

THE STATUS OF NEBRASKA FISHES IN THE MISSOURI RIVER,

5. SELECTED CHUBS AND MINNOWS (CYPRINIDAE):

SICKLEFIN CHUB (*MACRHYBOPSIS MEEKI*), STURGEON CHUB (*M. GELIDA*),
SILVER CHUB (*M. STORERIANA*), SPECKLED CHUB (*M. AESTIVALIS*),
FLATHEAD CHUB (*PLATYGOBIO GRACILIS*), PLAINS MINNOW (*HYBOGNATHUS PLACITUS*),
AND WESTERN SILVERY MINNOW (*H. ARGYRITIS*)

Larry W. Hesse

Nebraska Game and Parks Commission
Box 934, Norfolk, Nebraska 68702

Federal Aid in Sport Fish Restoration, Dingell-Johnson Project, F-75-R-11 December 1993. Publication funded by Nebraska Game and Parks Commission.

ABSTRACT

Seven species of native Missouri River cyprinids have been reduced in abundance by 70 to 98%. Several have been extirpated from the reach upstream from Gavins Point Dam. The reasons for the decline are most likely the alteration of sediment dynamics due to dam construction, the elimination of bankful discharge, and the elimination of critical habitats, such as sandbars and off-channel areas.

† † †

The minnow family is large, with more than 40 species occurring as natives in the Missouri River Basin; more than 30 species are native to Nebraska, and at least 21 can be found associated with the Missouri River main channel on Nebraska's border (Eddy and Underhill, 1980; Hesse et al., 1989; Stasiak 1987). Native Nebraska minnows are more commonly found in streams than in lakes, and before the streams of the state were altered they may have been more numerous than any other fishes (Jones, 1963). Species with similar habits tended to be found together in guilds. Minnows are adapted to be carnivorous, herbivorous or detritivorous, and they served an important role in the transfer of solar energy up the trophic ladder in the Missouri River ecosystem (Fig. 1).

This paper presents the results of sampling effort carried out during the period of 1971–1993 to show the population trend for seven native cyprinids of the Missouri River in Nebraska. Some time will be allocated to a description of the future management requirements for these species.

Sicklefin chub life history (*Macrhybopsis meeki*)

The earliest collection of sicklefin chubs was made by Meek (1892) from the Missouri River near Sioux City, Iowa. Subsequently they were again collected by Johnson (1942) from the Missouri River and Morris (1960) from the Platte River. Although there is the possibility that these were misidentified (personal communication, Dr. Richard Stasiak, Professor, University of Nebraska at Omaha). Cross (1967) suggested that this species seemed so specialized for life in the large, silt-laden Missouri and lower Mississippi rivers that their survival might be threatened by impoundments and other modifications of habitat. Harlan and Speaker (1987) indicated that sicklefin chubs were rare at all sites, and their occurrence was restricted to the Missouri River, where they have been collected in Woodbury, Harrison, Pottawatomie, Mills and Fremont counties in Iowa. Bailey and Allum (1962) raised concern for this species in South Dakota because of the reduction in turbidity associated with impoundment. Pflieger and Grace (1987) determined that the species was more numerous in the lower Missouri River in Missouri in recent collections compared to two earlier periods (1940–45 and 1962–72). However, their presence was restricted to the lowermost reaches of the Missouri River near the confluence with the Mississippi River. The historical range of the species was the mainstem of the Missouri River from Montana downstream to the Mississippi River, and down the Mississippi River to the Gulf. Their range has been disjointed due to dam construction. With the exception of small extant populations in Montana and in Missouri, they are now so rare that they may be in danger of extinction (Carter, 1983; Guillory, 1979; Weldon, 1993a).

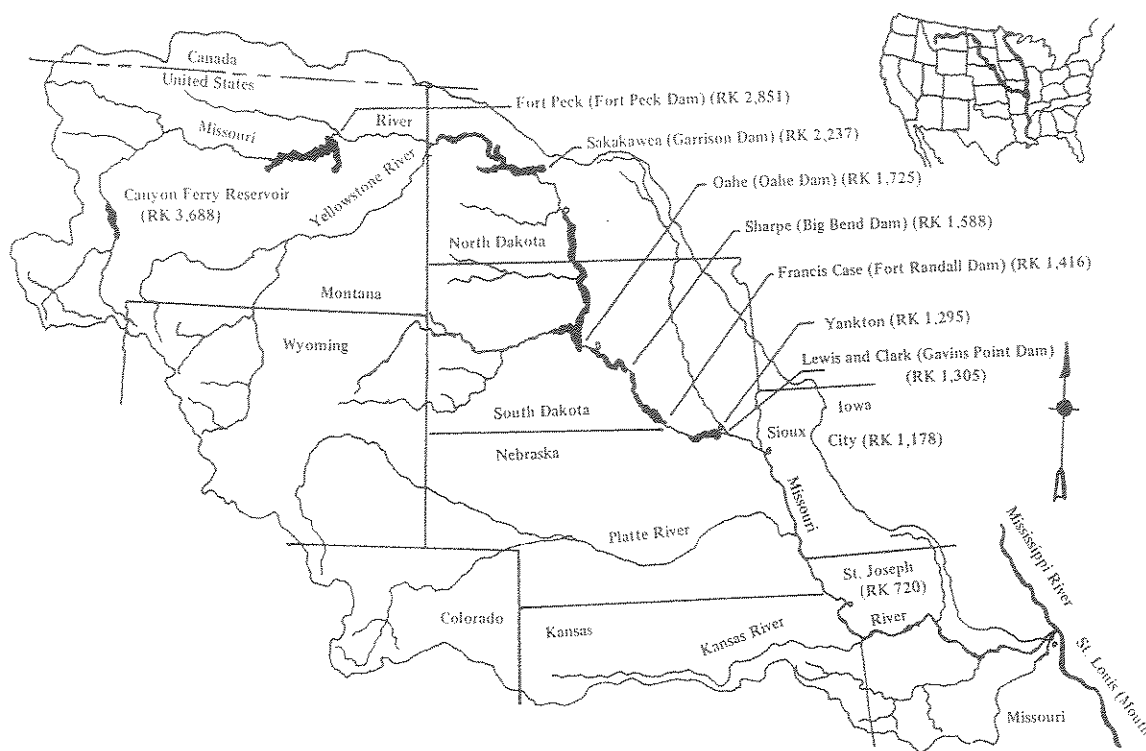


Figure 1. Map of the Missouri River showing the lowermost dams and unchannelized and channelized segments.

The sicklefin chub was very specialized for life in a large and turbid river. The animal's eyes are partially covered by skin and reduced in size to limit abrasion. It favors sandy bottoms in moderate current. It has taste buds on the outside of its head as well as numerous taste organs in its mouth, which are used to sort food from bottom soils (Pflieger, 1975). They most likely feed on aquatic insect larvae, and detritus consumed with them (Reigh and Elsen, 1979). The animal is thought to breed in the spring (Pflieger, 1975).

Sturgeon chub life history (*Macrhybopsis gelida*)

Sturgeon chubs were found in the Platte River in Nebraska by Everman and Cox (1896). Johnson (1942) found them in Bazile Creek near the Missouri River confluence, as well as throughout the Platte, Republican, Missouri and lower Elkhorn rivers. Bailey and Allum (1962) defined the difference in distribution of sturgeon and sicklefin chubs. The former replaced the latter in the upper Missouri River Basin; they were co-inhabitants of the middle Missouri and were replaced by sicklefin chubs in the lower Missouri. They are not known to ascend either the Ohio or Mississippi rivers above the confluence with the Missouri River. Their range may be explained by their penchant for strong current over gravel rather than sand-silt. However, in recent collections in Missouri more sturgeon chubs were

collected in the lower than upper Missouri River within the state of Missouri (Pflieger and Grace, 1987). Cross (1967) found this species only in the Kansas, lower Smoky Hill and Missouri rivers. Those collected in the Kansas River were commonly found where the water was very shallow and the velocity high, which kept fine sediments from accumulating. Stewart (1980) noted that sturgeon chubs were found only in gravel deposits in the Powder River in Wyoming, and that they did not ascend the Powder above the Salt Creek, a source of high turbidity. As in the case of the sicklefin chub, sturgeon chubs have highly developed cutaneous sense organs extending over the entire head and onto the fins (Moore, 1950). Cross (1967) described this species to be highly adapted to life in large turbid rivers. The fish has a depressed head and slender body somewhat wedge-shaped and tapering tailward, all of which provides minimal resistance to flow and makes use of the current to hold the fish on the bottom. The small eyes are somewhat shielded against abrasion. Moreover it has epidermal keels on scales above the lateral line which may aid in the smooth dissipation of flow across its body (Cross, 1967). It is mostly carnivorous, consuming aquatic insect larvae (Reigh and Elsen, 1979; Stewart, 1980). Stewart (1980) reported the onset of spawning in sturgeon chubs during early June in the Powder River. The historical range of the sturgeon chub has been much reduced to such an extent that it

may be in imminent danger of extinction (Guillory, 1979; Rowe, 1992; Stasiak, 1990; Werdon 1993b).

Silver chub life history **(*Macrhybopsis storeriana*)**

Silver chubs have been reported to occur in the lower reaches of the Platte, Loup, Elkhorn, and Republican rivers as well as throughout the Missouri River in Nebraska (Jones, 1963). Pflieger (1975) called it one of the common and characteristic minnows of the Missouri and Mississippi rivers. Cross (1967) found it in the Kansas, Blue, Smoky Hill, Neosho, and Arkansas rivers, though it was only numerous in the Missouri River. Bailey and Allum (1962) indicated that the upstream limit of silver chubs was Lewis and Clark Lake. Unlike other native chubs, this one ascends the Mississippi River above the confluence with the Missouri River and is found in the Des Moines and Skunk rivers as well (Harlan and Speaker, 1987). However, they note that it is still most commonly found in semi-turbid rivers in strong current over sand and gravel bottoms. It has a better-developed sense of sight than sturgeon and sicklefin chubs and uses this ability to help locate food, which is typically zooplankton and aquatic insect larvae. Pflieger (1975) suggested that it spawns in April and May.

Silver chubs increased in density in the Missouri River in Missouri from 1940–45 to 1962–72, but then declined again by 1978–83 (Pflieger and Grace, 1987). Little else has been published regarding the status of silver chub throughout its range. However, Parker et al. (1987) suggested that the animal was common in the western Lake Erie basin in the 1960s. More recent surveys suggest it is now rare in Canada. The decline has been linked to the disappearance of an important component in their diet, *Hexagenia* sp. (Parker et al., 1987).

Speckled chub life history **(*Macrhybopsis aestivalis*)**

Nebraska collections indicate speckled chubs lived in the lower Platte, Loup, Elkhorn, Republican, and Blue rivers in addition to the Missouri River (Jones, 1963). It was quite common throughout the streams of southern Iowa from the Mississippi to the Missouri (Harlan and Speaker, 1987). Bailey and Allum (1962) did not find this species in South Dakota. Two subspecies of this fish have been identified in Kansas, one in the Missouri River and the eastern part of the Kansas River Basin, and the other in the Arkansas River and its western tributaries (Cross, 1967). Pflieger (1975) described the speckled chub as one of the common and characteristic minnows of the Missouri and Mississippi rivers. It lived in the open channels but in areas of elevated current where silt did not accumulate. It was associated with sand and small gravel (Cross, 1967;

Pflieger, 1975).

Like other native chubs, it has a well developed external sensory system and unlike silver chubs must rely on these olfactory senses to feed. It feeds on aquatic insect larvae, crustaceans, and plant material (Pflieger, 1975). It is known to spawn during a protracted period from early May to late August, and eggs are semi-buoyant (Botrell et al., 1964). The animal is very short-lived (< 2 years).

The status of the species within its range is not well defined, but Pflieger and Grace (1987) indicated that it increased in abundance from 1940–45 to 1978–83 in Missouri's portion of the Missouri River. They also determined that their density was much higher in the lowermost reaches of the Missouri River, declining as one collected farther north in Missouri. Winston et al. (1991) were able to document that speckled chubs were extirpated from the North Fork of the Red River upstream from a dam built in 1946, although they were numerous downstream from the dam.

Flathead chub life history (*Platybio gracilis*)

Jones (1963) notes that flathead chubs were found extensively throughout all river drainages in Nebraska except the Big Blue, Little Blue, and Hat Creek drainages. Pflieger (1975) called this fish one of the most abundant minnows in the Missouri and lower Mississippi rivers, and it did not ascend the Mississippi River above the confluence with the Missouri River, much like the sicklefin and sturgeon chubs. Harlan and Speaker (1987) noted that flathead chubs were historically found in the Missouri and tributaries including the Nodaway, Nishnabotna, Boyer, Soldier, Little Sioux, and Big Sioux rivers in Iowa. Bailey and Allum (1962) called this species the dominant minnow in the turbid and flowing waters of the Missouri River and the larger streams of the western half of South Dakota.

The flathead chub is a long-lived cyprinid, not reaching sexual maturity until age 2, while all have matured by age 4, and surviving to at least 10 years (Bishop, 1975). Spawning in Perry Creek, Iowa, took place from mid-July through mid-August (Martyn and Schmulbach, 1978). This same spawning period was found in Montana flathead chubs (Gould, 1985). Water temperature at spawning time was 18–25°C. The average number of mature eggs per female (1.0 mm or greater in diameter) was found to be 491 (Gould, 1985), while Martyn and Schmulbach (1978) found the average total number per female to be 4,974 eggs.

Gould (1985) found flathead chubs associating with western silvery minnows and plains minnows among other non-cyprinids. Pflieger and Grace (1987) noted that flathead chubs and plains minnows were by far

the most numerous in the Missouri River in Missouri during 1940–45.

The flathead chub lives off the bottom more frequently than other native chubs (Pflieger, 1975), made possible by its large, powerful body and highly depressed head shape, allowing it to deflect current efficiently. It feeds mostly on terrestrial insects that fall into and drift with the flow of the river and to some extent on plant material. It has highly developed external sensory organs as the other native chubs and is highly tolerant of turbid conditions. It has declined dramatically in Missouri (Pflieger and Grace, 1987), but persists somewhat better in areas where it co-existed with sturgeon chubs, because flathead chubs are better adapted for sight feeding (Weldon, 1992).

Plains minnow life history (*Hybognathus placitus*)

Pflieger (1975) stated that the plains minnow was the most abundant minnow in the upper Missouri River in Missouri and became somewhat less abundant downstream. Cross (1967) noted that this species "abounds in all large streams of Kansas that have broad beds of sand and shallow, braided flow."

Plains minnows colonize the margins of the main channel, where the current eddies and organic debris accumulates. The minnow's long, coiled intestine attests to the herbivorous diet. It has a thin-lipped crescent-shaped mouth designed to scoop up the thin layer of plants living at the water-substrate interface (Cross, 1967). Cross (1967) noted that plains minnows are dietarily similar to the river carpsucker. The carpsucker seems to be better able to live in the present-day Missouri River because it obtains this food from deeper water, while the plains minnow was restricted to shallow sand bar habitat, which is now nearly gone from the river.

Plains minnows are short-lived, usually less than 2 years. Taylor and Miller (1990) determined that longevity was related to post-spawning mortality. They also found that spawning commenced during high or receding flows when photoperiod and water temperature was appropriate. In the case of the Cimarron River in Oklahoma, the peak time was during April through June. Taylor and Miller (1990) and Lehtinen and Layzer (1988) were able to correlate young-of-the-year occurrence with abrupt increases in spring discharge.

The status of the species is not well established across its range, but Winston and Taylor (1991) were able to demonstrate the near extirpation of plains minnows in a reach of the North Fork of the Red River with construction of a dam in 1946. Pflieger and Grace

(1987) showed a decline in the abundance of plains minnows between 1940–45 and 1978–83 in the Missouri River in Missouri. He also showed fewer living in the lower reaches of the Missouri River in Missouri in 1978–83 than in the upper reaches.

Western silvery minnow life history (*Hybognathus argyritis*)

The western silvery minnow, like the plains minnow, was widely distributed in Nebraska and in fact was thought to have even increased in abundance between 1890 and 1940 (Johnson, 1942; Jones, 1963). Pflieger (1975) noted that this fish was decidedly less abundant than the plains minnow in the Missouri River. He also noted that it was often found in schools with plains minnows and silver and flathead chubs. However, it is ecologically different from the plains minnow in that it is more commonly found in backwaters or protected areas where the current is low and the bottom is silty. A close relative, the western silvery minnow, was found to consume decaying plant material, diatoms, algae, and fungi (Whitaker, 1977).

Ozanne (1972) investigated the ecology of the silvery minnow in the Platte River in Nebraska but identified the samples as *Hybognathus nuchalis*. It is most likely that these were *Hybognathus argyritis*, since Pflieger (1975) lists the range of *H. nuchalis*, the central silvery minnow, as east of the Mississippi River. Indeed, the western silvery minnow was quite numerous in this early study on the Platte. Pflieger and Grace (1987) showed a decline in the abundance of western silvery minnows between 1940–45 and 1978–83.

METHODS

Tarred nylon seines have been used most effectively to capture small fishes from the Missouri River. For the most part, these seines have measured 15.2 × 1.8 m × 6.1 mm mesh. The nets were equipped with a bag located in the center. A unit of effort has been one haul achieved by dragging the distal end in a one-quarter circle with the other end firmly anchored to the bank. There were many circumstances that may have made this effort difficult to duplicate. Variable discharge and associated depth, depth of soft sediments, snags, etc. have all been encountered. However, the same method was attempted since at least 1971. Catch-per-unit-effort (CPUE) will be discussed but percent composition was also useful to display the changing abundance of selected species. In nearly every instance fish were preserved in the field with formalin and returned to the laboratory for identification.

This paper reports on the status of seven species; many others have been collected, and these data must

be used in future reports.

RESULTS

More than 45,500 small fish have been seined in 1,648 seine hauls from the Missouri River adjacent to Nebraska between 1970 and 1993 (Fig. 1). The effect of Gavins Point Dam is clearly displayed in Table 1. The total CPUE declined from 16.1 to 24.8 to 41.2 fish/seine haul in the upper unchannelized, lower unchannelized, and channelized sections, respectively. Even if the 1970–75 data were not included, the channelized CPUE for 1986–93 was 28.2 fish/seine haul. The total CPUE for the period 1970–75 was 51.1 fish/seine haul. These differences were tested and most differences were significant, but seining effort was not easily standardized, as discussed previously. The magnitude of the differences should serve to demonstrate the changes in abundance of these small fish. Unchannelized reaches appear to have much higher quality riverine habitat than the channelized reach. It is apparent that other factors (i.e., hydrograph, water clarity, organic matter availability) are affecting fish abundance. Moreover, the short life span of most cyprinids might readily contribute to the high fluctuation observed in total cyprinid, annual CPUE (Table 1).

Kallemeyn and Novotny (1977) seined the same sandbar habitat in the upper unchannelized section in 1976. Total CPUE was 56.0 fish/seine haul, and they used a smaller seine. The 1983–93 total CPUE was down by 75%. Total CPUE in the lower unchannelized section

in 1976 was 78.9, which was 69% higher than the CPUE in 1983–1993. The CPUE in 1976 in the channelized station was 54.7 (Kallemeyn and Novotny, 1977), which was similar to the CPUE we found in 1970–75 (51.1 fish/seine haul).

The sicklefin, sturgeon, flathead, and speckled chubs appear to have been extirpated from the Missouri River upstream from Lewis and Clark Lake. They were not collected in 1983–93, and they were also not represented in the seine samples acquired in 1976 in this reach (Kallemeyn and Novotny, 1977). Silver chubs were collected in this reach in 1983, 1986, 1987, and 1991. Plains and silvery minnows were collected in 1985 and 1989. In every instance these species represented less than 1% of the total catch (Table 2). They should be classified as very rare.

Sicklefin, sturgeon, flathead, and speckled chubs were not collected in the lower unchannelized reach (downstream from Gavins Point Dam) in 1983–93 nor in 1976 (Kallemeyn and Novotny, 1977). Silver chubs were collected in 1986 and 1989, and in 1976 but in minute numbers. Plains and silvery minnows were collected in 1983, 1984, 1985, and 1986 but not in 1976. In each instance that these minnows were collected, they comprised less than 1% of the total catch (Table 2). These three species should be considered very rare in the lower unchannelized reach.

One sicklefin and one sturgeon chub were collected in the Missouri River in the far southeastern corner of

Table 1. All fish seined from the upper unchannelized, lower unchannelized and channelized reaches of the Missouri River in Nebraska.

	Upper unchannelized			Lower unchannelized			Channelized		
	Fish	Hauls	CPUE	Fish	Hauls	CPUE	Fish	Hauls	CPUE
1970							1,966	73	26.9
1971							7,410	90	82.3
1974							7,811	140	55.8
1975							1,164	56	20.8
1983	1,847	102	18.1	1,484	63	23.6			
1984	2,182	139	15.7	1,110	89	12.5			
1985	2,816	228	12.4	1,954	115	17.0			
1986	709	93	7.6	1,597	31	51.5	1,606	67	24.0
1987	793	46	17.2	876	22	39.8	2,369	109	21.7
1988	1,144	12	95.3	199	22	9.1	560	23	24.3
1989	202	9	22.4	842	9	93.6	995	21	47.4
1990	492	13	37.9	621	4	155.3	616	14	44.0
1991	291	4	72.8	—	—	—	1,119	18	62.2
1993	117	11	10.6	219	4	54.8	447	21	21.3
Totals	10,593	657	16.1	8,902	359	24.8	26,063	632	41.2

Table 2. Percent composition of selected species seined during the period 1983–1993, in unchannelized sections of the Missouri River, Nebraska, and 1970–1993 for channelized sections.

Species	Upper unchannelized										
	1983	1984	1985	1986	1987	1988	1989	1990	1991	1993	
Sicklefin chub	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Sturgeon chub	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Flathead chub	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Silver chub	0.3	0.0	0.0	0.6	0.1	0.0	0.0	0.0	0.3	0.0	
Speckled chub	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Plains/Silvery	0.0	0.0	<0.1	0.0	0.0	0.0	0.5	0.0	0.0	0.0	
Lower unchannelized											
Sicklefin chub	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Sturgeon chub	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Flathead chub	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Silver chub	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	
Speckled chub	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Plains/Silvery	0.6	0.1	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	
Channelized											
	1970	1971	1974	1975	1986	1987	1988	1989	1990	1991	1993
Sicklefin chub	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
Sturgeon chub	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
Flathead chub	2.2	1.9	2.4	0.0	0.2	0.0	0.0	0.0	0.0	0.2	0.0
Silver chub	16.7	7.8	6.9	6.8	3.5	1.3	0.5	0.7	3.9	8.9	27.1
Speckled chub	0.4	0.7	0.2	0.2	0.0	0.0	0.0	0.1	0.2	1.0	0.2
Plains/Silvery	27.1	31.6	28.1	4.4	0.1	2.4	0.4	0.0	7.0	4.8	0.0

Table 3. The CPUE of flathead chubs, silver chubs, speckled chubs, plains and silvery minnows, seined from the Missouri River, Nebraska.

Species	Location	Period	Effort	No. sampled	All fish	%	CPUE
Flathead	chann.	1970–75	359	368	18,351	2.00	1.03
Flathead	chann.	1986–93	273	5	7,712	0.06	0.02
Flathead	unchann.	1983–93	1,016	0	19,495	0.00	0.00
Silver	chann.	1970–75	359	1,524	18,351	8.3	4.25
Silver	chann.	1986–93	273	344	7,712	4.5	1.26
Silver	unchann.	1983–93	1,016	16	19,495	0.1	0.02
Speckled	chann.	1970–75	359	80	18,351	0.4	0.22
Speckled	chann.	1986–93	273	14	7,712	0.2	0.05
Speckled	unchann.	1983–93	1,016	0	19,495	0.0	0.00
Pln/Silv	chann.	1970–75	359	5,121	18,351	28.0	14.26
Pln/Silv	chann.	1986–93	273	157	7,712	2.0	0.58
Pln/Silv	unchann.	1983–93	1,016	20	19,495	0.1	0.02

Nebraska in 1988. They were the only specimens found among 26,063 small fish seined between 1970 and 1993. More of the other species have been collected from the channelized reach than from the unchannelized sections, most probably because the numerous tributaries downstream from Sioux City, Iowa, have continued to bring in large quantities of sediment, thus maintaining a higher level of turbidity and organic matter. However, the percent of each of these species in the total seine catch has been very low since 1975 (Table 2). The silver chub has increased its share of the total sample during the last several years and even exceeded the percent composition from 1970–75 samplings. The plains and silvery minnows increased as well in 1990–91 but did not approach the percent of sample taken in the 1970s. However, CPUE demonstrated that the actual density of these species was much lower in 1986–93 than in 1970–75 (Table 3). CPUE was very low for all of these fish from the unchannelized section and declined for all of them between the 1970s and 1980s in the channelized section. Flathead chub relative abundance is down by 98%; silver chub by 70%; speckled chub by 77%, and plains and silvery minnows by 96% (Table 3).

Stasiak (1990) reported a catch of 3,600 cyprinids from the channelized Missouri River during 1989. Flathead chubs represented 0.4%, silver chubs were 2.4%, speckled chubs were 0.03%, and plains and western silvery minnows were 6.4% of his seine catch. This composition is not dramatically different from the percentage composition of my samples from the channelized reach in the 1986–93 period and are considerably lower than we found in the 1970–75 period, with the exception of flathead chub. The CPUE in Stasiak's (1990) study was higher for flathead chub and the two minnow species when compared with my 1986–93 results but considerably lower than my results for 1970–75, which also supports the conclusion that these species have declined during 1970–93. Moreover, though Stasiak (1990) collected over sand and gravel sites, he noted that in only several cases were samples taken behind wing dikes. All of my samples 1970–93 were taken behind wing dikes.

Altered conditions in the Missouri River have favored other species, while those listed in this paper have been unable to maintain their density relative to several other cyprinids. In particular the emerald shiner (*Notropis atherinoides*) has increased its share of the cyprinid population in the Missouri River. It has a wide tolerance for turbidity, or the lack of it, and is primarily a site feeder (Pflieger, 1975). It represented 17% of the catch of cyprinids in 1971–75 (Hesse and Wallace, 1976), but represented 69% of the cyprinids in Stasiak's (1990) seine hauls. However, in no way does this suggest that the species in this paper are not

declining. CPUE clearly displays that fact.

Schainost seined at Nebraska City and Brownville (channelized section) during 1977 and 1978 (Reynolds, 1979). The seines used were smaller by nearly half than those used later, and as a result CPUE was not very comparable. However, percent composition for the species discussed in that paper is as follows: 5,616 total fish were seined, 2 sturgeon chubs (0.04%), 22 flathead chubs (0.4%), 250 silver chubs (4.5%), 33 speckled chubs (0.6%), and 1,623 plains and silvery minnows (28.9%). These data support the findings of our studies.

The earliest seine collections were made by Fisher (1962) in 1945 for the state of Missouri. His northernmost sampling station is Watson, Missouri, which was 8 km north of our collection site at Brownville, Nebraska. He used a very small seine that was only one-fourth as long as the seines used in our studies. Therefore his catch would have to be multiplied by a factor of four to equalize effort. Fisher (1962) reported capturing 4,483 small fish in 46 seine hauls (97.5 fish/seine haul); with equalized effort it may have been nearly 390 fish/seine haul. Plains and silvery minnows dominated his catch (68.0%), flathead chubs followed at 20.4% of the catch, silver chubs represented only 1.0%, and speckled chubs were <0.1%. He captured 12 sicklefin chubs (0.3%) but no sturgeon chubs this far north in Missouri, although 23 were captured downstream. He did not capture any emerald shiners at the Watson site. The Missouri River in Missouri in 1945 had been "tamed" but the river was not under control. Without the benefit of upstream dams to control the largest of floods, these channel-control structures were constantly under attack by the river channel. It might be surmised that the fish community represented in Fisher's samples was close to pre-control, although some loss may have already begun to develop, since some habitats were most likely unavailable because of "river engineering." When even 1970 samples are compared to Fisher's data, the loss has been quite dramatic.

The status of these species in other Nebraska streams.

The Nebraska Department of Environmental Quality (NDEQ) collected over 70,000 small fish in 350 stream sites across Nebraska (excluding the Missouri River) during 1984–88 (Bazata, 1991). Another tributary study was completed by Stallwood (1988). The NDEQ did not collect sturgeon chubs or sicklefin chubs anywhere in Nebraska streams, and Peters et al. (1989) collected one sturgeon chub and no sicklefin chubs from the lower Platte River. Rowe (1992) collected three sturgeon chubs from the lower Platte River in 1991. Additional records of sicklefin and sturgeon chubs were reported by Stasiak (1990). Flathead chubs were only 0.6% by composition and were collected in only 8.8% of

the streams sampled. Johnson (1942) reported that this species was found in all drainages in Nebraska except the Big and Little Blue rivers. Ozanne (1972) did not collect flathead chubs in the Platte River in 1970-71. Peters et al. (1989) collected them in only 4% of 874 electrofishing grids in the lower Platte River. The NDEQ collected 4 (0.006% composition, 0.6% of streams) silver chubs, 12 (0.02% composition, 0.9% of streams) speckled chubs, 208 (0.3% composition, 2% of streams) plains minnows, and 182 (0.3% composition, 5.4% of streams) western silvery minnows (Bazata, 1991). Peters et al. (1989) collected only 8 silver chubs (0.9% of 874 grids), 28 speckled chubs (3% of 874 grids), 473 plains minnows (9% of 874 grids), and 180 western silvery minnows (3% of 874 grids) from the lower Platte River. Ozanne (1972) did not collect silver chubs from the Platte River, but speckled chubs were 0.6% of the total sample. The western silvery minnow was 16.1% of this early Platte River study.

The lower Niobrara River was sampled with primacord in 1976-78 (Hesse et al., 1979; Newcomb et al., 1981); 3,083 flathead chubs (15.3% composition), 20 (0.1%) silver chubs, and 40 (0.2%) plains minnows were collected (Table 4). This survey was repeated in 1991; 105 flathead chubs (12.6% composition); 2 silver chubs (0.2%), and no speckled chubs or plains minnows were collected. Catch rate with an explosive may be a better indicator of population density because the explosive effort was easily duplicated, and fish response to primacord is independent of other factors (e.g., water quality). Flathead chubs were collected at the rate of nearly 31 fish per blast in 1976-78 but only 5 fish per blast in 1991. Silver chubs increased slightly during this period.

Final comments

All seven of these species were once important native inhabitants of the Missouri River ecosystem. They have declined in abundance by more than 98%. The sturgeon and sicklefin chubs face the very real likelihood of extinction. Flathead chub is not very much better off. The speckled and silver chubs are only

slightly more secure. The plains and silvery minnows, considering their onetime high abundance, have declined precipitously. Although flathead chub, silver chub, speckled chub, and both minnow species are more numerous than either sturgeon or sicklefin chub, they have exhibited a very great reduction in density. State and/or federal listing is the best hope to prevent these species from becoming as rare as sturgeon and sicklefin chubs. For that reason I recommend that these species should be listed as endangered in Nebraska and should be considered for national listing.

The demise of these species has most likely contributed to the demise of sauger, catfish, burbot, and sturgeon, among others. All of these fishes were adapted to life in a large, warm, and turbid river with numerous sandbars, backwaters, and snags. This description hardly defines the Missouri River of today. If these conditions are not recovered very soon, all of these species will become federally listed species. The best way to prevent this eventuality is to provide a small floodplain corridor from Fort Randall Dam downstream. The corridor can be flooded annually. Flooding, in the frequency and timing that historically occurred will result in a renewal of off-channel habitat, and sandbars. More organic matter will become available as a result of overbank flows. Sediment transport systems must be designed to restore the sediment balance in the reaches downstream from Fort Randall and Gavins Point dams. Each of these actions will increase turbidity, which will provide the necessary in-stream cover for all native Missouri River fishes that depended on cloudy water for protection from predation.

The temperature of the water discharged from Fort Randall Dam must be mixed, surface with bottom, in order to mitigate the photoperiod/temperature relationship which governed native fish reproduction. And, finally, the spring and early summer flood pulse must be resumed because it was the cue for most native Missouri River fishes to begin annual reproductive efforts.

Table 4. Relative abundance of flathead, silver and speckled chubs, and silvery and plains minnows in the lower Niobrara River near the confluence with the Missouri River during 1976-1978 (when 20,150 fish were caught, including other species) and 1991, when 833 fish of all species were caught. CPUE values are number of fish per 15.2 m of primacord.

	1976-1978			1991		
	CPUE	Number	%	CPUE	Number	%
Flathead chub	30.73	(3,083)	15.3	5.00	(105)	12.6
Silver chub	0.03	(20)	0.1	0.10	(2)	0.2
Speckled chub	0.0	(0)	0.0	0.0	(0)	0.0
Plains/Silvery minnows	0.06	(40)	0.2	0.0	(0)	0.0

LITERATURE CITED

- Bailey, R. M., and M.O. Allum. 1962. *Fishes of South Dakota*. Ann Arbor, Museum of Zoology Pub. No. 119, University of Michigan: 132 pp.
- Bazata, K. 1991. *Nebraska stream classification study*. Lincoln, Nebraska Department of Environmental Quality.
- Bishop, F. G. 1975. Observations on the fish fauna of the Peace River in Alberta, Canada. *Canadian Field-Naturalist* 89: 423-430.
- Botrell, C. E., R. H. Ingersol, and R. W. Jones. 1964. Notes on the embryology, early development, and behavior of *Hybopsis aestivalis tetranemus*. *Transactions of the American Microscopical Society* 83: 391-399.
- Carter, F. A. 1983. Sickletfin chub in the Mississippi River bordering Arkansas. *Arkansas Academy of Science Proceedings* 37: 80.
- Cross, F. B. 1967. *Handbook of fishes of Kansas*. Lawrence, University of Kansas, Museum of Natural History, Pub. No. 45: 357 pp.
- Eddy, S., and J.C. Underhill. 1980. *How to know the freshwater fishes*. Dubuque, Iowa, Wm. C. Brown Company Publishers: 215 pp.
- Everman, B. W., and U. O. Cox. 1896. *Report upon the fishes of the Missouri River Basin*. U.S. Fish Commission, 20: 325-429.
- Fisher, H. J. 1962. Some fishes of the lower Missouri River. *American Midland Naturalist* 68(2): 424-429.
- Gould, W. 1985. Aspects of the biology of the flathead chub in Montana. *Great Basin Naturalist* 45(2): 332-336.
- Guillory, V. 1979. Distributional notes on some lower Mississippi River fishes. *Florida Scientist* 42(4): 248-250.
- Harlan, J. R., and E. B. Speaker. 1987. *Iowa fish and fishing*. Des Moines, Iowa, Department of Natural Resources: 323 pp.
- Hesse, L. W., and C. R. Wallace. 1976. *The effects of cooling water discharges from Fort Calhoun and Cooper nuclear stations on the fishes of the Missouri River*. Norfolk, Nebraska Game and Parks Commission, Final Report. Dingell-Johnson Project F-4-R: 378 pp.
- , G. Zuerlein, R. Vancil, L. Koziol, B. Newcomb, and L.A. Retelsdorf. 1979. *Niobrara-Missouri River fishery investigations*. Norfolk, Nebraska Game and Parks Commission, Nebraska Technical Series No. 5.
- , J. C. Schmulbach, J. M. Carr, K. D. Keenlyne, D. G. Unkenholz, J. W. Robinson, and G. E. Mestl. 1989. Missouri River fishery resources in relation to past, present, and future stresses. In: D. P. Dodge (ed.) *Proceedings of the International Large River Symposium*. *Canadian Special Publication of Fisheries and Aquatic Sciences* 106: 352-371.
- Johnson, R. E., 1942. *The distribution of Nebraska fishes*. Ann Arbor, University of Michigan, M.S. Thesis.
- Jones, D. J. 1963. *A history of Nebraska's fisheries resources*. Lincoln, Nebraska Game and Parks Commission, Final Report, Dingell-Johnson Project F-4-R: 76 pp.
- Kallemeyn, L. W., and J. F. Novotny. 1977. *Fish and fish food organisms in various habitats of the Missouri River in South Dakota, Nebraska, and Iowa*. Washington, D.C., U.S. Fish and Wildlife Service Pub. FWS/OBS 77/25: 100 pp.
- Lehtinen, S. F., and J. B. Layzer. 1988. Reproductive cycle of the plains minnow in the Cimarron River, Oklahoma. *Southwestern Naturalist* 33(1): 27-33.
- Martyn, H. A., and J. C. Schmulbach. 1978. Bionomics of the flathead chub. *Proceedings of the Iowa Academy of Sciences* 85(2): 62-65.
- Meek, S. E. 1892. A report upon the fishes of Iowa, based upon observations and collections made during 1889, 1890, and 1891. *Bulletin of the U.S. Fish Commission* 10: 217-248.
- Moore, G. A. 1950. The cutaneous sense organs of barbeled minnows adapted to life in the muddy waters of the Great Plains region. *Transactions of the American Microscopical Society* 69: 69-95.
- Morris, L. A. 1960. *The distribution of fish in the Platte River, Nebraska*. Columbia, University of Missouri, M.A. Thesis.
- Newcomb, B., B. Stewart, J. Klammer, L. Rupp, L. Hutchinson, L. Schlueter, and L. W. Hesse. 1981. *Forage fish in the Niobrara River*. Norfolk, Nebraska Game and Parks Commission.
- Ozanne, R. L., Jr. 1972. *The ecology of the silvery minnow in the Platte River system of Buffalo County, Nebraska*. Unpublished paper, Biology Department, Kearney State College, Kearney, Nebraska. 36 pp.
- Parker, B., P. McKee, and R. R. Campbell. 1987. Status of the silver chub in Canada. *Canadian Field-Naturalist* 101(2): 190-194.
- Peters, E. J., R. S. Holland, M. A. Callam, and D. L. Bunnell. 1989. *Platte River suitability criteria—habitat utilization, preference and suitability index criteria for fish and aquatic invertebrates in the lower Platte River*. Lincoln, Nebraska Game and Parks Commission, Nebraska Technical Series No. 17.
- Pflieger, W. L. 1975. *The fishes of Missouri*. Jefferson City, Missouri Department of Conservation: 343 pp.
- , and T. B. Grace. 1987. Changes in the fish fauna of the lower Missouri River, 1940-1983. In: W. J. Matthews and D. C. Heins (eds.) *Community and evolutionary ecology of North American stream fishes*. Norman, University of Oklahoma Press: 166-181.

- Reigh, R. C., and D. S. Elsen. 1979. Status of the sturgeon chub and sicklefin chub in North Dakota. *Prairie Naturalist* 11(2): 49-52.
- Reynolds, J. B. 1979. *Value of notched dikes to fish habitat in the lower Missouri River*. Washington, D.C., U.S. Fish and Wildlife Service: 175 pp.
- Rowe, J.W. The sturgeon chub and the brook silverside in the Platte River of Nebraska. *Prairie Naturalist* 24 (4):281-282.
- Stasiak, R. H. 1987. The minnows and killifish. pages In: K. Bouc (ed.) *The fish book*. NEBRASKALAND 65(1): 56-64.
- . 1990. *Population status of sicklefin chub and sturgeon chub in the Missouri River in Nebraska in 1989*. U.S. Army Contract, Department of Biology, University of Nebraska at Omaha: 16.pp.
- Stallwood, D. 1988. *An index of biotic integrity based on fishes of the Missouri tributaries basin, Nebraska*. University of Nebraska at Omaha, M.A. Thesis: 73 pp.
- Stewart, D. D. 1980. *A preliminary study of the biology of the sturgeon chub in the Powder River in Wyoming*. Casper, Wyoming, Proceedings of the Colorado-Wyoming American Fisheries Society Meeting, Wyoming Game and Fish: 38-41.
- Taylor, C. M., and R. J. Miller. 1990. Reproductive ecology and population structure of the plains minnow in central Oklahoma. *American Midland Naturalist* 123: 32-39.
- Weldon, S. J. 1992. *Population status and characteristics of Macrhybopsis gelida, Platygobio gracilis, and Rhinichthys cataractae in the Missouri River Basin*. Brookings, South Dakota State University, M.S. Thesis: 63 pp.
- . 1993a. *Status report on sicklefin chub, a candidate endangered species*. Bismarck, North Dakota, U.S. Fish and Wildlife Service: 41 pp.
- . 1993b. *Status report on sturgeon chub, a candidate endangered species*. Bismarck, North Dakota, U.S. Fish and Wildlife Service: 58 pp.
- Whitaker, J. O., Jr. 1977. Seasonal changes in food habits of some cyprinid fishes from the White River at Petersburg, Indiana. *American Midland Naturalist* 97(2): 411-418.
- Winston, M. R., C. M. Taylor, and J. Pigg. 1991. Upstream extirpation of four minnow species due to damming of a prairie stream. *Transactions of the American Fisheries Society* 120:98-105.