State Wildlife Grant Final Report

Status and critical habitat of rare fish species in the Mississippi River from the Coon Rapids Dam to the Iowa border

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Paddlefish *(Polyodon spathula)* from Lake Pepin

Abstract

From 2006 through 2008, the Mississippi River was surveyed from the Coon Rapids Dam (Pool A) to the Iowa border (Pool 9). Sampling gear consisted of boat and backpack electroshockers, gill nets, trap nets, trawls, seines, dip nets and setlines. Habitats included main and side channels, backwaters, tributary mouths and tailwater zones of dams. The three year study found 16 of 22 Species in the Greatest Conservation Need (SGCN) reported from the Minnesota reach of the Mississippi River.

Introduction

The study area covers 192 river miles and includes 12 pools impounded by locks and dams that were originally designed for commercial navigation, but this corridor has become extremely popular with recreational watercraft users. The US Army Corps of Engineers maintains the navigation channel of the pools at a minimum depth of nine feet. Prior to the lock and dam system, thousands of closing and wing dams were constructed during the late 1800s. The closing dams reduced flow to backwaters and side channels, while wing dams directed current down the main channel to maintain navigable depths. These structures are not maintained, but most remain and continue to function. The long-term results of this altered flow regime has filled in many side channels and backwaters with sediments or greatly reduced their depth and size.

The Mississippi River has a long and rich history of both commercial and sport fishing (Carlander 1954). Today, the river still hosts a remarkable sport fishery for many anglers, but commercial harvesters are a fraction of a once bustling industry. Prior to the 1940s, species presence and abundance data in the Mississippi River are generally restricted to commercial and sport fishes, and often, anecdotal in nature. The Upper Mississippi River Conservation Commission (UMRCC) conducted the first full community fish surveys in the 1940s of Pools 3-11 (John Greenbank et al unpublished data). The Minnesota DNR Ecological Resources Division surveyed Pools B-9 in 1995 (Mark Stopyro et al unpublished data). And both the Minnesota and Wisconsin DNR Long Term Resource Monitoring Programs (LTRMP) have surveyed Pools 4 and 8 respectively since 1989. The cumulative species total that includes the State Wildlife Grant (SWG) surveys for the 12 navigation pools is 109 fishes representing 25 families (Appendix 2). However, the presence of the blackchin shiner is suspect because this species is very similar in appearance to the weed shiner that is present in this reach of river. Regional museum collections should be searched for extant specimens to examine and verify the blackchin shiner's occurrence. Three additional species (banded killifish, ghost shiner and suckermouth minnow) have not reported for more than half a century and are likely extirpated from the Mississippi River.

Several rare species have been reported from the 12 pools; however, Minnesota shares this border with Wisconsin from Pool 3 to the Iowa border. Both states have established rare species lists that are similar in composition, but vary greatly in status designations. Minnesota lists 22 species that include one Threatened, 9 Special Concern and 12 tracked/non-tracked SGCN. Wisconsin lists five additional species: starhead topminnow, goldeye, banded killifish, silver chub and weed shiner (Appendix 2).

Until recently, there were few exotic species in the Mississippi River. Since introduction during the late 1800s, common carp have become widespread and abundant while brown and rainbow trout are rare and rainbow smelt has been reported once. Grass carp have been

present for decades, but were extremely rare until 2008 and 2009 when commercial harvesters reported 23 fish from Pools 5, 5A, 6 and 8. Bighead carp were reported from Pool 4 in 2003 and 2007, and Pools 5A, 8 and 9 in 2008 and 2009. And the first silver carp was reported from Pool 8 in 2008.

Methods and Materials

The historic location of St. Anthony Falls (Pool B) was initially proposed as the northern end of the study area; however, Pool A was added because it is the head of commercial navigation in the Mississippi River. The expanded study area included the tailwaters of the Coon Rapids Dam to the Iowa border (Pool 9).

During the three year study, 403 sites were surveyed with multiple sampling gears consisting of boat shockers, backpack shockers, trawls, trap nets, seines, dip/kick nets and set lines (Appendix 1: Figure 1). A large boat shocker sampled main channel sites where water depths were sufficient for maneuvering near shore. A smaller, lighter boat was used in shallow side channels and backwaters. Where depths were too shallow to run an outboard, this boat could be quickly modified for use as a tow barge. A 12 volt backpack shocker sampled small, shallow tributaries and tops of wing and closing dams. A "Missouri" bottom trawl was used for sampling small fish species in deep water of the navigation channel and scour holes below wing and closing dams. Trap nets were set in backwater lakes for approximately a 24 hour period. Minnow seines were used in backwaters and slack water areas of the main channel. Dip/kick nets sampled benthic fishes (e.g., darters) in riffles, rip-rap, undercut banks and aquatic vegetation. Set lines rigged with multiple hooks were used a handful of times, but discontinued due to vandalism at these sites.

Commercial harvest catches were observed several times in 2008. Gear consisted of drive gill nets, bottom set gill nets and seines. Drive nets were 1300 feet in length and used where seine hauls were not possible along shore due to ice conditions. The net was deployed along the edge of ice. Then one or two boats would drive along parallel transects beginning far from the net and slowly work toward it while banging the hull with a hammer or pipe. The noise would "drive" fish into the net. Bottom set gillnets were used in Lake Pepin where the depth was approximately 30 feet and left overnight. Large mesh seines were used when shorelines were free of ice and were approximately 700 feet in length. One boat was anchored with the folded seine. The loose end of the seine was tied to another boat that deployed it downstream and looped it into shore where it was securely anchored. The anchored boat then pulled the seine upstream gradually looping that end into shore while the first boat moved upstream and banged the hull heading downstream toward the closing loop.

All species were recorded and SGCN were tallied. Generally up to 10 of each SCGN were preserved in formalin for deposition in the James Ford Bell Museum (JFBM) of Natural History in St. Paul or the Indiana Biological Survey (INBS) in Bloomington, IN. Large specimens were photographed. Tissues were preserved in 95% ethyl alcohol for use in future genetic research. One collection of all small, non-SGCN fishes was preserved from each pool. Coordinates were recorded at the beginning and end of each site. Records of all tracked SGCN were provided to the Natural Heritage database, and occurrence maps of SGCN fishes sampled in the SWG surveys have been reported in Appendix 1 (Figures 2-5) of this report.

Results and Discussion

Occurrence, Distribution and Habitat Usage: The 2006-2008 SWG fish surveys sampled 93 species representing 23 families and includes16 of 22 SGCN fishes reported from the study area (Table 1). The six absent SGCN species include: American brook lamprey, skipjack herring, pallid shiner, suckermouth minnow, yellow bass and bluntnose darter. However in 2008, the Lake City Area Fisheries Office forwarded specimens to the JFBM fish collection of a skipjack herring from a commercial harvester in Lake Pepin (Pool 4) and a yellow bass sampled during a fish survey of Pool 9.

Table 1. SWG survey results: distribution, catch and habitats of 16 SGCN fishes in Pools A-9.

SGCN Species	Pools	Total Catch	Back-water	Main Channel Border	Side Channel Border	Tailwater Zone	Tributary	Lake Pepin
Acipenseridae - Sturgeon Family								
Lake sturgeon *(Acipenser fulvescens)*	4, 5A	19	1			2		16
Shovelnose sturgeon *(Scaphirhynchus platorynchus)*	3, 4	5		3	1			1
Polyodontidae - Paddlefish Family								
Paddlefish *(Polyodon spathula)*	4	2						2
Anguillidae - Freshwater Eel Family								
American eel *(Anguilla rostrata)*	2, 6	2				2		
Cyprinidae - Minnow Family								
Mississippi silvery minnow *(Hybognathus nuchalis)*	6, 9	2		1		1		
Shoal chub *(Macrhybopsis hyostoma)*	2-5, 6, 8	284		262	20	1	1	
Pugnose minnow *(Opsopoeodus emiliae)*	3, 5, 6, 9	32	31	1				
Catostomidae - Sucker Family								
Blue sucker *(Cycleptus elongatus)*	2-5A	35		15	10	8	2	
Black buffalo *(Ictiobus niger)*	A, 1, 2, 4, 5, 6, 9	28	11	9	7		1	
River redhorse *(Moxostoma carinatum)*	2-7, 9	42	1	20	17	4		
Greater redhorse (Moxostoma valenciennesi)	A, 2	6		5			1	
Aphredoderidae - Pirate Perch Family								
Pirate perch *(Aphredoderus sayanus)*	5, 7	16			12		4	
Centrarchidae - Sunfish Family								
Warmouth *(Lepomis gulosus)*	5A , 9	8	8					
Percidae - Perch Family								
Western sand darter *(Ammocrypta clara)*	5-9	333	9	184	14	100	26	
Crystal darter *(Crystallaria asprella)*	5	2		2				
Mud darter *(Etheostoma asprigene)*	4-9	310	193		92	2	23	

The most widespread species were river redhorse, black buffalo and mud darter that were found in 8, 7 and 7 of 12 pools, respectively. The most restricted species were paddlefish and crystal darter that were sampled only in Pools 4 and 5, respectively. The most abundant were shoal chub, western sand darter and mud darter. And the rarest were paddlefish, American eel, Mississippi silvery minnow and crystal darter. The pugnose minnow, warmouth and mud darter were most often found in backwaters. However, the mud darter was also sampled at about half the frequency in side channels. Shoals chubs and western sand darters preferred the main channel, but the latter also exhibited a secondary preference for tailwater zones downstream of locks and dams.

The Minnesota and Wisconsin LTRMP has collected full community fish data in Pools 4 and 8 since 1989 and compiled substantially more information on SGCN abundance and habitat preferences (Table 2). The pallid shiner, pugnose minnow, pirate perch, yellow bass, warmouth and mud darter are predominately backwater species. The American brook lamprey, blue sucker, river redhorse and western sand darter prefer the main channel border. The Mississippi silvery minnow is most often found along side channel borders, but also exhibits a secondary preference for main channel borders. And lake and shovelnose sturgeon, paddlefish, shoal chub and black buffalo prefer tailwater zones. There are a number of differences with Table 1; however, none of these species were found in a single habitat and nine have been reported from all five. Additional research is needed to determine habitat usage during spawning periods, rearing areas for young of the year and juveniles and the annual seasonal movements of adults. Another factor impeding this research objective will be the maximum depth many of these species have been sampled. Eight SGCN have been found at depths greater than 6 m (ca 20 ft). Very few sampling gears can be deployed in deep, swift water and the efficacy of capture is likely poor at best.

Historic SGCN Presence and Species Diversity: Pools A-1 had the lowest occurrence of SGCN (0-2 species), Pools 2, 3 and 7 were intermediate (9-12) and Pools 4-6, 8 and 9 had the greatest number (17-22) (Appendix 2). Species diversity mirrored a similar pattern: Pools A-1 (31-60 species), Pools 2, 3 and 7 (77-81) and Pools 4-6, 8 and 9 (85-102). The lower species diversity of the upper pools is partially attributable to both natural and man-made factors. St. Anthony Falls functioned as a fish barrier to upstream migration for thousands of years and the species' assemblage above the falls consisted of about half the diversity found downstream (Eddy et al 1963). However, since completion of the two St. Anthony locks and dams in 1963, at least eight species historically restricted below the falls have become established above the former barrier (Hatch et al 2003). No SGCN have ever been reported from Pool B and it also has the most depauperate community of all the navigation pools. However this is also the shortest pool at about one-half mile and habitat is extremely limited. Historically, Pool 1 was a rapid filled gorge, but today US Lock and Dam 1 impounds most of the pool's six mile reach. Pools 4 and 8 have the greatest diversity of the 12 pools at 102 and 101 species, respectively and Pool 8 also has the greatest SGCN count at 22. However, these results likely reflect the much greater survey effort of the MN/WI-DNR LTRMP. These tallies also include historic records and some species have been extirpated from the pools for decades (e.g. Mississippi silvery minnow, suckermouth minnow and ghost shiner). Finally, misidentification is an inherent issue in fish surveys when there are no extant specimens or images for independent verification. The blackchin shiner has been mentioned previously, but greater redhorse reported from Pools 5 and 8 are also suspect because there are no extant museum specimens downstream of Pool 2.

Table 2. Mississippi River Pools 4 and 8 habitat occurrence of 19 SGCN fishes. Source: MN/WI-DNR LTRMP data.

SGCN Species	Total Catch (Pool 4/8)	Record Period	Depth Range (m)	Back-water	Impounded	Main Channel Border	Side Channel Border	Tailwater Zone
Petromyzontidae - Lamprey Family								
American brook lamprey *(Lampetra appendix)*	2/9	1993-2004	0.6-2.5	3		6	1	1
Acipenseridae - Sturgeon Family								
Lake sturgeon *(Acipenser fulvescens)*	27/4	1994-2008	0.9-20.0	5				26
Shovelnose sturgeon *(Scaphirhynchus platorynchus)*	184/130	1990-2008	1.0-20.8	1		6	4	290
Polyodontidae - Paddlefish Family								
Paddlefish *(Polyodon spathula)*	8/0	1997-2007	1.5-7.6	1		1		6
Anguillidae - Freshwater Eel Family								
American eel *(Anguilla rostrata)*	30/6	1990-2002	0.8-3.1	11	5	8	2	10
Clupeidae - Herring Family								
Skipjack herring *(Alosa chrysochloris)*	2/1	1993	0.7-1.3	1				2
Cyprinidae - Minnow Family								
Mississippi silvery minnow *(Hybognathus nuchalis)*	0/994	1989-2004	0.3-2.1	92	154	255	480	13
Pallid shiner *(Hybopsis amnis)*	1/20	1989-2005	0.4-1.4	10		6	5	
Shoal chub *(Macrhybopsis hyostoma)*	877/18	1989-2008	0.3-20.0	2		205	233	445
Pugnose minnow *(Opsopoeodus emiliae)*	3443/15529	1989-2008	0.2-5.6	15916	201	306	2256	293
Catostomidae - Sucker Family								
Blue sucker *(Cycleptus elongatus)*	39/89	1992-2008	0.2-19.0	2	6	76	34	10
Black buffalo *(Ictiobus niger)*	21/3	1993-2007	1.0-8.0	1	1	1	3	18
River redhorse *(Moxostoma carinatum)*	630/1167	1990-2008	0.1-6.4	45	9	1543	152	48
Aphredoderidae - Pirate Perch Family								
Pirate perch *(Aphredoderus sayanus)*	4/5	1993-2008	0.8-1.8	8			1	
Moronidae - Temperate Bass Family								
Yellow bass *(Morone mississippiensis)*	0/27	1991-2002	0.7-2.2	13	1	2	4	7
Centrarchidae - Sunfish Family								
Warmouth *(Lepomis gulosus)*	0/395	1990-2008	0.3-2.3	310	45	6	19	15
Percidae - Perch Family								
Western sand darter *(Ammocrypta clara)*	306/1206	1989-2008	0.2-9.0	26	1	1092	207	184
Crystal darter *(Crystallaria asprella)*	6/6	1991-1998	0.4-10.0			6	2	4
Mud darter *(Etheostoma asprigene)*	107/690	1989-2008	0.1-2.9	431	19	119	188	40

SGCN Vulnerability to Sampling Gears: To monitor and manage rare fishes, it is essential to determine effective sampling methods. There is no silver bullet gear that will work on all species. Most species do exhibit a significant vulnerability to at least one routinely used gear, but others we assume are extremely rare do not (e.g. crystal darter). Eight SGCN species

sampled during the SWG surveys exhibited greater vulnerability to one gear type (Table 3). Points to note in gear variations include gill nets (bottom set and drive) and seines (commercial and minnow). Dip/Kick nets were very effective for sampling pirate perch and mud darters, boat shockers for pugnose minnow, blue sucker and river and greater redhorse; gill nets for lake sturgeon; commercial seines for black buffalo; and Missouri trawl for shoal chubs and western sand darters.

Table 3. SWG sampling gear vulnerability of 16 SGCN fishes in Mississippi Pools A-9.

SGCN Species	Total Catch	Dip/Kick Net	Boat Shocker	Gill Net	Seine	Trawl
Acipenseridae - Sturgeon Family						
Lake sturgeon *(Acipenser fulvescens)*	19		1	16	1	1
Shovelnose sturgeon *(Scaphirhynchus platorynchus)*	5		1	1		3
Polyodontidae - Paddlefish Family						
Paddlefish *(Polyodon spathula)*	2			2		
Anguillidae - Freshwater Eel Family						
American eel *(Anguilla rostrata)*	2		2			
Cyprinidae - Minnow Family						
Mississippi silvery minnow *(Hybognathus nuchalis)*	2		1			1
Shoal chub *(Macrhybopsis hyostoma)*	284		1			283
Pugnose minnow *(Opsopoeodus emiliae)*	32		25		7	
Catostomidae - Sucker Family						
Blue sucker *(Cycleptus elongatus)*	35		25	10		
Black buffalo *(Ictiobus niger)*	28		7	4	17	
River redhorse *(Moxostoma carinatum)*	42		41		1	
Greater redhorse (Moxostoma valenciennesi)	6		6			
Aphredoderidae - Pirate Perch Family						
Pirate perch *(Aphredoderus sayanus)*	16	15	1			
Centrarchidae - Sunfish Family						
Warmouth *(Lepomis gulosus)*	8	4	4			
Percidae - Perch Family						
Western sand darter *(Ammocrypta clara)*	333		13		47	273
Crystal darter *(Crystallaria asprella)*	2					2
Mud darter *(Etheostoma asprigene)*	310	304	2		1	3

The MN/WI-DNR LTRMP surveys utilize a larger array of sampling gear, and again, there are variable methods and gear designs. Boat shockers were most effective for American brook lamprey, blue sucker, river redhorse and yellow bass; fyke nets for American eel, shoal chub, pugnose minnow, warmouth and mud darter; hoop nets for black buffalo; seines for

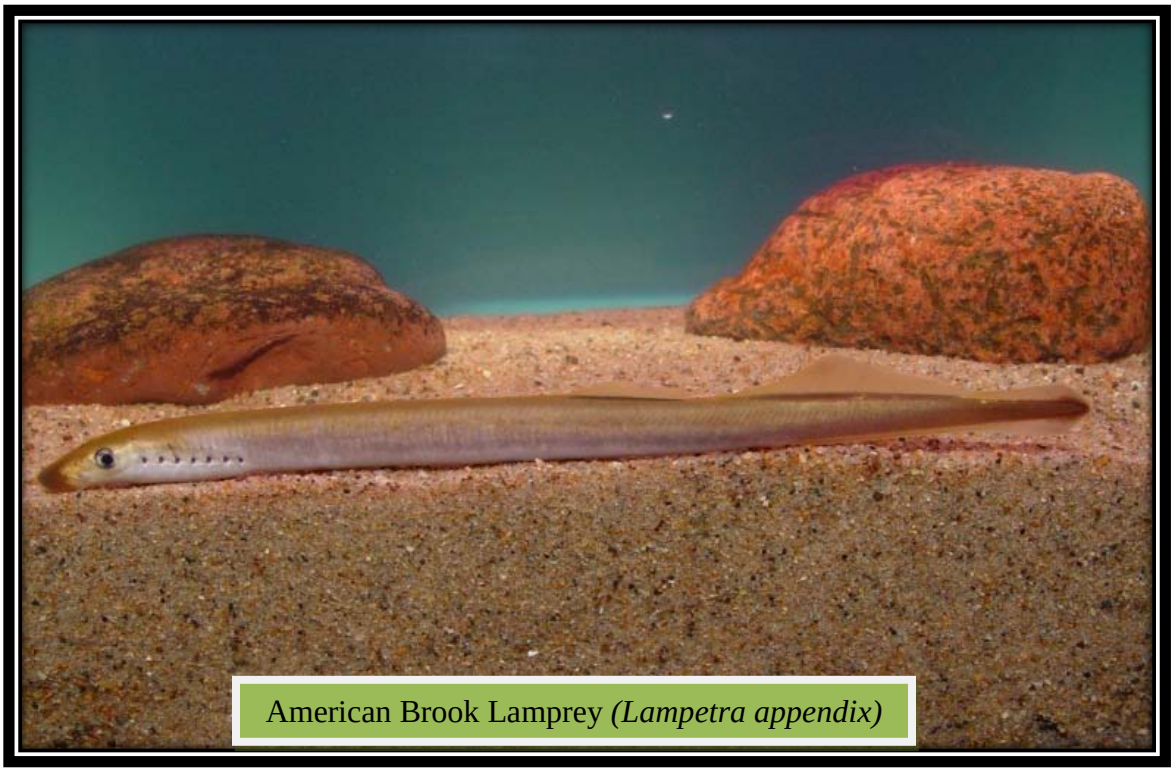
Mississippi silvery minnow; and trawls for shovelnose sturgeon (Table 4). Boat shocking also exhibited a greater effectiveness for paddlefish; however, this gear is not recommended for targeted surveys of the species due to mortality from notochord damage.

Table 4. Sampling gear vulnerability of 19 SGCN Fishes in Pools 4 and 8. Source: MN/WI-DNR LTRMP data.

SGCN Species	Total Catch	Boat Shocker	Fyke Net	Gill Net	Hoop Net	Seine	Trammel Net	Trawl
Petromyzontidae - Lamprey Family								
American brook lamprey *(Lampetra appendix)*	11	11						
Acipenseridae - Sturgeon Family								
Lake sturgeon *(Acipenser fulvescens)*	31	1	1	3	5		1	20
Shovelnose sturgeon *(Scaphirhynchus platorynchus)*	314	3		5	16			290
Polyodontidae - Paddlefish Family								
Paddlefish *(Polyodon spathula)*	8	5		1				2
Anguillidae - Freshwater Eel Family								
American eel *(Anguilla rostrata)*	36	10	23	1	2			
Clupeidae - Herring Family								
Skipjack herring *(Alosa chrysochloris)*	3	1	1			1		
Cyprinidae - Minnow Family								
Mississippi silvery minnow *(Hybognathus nuchalis)*	994	314	17			663		
Pallid shiner *(Hybopsis amnis)*	21	8				13		
Shoal chub *(Macrhybopsis hyostoma)*	895		519			239		137
Pugnose minnow *(Opsopoeodus emiliae)*	18972	1649	15530			1793		
Catostomidae - Sucker Family								
Blue sucker *(Cycleptus elongatus)*	128	87	1	2	5	27		6
Black buffalo *(Ictiobus niger)*	24	5	1		17		1	
River redhorse *(Moxostoma carinatum)*	1797	1759	23	4	9	2		
Aphredoderidae - Pirate Perch Family								
Pirate perch *(Aphredoderus sayanus)*	9	6	3					
Moronidae - Temperate Bass Family								
Yellow bass *(Morone mississippiensis)*	27	23	4					
Centrarchidae - Sunfish Family								
Warmouth *(Lepomis gulosus)*	395	64	324		4	3		
Percidae - Perch Family								
Western sand darter *(Ammocrypta clara)*	1512	246	13			1250		3
Crystal darter *(Crystallaria asprella)*	12	5				4		3
Mud darter *(Etheostoma asprigene)*	792	201	339	257				

Conclusions and Recommendations

Species Status: Based on recent trends in occurrences some SGCN fishes can be confidently grouped as recovering, stable or critically imperiled. However, the status of many cannot be assessed. Future efforts and funding should focus on SGCN critically imperiled and of uncertain status. The following species summaries may aid in ranking and guiding subsequent studies.



American Brook Lamprey *(Lampetra appendix)*

American Brook Lamprey: Species was not sampled during SWG surveys. Status and long term survival of Mississippi River populations is uncertain as well as those in the Minnesota River drainage. Stable and secure in southeast Minnesota where the species preferred habitat is small to mid-size cold/cool water streams.

Lake Sturgeon: Populations of this long lived species and late maturing, intermittent spawner were decimated throughout the state from overharvest in the late 1800s. Species remained at critically low levels and recovery was impeded throughout most of the 1900s from pollution and dams. Currently, the species is exhibiting recoveries of varying degrees in all historic drainages. Mississippi River populations are far from historic levels, but are frequently reported by anglers, DNR fish surveys and incidental catches of commercial harvesters.

Shovelnose Sturgeon: The healthiest population is in the Minnesota River and recently reported in the St. Croix River after a long absence. Recovering in the Mississippi River and recently reported near Peterson in the Root River (ca 40 stream miles from the Mississippi).

Lake Sturgeon *(Acipenser fulvescens)*

Shovelnose Sturgeon *(Scaphirhynchus platorynchus)*

Paddlefish *(Polyodon spathula)*

Paddlefish: Commercial harvesters have reported an increasing frequency in incidental catches for several years with the greatest number coming from the lower St. Croix River, but abundance remains far below early historical accounts. Recent reports from several anglers have shown a similar pattern for the Mississippi and Minnesota Rivers. ***Recommendations:*** (1) Study the feasibility of a future recreational harvest using a Missouri Department of Conservation management model of supplemental stocking that could fully recover Minnesota's only Threatened fish species. (2) Research the frequency of prop strikes and degree of mortality from recreational watercraft. (3) Implement long term monitoring surveys that utilize cooperating commercial harvesters and seasonal creel census clerk who serve as on-board observers.

American Eel: Species has never been abundant in Minnesota and is difficult to sample, but anecdotal reports imply a precipitous decline over the last few decades. The US Fish and Wildlife Service recently reviewed the species for federally Endangered or Threatened status, but the conclusion was federal listing was not warranted. ***Recommendations:*** Elevate species to Special Concern. State Endangered or Threatened status may be warranted if the decline is eventually linked to factors impacting the species habitats in the upper Mississippi River. However, the American eel is catadromous and only females occur in Minnesota. At sexual maturity, they migrate to the Atlantic Ocean and spawn in the Sargasso Sea. Larval eels ride the Gulf Stream while growing and passing through metamorphic stages before migrating up East Coast and Gulf of Mexico Rivers. There is a high probability the source of the decline is well beyond both Minnesota and US borders.

American Eel *(Anguilla rostrata)*

Skipjack Herring *(Alosa chrysochloris)*

Skipjack Herring: Historically, this species migrated annually to spawn several hundred miles up the Mississippi River and tributary streams. It was once common in the Minnesota River to Big Stone Lake on the Minnesota-South Dakota border and also reached both St. Anthony Falls on the Mississippi and St. Croix Falls on the St. Croix. However in 1913, with the completion of the Keokuk Dam in southeastern Iowa, the spawning migrations in the upper Mississippi abruptly ceased (Eddy and Underhill 1974). Since 1986, a few specimens have been reported in Minnesota up to Lake Pepin, but only during extended periods of high stream flows. ***Recommendations:*** (1) Elevate species to Endangered status. (2) Study the feasibility of implementing a similar and highly successful recovery model of a related species, American shad *(Alosa sapidissima)*, in the Susquehanna River. This model retrofitted dams with fish ladders and lifts on the Susquehanna and modified or removed barrier dams on tributary streams. Stocking was continued until the species was restored and maintained through natural reproduction.

Mississippi Silvery Minnow *(Hybognathus nuchalis)*

Mississippi Silvery Minnow: UMRCC surveys from 1942-1949 reported the species from Pools 3-9 and includes several large samples (max N=1981) from pool 4. It has not been reported since then from Pools 3-5A (Appendix 2) and rarely sampled in Pools 6, 7 and 9. WI-DNR LTRMP surveys of Pool 8 have reported a few large samples greater than 100 individuals, but not since 1993. Another extirpation of the species followed the construction of Tennessee Valley Authority dams on the Tennessee River in the early 1940s (Etnier et al 1979). This paper also reported the disappearance of the goldeye and drastic decline of the sand shiner. In Wisconsin, the goldeye is Endangered and the sand shiner is rare in the Mississippi River. ***Recommendations:*** (1) Elevate to Threatened status. (2) Focus future research studying the suspected detrimental effects impoundments have on this species.

Pallid Shiner *(Hybopsis amnis)*

Shoal Chub *(Macrhybopsis hyostoma)*

Pallid Shiner: Not sampled during the SWG surveys. Once occurred as far north as Pool 2. UMRCC surveys (1942-1949) reported the species from Pools 3, 5 and 7-9, and at greater numbers in Pools 7-9 (N=34, 87 and 260, respectively) than recent (1989-2008) LTRMP surveys of Pool 8 (N=20). ***Recommendations:*** Elevate species to Endangered status.

Shoal Chub: Rarely reported in electrofishing surveys; however, recent use of more effective sampling gears have revealed stable, or perhaps, increasing populations. The species is flourishing in the Minnesota River and Missouri trawls recently sampled the shoal chub from several locations in the lower St. Croix River where it had not been reported for 25 years.

Ghost Shiner *(Notropis buchanani)*

Ghost Shiner: A non-SGCN, but covered in this report because of its extirpation in the Mississippi River. UMRCC surveys sampled the species in Pools 3, 4, 5A and 7-9. Pool 3 yielded the most specimens (N=158) from 1945-1947. The last report of ghost shiners from the SWG study area were from Pool 8 in 1957 (Appendix 2).

Pugnose Minnow: Appears stable and secure in the Mississippi River and may also be stable in the lower St. Croix River, but the species abundance is typically very rare at samples sites.

Suckermouth Minnow: Not sampled during SWG surveys and likely extirpated from the Mississippi River where it was last reported in 1955 from Pool 4 (Appendix 2). The suckermouth minnow is a pioneering species and one of the first to colonize recently disturbed habitats (e.g. channelization) where it often becomes a dominant species. However, it appears to be declining throughout its range in southeastern Minnesota. This *may* indicate stream habitats and water quality are improving and the species is returning to what *may have been* its historic distribution and abundance. ***Recommendations:*** Elevate species to Special Concern.

Pugnose Minnow *(Opsopoeodus emiliae)*

Suckermouth Minnow *(Phenacobius mirabilis)*

Blue Sucker *(Cycleptus elongatus)*

Blue Sucker: Once abundant and highly sought species of commercial fishermen who called it "Sweet Sucker" (Becker 1983). The species was rare for decades, but fish surveys began sampling blue suckers at greater frequencies, first in the Minnesota and St. Croix Rivers during the late 1980s, and the Mississippi River in the early 1990s. Currently, far below historic abundance, but is often reported in fish surveys, incidental catches of commercial harvesters, and occasionally, anglers' creels. However, one population may be extirpated in the St. Croix River above St. Croix Falls where the species was last reported in 1979.

Black Buffalo: Rarely reported in Mississippi River surveys for decades; however, like the blue sucker, a greater frequency of occurrence began during the early 1990s. A similar, modest recovery has been observed in the Minnesota River. Currently, black buffalo are never abundant, but most often reported as incidental catches of commercial harvesters. One area of concern is a high frequency of what appears to be black x bigmouth buffalo hybrids. ***Recommendations:*** (1) Elevate to Threatened status. (2) Research potential detrimental effects of hybrids may have on the genetic integrity of black buffalo.

River Redhorse: Appears stable and secure in the Mississippi and St. Croix Rivers, but has been extirpated from the Minnesota River since the late 1800s. ***Recommendations:*** Conduct surveys of preferred habitats in lower Minnesota River because of recent occurrences in Mississippi River Pool 2 which is also the confluence of both rivers.

Black Buffalo *(Ictiobus niger)*

River Redhorse *(Moxostoma carinatum)*

Greater Redhorse *(Moxostoma valenciennesi)*

Pirate Perch *(Aphredoderus sayanus)*

Greater Redhorse: Appears stable and secure in all historic drainages except the Rainy River where it has been extirpated since the late 1800s.

Pirate Perch: Access and sampling of preferred habitats are extremely difficult and species status is unknown. ***Recommendations:*** Research and develop an effective sampling method.

Yellow Bass *(Morone mississippiensis)*

Yellow Bass: Extremely rare in the Mississippi River at Minnesota latitudes, but the species is considered secure in both Wisconsin (Lyons et al 2000) and Iowa (Harlan and Speaker 1987).

Warmouth: Access and sampling of preferred habitats are extremely difficult and species status is unknown, but like the yellow bass, is secure in both Wisconsin and Iowa.

Western Sand Darter: Appears stable and secure in the Mississippi and lower St. Croix Rivers, but likely extirpated from the Minnesota River where it was last reported in 1970.

Crystal Darter: Surveying preferred habitats is often extremely difficult, and likely, ineffective in obtaining representative samples. The species is assumed to be extremely rare in the Mississippi River. However, it appears somewhat more common in the lower St. Croix River based on several recent observations of MN-DNR biologists using SCUBA gear. ***Recommendations:*** (1) Elevate to Endangered status. (2) Conduct SCUBA surveys in Mississippi River from fall to spring when water clarity is optimal.

Warmouth *(Lepomis gulosus)*

Western Sand Darter *(Ammocrypta clara)*

Crystal Darter *(Crystallaria asprella)*

Bluntnose Darter *(Etheostoma chlorosoma)*

Bluntnose Darter: Species was assumed extirpated until 1997 when it was collected from Pool 8 and again in 2001 from Pool 6. Recommendations: Elevate to Endangered status.

Mud Darter: Appears stable and secure in Mississippi River, but extremely rare in lower St. Croix.

Mud Darter *(Etheostoma asprigene)*

General Recommendations: (1) The study area is too large an area to effectively monitor 22 SGCN fishes and their habitats. Possible options include: (a) Monitor pools on a rotating schedule where one or two pools are surveyed annually. (b) Stagger survey schedule that targets one habitat type (e.g. main channel, side channel or backwaters). (c) Hire seasonal creel census clerks who would collect SGCN data of incidental commercial catches. (d) Fully fund MN/WI-DNR LTRMP on Pools 4 and 8 that would restore one sampling period and seining component of surveys. Both have been discontinued due to budget cuts. (2) Special, short-term studies should be scheduled to measure SGCN responses to habitat improvement and channel maintenance projects (e.g. Pool 2 wing dam notching, pool drawdowns, and dredging). This would also include the research and development of more effective sampling and assessment methods (e.g. winter sampling, SCUBA surveys and commercial gear).

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Literature Cited

Becker, G.C. 1983. Fishes of Wisconsin. University of Wisconsin Press. 1052 pp.

Carlander, H. B. (1954). A history of fish and fishing in the Upper Mississippi River. Upper Mississippi River Conservation Commission. 96 pp.

Eddy, S., J. B. Moyle and J. C. Underhill. 1963. The fish fauna of the Mississippi River above St. Anthony Falls as related to the effectiveness of this falls as a migration barrier. Journal of the Minnesota Academy of Science. 32: 111-115.

Eddy, S., and J.C. Underhill. 1973. Northern Fishes. University of Minnesota Press, Minneapolis. 414 pp.

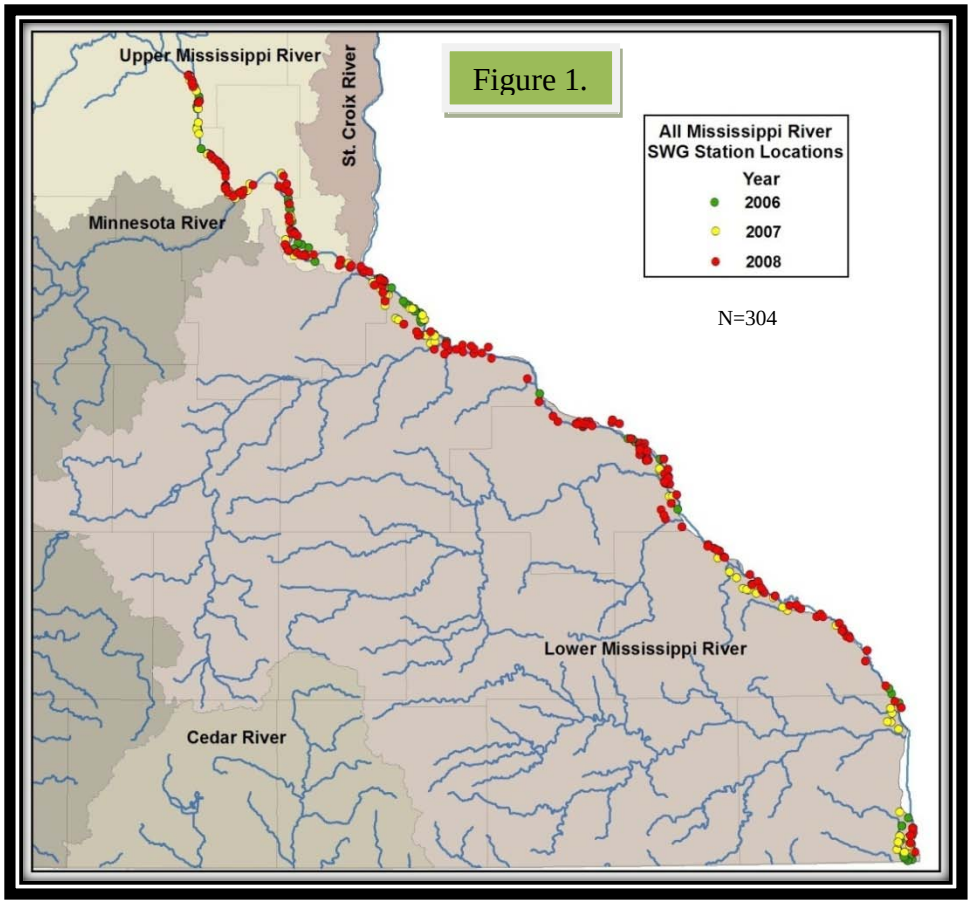
Etnier, D.A. , W.C. Starnes and B.H. Bauer. January 1979. Whatever happened to the silvery minnow (*Hybognathus nuchalis*) in the Tennessee River? Southeastern Fishes Council Proceedings. 4 pp.

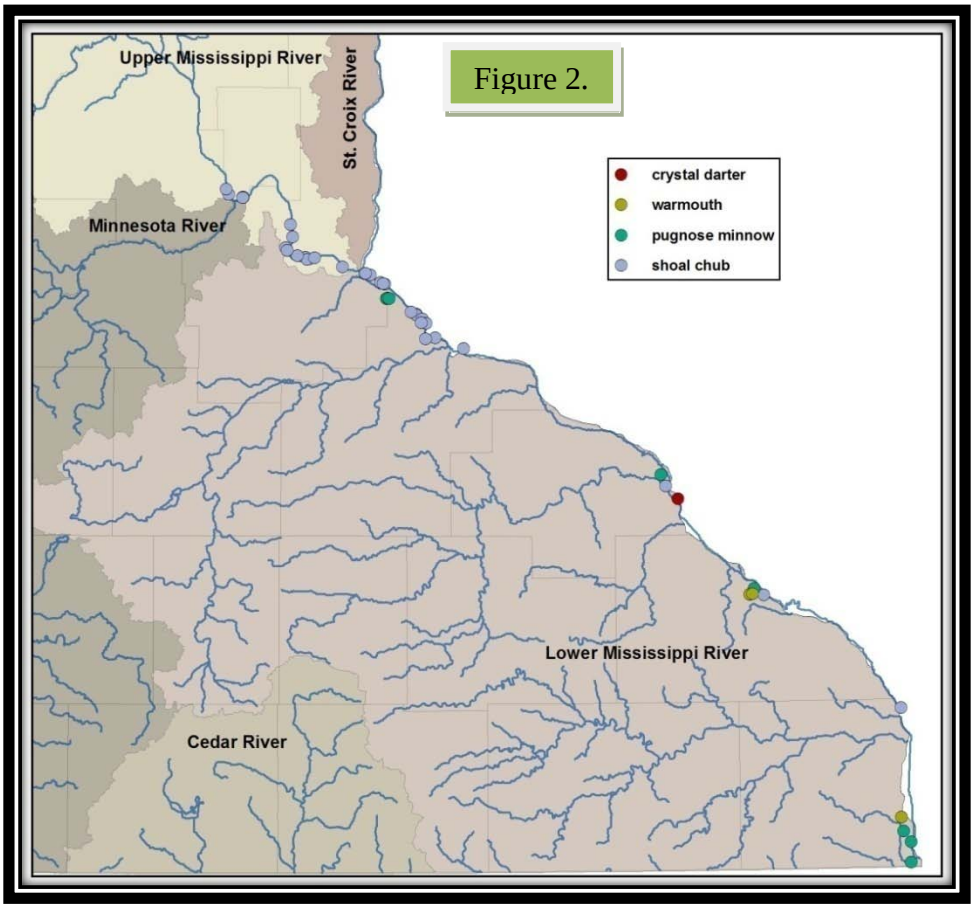
Harlan, J.R., E.B. Speaker and J. Mayhew. 1987. Iowa Fish and Fishing. Iowa Dept. of Natural Resources. 323 pp.

Hatch, J.T., K.P. Schmidt, D.P. Siems, J.C. Underhill, R.A. Bellig, and R.A. Baker. 2003. A new distributional checklist of Minnesota fishes, with comments on historical occurrence. Journal of the Minnesota Academy of Science 67:1-17.

Lyons, J., P.A. Cochran and D. Fago. 2000. Wisconsin Fishes 2000: Status and Distribution. UW-Sea Grant, Madison. 87 pp.

Appendix 1. SWG survey sites and SGCN occurrence maps.





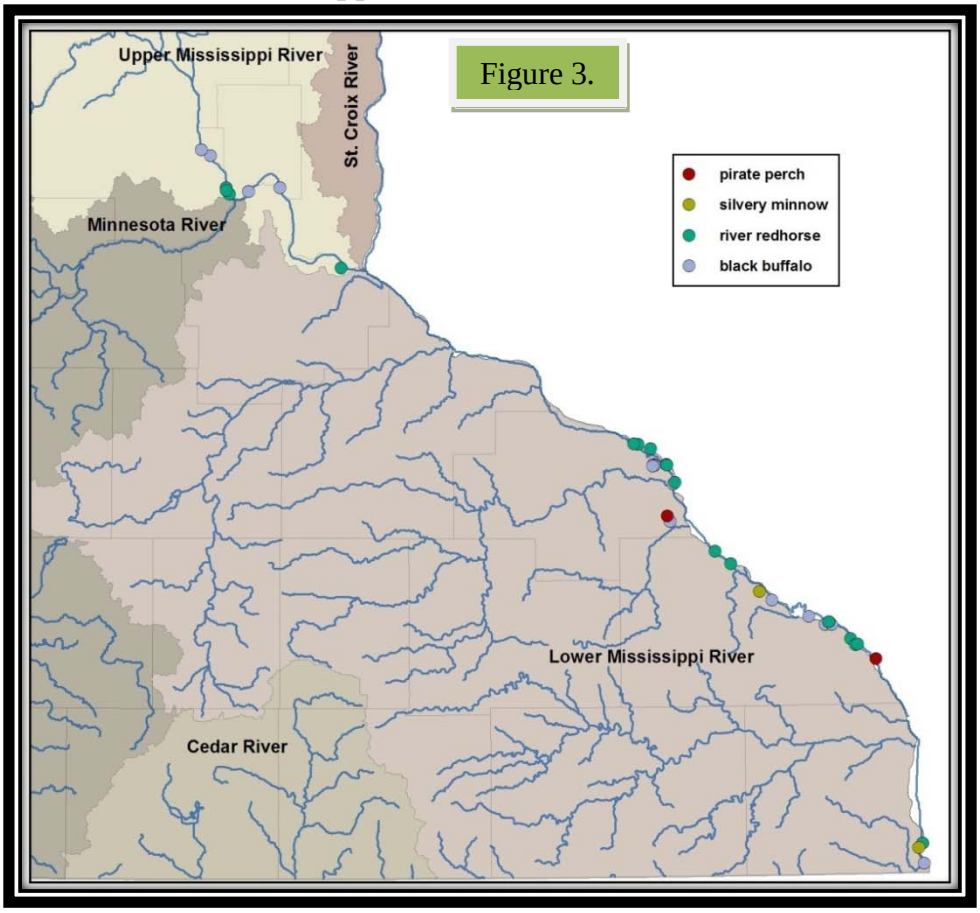


Figure 3.
Upper Mississippi River
St. Croix River
Minnesota River
Lower Mississippi River
Cedar River
pirate perch
silvery minnow
river redhorse
black buffalo

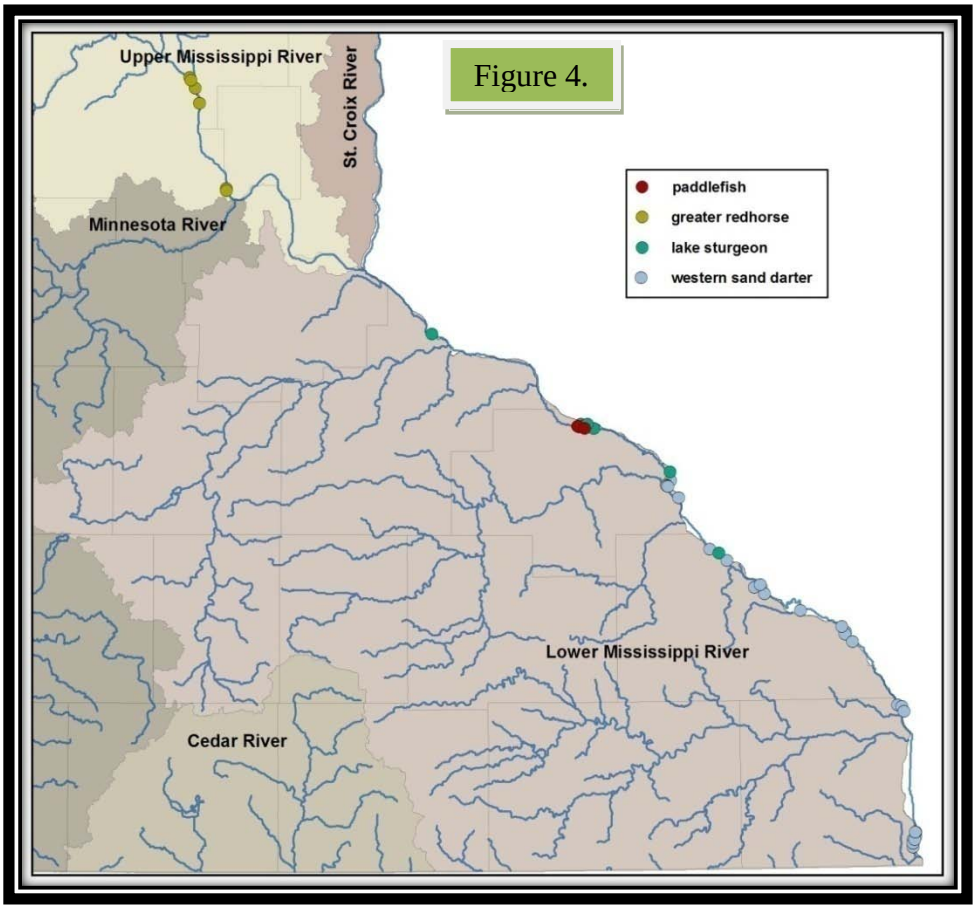
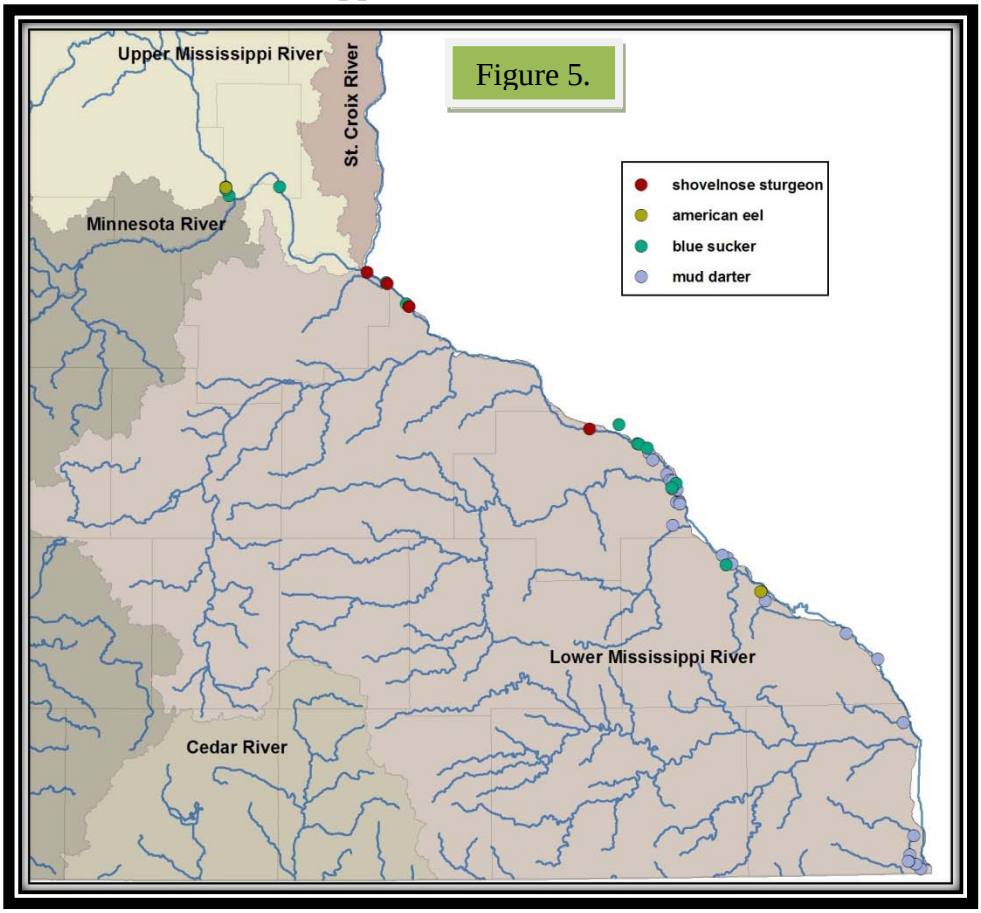


Figure 4.
Upper Mississippi River
St. Croix River
Minnesota River
Lower Mississippi River
Cedar River
paddlefish
greater redhorse
lake sturgeon
western sand darter


Upper Mississippi River
St. Croix River
Figure 5.
shovelnose sturgeon
american eel
blue sucker
mud darter
Minnesota River
Lower Mississippi River
Cedar River

Appendix 2. Mississippi River Pools A-9 Historical Species List, Pool Diversity and SGCN Occurrence (Key follows table).

SPECIES	WISCONSIN STATUS	POOL NUMBER AND SGCN (ALL SPECIES) TOTALS											
		A	B	1	2	3	4	5	5A	6	7	8	9
Petromyzontidae - Lamprey Family		2(60)	0(31)	1(44)	9(79)	10(77)	18(102)	17(89)	17(85)	18(87)	12(81)	22(101)	18(90)
Chestnut lamprey *(Ichthyomyzon castaneus)*						1995		2000			1987	2008	1967
Silver lamprey *(Ichthyomyzon unicuspis)*					1997		2007		1980		1995		1995
American brook lamprey (Lampetra appendix)							1998			1999		2004	
Acipenseridae - Sturgeon Family													
Lake sturgeon *(Acipenser fulvescens)*	Special Concern					2003				2008	2000	2001	1979
Shovelnose sturgeon *(Scaphirhynchus platorynchus)*					1981			1981	1980	2001		2008	1980
Polyodontidae - Paddlefish Family													
Paddlefish *(Polyodon spathula)*	Threatened				2003	2008			2002	1992	1992	1994	1995
Lepisosteidae - Gar Family													
Longnose gar *(Lepisosteus osseus)*				1899	1978							2008	
Shortnose gar *(Lepisosteus platostomus)*				1899	1995		2008				1995		
Amiidae - Bowfin Family													
Bowfin *(Amia calva)*													
Hiodontidae - Mooneye Family													
Goldeye *(Hiodon alosoides)*	Endangered				2001	1998	2001	1995				2000	1995
Mooneye *(Hiodon tergisus)*								2000			1995	2007	
Anguillidae - Freshwater Eel Family													
American eel *(Anguilla rostrata)*	Special Concern	1974				1996	2002	1986	1980			1996	1979
Clupeidae - Herring Family													
Skipjack herring *(Alosa chrysochloris)*	Endangered						2008	1986	2002	1900		1993	1928
Gizzard shad *(Dorosoma cepedianum)*				1981									
Cyprinidae - Minnow Family													
Central stoneroller *(Campostoma anomalum)*		2001			1990		2000				1946	2004	1995
Spotfin shiner *(Cyprinella spiloptera)*													
Common carp *(Cyprinus carpio)*			1995										
Grass carp *(Ctenopharyngodon idella)*							2005		2009	2008		2008	
Brassy minnow *(Hybognathus hankinsoni)*						1996	2001	1993		1946	1993	2000	1995
Mississippi silvery minnow *(Hybognathus nuchalis)*						1946	1949	1946	1948		1993	2004	
Silver Carp (Hypophthalmichthys molatrix)												2008	
Bighead carp *(Hypophthalmichthys nobilis)*							2007					2008	2008
Pallid shiner *(Hybopsis amnis)*	Endangered				1926	2002	1994	1978	1949		1949	2005	1969
Common shiner (Luxilus cornutus)			1992				2005	1986		1991		1999	
Shoal chub *(Macrhybopsis hyostoma)*	Threatened										1995		1979
Silver chub *(Macrhybopsis storeriana)*	Special Concern								1994	1946	1994	2000	1995
Hornyhead chub *(Nocomis biguttatus)*							2000						
Golden shiner *(Notemigonus crysoleucas)*		2000	1992										
Emerald shiner *(Notropis atherinoides)*													
River shiner *(Notropis blennius)*					1997	2000	2007		1999		2000		
Ghost shiner *(Notropis buchanani)*						1953	1949		1948	1949	1946	1957	1953
Bigmouth shiner *(Notropis dorsalis)*						2001		1946	1980	1946	1946	1946	1998
Blackchin shiner *(Notropis heterodon)*						1995	1899	1900	1900	2001			
Spottail shiner *(Notropis hudsonius)*		1929			1995		2008			1986			
Sand shiner *(Notropis stramineus)*							2007	1995	1995	1995		2008	1995
Weed shiner (Notropis texanus)	Special Concern				1953	1998							
Mimic shiner *(Notropis volucellus)*								2000	1997				
Channel shiner *(Notropis wickliffi)*									1946				
Pugnose minnow *(Opsopoeodus emiliae)*	Special Concern						2008		2004		1999	2008	
Suckermouth minnow *(Phenacobius mirabilis)*							1955		1946			1945	1953
Southern redbelly dace (Phoxinus erythrogaster)							1940						
Bluntnose minnow *(Pimephales notatus)*									1997	2001	1949	2007	
Fathead minnow *(Pimephales promelas)*							2008		1995	2001		2008	
Bullhead minnow (Pimephales vigilax)													
Blacknose dace *(Rhinichthys atratulus)*		1926			1999		2000						
Creek chub *(Semotilus atromaculatus)*							1989		1928			2000	1978
Catostomidae - Sucker Family													
River carpsucker *(Carpiodes carpio)*				1995				2000	1980	1945	1995	2008	
Quillback *(Carpiodes cyprinus)*											1995	2008	
Highfin carpsucker *(Carpiodes velifer)*		1979		1988		1997	1997	1986	1977		1995	2008	1979
White sucker *(Catostomus commersonii)*				1891		1989	2008			1999			
Blue sucker *(Cycleptus elongatus)*	Threatened									1995		2001	1995
Northern hog sucker *(Hypentelium nigricans)*					1997	1978				1945		2008	
Smallmouth buffalo *(Ictiobus bubalus)*											1945	2008	
Bigmouth buffalo *(Ictiobus cyprinellus)*											1995		
Black buffalo *(Ictiobus niger)*	Threatened								1949			2004	
Spotted sucker *(Minytrema melanops)*						1997							
Silver redhorse (Moxostoma anisurum)													
River redhorse (Moxostoma carinatum)	Threatened											2008	
Golden redhorse (Moxostoma erythrurum)													

Appendix 2. Mississippi River Pools A-9 Historical Species List, Pool Diversity and SGCN Occurrence (Continued).

SPECIES	WISCONSIN STATUS	POOL NUMBER AND SGCN (ALL SPECIES) TOTALS											
		A	B	1	2	3	4	5	5A	6	7	8	9
Shorthead redhorse (Moxostoma macrolepidotum)													
Greater redhorse (Moxostoma valenciennesi)	Threatened							1971				1971	
Ictaluridae - Bullhead Catfish Family													
Black bullhead *(Ameiurus melas)*						2001			1928	2001	1987	2008	
Yellow bullhead *(Ameiurus natalis)*													1999
Brown bullhead *(Ameiurus nebulosus)*							2000	1985		2001	1987	2001	1996
Channel catfish *(Ictalurus punctatus)*											1995	2008	
Stonecat *(Noturus flavus)*							2000	1979	1994	1946	1993	2002	1945
Tadpole madtom *(Noturus gyrinus)*		1926									1995		
Flathead catfish *(Pylodictis olivaris)*											1995		
Esocidae - Pike Family													
Northern pike (Esox lucius)													
Muskellunge (Esox masquinongy)							2004						
Umbridae - Mudminnow Family													
Central mudminnow *(Umbra limi)*							2005						
Osmeridae - Smelt Family													
Rainbow smelt (Osmerus mordax)												1993	
Salmonidae - Trout Family													
Cisco *(Coregonus artedi)*		1998											
Rainbow trout *(Oncorhynchus mykiss)*				1995	1975								
Brown trout *(Salmo trutta)*								1995				2000	1979
Brook trout *(Salvelinus fontinalis)*													
Percopsidae - Trout-perch Family													
Trout-perch *(Percopsis omiscomaycus)*									1999		1994	2004	
Aphredoderidae - Pirate Perch Family													
Pirate perch *(Aphredoderus sayanus)*	Special Concern				1991		2008		1983	1995		2002	2002
Gadidae - Cod Family													
Burbot *(Lota lota)*				1897	1995		2008					2001	1995
Fundulidae - Killifish Family													
Banded Killifish *(Fundulus diaphanus)*	Special Concern	1926					1940						
Starhead topminnow *(Fundulus dispar)*	Endangered										1996		
Atherinopsidae - Silverside Family													
Brook silverside *(Labidesthes sicculus)*												2008	
Gasterosteidae - Stickleback Family													
Brook stickleback *(Culaea inconstans)*		1999								1999		1999	
Moronidae - Temperate Bass Family													
White bass *(Morone chrysops)*											1999	2008	
Yellow bass *(Morone mississippiensis)*								1992			1983	2002	2008
Centrarchidae - Sunfish Family													
Rock bass *(Ambloplites rupestris)*												2008	
Green sunfish *(Lepomis cyanellus)*							2008		2000		2000		
Pumpkinseed *(Lepomis gibbosus)*				1891		1997				2001			
Warmouth *(Lepomis gulosus)*								1985		1999	1982	2008	
Orangespotted sunfish *(Lepomis humilis)*							2008	1985	1999		2000		
Bluegill *(Lepomis macrochirus)*													
Smallmouth bass *(Micropterus dolomieu)*													
Largemouth bass *(Micropterus salmoides)*													
White crappie (Pomoxis annularis)							2008	2000		2001	1999	2008	2000
Black crappie (Pomoxis nigromaculatus)													
Percidae - Perch Family													
Western sand darter *(Ammocrypta clara)*	Special Concern						2008						
Crystal darter *(Crystallaria asprella)*	Endangered						1997		1994	1994		1998	
Mud darter *(Etheostoma asprigene)*	Special Concern												
Bluntnose darter *(Etheostoma chlorosoma)*	Endangered									2001		1997	1944
Iowa darter (Etheostoma exile)		1999					1995		1942		1947		1998
Fantail darter *(Etheostoma flabellare)*							1949					2006	
Johnny darter *(Etheostoma nigrum)*							2008					2008	
Banded darter *(Etheostoma zonale)*							2000				2000	2007	
Yellow perch *(Perca flavescens)*		2001		1891						2001			
Logperch *(Percina caprodes)*		2001											
Blackside darter *(Percina maculata)*							2000	1980	1948			2002	
Slenderhead darter (Percina phoxocephala)							2008	2000			1949	2008	
River darter *(Percina shumardi)*								1995	1994		1946	2008	
Sauger *(Sander canadensis)*		1980								2000			
Walleye *(Sander vitreus)*													
Sciaenidae - Drum Family													
Freshwater drum *(Aplodinotus grunniens)*													

Key:		2006-2008 SWG	YEAR	Last year reported from pool		
		MN SGCN		Exotic		Identification suspect