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Final Report to the U.S. Fish and Wildlife Service
Big Muddy National Fish and Wildlife Refuge, Columbia, MO
December 2002, revised December 2003

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Chapter 5

Fishes of Lisbon Bottom Wetlands

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Chapter 5. Fishes of Lisbon Bottom Wetlands

Duane C. Chapman

Abstract

Fish were collected and identified in permanent and temporary wetlands and ephemerally flooded areas of Lisbon Bottom, Missouri, in order to 1) Determine the seasonal use of Lisbon Bottom by flood-plain-dependent fishes, 2) compare the fish assemblage of the flood plain to that of the main river, and 3) to examine wetland fidelity of lentic, flood-plain fishes. Lisbon Bottom consists of approximately 875 ha of flood plain within a single bend of the Missouri River, with a variety of types of wetlands with different water sources and periods of flooding. Forty species of fish were captured in the wetlands. Buffalos (*Ictiobus* sp.), gizzard shad (*Dorosoma cepedianum*), common carp (*Cyprinus carpio*), and shortnose gars (*Lepisosteus platostomus*) were observed spawning and were captured exuding sex products during flood events. Therefore this flood plain, which was reconnected to the river after the 1993 floods is used by fishes from the river for spawning.

Fishes found in the flood-plain wetlands were very different from fishes captured in the Missouri River and Lisbon Chute at the same time period by another researcher (Louise Mauldin, U.S. Fish and Wildlife Service). Gizzard shad composed less than three percent of the fish captured in the wetlands, but almost seventy percent of the river and chute fish. Striped bass (*Morone saxatilis*) and white bass (*Morone chrysops*) were not captured in the wetlands but were common in the river and chute. Freshwater drum (*Aplodinotus grunniens*) was also common in the river and rare in the flood plains. In contrast, the flood-plain wetlands had higher relative abundances of cyprinids (especially *Notropis* sp. and *Cyprinellis* sp.) and centrarchids.

Although all of the wetlands except Wetland 12 were connected with a single sheet of water during the highest floods, fish species captured varied between wetlands. Basins with similar morphology and water sources generally had similar species of fish. Ephemerally flooded areas held fish during floods, but shallow very ephemeral basins left by the retreating floodwaters did not hold fish, an indication that fish have mechanisms to avoid being stranded in the very shallow areas. However, many slightly deeper wetlands apparently did concentrate fish that were unable to escape as the wetlands eventually dried. One topflooding wetland that eventually dried held many riverine fishes such as blue sucker (*Cycleptus elongatus*), sauger (*Stizostedion canadense*), and goldeye (*Hiodon alosoides*), that were most likely trapped there after a flood.

Small native cyprinids, especially red shiner (*Cyprinella lutrensis*), dominated the temporary wetlands in this study. Young-of- the-year (YOY) buffalo occupied shallower, more ephemerally flooded habitats than did small cyprinids. Orangespotted sunfish (*Lepomis humilis*) and green sunfish (*Lepomis cyanellus*) were also common in temporary wetlands.

White and black crappies (*Pomoxis annularis* and *P. nigromaculatus*) were the dominant large species in the topflooding permanent scours and were abundant in the backflooding permanent scour. These are the most likely fish in the wetlands to be targeted by recreational fishermen. Crappie were large and growth rates were rapid, despite temperatures that were significantly higher than those known to provide good crappie survival and growth. Tagged crappie were never captured in a wetland other than that in which they were tagged, and large crappie were

generally not caught in temporary wetlands, but the data were insufficient to determine the degree of wetland loyalty.

Introduction

The Lower Missouri River ecosystem has drastically changed over the past 50 years due to construction of main-stem impoundments, channelization, bank stabilization, and concomitant flow alteration. Confinement and straightening of the channel has led to the loss of approximately 72 km of river from Rulo, Nebraska to the mouth of the river at St. Louis (Funk and Robinson, 1974) and a loss of 41,000 ha of aquatic habitat (Hesse and others, 1989). Channel confinement has led to an increase in average current velocities and a loss of shallow backwater and sand island habitat. In addition, levee construction has led to a disconnection of the river with its flood plain which is known to be critical in the reproduction and recruitment of flood-plain-dependent fishes (Junk and others, 1989; Galat and others, 1998).

These combined alterations have led to significant changes in the fish communities of the Lower Missouri River (Pflieger and Grace, 1987; Hesse and others, 1989). Numerous fish species including buffalo (*Ictiobus* sp.) and carpsuckers (*Carpiodes* sp.) that are dependent on vegetated flood-plain habitats for spawning have declined (Pflieger and Grace 1987; Galat and others, 1998). However, major recent floods have served to reconnect portions of the Lower Missouri River flood plain with the river. In 1993 and 1995 floodwaters breached many levees along the Missouri River and created new habitats including shallow erosional depressions and deep, steep-sided evorsions known as “blew-holes” or “scours” that sometimes exceeded 30 m in depth. Smaller, shallower, scours occurred at secondary breaks in levees or around other obstructions on the flood plain. When the floodwaters receded these basins became a diverse assortment of wetlands ranging from shallow, vegetated temporary wetlands to both connected and non-connected scours.

Connected and non-connected scours have been the focus of several recent studies and a few of these have addressed fish assemblages. Tibbs and Galat (1997) and Galat and others (1998) investigated fish use of connected and non-connected scours and found that connected scours contained greater species richness of fishes compared to non-connected scours. In addition, the fish assemblages of these two habitat types have been shown to be quite different (Galat and others, 1998). Gelwicks (1995) studied seasonal fish use of a managed wetland complex of the Lower Missouri River and found that these habitats were extensively used by flood-plain spawners including gizzard shad (*Dorosoma cepedianum*) and *Cyprinus* sp. To date, however, there have been few studies of the entire continuum of wetland types that occurs in reconnected flood-plain habitats of the Lower Missouri River. In this study, we investigated the fish use of a series of temporary, seasonal, and permanent wetlands located at Lisbon Bottom, near Glasgow, MO. This study comprised the entire period of pre-flood, flood, and post-flood conditions during Spring 1999. Lisbon Bottom consists of approximately 875 ha of flood plain within a single bend of the Missouri River, and was recently purchased by the U.S. Fish and Wildlife Service as part of the Big Muddy National Fish and Wildlife Refuge. The Lisbon tract is passively managed as a reconnected flood-plain complex. Breaks in the levees on this bend of the river have not been repaired which makes Lisbon Bottom a natural laboratory to examine seasonal use of the flood plain by a large-river fish community. This study had the following objectives: 1)

Determine the seasonal use of Lisbon Bottom by flood-plain-dependent fishes, 2) compare the fish assemblage of the flood plain to that of the main river, and 3) to examine wetland fidelity of lentic, flood-plain fishes.

Methods

Fish were sampled with minifyke nets, trammel nets, three sizes of hoop nets, an aquarium net, and a bag seine. Metal minnow traps with leads were also used but were abandoned early in the study because they were not effective. Two sizes of the hoop nets used were the "large" and "small" hoop nets described by Gutreuter and others (1995). An intermediate size hoop net (3 ft diameter, 1 inch bar mesh, single throat) was also used. The minifyke net (fig. 5-1) and the trammel nets (fig. 5-2) are also those described by Gutreuter and others (1995). Leads (50 ft long, 1 inch bar mesh on the large and medium hoop nets and ¾ inch bar on the small hoop nets) were used on the hoop nets to guide fish into the nets.

Minifykes and hoop nets were generally placed perpendicular to the shoreline with the mouth facing the shoreline and the lead running to the bank. In some cases, especially during flooding episodes (fig. 5-3), an appropriate bank did not exist. In that case, two net/lead systems were attached together, face to face. Hoop and fyke nets were set overnight, and two consecutive nights were always fished at the same location.

Nine locations were sampled using passive gear. These consisted of three permanent scour wetlands (4, 5, and 26), five temporary wetlands (2, 3, 8, 9 and 22), and an ephemerally flooded area (E5) (fig. 5-4). Descriptions of the permanent and temporary wetlands may be found in Chapter 2, table 2-1. All or portions of those wetlands were also sampled using a 50 ft, 1/8 inch ace mesh bag seine, depending on the morphology of the wetland and the location and abundance of submerged vegetation. Trammel nets (50 ft long, 4 ft deep, 1 inch bar mesh on the small weave netting and 12 inch on the large weave netting) were set for approximately two hours, and at least two trammel sets were used in each location. Wetlands 2 and 3 were connected due to flooding at the time of sampling, and were fished as one unit, with the larger passive gear installed in Wetland 3. Wetland 2 is much shallower than Wetland 3 and more ephemerally inundated.

Four shallow (< 20 cm deep) ephemerally flooded areas (Wetlands E2, E3, E4, and E6, fig. 5-4) were seined in their entirety with the bag seine after the retreat of floodwaters to look for stranding of small fish. Wetland 21, a moderately deep temporary scour, was also sampled only by seining. Lastly, in Wetland 10 and ephemerally flooded area E1, visible schools of small fish were captured using an aquarium net. In these very shallow wooded wetlands, none of our gear other than the aquarium net would have been appropriate because of the abundance of small trees, leaf litter and woody debris.

Access to these wetlands is extremely difficult for much of the year, often being too muddy and rugged even for all-terrain vehicle access (fig. 5-5). Nets and gear often had to be carried by hand for up to a kilometer over muddy terrain. This limited the amount of sampling that was possible. Trap style nets were fished for two consecutive nights at the same location. Permanent scour Wetlands 4, 5, and 26 were each fished for two sampling occasions, with a cumulative total of at least 16 hoop-net nights. Minifyke nets were fished for a total of 8 net-nights each in Wetlands 4 and 5. Temporary and ephemeral wetlands were fished on one sampling occasion only and generally for half as many total hoop net nights. Naturally, wetlands were fished during periods in which they were inundated or contained water. Wetland morphology and vegetation precluded the use of certain gear in different wetlands. For example, minifyke nets were not used in Wetland 26 because the steep sides of this wetland made such gear inappropriate. In Wetlands 9 and 22, only minifykes, seines, and minnow traps were used because of shallow water depths.

Seine hauls were very different in length, and also in width, depending on the physical characteristics of the wetlands being fished. It was not feasible to standardize this aspect of fishing between wetlands because seining is very dependent on an adequate bottom, absence of snags, an adequate shoreline for entrapment, depth, and other factors. We recorded the length of seine hauls, but they are not reported here because we believe that any attempt to standardize these results to catch per unit effort would not be useful. Catch efficiency was strongly affected by many factors other than length of haul. Similarly, the efficacy of the other gears depended greatly on wetland morphology and, in the case of the hoop and fyke nets, by beaver and muskrat activity. Therefore, the data herein are not discussed in terms of catch per unit effort, but rather in terms of presence-absence and relative abundance.

Large fish were identified on site, measured, and released. Centrarchids, catastomids, and shortnose gar (*Lepisosteus platostomus*) exceeding 100 mm in length were tagged before release, using individually numbered Floy®T-bar tags. Scales were taken from centrarchids and catastomids. Using methods of Carlander (1982), fish were aged and lengths at age were back calculated. Tag return data and length at age were used in an attempt to determine the fidelity of fish to the wetland in which they were captured. Since these wetlands differ in their hydrology, it is likely that growth rates of fish may differ between wetlands. Back-calculated length-at-age was compared, using Duncan's multiple range test, between wetlands as an attempt to determine fish loyalty to a given wetland. If back-calculated growth of similar-aged fishes is similar within ponds, but different between ponds, this would be evidence of pond loyalty. Adult fish were examined in the field for evidence of spawning activity, (exudation of sex products, spawning coloration or tubercles) and in some cases fish were actually observed spawning during the collections.

If circumstances allowed, small fish were identified on site and released, but generally time and accuracy of identification required that the fish be preserved on-site for later identification. Preserved fish were fixed on site with formalin, and later rinsed and transferred to ethanol. Louise Mauldin, U.S. Fish and Wildlife Service, confirmed the identification of small fish, and Matthew Winston, Missouri Department of Conservation, confirmed the identification of YOY stonerollers.

Duncan's multiple range test was used to test for differences between back-calculated length of fish between wetlands, and a Student's *t* test was used to test differences in length between black and white crappie of similar ages within a wetland. Ward's minimum variance cluster analysis was used to group wetlands by similarity of the fish species assemblages.

Results and Discussion

Forty species of fish were collected (table 5-1) including large and small fishes caught by all methods. Fish captured on Lisbon flood-plain wetlands differed greatly from fish caught in the Missouri River adjacent to Lisbon Bottom and in Lisbon Chute by another researcher during the same time period (fig. 5-6, Louise Mauldin, U.S. Fish and Wildlife Service). Gizzard shad composed almost 70% of the catch in the river and chute. Adult gizzard shad were uncommon in the wetlands and were encountered mostly during flood events when they were actively spawning. Gizzard shad YOY were only beginning to recruit into the flood-plain wetland catch by the end of the study. For purposes of easier comparison, figure 5-6B shows the same data as figure 5-6A, with the influence of gizzard shad removed. White bass and striped bass (Moronidae; *Morone chrysops* and *M. saxatilis*) and freshwater drum (Sciaenidae; *Aplodinotus grunniens*) were abundant in the river and chute, while moronids were not captured and sciaenids were rare in the wetlands (fig 5-6B). Native cyprinids, especially shiners, had a higher relative abundance on the flood plain than in the river and chute. Relative abundance of non-native cyprinids (excluding influence of gizzard shad) was about the same between the flood plain and the riverine environments. Centrarchids also had a much higher relative abundance on the flood plain. Fishes in addition to white bass and striped bass which were caught in the riverine environments but not on the flood plain include blue catfish, (*Ictalurus furcatus*), bigmouth shiner (*Notropis dorsalus*), brassy minnow (*Hybognathus hankinsoni*), shovelnose sturgeon (*Scaphirhynchus platorynchus*), mooneye (*Hiodon tergisus*), paddlefish (*Polyodon spathula)*, river shiner (*Notropis blennius*), silverband shiner (*Notropis shumardi*), silver carp (*Hypophthalmichthys molitrix*), silver chub (*Macrohybopsis storeriana*), sturgeon chub (*Macrohybopsis gelida*), and suckermouth minnow (*Phenacobius mirabilis*). Fishes that were caught on the flood plain but not in the river or chute include channel shiner (*Notropis wickliffi*), golden shiner (*Notemigonus chrysoleucas*), mimic shiner (*Notropis volucellus*), and white sucker (*Catostomus commersoni*).

During the spring floods, we observed gar (*Lepisosteus* sp.) and buffalo actively spawning in the wetlands flooded by the river, and we captured bigmouth buffalo (*Ictiobus cyprinellus*), common carp (*Cyprinus carpio*) (fig. 5-7A), and gizzard shad (fig. 5-7B) that were releasing sex products when captured during flood events. There is little doubt that riverine fish can and do spawn on this recently reconnected flood plain.

For the purposes of analysis, we considered small and large fish separately. Small fish were defined as fish less than 80 mm total length, regardless of species. This division was chosen because it was a natural break in the data. It included almost all young-of-the-year (YOY) fish, all native cyprinids and all orangespotted sunfish (*Lepomis humilis*).

Small Fish

Over 2300 small fish were captured in Lisbon Bottom wetlands. Table 5-2 provides data on total number of fish, fish families, and fish species caught in each wetland. The entire dataset (Attributes of USGS 1999 Small fish species relative abundance) are reported in Korschgen and others (ArcView-based spatial decision support system for the Lisbon Bottom Unit of the Big Muddy National Fish and Wildlife Refuge, unpub. data, 2001).

Ephemerally flooded areas E2, E3, E4, and E6 were shallow depressions that held water briefly after the retreat of floodwaters. We seined these wetlands to determine whether they held trapped fish. The water depth of these depressions at the time of seining did not exceed 20 cm. No fish were captured in these drying areas, nor were any fish observed but not captured. These areas held some vegetation, mainly young cockleburs and dead cockleburs from the previous year. The vegetation interfered with seining and some fish may have escaped. However, we feel that if significant numbers of fish had been present at the time of sampling, that some fish would have been captured. There were very few, if any, fish remaining in these small depressions. We did catch small and large fish in ephemerally flooded areas E1, E5, and ephemeral Wetlands 2 and 10, an indication that fish do use the entire bottom when it is available to them. Therefore, fish probably have mechanisms to avoid entrapment in these small depressions. If not, E2, E3, E4, and E6 would probably have concentrated large numbers of fish as the floods receded. However, many slightly deeper wetlands (8, 9, 21) apparently did concentrate fish that were unable to escape as the wetlands eventually dried.

Other sites where few or no small fish were captured were Wetlands 4 and 5, and ephemerally flooded area E5. No small fish were captured in Wetland 4 and only five small fish (all centrarchids; three orangespotted sunfish, one juvenile white crappie [*Pomoxis annularis*] and one juvenile bluegill [*Lepomis macrochirus*]) were captured in Wetland 5. However, schools of unidentified larval fish were seen in both of these wetlands. The lack of small fish in the catch in these wetlands stems partly from the inefficacy of the available methods used for the capture of small fish in these wetlands. Seines and minifykes were the primary gears used in this study for the capture of small fish. Neither of these scour wetlands was seined; Wetland 4 was too deep, steep-sided and full of woody snags, and Wetland 5 had very deep unconsolidated mud that made effective seining impossible. Minifykes were set in these wetlands, but the steep sides of Wetland 4 made them ineffective because the tops of the traps were inundated. However, it is likely that the number of large predatory fish in these wetlands (mostly white crappies, black crappies [*Pomoxis nigromaculatus*] and some largemouth bass [*Micropterus salmoides*]) is at least partly responsible for the low numbers of small fish and the complete absence of small cyprinids and catastomids in the catch. E5 was a normally terrestrial area of the bottom that was sampled during a major flood event. The seine was not used at E5 because the entire area was covered with temporarily submerged small trees and other vegetation that would have made seining impossible. At E5, one red shiner (*Cyprinella lutrensis*), one emerald shiner (*Notropis atherinoides*) and two western mosquitofish (*Gambusia affinis*) were caught in minifykes.

Other than E2–E6 and Wetlands 4 and 5, at least 40 small fish were captured per wetland (table 5-2). Figure 5-8 shows the relative abundance of small fishes in wetlands where 40 or more small fish were caught. Cyprinids and centrarchids replaced catastomids with increasing permanence of the wetland. All the small catastomids caught in the ephemeral wetlands in this study were YOY bigmouth buffalo, whereas the cyprinids were very diverse (fig. 5-9). Young-of-the-year bigmouth buffalo apparently selected for these very shallow habitats, which were often highly vegetated and full of leafy and woody debris. Schools of hundreds of these fish could be seen in these areas.

Wetland 21 had the highest small fish family diversity (table 5-2 and fig. 5-8) with seven families, at least one species of every family captured in the study except Poeciliidae. This is to some measure due to the topflooding nature of this wetland. This wetland contained juvenile sauger (*Stizostedion canadense*), blue suckers (*Cycleptus elongatus*), and goldeye (*Hiodon alosoides*), all of which are commonly found only in lotic habitats. These fish were probably deposited in this wetland during a flood event and were unable to find egress. Wetland 21 had many YOY common carp and very abundant crayfish at the time it was sampled. This wetland was sampled in June when wetlands were drying, and thus may have concentrated fish and crayfish; biomass of fish and crayfish in this wetland was very high. This entire small wetland was seined in two separate hauls (fish had the opportunity to move to the portion not being seined) and at least 30 kilos of fish and crayfish were captured from each haul (fig. 5-10). Subsamples were taken from each seine haul because it would have been impossible to identify that quantity of fish.

Red shiners were the most common cyprinid overall in the study (fig. 5-9). Red shiners are the most common and widely distributed fish in non-Ozark Missouri (Pflieger, 1997), and are well adapted to turbid, silty waters. Red shiners are parasitic spawners (Pflieger, 1997), usually laying their eggs in the nests of sunfishes (especially orangespotted and green sunfish [*Lepomis cyanellus*]). This behavior allows them to reproduce efficiently in these habitats, which have very small grain size substrates. We captured both adult and YOY red shiners in most wetlands where they were found.

Common carp YOY were captured in large numbers in only two wetlands, 21 and 22. Although these two wetlands are close together, they are separated by a levee and are very different in their hydrology. Wetland 21 was filled by topflooding, while Wetland 22 has a strong stream influence and backflooded through Wetland 26 at least four separate times during the study. The abundance of YOY common carp in these two wetlands and only these two wetlands is puzzling but this may be partially explained by the dates of the sampling. Wetlands 21 and 22 were the last wetlands to be sampled. Some other wetlands may have contained common carp YOY that were too small to be captured at the time of sampling. Common carp YOY averaged 51 mm at the time that Wetlands 21 and 22 were sampled, much larger than the minimum size that would be caught by our seine. Nevertheless, common carp YOY would likely have been too small to be captured in wetlands that were sampled early in the study.

On the small fish family graph (fig. 5-8), Wetland 22 and 26 appear similar, being dominated in numbers by cyprinids and secondly by centrarchids. These two wetlands often connect through high water. However, the species of cyprinids found in these two wetlands were very different, with the more riverine shiners (mimic, channel, sand [*Notropis stamineus*], ghost, and emerald) being found in high numbers in Wetland 26, which was closer to the river (fig. 5-9). Small cyprinids in Wetland 22 were mostly red shiners, bluntnose minnows (*Pimephales notatus*), YOY common carp, and some sand shiners. While these wetlands were very different in morphology, there were two coves of Wetland 26 which were shallow and resembled Wetland 22 in morphology. These coves were seined, and were the source of all the small fish captured in Wetland 26. Therefore, the riverine shiners were captured in habitat that resembled Wetland 22 morphologically, but which had better access to deep water and to the river.

Many YOY central stonerollers (*Campostoma anomalum)* were captured in Wetland 8. No adult stonerollers were captured. The presence of these fish, which are generally considered residents of gravelly streams, (Pflieger, 1997) is surprising. Substrate in the upper end of Wetland 8 where these fish were captured was mostly consolidated clay. The substrate in the larger, shallower, downstream end of Wetland 8 was mostly unconsolidated clay when it was flooded, but this portion was dry at the time of fish sampling. One would assume that to have many YOY in this wetland (and in none other) that spawning likely occurred there. Stonerollers are usually stream riffle spawners, but Pflieger (1997) indicates that they sometimes do spawn in quiet pools

Relatively few small gizzard shad were captured in this study, because YOY gizzard shad had just begun to enter the catch by the end of this study. Gizzard shad did spawn in these wetlands. Gizzard shad spawn in tight, milling, schools at the surface of the water (Pflieger, 1997). Small spawning aggregations of gizzard shad were observed actively spawning in Wetlands 2 and 3, and some of these fish were captured while still exuding sex products (fig. 5-7). Very young gizzard shad were caught in Wetlands 21 and 22.

Wetland 12 was separated from the river by a levee and was never flooded during this study. It was also the only wetland that had more than a few submerged aquatic macrophytes. Most fish captured at this wetland were western mosquitofish, which were not dominant in any other wetland. No large fish were captured in Wetland 12.

Large Fish

More than 500 large fish were captured during this study. Distinctly different fish assemblages were captured in different wetland types (fig. 5-11). Table 5-3 lists the number of families of large fish, number of species, and total number of fish captured in each wetland. No large fish were caught in any of the ephemerally flooded areas except E5 and Wetland 2, which were deeper than the other ephemerally flooded sites at the time of sampling. Wetland 12 also had no large fish, and Wetland 9 had only one black crappie, a year-old fish. Wetland 21 had no large fish except for YOY shortnose gar, which were growing so quickly they were already exceeding 100 mm on average by the late June sampling date. Wetlands in which more than a few large fish were caught were either deep wetlands or, in the case of Wetland 2 and E5, were ephemerally flooded areas that were connected to deep water at the time of sampling and were populated largely by fishes that were actively spawning.

Permanent Wetlands 4 and 5 were similar in that they were strongly influenced by topflooding from the river during very high water stages. They differed in that Wetland 5 was shallower and more strongly flushed by the river during flooding events, and in that Wetland 4 received more runoff from rainfall events (see Chapters 1 and 2). Both of these wetlands were dominated by white and black crappies. Crappies composed 59% of the catch by number at Wetland 5 (65 total crappies) and 51% (49 crappies) at Wetland 4. More than eight crappies per large hoop net set were captured, despite beaver damage to many of the nets (fig. 5-12). White crappies outnumbered black crappies by almost 4 to 1. Crappies captured from permanent wetlands were large, averaging 242 mm total length, black and white crappies combined. In Wetland 5, 12% of the fish caught were large gizzard shad, but large gizzard shad were not caught in Wetland 4. In Wetland 4, 12% of the fish were smallmouth buffalo (*Ictiobus bubalus*), which were not caught in Wetland 5. River carpsucker (*Capriodes carpio*), largemouth bass and small numbers of bigmouth buffalo and bluegill were caught in both wetlands.

Wetland 26 was the wetland most connected to the river. This probably accounts for the prevalence of river carpsucker and shortnose gar in this wetland. Crappies, mostly white crappies, composed 16% of the large fish catch in this wetland.

Flows entering Wetlands 4 and 5 were generally strong and unidirectional; those entering Wetland 26 were usually gentle flows, and the water entered and exited by the same path. Fish had clear access to and from the river in Wetland 26 when they were connected, but this is much less clear in the case of Wetlands 4 and 5. Fish may have been swept into these wetlands through the violent currents at the crevasse, but they probably would have encountered difficulty returning to the river, except in the periods when most of the flood plain was inundated and escape downstream was possible.

Wetland 8, a temporary wetland that was deeper in a small percentage of its area than most temporary wetlands, had some crappies (12% relative abundance), but they were much smaller (mean 142 mm total length) than those caught in the permanent wetlands. Temporary Wetlands 8 and 22 were dominated by centrarchids, but these were primarily orangespotted sunfish, bluegills and green sunfish.

In E5, the ephemerally flooded (non-basin) bottom, shortnose gar composed the majority of the catch. This reflects the observed spawning of gar during that sampling period. The lack of other flood-plain spawners in this catch is probably due to the time of year (early April) that flooding of this somewhat higher area of Lisbon Bottom occurred. Most flood-plain spawning fishes have not usually begun to spawn in this portion of the Missouri River until late April or May (Tibbs and Galat, 1997). Other fish captured on the flooded bottom included carp, immature channel catfish (*Ictalurus punctatus*), and a single very large (1016 mm) grass carp (*Ctenopharyngodon idella*).

Wetlands 2 and 3 were connected at the time of sampling and were sampled as one unit. These wetlands are shallow and ephemeral. They were sampled during a mid-May flood event when young trees at the margins were flooded. Shortnose gar, bigmouth buffalo, large gizzard shad, centrarchids (mostly bluegill), black bullhead (*Ameiurus melas*), and cyprinids (primarily juvenile bighead carp [*Hypophthalmichthys nobilis*]) were evenly represented in the catch. Wetlands 2 and 3 were sampled at a period when the fish would likely have had access to and from the river via the flooded bottomland, but they are located far from the mainstem Missouri River or the chute (fig. 1-3). However, large numbers of buffalo and some gizzard shad were observed spawning in this area at the time of sampling (fig. 5-7B).

Figure 5-13 shows a cluster analysis of the wetlands by large fish species relative abundance. Ward's minimum variance cluster analysis grouped the shallow ephemeral wetlands together, and the deep scours also were grouped together. This is an indication that wetlands with similar morphologies had similar large fishes.

Crappie Age and Growth, and Wetland Loyalty

Growth rates of the two crappie species were not significantly different except for 3-year-old fish in Wetland 4, where white crappies were significantly longer ($p = 0.02$, fig. 5-14). However, this study was hampered by unusual illegibility of the scale annuli of crappie, especially white crappie. For example, of 48 white crappie captured in Wetland 5, only 15 of them could be reliably aged. More black crappie than white crappie could be reliably aged in Wetland 5, and more white crappie than black crappie could be reliably aged in Wetland 4. Thus, comparisons of crappies between the wetlands were hampered by low sample size of same-age, same-species groupings of successfully aged crappie.

Growth of crappies was rapid, compared to other studies of crappie growth in Missouri (fig. 5-14). Two-year-old fish (white and black crappie together) averaged 200 mm, and 3-year-olds averaging 266 mm. Few 1-year-old fish were caught, probably because our gear was not effective in capturing small fish that do not enter the shallower portions of the wetlands. The oxic epilimnion was narrow, and summer temperatures within this zone exceeded 35 °C in Wetlands 4 and 5 by mid-June. This is far above optimal temperatures for crappie growth (Hayward and Arnold, 1996). Also, water levels fluctuate dramatically in the wetlands. Therefore, one would expect that these wetlands would constitute a stressful environment for crappie. However, the data indicate that crappie captured in these wetlands are growing rapidly.

YOY crappies and several yearlings were captured from temporary wetlands, indicating that there is movement of small fish between wetlands. Also, in previous work in Wetlands 5 and 8 in 1997 (Chapman and Ehrhardt, 1999) adult crappies were captured and observed on spawning beds in Wetland 5, but only YOY juvenile crappies were found in Wetland 8, which is a temporary wetland that receives floodwater through Wetland 5 during topflooding events.

Investigations into wetland fidelity by adult crappies were inconclusive. With the exception of seven adult fish captured in Wetland 8, no crappies older than 1-year-old were found in temporary or ephemeral habitats. Wetland 8 is directly downstream from Wetland 5, which was losing water depth and appropriate crappie habitat due to sedimentation. At the beginning of the study, Wetland 5 was much deeper than Wetland 8, but due to sedimentation of Wetland 5 and scouring in Wetland 8, Wetland 8 was deeper at the time it was sampled for fishes. These fish may have been washed from Wetland 5 during a topflooding event because of inadequate deep habitat to provide refuge from the current, or it is possible that the fish selected this deeper habitat.

Likewise, tagging of fish failed to answer the question of wetland loyalty. No tagged fish were recaptured from any wetland other than that in which it was originally captured, however there may have been inadequate flooding after the fish were tagged to provide for movement. Six tagged crappie were recaptured in each of Wetland 5 and Wetland 4. One of the Wetland 5 recaptures was recaptured on two occasions. No tagged fish were recaptured from any other wetland or ephemerally flooded area. In addition, recreational fishers captured four tagged crappies from Wetland 4 in June 2000. Therefore, crappie survived the late summer and through the winter in Wetland 4. All of these fish were originally tagged in Wetland 4, but there were no occasions of topflooding in the spring of 2000, so there were no opportunities for crappies to move between wetlands and the river during this period.

Examination of back-calculated length-at-age was also inconclusive in determining questions of wetland loyalty of adult crappies. If back-calculated lengths of crappies were similar within a wetland but different between wetlands, this would be an indication that different populations of crappies exist, and thus would be an indication of loyalty to the wetlands. We did not consider the last annulus in this analysis because fish may not have had sufficient opportunities to move since the majority of the last growing season, thus only three-year-old and older fish could provide useful data. This requires an adequate sample size of same-age fish old enough to have experienced flood events at least one year earlier. In this study, the ages and species of fish that could be accurately aged varied between wetlands, therefore, sample sizes were inadequate to test this hypothesis. Figure 5-16 shows the back-calculated length-at-age of 3-year-old white crappie from three wetlands. In this age class, back-calculated lengths at the second at Wetland 4 were significantly longer than at Wetland 26 ($p = 0.02$ for both annuli). However, the data from Wetland 26 is based on only two fish of that age and species, and therefore the relationship is questionable. No other significant differences in back-calculated lengths were found.

Conclusions and Management Recommendations

Flood-plain spawning fishes did use Lisbon Bottom for spawning during flood events. Fish evidently had mechanisms to avoid entrapment in shallow wetlands, but many fish were trapped in deeper wetlands when routes of egress, and then the wetlands, eventually dried. Entrapment of fish in wetlands that dry might not always be considered a negative occurrence; wading birds and fish-eating mammals may find these concentrations of easily catchable fish useful. However, for maximum advantage to flood-plain spawning riverine fishes, the wetlands on the southern, downstream portion of the bottom were probably more useful. They were connected to the river more often, allowing more potential for access during periods when the water temperature was appropriate for spawning to occur. Also, during periods of receding floods, there was more opportunity for the fish to return to the river instead of being trapped in wetlands in the upstream portion of the bottom.

Although Wetland 26 was often connected via Coopers Creek to the Missouri River, none of the wetlands in which fish were sampled had the same degree of connectivity to the river as the connected scours described by Galat and others (1998). Scour Wetlands 4 and 5 were similar to the isolated scours described in that study, and were similarly dominated by centrarchids. Wetland 26, with its limited connectivity, was intermediate between the connected scour and isolated scour species assemblages described by Galat and others (1998).

Scours, wetlands more often influenced by the river, and ephemerally flooded areas were more important to fishes than wetlands that were primarily influenced by streams and runoff. In contrast, the stream-influenced wetlands had the highest numbers and diversity of macroinvertebrates and of waterbirds (Chapters 4 and 6).

Topflooding wetlands sometimes contained fish that are not well adapted to life in shallow soft-bottomed wetlands. These fish were probably trapped in these wetlands after being deposited, perhaps violently, on the bottom during flood events. During flooding periods, fish used both topflooding and backflooding wetlands for spawning. Temporary topflooding wetlands, however, trapped many fish, especially YOY buffalo and gizzard shad, because there was no opportunity for egress to the river. In backflooding Wetlands 22 and 26, the fishes had much more opportunity to come and go to the river as their instincts led them (fig. 2-4). Wetland 22 and Area E5 were the only temporarily flooded areas sampled that were influenced by backflooding. Neither of these two areas were observed to trap any fish, but all of the temporary topflooding wetlands trapped fish which died when the wetlands dried. It should be noted, however, that drying wetlands which trap fish may be useful for birds and wildlife that experience a windfall food source (Chapman and Ehrhardt, 1999).

The relative abundance of fish species varied between wetlands depending on water source and wetland morphology. For maximum diversity of fish species, a diversity of wetland types should be maintained.

Crappies in the scour wetlands grew quickly, despite temperatures that are considered to be much higher than optimal. They survived through the high temperatures of late summer and through the winter. It is unclear whether these crappies were able to find thermal refugia in these wetlands, or if these fish have different requirements from crappies found in reservoirs and small impoundments.

We were unable to determine satisfactorily the degree of crappie loyalty to scour wetlands. Loyalty to wetlands is an important management question. If adult crappies are loyal to these wetlands, harvest in intensively fished wetlands should be limited. If there is no wetland loyalty, then new crappies will enter the wetland from other less intensively fished areas, and harvest limits are less important. Crappies are the species most likely to provide recreational fishing opportunities in these wetlands, and they were most abundant in the topflooding scours. Crappie growth rate comparisons between connected and unconnected scours have not been made, but crappie growth is probably tied to primary productivity in the wetland, which is strongly controlled by flooding (see Chapter 2). Flooding may also provide a source of prey to adult crappies, as small fish are washed into these wetlands from the river. However, repeated flooding from small floods may result in the eventual sedimentation and loss of the scours.

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List of Tables and Figures

Tables

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Table 5-1. List of fish species captured in wetlands of Lisbon Bottom between late March and the end of June 1999. Forty species were captured in all.

Catostomidae	**Cyprinidae**	**Hiodontidae**	**Poeciliidae**
white sucker	red shiner	goldeye	western mosquitofish
blue sucker	bluntnose minnow		
bigmouth buffalo	central stoneroller	**Ictaluridae**	**Sciaenidae**
smallmouth buffalo	bullhead minnow	channel catfish	freshwater drum
river carpsucker	golden shiner	flathead catfish	
quillback	emerald shiner	black bullhead	
	sand shiner		
Centrarchidae	ghost shiner	**Lepisosteidae**	
bluegill	channel shiner	shortnose gar	
green sunfish	mimic shiner	longnose gar	
orangespotted sunfish	fathead minnow		
black crappie	plains minnow	**Percidae**	
white crappie	creek chub	sauger	
largemouth bass	western silvery minnow		
	common carp	**Petromyzontidae**	
Clupeidae	grass carp	chestnut lamprey	
gizzard shad	bighead carp		

quillback (*Carpiodes cyprinus*)
bullhead minnow (*Pimephales vigilax*)
plains minnow (*Hybognathus placitus*)
creek chub (*Semotilus atromaculatus*)
western silvery minnow (*Hybognathus argyritis*)
flathead catfish (*Pylodictis olivaris*)
longnose gar (*Lepisosteus osseus*)
chestnut lamprey (*Ichthyomyzon castaneus*)

Table 5-2. Small fish summary data. Sample sites are in order of increasing permanence.

Wetland	Number of families captured	Number of species captured	Number of fish captured
E5	2	3	4
E2	0	0	0
E3	0	0	0
E4	0	0	0
E6	0	0	0
E1	2	2	170
10	1	1	166
2	5	11	92
9	3	9	42
21	7	8	226
8	6	15	253
22	4	16	676
5	1	3	5
4	0	0	0
26	3	13	607
12	4	4	40

Table 5-3. Large fish summary data. Sample sites are in order of increasing permanence. Wetlands 2 and 3 were connected at the time of sampling and fished as one unit.

Wetland	Number of families captured	Number of species captured	Number of fish captured
E5	5	5	28
E2	0	0	0
E3	0	0	0
E4	0	0	0
E6	0	0	0
E1	0	0	0
10	0	0	0
2 and 3	6	12	100
9	1	1	1
21	1	1	17
8	4	9	93
22	5	6	9
5	6	9	97
4	3	12	99
26	8	14	76
12	0	0	0

Figure 5-1. Minifyke net deployment.

Figure 5-2. Deployment of trammel nets from a canoe amid flooded willows.

Figure 5-3. Setting hoop nets during flood pulse.

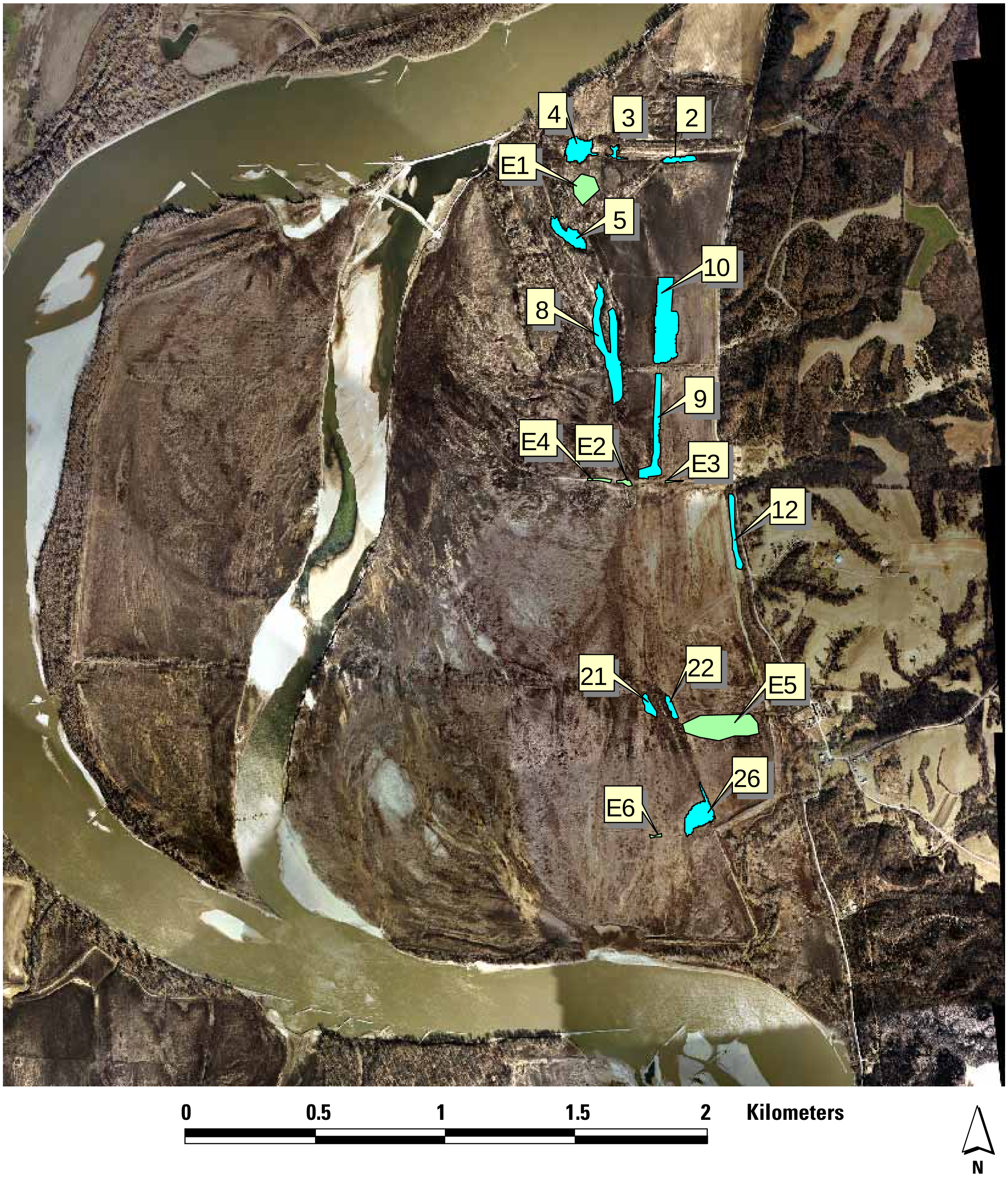

Figure 5-4. Fish sampling locations at Lisbon Bottom. Locations E1 through E6, in green, are very ephemerally flooded areas and are not shown on the map of numbered wetlands (fig 1-3). *Background photo courtesy of U.S. Army Corps of Engineers, Kansas City, MO, March 2000.*

Figure 5-5. Use of an ATV and trailer to transport fishing gear across Lisbon Bottom. Lisbon Bottom is often impassible even with an ATV, and transportation of nets on foot was often required.

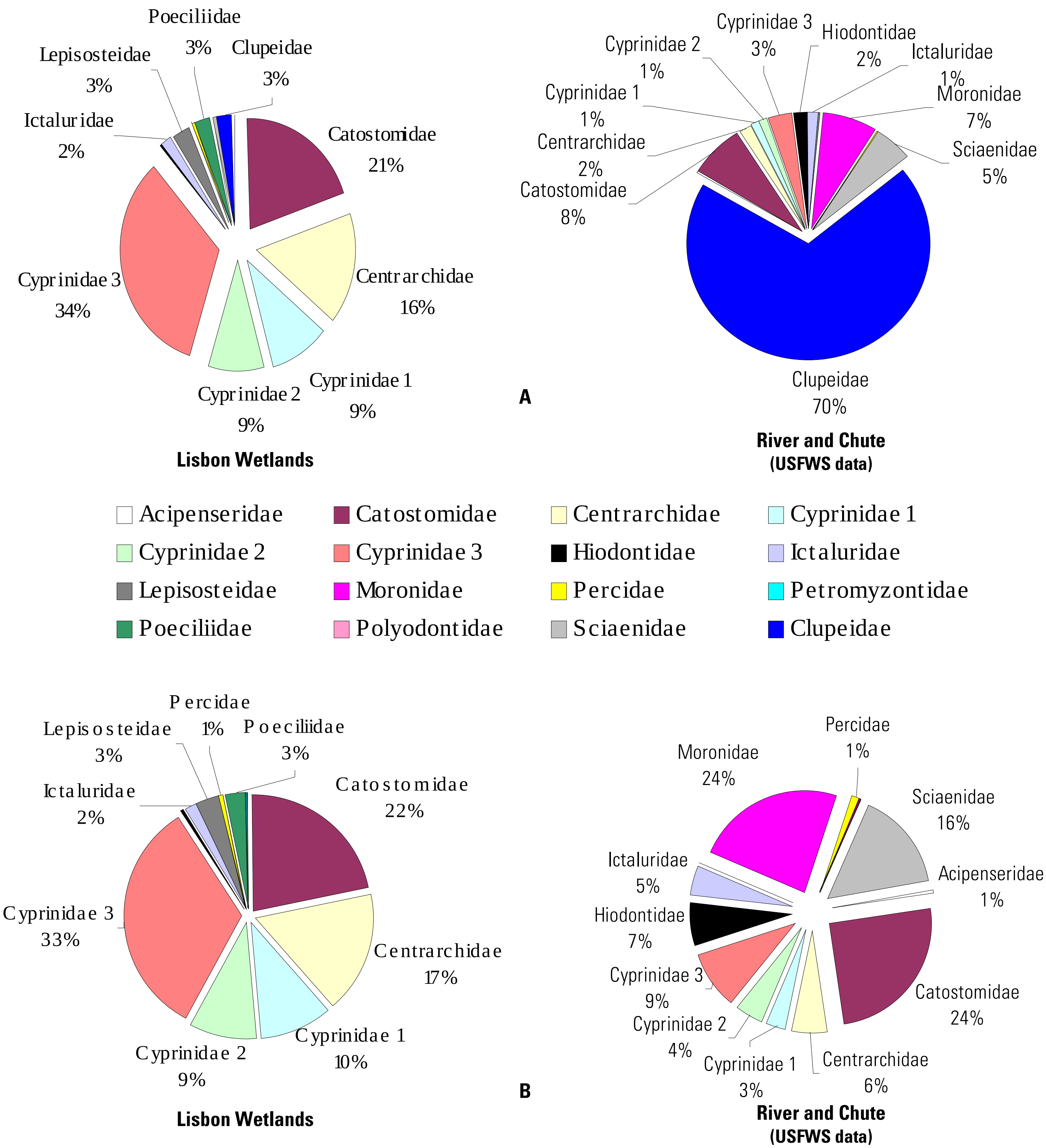

Figure 5-6. Relative abundance of fish families in Lisbon wetlands compared to the adjacent Missouri River and Lisbon Chute (A). Figure (B) with the family Clupeidae (gizzard shad) removed. Fish were sampled during the same period of 1999. Missouri River and Chute data from Louise Mauldin (US Fish and Wildlife Service, unpublished data). Cyprinidae 1 = native cyprinids exclusive of the genera *Cyprinella* and *Notropis*. Cyprinidae 2 = non-native cyprinids (common carp, bighead carp, and silver carp). Cyprinidae 3 = Cyprinids of the genera *Cyprinella* and *Notropis* (shiners).

A

B

Figure 5-7. Fish captured in Lisbon Bottom wetlands that were exuding sex products when captured. **A.** Male common carp. **B.** Female gizzard shad.

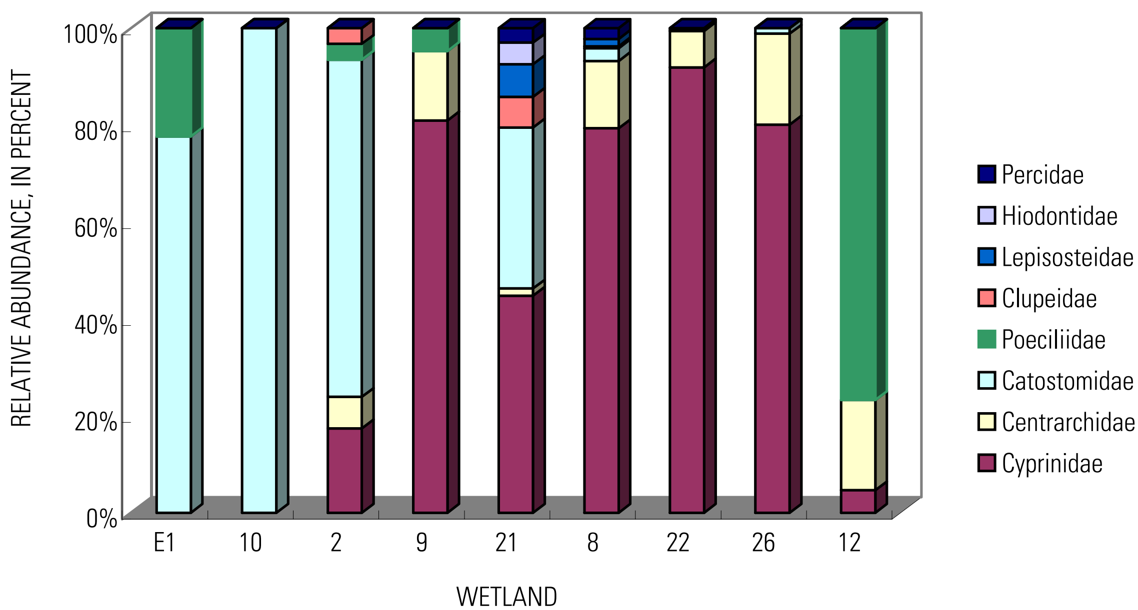

Figure 5-8. Relative abundance of small fish families in Lisbon Bottom wetlands. Wetlands E1 through 26 are ordered by increasing permanence. Catastomids were gradually replaced by cyprinids with increasing permanence. The catastomids in these wetlands were almost all young of the year bigmouth buffalo, whereas the cyprinids were very diverse. Wetland 12 is very different in hydrology from the other wetlands, being strongly stream and runoff influenced, and never inundated by the river. Wetland 12 also was the only wetland with submerged aquatic macrophytes. Wetlands with very few (< 10) small fish captured are not included in the figure. Number of captured fish in shown wetlands ranged between 42 and 678.

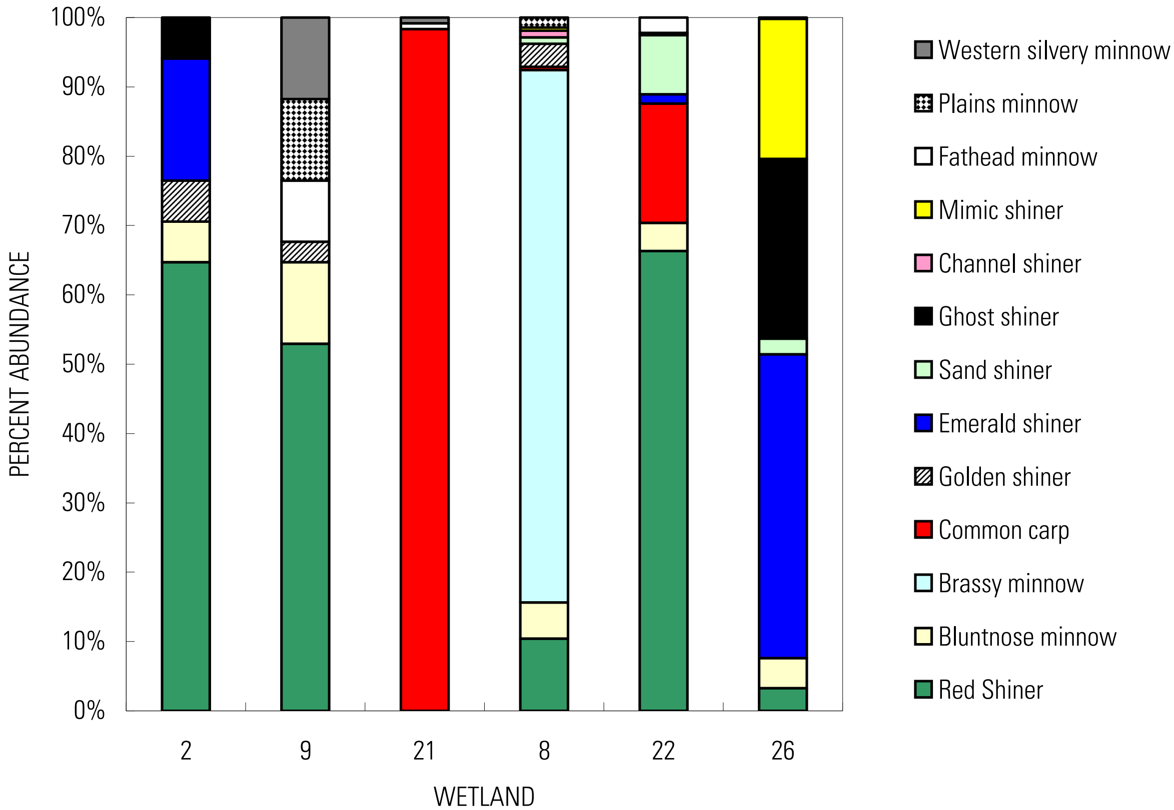

Figure 5-9. Relative abundance of small and juvenile cyprinids in Lisbon Bottom wetlands. Wetlands are ordered by increasing permanence. Only wetlands where significant numbers of small cyprinids were captured are shown.

Figure 5-10. A bag seine haul in Wetland 21, Lisbon Bottom.

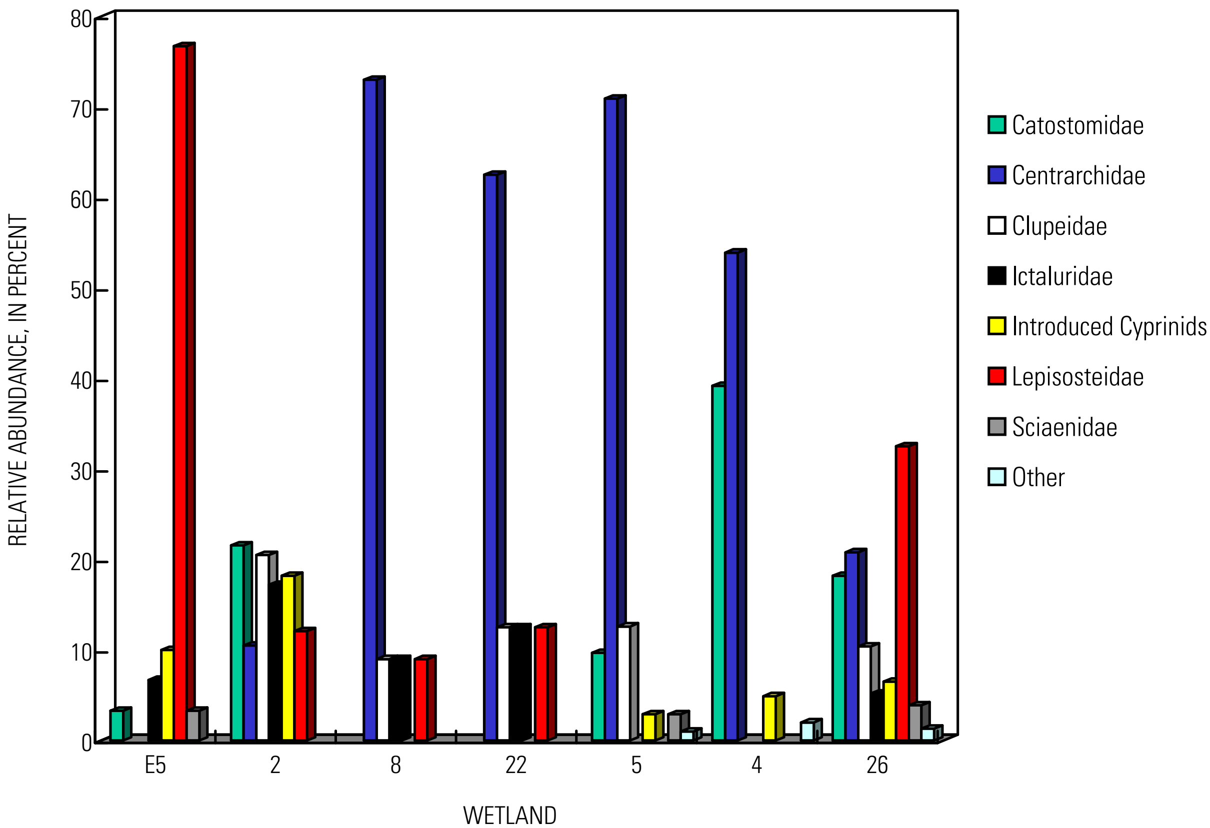

Figure 5-11. Relative abundance of large fish captured in Lisbon Bottom wetlands by family. Wetlands are ordered by increasing permanence. Only wetlands in which significant numbers of large fish were captured are shown.

Figure 5-12. Mending beaver-damaged hoop nets. Beaver damage to hoop nets was severe, often affecting more than half of the nets in place on overnight sets.

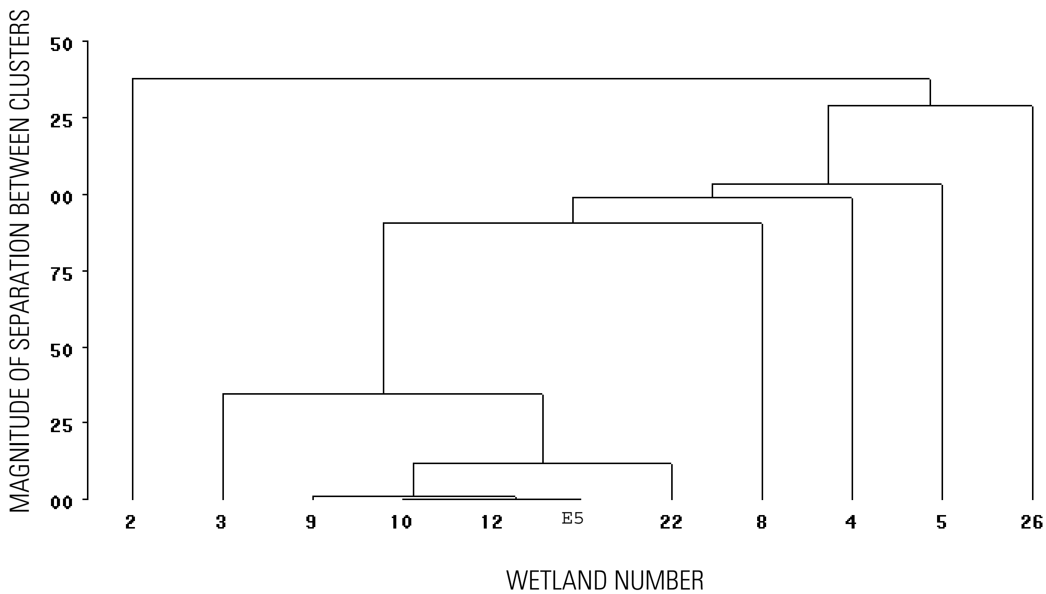

Figure 5-13. Ward's minimum variance cluster analysis of Lisbon Bottom wetlands by large fish species abundance.

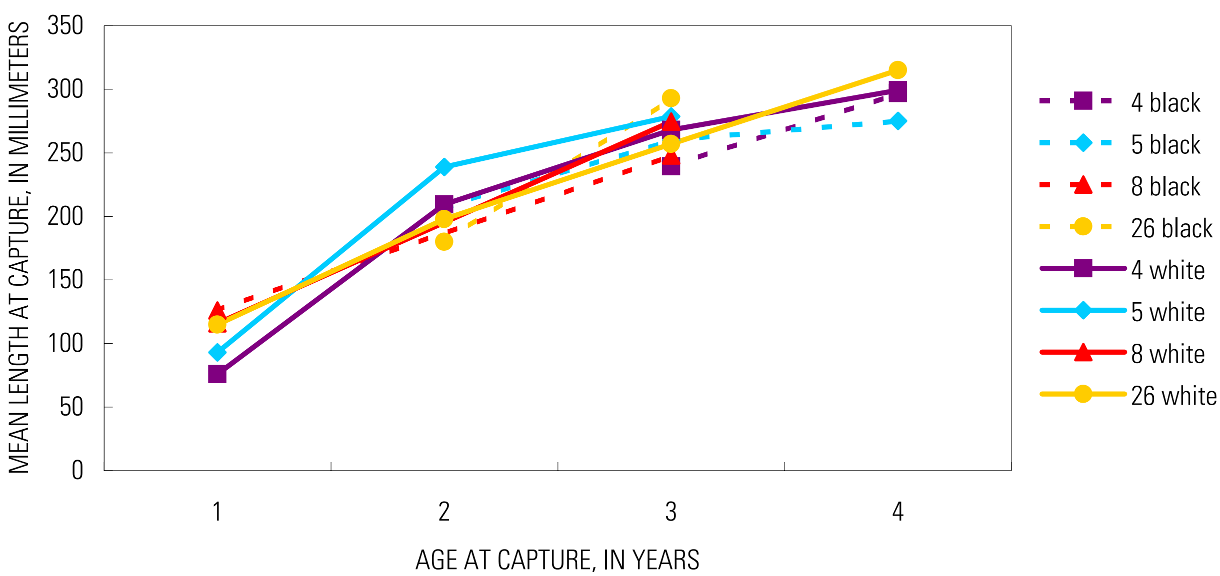

Figure 5-14. Comparison of mean lengths and ages at capture for black and white crappie captured in four wetlands of Lisbon Bottom, Missouri. Black crappies are indicated by broken lines and white crappies by unbroken lines.

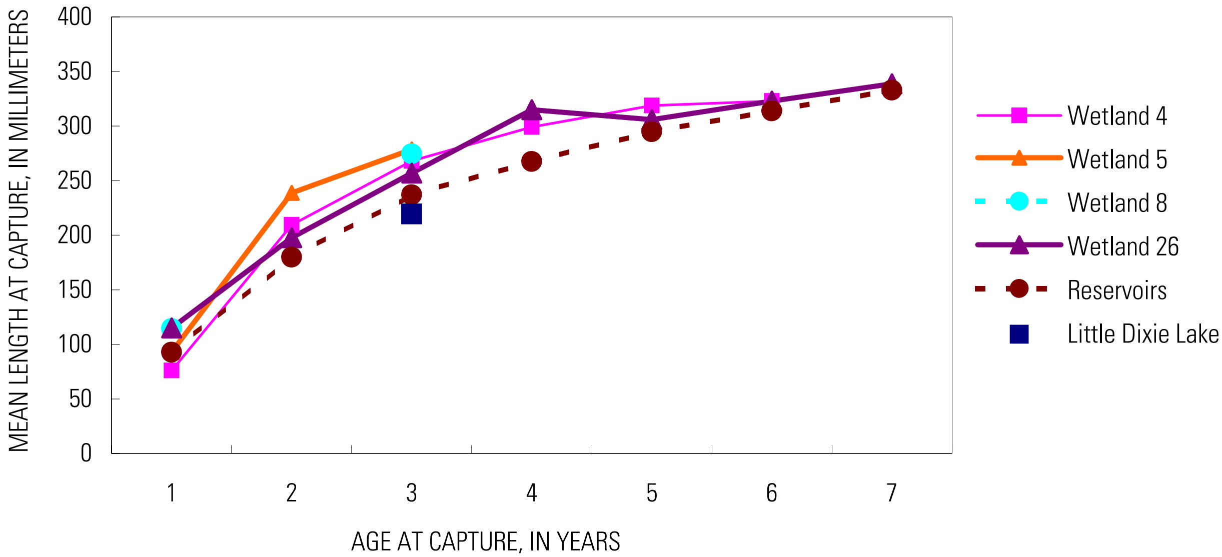

Figure 5-15. White crappie lengths and ages at capture in four wetlands at Lisbon Bottom, Missouri, compared to an eight-year study of white crappies from four Missouri reservoirs (Colvin, 1991) and to a three-year study of Little Dixie Lake, Missouri (Craig Gemming, Missouri Department of Conservation, unpublished data).

Figure 5-16. Back-calculated length at ages 1 and 2, from scales, for 3+ -year-old white crappies from Wetlands 4, 5 and 26, Lisbon Bottom, Missouri. Different letters indicate a significant difference in back-calculated length between wetlands within an age class. Different length at back-calculated ages is an indicator of distinct populations and wetland loyalty. Length at age 3 is not included in the analysis because fish may not have had an opportunity to move between wetlands since the last year's growth. These data are based on a small number of fish: 8 from Wetland 4, and 2 each from Wetlands 5 and 26.