uses and upland watersheds were estimated using Map Tech Terrain Navigator and WDNR WebView where applicable. WILMS watershed phosphorus loading module will be applied to the land use data. This information represented only an initial screening and does not account for alluvial groundwater inputs during floods or event related scour and deposition. The WILMS Trophic State Index (TSI) model was used to transform total phosphorus, chlorophyll and secchi water clarity measurements to TSI water quality values. The range is 0-100 with values higher values reflecting

eutrophic conditions. The TSI values did not account for rooted plant suppression of planktonic algae.

Figure 1: Map of Project Area including Waterbody Identification Codes (WBIC)



Findings

The results of the surveys demonstrate that the conditions in floodplain lakes were highly variable and reflect diversity of habitats along the three river systems. The common element among most of the floodplain lakes is that they were all very shallow water systems with most surrounded with emergent vegetation.

Alkalinity is a measure of the amount of carbonates, bicarbonates and hydroxides in the lakes. Alkalinity levels ranged from 94 to 253 mg/l (mean concentration = 154 - Figure 2). The alkalinity levels did not appear to respond to algal productivity (chlorophyll) but rather reflected groundwater inputs (Figure 4). Chlorophyll concentrations ranged from1.25 ug/l to 62.3 ug/l (mean concentration = 13.2 ug/l -Figure 3). The highest chlorophyll concentration coincided with a modest alkalinity in a Wisconsin River slough without apparent upland groundwater. Color measurements are summarized in Figure 5. Higher color levels did not coincide with higher chlorophyll concentrations, often due to macrophyte suppression of algae, but rather reflected tannins in marshy lakes that lacked upland groundwater (Figure 6). Total phosphorus was generally high in these productive

shallow lakes with concentrations ranging from 0.02 mg/l to 0.300 (mean concentration = 0.144 mg/l – Figure 7). Lakes influenced by upland groundwater generally had lower phosphorus concentrations. A weak relationship between total phosphorus and chlorophyll was further evidence of algal suppression from abundant aquatic plants, perhaps higher reactive phosphorus in marshy lakes with high levels of organic matter and/or groundwater (Figure 8). Specific conductance levels and pH values were also typically higher where evidence of upland groundwater was found (Appendix A).

Figure 2: Alkalinity Concentrations in Crawford County floodplain lakes

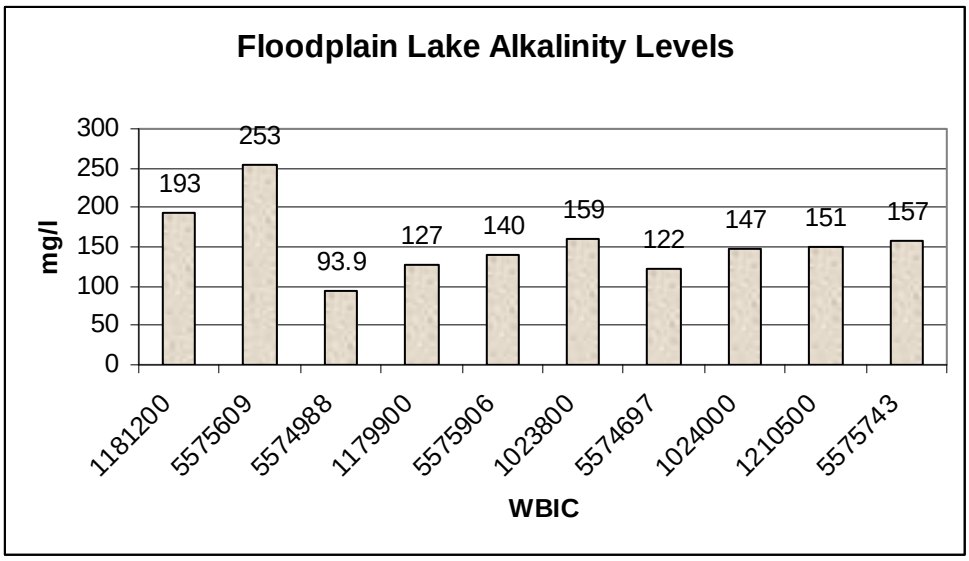
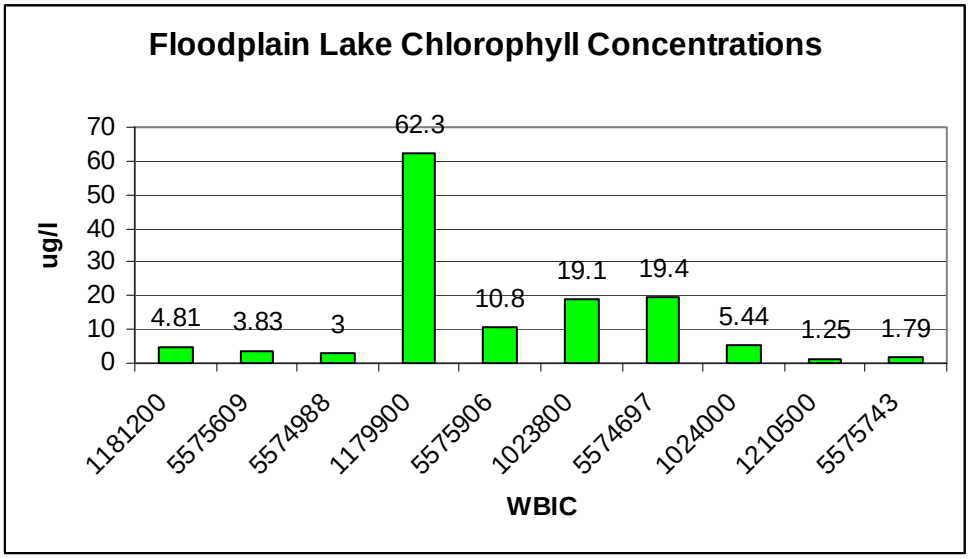


Figure 3: Chlorophyll concentrations in Crawford County floodplain lakes



1210500 = Clear Lake, 5575743 = Garnet Lake, and
5574697, 1023800, 1024000 = Kickapoo R. oxbows

Figure 4: Relationship between alkalinity and algal productivity

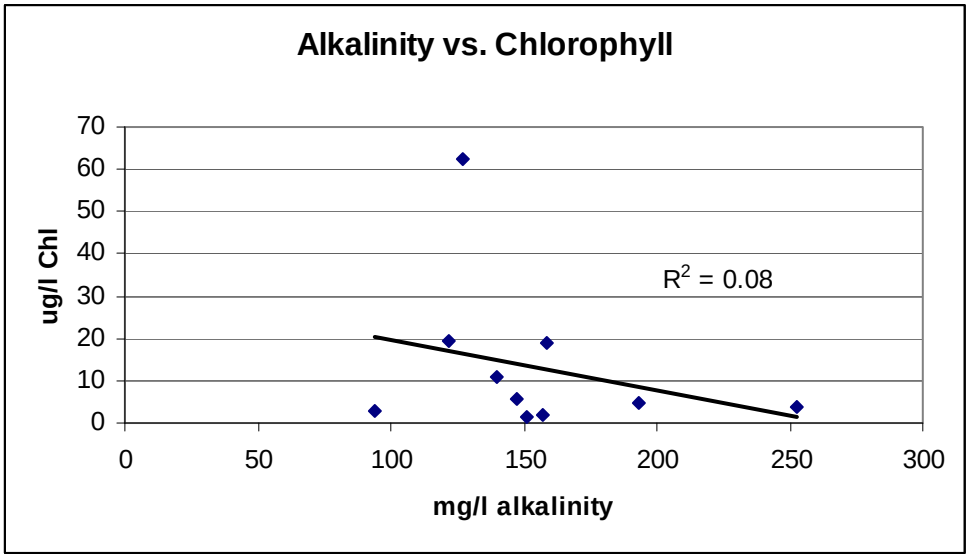


Figure 5: Color levels in Crawford County floodplain lakes

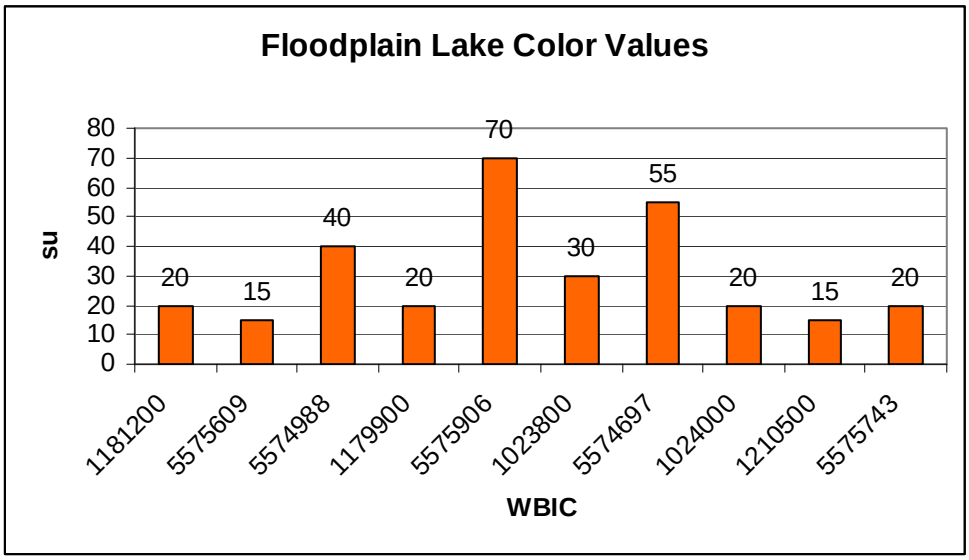


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Figure 6: Relationship between color and chlorophyll a

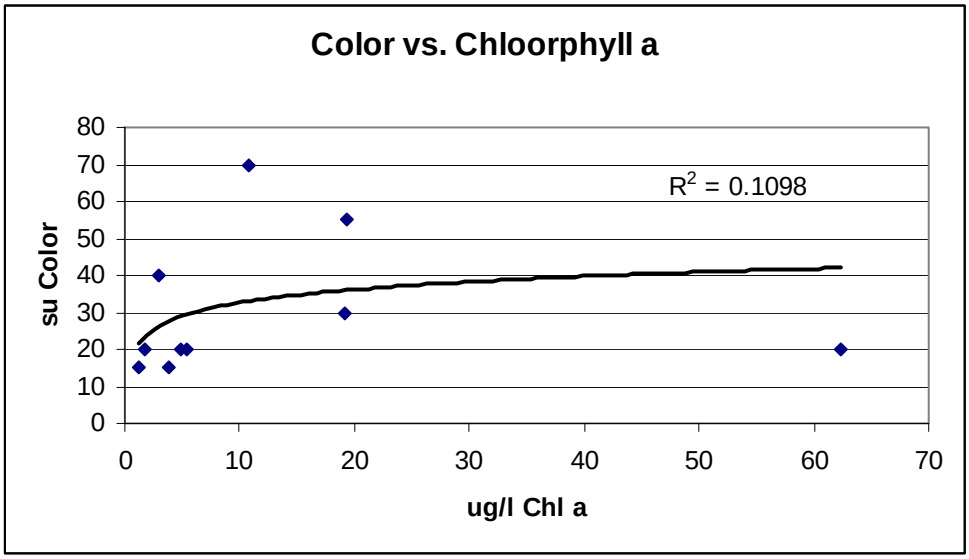
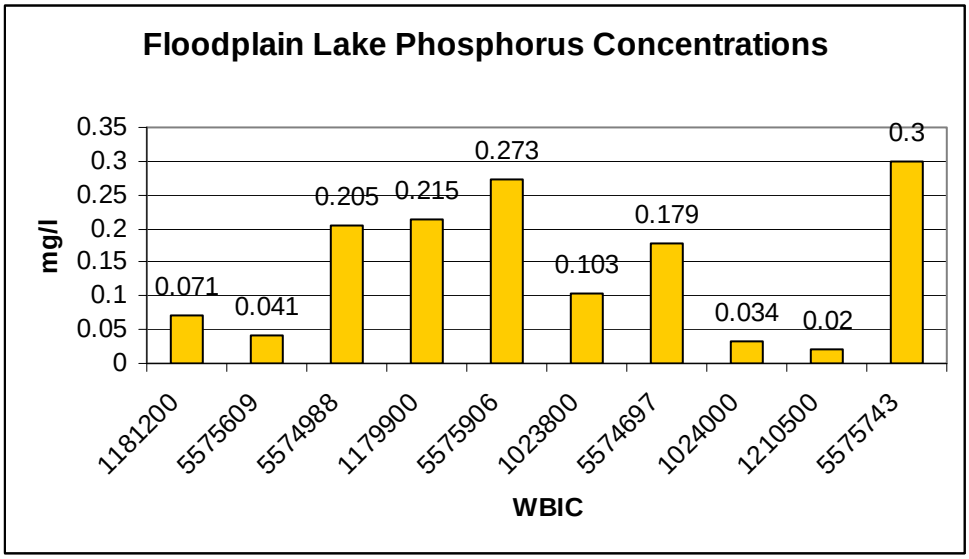


Figure 7: Total Phosphorus levels in Crawford County floodplain lakes



1210500 = Clear Lake, 5575743 = Garnet Lake, and
5574697, 1023800, 1024000 = Kickapoo R. oxbows

1181200, 5575609, 1023800, 1024000 and 1210500 displayed evidence of upland groundwater including upland tributaries.

Figure 8: Relationship between chlorophyll a and total phosphorus

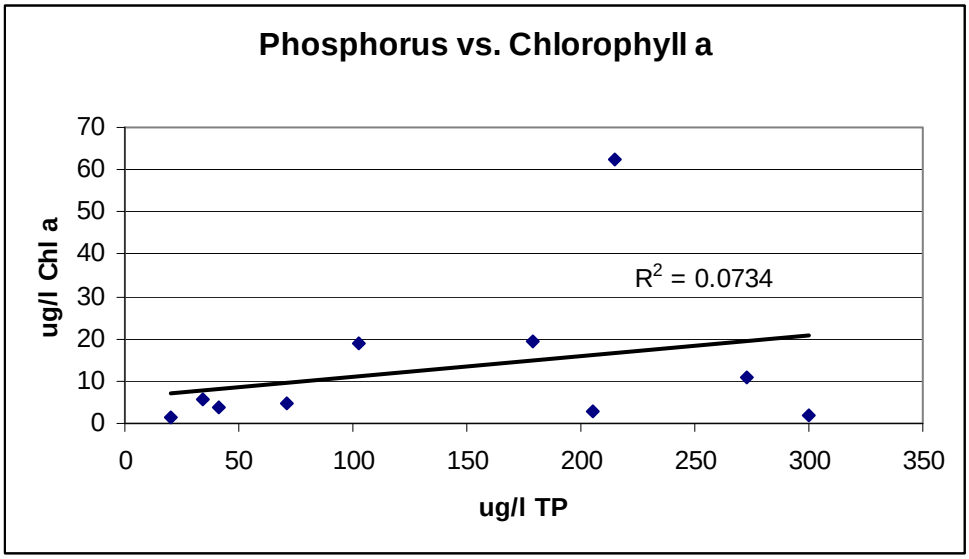
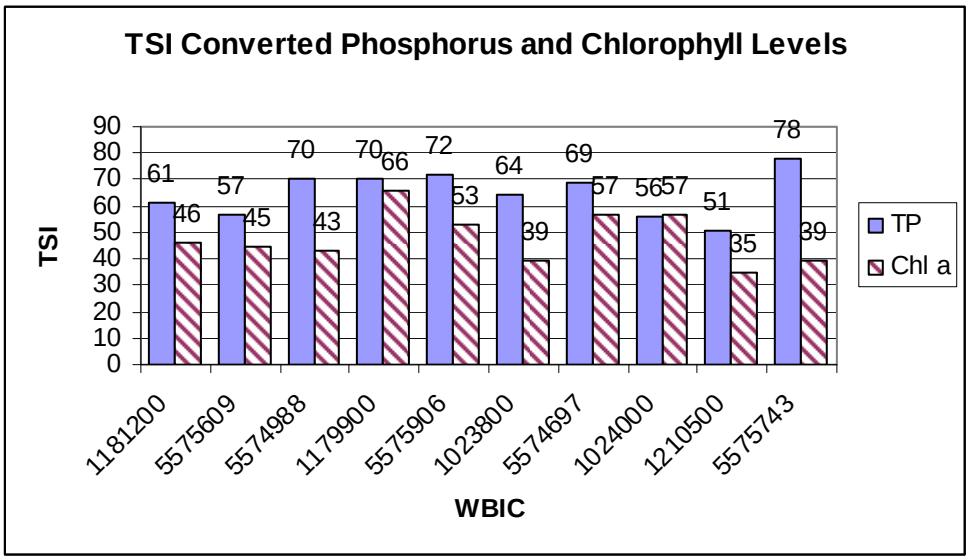


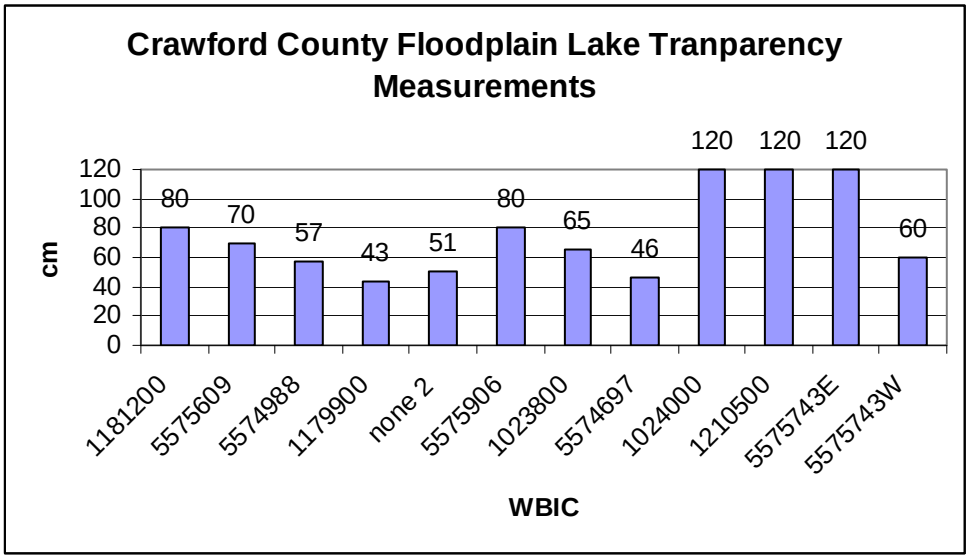
Figure 8a: Trophic State Index transformed chlorophyll and total phosphorus measurements



1210500 = Clear Lake, 5575743 = Garnet Lake, and
5574697, 1023800, 1024000 = Kickapoo R. oxbows

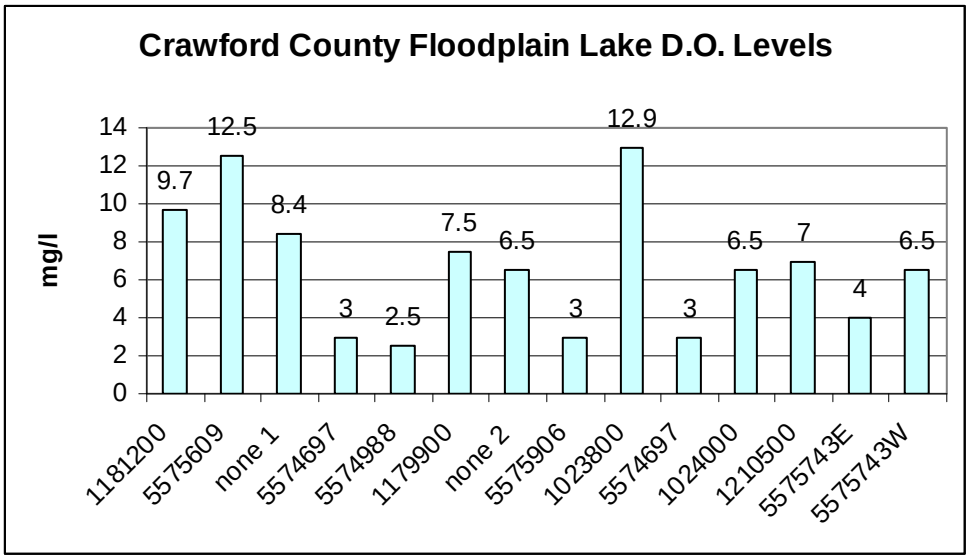
With the exception of Garnet Lake of the Mississippi River, most of the floodplain lakes sampled in Crawford County were less than three feet in depth and therefore rendered secchi measurements useless. Therefore, instead of a standard secchi disc water clarity was measured with a 120 cm transparency tube (Figure 9).

Figure 9: Crawford County transparency measurements



Fish were collected from all of the floodplain lakes that were sampled. In a few sloughs, fish were collected in water with dissolved oxygen as low as 2.5 mg/l. Consistent with other parameters, dissolved oxygen levels were highly variable with higher values reflecting upland groundwater inputs and organic enrichment (Figure 10).

Figure 10: Dissolved oxygen levels in Crawford County floodplain lakes



Likely upland groundwater inputs observed at 1181200, 5575609, 1179900, 1023800, 1024000 and 1210500 where high dissolved oxygen levels were measured.

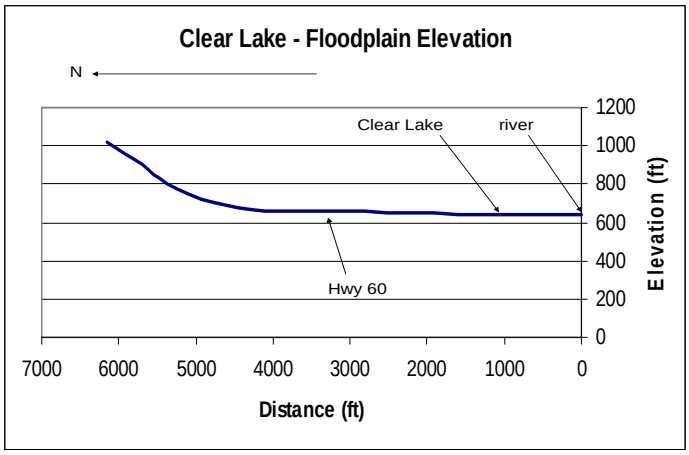
The chemical data suggest that floodplain lakes that receive upland groundwater or tributary flow are less eutrophic and are more favorable for fish survival. Another variable may be floodplain geology. The Lower Wisconsin River is a braided channel

river system, the legacy of glacial outwash sands from ancient glacial Lake Wisconsin. Some of the floodplain lakes periodically arise as braided channels that were separated from base river flows. These lakes are often linear and lie parallel to the river, ultimately allowing for significant scour velocities during floods. The scouring floods may rejuvenate the braided channel oxbows. Alternatively, the Kickapoo River is a meandering single thread river. The Kickapoo River produces the more standard oxbow lakes that have potential for greater sediment storage, particularly over the last 200 years following floodplain soil deposition. Several floodplain lakes along the Kickapoo River were targeted for sampling but were discovered to be dry during the drought of 2009. Loss of water storage capacity can make some floodplain waterbodies vulnerable during dry weather. The Mississippi River differs from the other rivers due to the numerous locks and dams that caused permanent floodplain lake inundation as well as invasive zebra mussels.

Lower Wisconsin State Riverway Floodplain Lakes

Clear Lake – WBIC 1210500: Clear Lake is the only named floodplain lake within the Crawford County portion of the State Riverway. It was previously considered a winterkill lake that supported common carp and a few common lake species (WDNR 1972). The recent survey revealed a moderately diverse warm water fishery that included the State Special Concern mud darter (Appendix B). The gin clear water also supports a diverse aquatic plant community including white water lily, Elodea, leafy pondweed, large-leaf pondweed, water stargrass, Eurasian watermilfoil, Northern watermilfoil, common bladderwort, coontail and Chara (Appendix C). The lake is entirely encompassed by State Riverway lowlands, resulting in a wilderness setting. Water chemical sampling revealed that Clear Lake was the least eutrophic of the floodplain lakes sampled in Crawford County. The clear water conditions with moderate alkalinity suggest that it receives upland groundwater flow. At nearly the same elevation of the river and east-west linear basin, river flood water scouring may reduce lake aging (Figure 11). This elevation profile is typical for floodplain lakes along the Lower Wisconsin State Riverway.

Figure 11: Clear Lake floodplain elevation profile



Clear Lake has a very small upland watershed (~98 acres) consisting of State Riverway upland forest and wetlands. The nearby upland watershed is largely channeled via an unnamed stream toward Lower Lake in Richland County. Therefore, the balance of nutrient inputs and export is primarily determined by Wisconsin River flooding while the upland groundwater sustains the nearly pristine conditions of this high quality floodplain lake.

Photos of Clear Lake

Shoreline electro-shocking on Clear Lake

Unnamed oxbow – WBIC 5574988: Open water in this unnamed floodplain lake was primarily limited to a narrow channel during the drought of 2009. It was completely surrounded by an extensive stand of emergent arrowhead. Submersed plants were limited to Elodea and coontail. The dissolved oxygen was only 2.5 mg/l when the oxbow was surveyed, the lowest concentration of any slough where fish were found. The oxbow supported six fish species including the State Special Concern lake chub sucker. The small floodplain lake appeared to lack upland groundwater and is primarily influenced by the Wisconsin River floodplain, wetland drainage and alluvial groundwater.

Andy Fayram and Jerrod Parker preparing to seine the oxbow

Unnamed slough – WBIC 1179900, 43 ^{o} 04.633' – 90 ^{o} 52.883': The Wisconsin River slough was selected after WBIC 5574971 was found to be dry. The slough is located in just upstream of the Kickapoo River mouth and may be influenced by both rivers at times. An upland watershed is lacking and appeared to be influenced by both wetland drainage and river water. The turbid water supported a diverse warm water fishery including State Special Concern mud darters and lake chub suckers (Appendix B). Aquatic plant growth was relatively low in the turbid water and coarse woody debris comprised most the fish habitat.

Unnamed slough – WBIC 1179900, 43 ^{o} 04.633’ – 90 ^{o} 52.883’

Unnamed oxbow – WBIC 1181200: The Wisconsin River connected oxbow supported a diverse fishery including State Endangered starhead topminnow, State Special Concern pirate perch and State Special Concern lake chub sucker (Appendix B). This oxbow was influenced by upland groundwater and Gran Grae Creek, a trout stream. In just two feet of water, the surface temperature was 23.9 ^{o} C and bottom temperature was 16.8 ^{o}. Gran Grae Creek had a water temperature of 14.4 ^{o} C. Aquatic plants included white water lily, Elodea, leafy pondweed, water stargrass, curly-leaf pondweed, Eurasian watermilfoil, coontail and small duckweed. The oxbow is connected to unnamed oxbow WBIC 5575609 via a Wisconsin River channel and tributary stream.

WBIC 1181200

Unnamed oxbow – WBIC 5575609: This unnamed oxbow is connected to 1181200 by a Wisconsin River side channel and Gran Grae Creek, a trout stream. The upland watershed is quite large encompassing about 18.4 square miles of woodland (~6,004 acres), crops (~2,002 acres), pasture (3,060 acres) and wetlands (~706 acres) contributing approximately 3,150 lbs. of phosphorus per year to these oxbows. Substantial phosphorus loading is not likely deposited in these relatively small floodplain lakes (5575609 is 1.3 surface acres and 1181200 is 4.8 surface acres) due to the small volumes and continuous flow in Gran Grae Creek. However, the floodplain lakes would benefit from land use management that would also improve the trout stream. Oxbow 5575609 supported a moderately diverse fishery including State Endangered starhead topminnow and State Special Concern lake chub sucker. Aquatic plants were very scarce in the small oxbow. The starhead topminnow is considered an obligate macrophyte species and limited to a small pocket of macrophytes.

WBIC 5575609

Unnamed oxbow – No WBIC, 43 ^{o} 01.778', 90 ^{o} 59.446': Located just 360 feet west of 5575609 is a small oxbow that does not receive upland groundwater. The stained oxbow was choked with Elodea, coontail, small duckweed and water meal. The stained water primarily reflected soft flood water and alluvial groundwater inputs. The surface dissolved oxygen was 8.4 mg/l during the daytime but significant 24 hour fluctuation is likely due to nighttime respiration. Two species of fish were seined from the small oxbow: State Endangered starhead topminnow and American grass pickerel.

Unnamed oxbow – WBIC 5575906: This unnamed oxbow was well vegetated with emergent and floating leaf plants including wild rice, arrowhead, pickerel weed, Elodea and coontail. The location of the oxbow was too remote for electro-shocking gear access and vegetation was too dense for seining. Dip netting did not yield any fish but a few American grass pickerel were observed. Dissolved oxygen was relatively low at 3 mg/l and there was no evidence of upland groundwater. The oxbow appears to be connected

to an extensive network of small floodplain wetlands and ponds. Direct upland drainage appears to be limited to about 12 acres of woods and 8 acres of cropland.

WBIC 5575906

Unnamed wetland complex – No WBIC, "None 1" on map: A large wetland complex is located east of the Burlington Northern railroad trestle and just south of Prairie du Chien. Within a vast arrowhead stand, a sluggish channel supports long-leaf pondweed, Elodea, Eurasian watermilfoil and water stargrass. A diverse fishery was found in the slough including State Endangered starhead topminnow, State Special Concern pirate perch and State Special Concern mud darter. This was the 55th site along the Lower Wisconsin State Riverway where the rare topminnows were found.

No WBIC- 43 00.724', 91 07.838', "None 2 on map"

Kickapoo River Floodplain Lakes

Unnamed oxbow –WBIC 1023800: The unnamed oxbow drains a relatively small watershed of approximately 118 acres of public land (~112 woods and 6 acres wetlands). The Kickapoo River floodway is the primary environmental factor. The oxbow receives a modest amount of upland groundwater but appears to be organically enriched with abundant growths of white water lily, Elodea, bulrush, arrowhead, coontail and duckweed. The oxbow supported a modest fishery but no NHI species were found (Appendix B).

Jerrod Parker electro-shocking WBIC 1023800

Unnamed oxbow – WBIC 5574697: This marshy oxbow drains about 67 acres of wooded ridge top. No upland groundwater was observed and the oxbow appeared to be organically enriched. Lush growths of submersed, floating and emergent vegetation was observed including burr reed, pickerel weed, smart weed, white water lily, common bladderwort, Elodea, coontail and small duckweed. The environmentally tolerant mud minnow was the only fish species collected and suggests environmentally stressful habitat, perhaps winterkill.

Jean Unmuth and Frank Fetter inspecting fish in WBIC 5574697

Unnamed oxbow – WBIC 1024000: Located along Hwy 60 east of Wauzeka and across from 5574697, this unnamed oxbow does not drain uplands but does display evidence of upland groundwater based on clear unstained water and more moderate productivity compared to the other Kickapoo River floodplain lakes that were sampled. Aquatic plants were abundant including Elodea, coontail, flatstem pondweed, common bladderwort, leafy pondweed, white water lily, small duckweed and watermeal. Fish species collected included largemouth bass, bluegill, mudminnow and bowfin.

WBIC 1024000

Mississippi River – Garnet Lake WBIC 5575743

Garnet Lake is influenced by the greater Mississippi River floodplain and vast watershed but also locally where a side channel carries runoff from the City of Prairie du Chien and municipal wastewater effluent. The east channel has potential for delivering local phosphorus sources amounting to ~7,754 lbs/yr; ~6077 lbs/yr from the municipal wastewater treatment plant (1 mg/l TP x 2 MGD) and ~1,677 lbs/yr runoff from 1,760 acre urban area. The potential local sources of phosphorus may explain why Garnet Lake had the highest phosphorus concentration. Where local nutrient sources enter Garnet Lake, water clarity on the east side (>120 cm) is significantly better than the river side (60 cm) of the slough. The east side of the lake is marshy with abundant floating leaf and submersed aquatic plants and algal suppression is likely. Along the east and south parts of the lake, a massive floating-leaf plant area was dominated by American lotus and white water lily. Toward the middle of the lake dense stands of wild celery, water stargrass, Elodea, coontail and leafy pondweed were found. In the west side of the lake, the Mississippi River phytoplankton loads reduced the water clarity but sustained higher dissolved oxygen. The dissolved oxygen on the east side of the lake was only 4 mg/l at the surface and 1 mg/l just one meter deeper. At 2:00 pm on a clear sunny day, the low dissolved oxygen levels suggested that a form of BOD had consumed most of the photosynthetic oxygen release. Dissolved oxygen was 6.5 mg/l at the surface of the river side of the lake. A moderately diverse group of fish species were found in the lake, including the State Special Concern mud darter that was found in relatively high numbers within coarse woody debris on the west side of the lake.

Garnet Lake (facing northeast)

Discussion

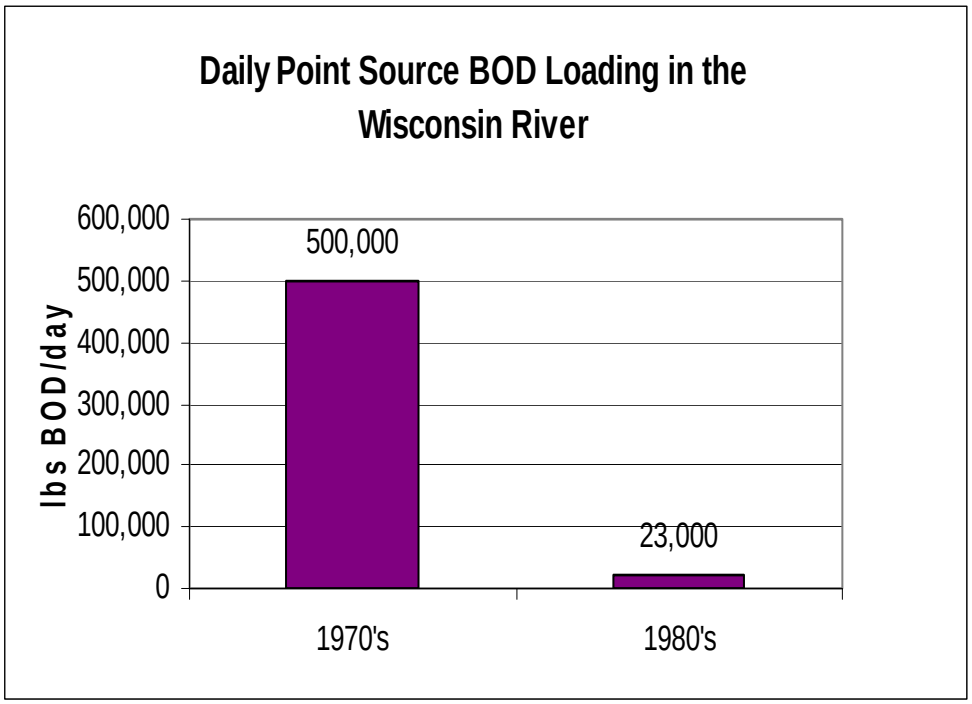
The planning grant study revealed diverse floodplain lakes in Crawford County, particularly along the Lower Wisconsin State Riverway and Kickapoo River that remain relatively natural river floodplains. These habitats sustain the high biodiversity and provide important ecological functions linked to the 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, 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.

In the past, floodplain lakes had been rarely sampled for fish populations, aquatic plants or water quality parameters. Some of the waterbodies we sampled are described in "Surface Water Resources of Crawford County", a document that DNR had prepared in 1972 but lacks significant fisheries or water quality information. Lyons et al. (2000) indicated that State Endangered starhead topminnows were more widespread along the Lower Wisconsin State Riverway than previously reported. More recently, the oxbows along the river had been described as important habitats for starhead topminnows and other rare species (Marshall and Lyons 2008). The 2009 Lake Planning Grant Study surveys revealed high numbers of State Endangered starhead topminnows in all of the habitats we sampled. The starhead topminnow is now more common than previous distribution maps found in "Fishes of Wisconsin" (Becker 1983) or "Distribution and Relative Abundance of Fishes in Wisconsin" (Fago 1992). The Lower Wisconsin State Riverway floodplain lakes may be the "topminnow sanctuary" that Becker (1983) had envisioned for the survival of this rare species. Interestingly, starhead topminnows have not yet been found along the Kickapoo River or Mississippi River.

Upland groundwater plays an important role in the survival of starhead topminnows and other fish species. 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 (Giebert and Krug 1996, Potter 1991). These changes were linked to improved agricultural land use practices. Increased tributary lowflow rates to the floodplain lakes may have improved habitat for starhead topminnows and other 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 (Figure 12). Similar declines have occurred along the Mississippi River and Kickapoo River. Floodplain habitats are now exposed to cleaner water during seasonal flood events.

Figure 12: Reduce BOD loading linked to the Clean Water Act



Secondly, land uses in the counties surrounding the Lower Wisconsin River have changed dramatically over the years, affecting nutrient loads. Just as baseflows have increased and peak flows have declined, watershed pollution loads had decreased. The numbers of dairy farms in southwest Wisconsin had declined by roughly 50% since the 1970s and animal unit numbers (and manure production) declined even though average farm sizes increased. Coinciding with reduced numbers of dairy farms was significant participation in the federal Conservation Reserve Program (CRP) since 1986. A more recent decline may negate some of the recent environmental benefits. Improved farming practices and implementation of CRP had greatly improved trout streams within the Driftless Area (Marshall et al. 2008). The same land use practices that had benefited trout streams may have benefited floodplain habitats but more research is needed to support this hypothesis. Of concern is the more recent decline in CRP participation as the value of corn for ethanol production increased.

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Appendix A: Crawford County Floodplain Lake SLOH Data

WBIC	Lat	Long	Chl a – ug/l	Tot Phos – mg/l	Color - su	Alkalinity mg/l
1181200	43 01.866	90 58.983	4.81	0.071	20	193
5575609	43 01.779	90 39.504	3.83	0.041	15	253
5574697	43 06.117	90 51.283	19.4	0.179	55	122
5574988	43 04.783	90 52.233	3	0.205	40	94
1179900	43 04.633	90 52.883	62.3	0.215	20	127
5575906	43 00.03	91 05.63	10.8	0.273	70	140
5575743	43 00.547	91 09.462	1.79	0.30	20	157
1023800	43 06.433	90 52.562	19.1	0.103	30	159
1024000	43 06.033	90 51.367	5.44	0.034	20	147
1210500	43 10.6’	90 40.617’	1.25	0.02	15	151

Crawford County Floodplain Lake Field Data

WBIC	Lat	Long	Date	D.O. – mg/l	Temp - C	pH - su	Sp Con - uS/cm	Trans - cm
1181200	43 01.866	90 58.983	07/07/09	10.5	17.5			
1181200	43 01.866	90 58.983	07/16/09	8.9	16.8	8.0	404	80
5575609	43 01.779	90 39.504	07/16/09	12.5	22.7	7.92	540	70
none	43 01.778	90 59.446	07/16/09	8.4	24.4		404	
5574697	43 06.121	90 51.328	08/08/09	3.0	20.1	6.95	305	
5574697	43 06.117	90 51.283	08/20/09	3.0	23.0	7.14	297	46
5574994	43 04.783	90 52.233	08/12/09	2.5	24.0	7.16	195	57
1179900	43 04.633	90 52.883	08/12/09	7.5	25.6	7.85	315	43
none	43 00.205	91 07.838	08/18/09	6.5	25.5	7.77	402	51
5575906	43 00.03	91 05.63	08/18/09	3.0	21.2	7.23	299	80
5575743	43 00.724	91 05.63	08/18/09	4.0/1.0	23.3	8.2	329	120
5575743	43 00.547	91 09.462	08/18/09	6.5	25.9			60
1023800	43 06.433	90 52.562	08/20/09	12.9	22.5	8.02	314	65
1024000	43 06.033	90 51.367	08/20/09	6.5	23.5	7.71	358	120
1210500	43 10.6’	90 40.617’	08/31/09	7.0	19.2	7.92	298	120

Appendix B: Crawford County Floodplain Lake Fishery Data

Species	Scientific Name	1181200	5575609	None1	5574697	None2	5574988
Bowfin	*Amia calva*						
Gr. pickerel	*E. americanus*	19	2	8		7	
N. pike	*Esox lucius*		1				1
Mudminnow	*Umbra limi*	4			18	1	4
Golden shiner	*N. crysoleucas*	9	2			1	3
Spottail shiner	*N. hudsonius*						
Spotfin shiner	*C. spiloptera*					1	
Lake chub sucker	*E. sucetta*	80	1				2
Spotted sucker	*M. melanops*		1				
Black bullhead	*Ameirus melas*						
Yellow bullhead	*A. natalis*						
Tadpole madtom	*Noturus gyrinus*					1	
Pirate perch	*A. sayanus*	4				2	
Starhead topmin.	*Fundulus dispar*	17	2	2		5	
Brook silverside	*L. sicculus*		9			>400	
Green sunfish	*L. cyanellus*	1					
Pumpkinseed	*L. gibbosus*						
Warmouth	*L. gulosus*	2	1				
Bluegill	*L. macrochirus*	3	2			18	11
Orange spotted	*L. humilis*						
Largemouth bass	*M. salmoides*	118	26			10	4
Black crappie	*Pomoxis nigromaculatus*	5				1	1
Mud darter	*E. asprigene*						
Johnny darter	*E. nigrum*		1			1	3
Blackside darter	*P. maculata*	1					
Yellow perch	*P. flavescens*						

1) 43 ^{o} 01.778’ – 90 59.446’ 2) 43 ^{o} 00.205’ – 91 07.838’

Species	Scientific Name	1179900	5575743	1023800	1024000	1210500
Bowfin	*Amia calva*				1	
Gr. pickerel	*E. americanus*	3		1		13
N. pike	*Esox lucius*		1			1
Mudminnow	*Umbra limi*	3		25	>200	>100
Golden shiner	*N. crysoleucas*					
Spottail shiner	*N. hudsonius*					
Spotfin shiner	*C. spiloptera*					
Lake chub sucker	*E. sucetta*	29				
Spotted sucker	*M. melanops*	1				
Black bullhead	*Ameirus melas*					14
Yellow bullhead	*A. natalis*					2
Tadpole madtom	*Noturus gyrinus*	1	23			4
Pirate perch	*A. sayanus*					
Starhead topmin.	*Fundulus dispar*					
Brook silverside	*L. sicculus*	>200				
Green sunfish	*L. cyanellus*			1		
Pumpkinseed	*L. gibbosus*	1		1		3
Warmouth	*L. gulosus*					
Bluegill	*L. macrochirus*	2		1	1	44
Orange spotted	*L. humilis*		2			
Largemouth bass	*M. salmoides*	40	16		1	4
Black crappie	*Pomoxis nigromaculatus*	14	1			
Mud darter	*E. asprigene*	3	12			1
Johnny darter	*E. nigrum*	4				
Blackside darter	*P. maculata*					
Yellow perch	*P. flavescens*	4				

Appendix C: Crawford County Floodplain Lake Macrophyte Observations/Collections

Species	Scientific Name	1181200	5575609	None1	5574697	None2	5574988
American lotus	*Nelumbo lutea*						
White water lily	*Nymphaea odorata*	X	X	X	X	X	X
Elodea	*Elodea canadensis*	X	X		X	X	X
Leafy pondweed	*Potamogeton foliosus*	X					
Large-leaf pondweed	*Potamogeton amplifolius*					X	
Water stargrass	*Heteranthera dubia*	X	X			X	
Flatstem pondweed	*Potamogeton zosteriformis*					X	
Curly-leaf pondweed	*Potamogeton crispus*	X	X				
Eurasian watermilfoil	*M. spicatum*	X				X	
N. watermilfoil	*M. sibiricum*						
Bladderwort	*Utricularia vulgaris*						
Coontail	*Ceratophyllum demersum*	X	X	X	X	X	X
Pickerel weed	*Pontederia cordata*				X	X	X
Arrowhead	*Sagittaria latifolia*				X	X	X
Burr reed	*Sparganium eurycarpum*				X		
Wild rice	*Zizania*		X				
Muskgrass	*Chara*				X		

1) 43 ^{o} 01.778’ – 90 59.446’ 2) 43 ^{o} 00.205’ – 91 07.838’

Species	Scientific Name	1179900	1023800	1024000	5575743	1210500
American lotus	*Nelumbo lutea*				X	
White water lily	*Nymphaea odorata*		X	X	X	X
Elodea	*Elodea canadensis*		X	X	X	X
Leafy pondweed	*Potamogeton foliosus*			X	X	X
Large-leaf pondweed	*Potamogeton amplifolius*					X
Water stargrass	*Heteranthera dubia*			X	X	X
Flatstem pondweed	*Potamogeton zosteriformis*			X	X	
Curly-leaf pondweed	*Potamogeton crispus*			X		
Eurasian watermilfoil	*M. spicatum*					X
N. watermilfoil	*M. sibiricum*					X
Bladderwort	*Utricularia vulgaris*			X		X
Coontail	*Ceratophyllum demersum*	X	X	X	X	X
Pickerel weed	*Pontederia cordata*					
Arrowhead	*Sagittaria latifolia*		X			
Burr reed	*Sparganium eurycarpum*					
Wild rice	*Zizania*				X	
Muskgrass	*Chara*					X

Appendix D: Crawford County Floodplain Lakes Fish Habitat Evaluation (adopted from Lyons 2004)

WBIC	1181200	5575609	None 1	5574697	None 2	5574988
Substrate	Clay	Clay-sand	Muck	Muck	Clay	Detritus
Overall Plants	High	Low	Medium	High	High	High
Floating-leaf plants	High	Medium-Low	Low	Absent	Low	High
Woody debris	Medium	Low	Medium	Low	Absent	Medium
Overall habitat	High	Medium	Low	Low	Medium	Medium
Upland groundwater	Yes	Yes	No	No	Yes	No
Observed color	Slightly turbid	Slightly turbid	Stained	Stained-turbid	Turbid	Stained-turbid

1) 43 ^{o} 01.778’ – 90 59.446’ 2) 43 ^{o} 00.205’ – 91 07.838’

WBIC	1179900	1023800	1024000	5575743	1210500
Substrate	Sand	Clay	Clay	Muck	Sand-silt
Overall Plants	Low	High	High	High	High
Floating-leaf plants	Absent	High	Low	High	Medium
Woody debris	Medium	Absent	Low	High	Medium
Overall habitat	Low	Medium	Medium	High	High
Upland groundwater	No	Yes	Yes	No	Yes
Observed color	Turbid	Slightly stained/turbid	Clear	Clear	Clear