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Fish Community Persistence in Eastern North and South Dakota Rivers

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FISH COMMUNITY PERSISTENCE IN EASTERN NORTH AND SOUTH DAKOTA RIVERS

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ABSTRACT—Over the past 25 years, the James River in North and South Dakota has experienced records in minimum and maximum discharge. Our objectives were to compare: (1) the fish community in the main river after dry (1988-90) and wet (1993-2000) years, and (2) the fish community of both the main river and tributaries between dry (1975) and wet (1998-2000) years. In South Dakota in the main river, there were 10 families and 29 species after several dry years and 11 families and 35 species after several wet years. Percichthyidae was the additional family after the wet years. Basinwide, there were 41 species present after the dry 1970s and 50 species after the wet 1990s. Overall, 93% of the species collected in 1975 have persisted. Our results provide some support for the flood pulse concept, and the findings suggest that the fish community can be useful for biomonitoring of prairie streams.

Key Words: fish communities, hydroperiod, James River, natural variability, persistence, prairie streams

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Introduction

The stochastic nature of prairie streams leads to systems predominantly influenced by abiotic controls (Poff and Ward 1989) that foster persistent fish communities with unstable populations (Grossman et al. 1982; Ross et al. 1985; Schlosser 1985; Schlosser 1987; Matthews et al. 1988). The interannual cycling of wet and dry years provides a temporal scale within which stream flows vary and fish communities must adapt (Poff and Ward 1989). The climatic gradient in the Northern Glaciated Plains ecoregion (Omernik 1987) further influences the degree to which flow regimes modify stream fish communities (Cross et al. 1986; Milewski et al. 2001). For example, fish communities in semiarid landscapes often have low species richness and are more tolerant to fluctuating physicochemical conditions than are fish communities in more mesic, subhumid landscapes (Maret and Peters 1980; Matthews 1988; Schlosser and Ebel 1989; Bramblett and Fausch 1991; Strange et al. 1992; Poff and Allan 1995). Habitat guilds may form in hydrologically stable systems (Horwitz 1978; Bain et al. 1988; Taylor et al. 1996), but they typically do not form in hydrologically variable systems (Angermeier and Schlosser 1989) such as northern prairie streams where fish with generalist life-history strategies are successful (Matthews 1988).

Fish persistence is usually evaluated at the level of species (e.g., Matthews et al. 1988) or assemblage (e.g., Ross et al. 1985). Species persistence is the continued existence of a species over time (Connell and Sousa 1983). Persistence depends on the scale examined (Anderson et al. 1995) and degree of environmental stress (Bonner and Wilde 2000). Nationwide, about 40 fish species are extinct and many species (about 37% of about 790 in the US) are declining (Hughes and Noss 1992). No species in the prairie region is known to have become extinct (Miller et al. 1989), but several species in the southern Great Plains are threatened (Cross et al. 1985). The persistence of fishes in the northern Great Plains is less well known. In fact, Rabeni (1996) omitted all major stream systems in South and North Dakota (except the Little Missouri River) from his discussion of the status of prairie-stream fishes. However, new information on the fishes of South Dakota rivers indicate that most species have persisted over periods of 30 to 40 years (Braaten and Berry 1997; Dieterman and Berry 1999).

The ichthyofaunal record of James River fishes spans 100 years. The fish community has changed somewhat over 110 years, although data from historical surveys are difficult to assess. Six species may have been extirpated in the early 1900s, and seven species introduced to make up the 57

species that have been recorded in one or more surveys between 1970 and 1990 (reviewed by Berry et al. 1993). Our survey of the James River fish community in 2000 allowed us to characterize the persistence of fish over a 25-year period and compare temporal changes in the fish community of the James River with those in the Big Sioux and Vermillion Rivers. Record high discharges from 1993 to 1998 and historic data from drought years (Elsen 1977; Walsh 1992) allowed us to examine species presence between wet and dry periods.

Study Site

The 1,195-km-long James River is located in the Central Lowlands Province of the upper Great Plains (Fig. 1). The basin is situated on a subhumid to semiarid climatic gradient from east to west and is characterized by alternating wet years of prolonged flooding and high discharge, and dry years of extended drought and intermittent flows (Fig. 2). The watershed drains approximately 21,000 km^2 of central North Dakota and 36,000 km^2 of eastern South Dakota. The Lake Dakota Plain has a gradient of about 0.02 m/km, whereas the rest of the channel averages 0.05 m/km (Owen et al. 1981; US Army Corps of Engineers 1992), making the James River one of the flattest rivers in the United States and thus prone to flooding (Benson 1983).

The basin is characterized by row-crop agriculture and livestock grazing, both of which reduce water quality (Owen et al. 1981; SD-DENR 2000). Approximately 230 low head dams and rock crossings impede flows and sometimes fish migration during low flows. The fish community has been repeatedly inventoried (Berry et al. 1993), but most studies have been conducted after droughts. A catfish (Ictaluridae), carp (Cyprinidae), and carpsucker (Catostomidae) community characterizes the fish assemblage of the James River, while northern pike (*Esox lucius*) and channel catfish (*Ictalurus punctatus*) are the two primary game fish (Berry et al. 1993; Shearer 2001). Fish communities are influenced by the Missouri River in the lower portion of the basin.

Methods

Main Stem, South Dakota

In the South Dakota portion of the James River we refer to the 1989-90 study sites as dry-year sites and the 2000 study sites as wet-year sites

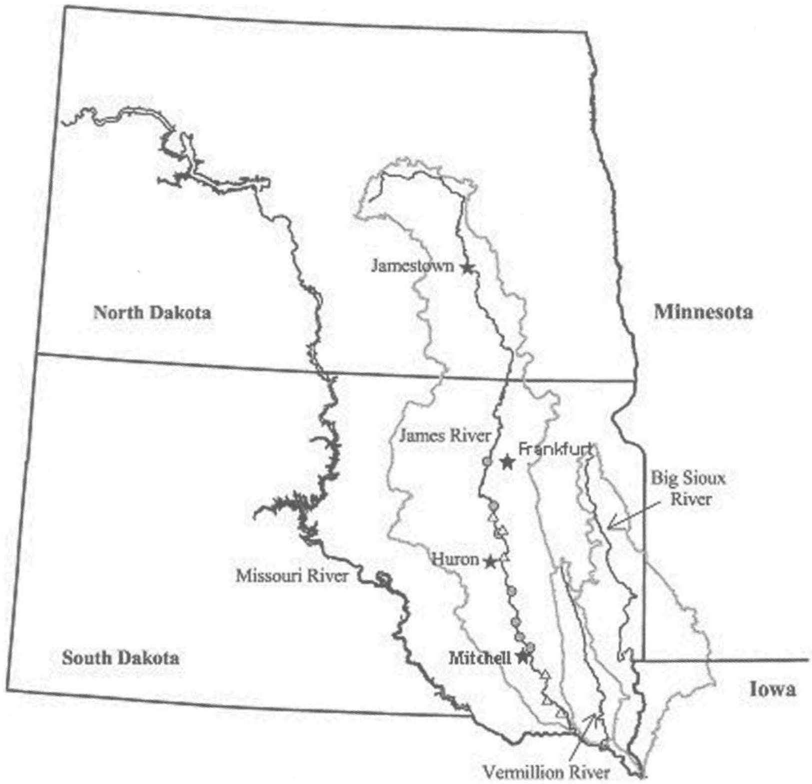
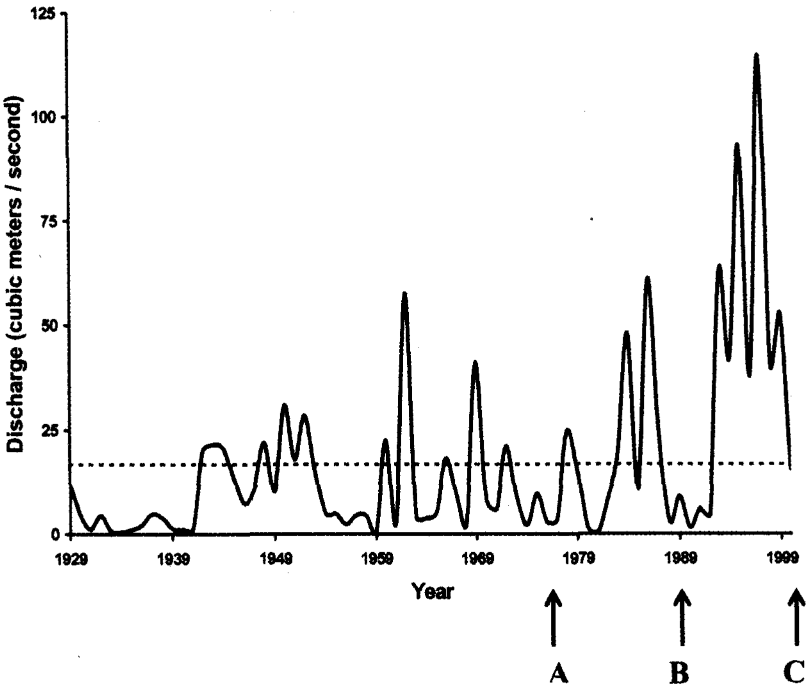


Figure 1. Map of James River watershed in North and South Dakota. Dry year (1989-90) study sites are designated by circles and wet year (2000) study sites are designated by triangles. Scale: 1 inch = approximately 117 kilometers.

(Fig. 1). Wet years had a mean annual discharge above the historical average, whereas dry years had a mean annual discharge below the historical average. Both studies were conducted from early June through late August. Thirty-eight dry-year sites were located in the middle portion of the river between Frankfort and Mitchell (Fig. 1). These sites represented either complex or simple habitats because of the particular study objectives (Walsh 1992). Complex habitats were snags, low head dams or rock crossings, gravel or hard-bottom substrates, or tributary confluences. Simple habitats were areas where no dominant instream structure existed.



A: sampled by Elsen (1977)
B: dry year sites (Walsh 1992)
C: wet year sites (Blausey 2001, Shearer 2001)

Figure 2. Mean annual discharge records of the James River near Scotland, SD. The interannual cycling of low-water years (e.g., 1988-1992) and high-water years (e.g., 1993-1998) has characterized the basin since discharge records were first recorded in 1929 (USGS 2000). Dashed line indicates historical average. Sample dates were (A) 1975, (B) 1989-90, (C) 1998-2000. Sources: (A) sampled by Elsen (1977), (B) dry year sites of Walsh (1992), (C) wet year sites of Shearer (2001) and Blausey (2001).

Dry-year sites were sampled once using a seine (30.5 x 1.5 m bag seine, 6.4 mm mesh). Double-wing trap nets (12.7 mm mesh) were placed at the upstream and downstream limits of the habitat being sampled. Seining was then conducted between the trap nets that were stretched from bank to bank, thus acting as block nets (Walsh 1992). Three to five seine hauls were conducted for each habitat sampled. The blocked reaches were then poisoned to determine seining efficiency.

TABLE 1
TOTAL CATCH AND RELATIVE ABUNDANCE OF EACH SPECIES OF THE 1989-90 (DRY YEAR) AND 2000 (WET YEAR) STUDIES ON THE MAIN STEM OF THE JAMES RIVER IN SOUTH DAKOTA

Family *Scientific name*	Common name	No. collected (1989-90)	Relative abundance (%)	No. collected (2000)	Relative abundance (%)
Lepisosteidae					
Lepisosteus osseus	Longnose gar	2	T	2	T
L. platostomus	Shortnose gar	314	0.6	81	0.8
Hiodontidae					
Hiodon alosoides	Goldeye	381	0.8	128	1.2
Clupeidae					
Dorosoma cepedianum	Gizzard shad	14,229	28.0	375	3.6
Cyprinidae					
Cenopharyngodon idella	Grass carp			1	T
Cyprinella lutrensis	Red shiner	9,745	19.2	2,434	23.2
Cyprinus carpio	Common carp	2,621	5.2	1,413	13.5
Hybognathus hankinsoni	Brassy minnow			19	0.2
Luxilus cornutus	Common shiner			19	0.2
Notropis atherinoides	Emerald shiner	1,977	3.9	1,161	11.1
N. dorsalis	Bigmouth shiner			77	0.7
N. ludibundus	Sand shiner	7,967	15.7	555	5.3
Pimephales promelas	Fathead minnow	905	1.8	411	3.9
Semotilus atromaculatus	Creek chub	1	T		
Catostomidae					
Carpiodes carpio	River carpsucker	675	1.3	118	1.1
C. velifer	Highfin carpsucker			1	T
C. cyprinus	Quillback			3	T
Catostomus commersoni	White sucker	45	T	39	0.3
Cycleptus elongatus	Blue sucker			26	0.2
Ictiobus bubalus	Smallmouth buffalo			85	0.8
I. cyprinellus	Bigmouth buffalo	615	1.2	84	0.8
Moxostoma macrolepidotum	Shorthead redhorse	321	0.6	279	2.7
Ictaluridae					
Ameiurus melas	Black bullhead	3,481	6.9	2,067	19.7
A. natalis	Yellow bullhead	223	0.4	96	0.9
Ictalurus punctatus	Channel catfish	458	0.9	516	4.9
Pylodictis olivaris	Flathead catfish	5	T	86	0.8
Noturus flavus	Stonecat			1	T
N. gyrinus	Tadpole madtom	18	T		
Esocidae					
Esox lucius	Northern pike	353	0.7	153	1.5
Percichthyidae					
Morone chrysops	White bass			2	T
Centrarchidae					
Lepomis cyanellus	Green sunfish	18	T	9	T
L. humilis	Orange spotted sunfish	1,364	2.7	16	0.2
L. macrochirus	Bluegill	113	0.2	4	T
M. salmoides	Largemouth bass	75	0.1	6	T
Pomoxis annularis	White crappie	1,313	2.6		
P. nigromaculatus	Black crappie	1,598	3.1	29	0.3
Percidae					
Etheostoma nigrum	Johnny darter	3	T		
Stizostedion vitreum	Walleye	216	0.4	35	0.3
Sciaenidae					
Aplodinotus grunniens	Freshwater drum	1,738	3.4	141	1.3
Total number of individuals:		50,774		10,472	

Note: T < 0.1%

TABLE 2
COMPARISON OF FISH PRESENCE AND LOCATION IN JAMES RIVER BASIN IN 1975 AND IN 1998-2000

Family *Scientific name*	Common name	Presence and location[a] 1975	2000
Lepisosteidae			
Lepisosteus platostomus	Shortnose gar	S	S
L. osseus	Longnose gar		S
Clupeidae			
Dorosoma cepedianum	Gizzard shad	S	S
Hiodontidae			
Hiodon alosoides	Goldeye	S	S
Cyprinidae			
Campostoma anomalum	Central stoneroller	S	S
Cenopharyngodon idella	Grass carp[c]		S
Cyprinella lutrensis	Red shiner	S	S
Cyprinus carpio	Common carp[c]	N, S	N, S
Hybognathus hankinsoni	Brassy minnow		S
Luxilus cornutus	Common shiner	N, S	N, S
Notropis atherinoides	Emerald shiner	S	S
N. dorsalis	Bigmouth shiner	S	S
N. hudsonius	Spottail shiner	S	N
N. ludibundus	Sand shiner	N, S	N, S
N. topeka	Topeka shiner	S	S
Pimephales notatus	Bluntnose minnow		S
P. promelas	Fathead minnow	N, S	N, S
Rhinichthys atratulus	Blacknose dace	N	N
R. cataractae	Longnose dace		S
Semotilus atromaculatus	Creek chub	N, S	N, S
Catostomidae			
Carpiodes carpio	River carpsucker	N, S	S
C. velifer	Highfin carpsucker		S[b]
C. cyprinus	Quillback		S
Catostomus commersoni	White sucker	N, S	N, S
Cycleptus elongatus	Blue sucker		S
Ictiobus bubalus	Smallmouth buffalo	S	S
I. cyprinellus	Bigmouth buffalo	N, S	S
Moxostoma macrolepidotum	Shorthead redhorse	N, S	N, S
Ictaluridae			
Ameiurus melas	Black bullhead	N, S	N, S
A. natalis	Yellow bullhead	S	S
Ictalurus punctatus	Channel catfish	S	S
Noturus flavus	Stonecat		S[b]
N. gyrinus	Tadpole madtom	N, S	N, S
Pylodictis olivaris	Flathead catfish	S	S
Esocidae			
Esox lucius	Northern pike	N, S	N, S
Cyprinodontidae			
Fundulus sciadicus	Plains topminnow	S	S
Gasterosteidae			
Culaea inconstans	Brook stickleback	N, S	N
Percichthyidae			
Morone chrysops	White bass	S	S

Table 2 continued on next page

TABLE 2 continued

Family *Scientific name*	Common name	Presence and location[a] 1975	 2000
Centrarchidae			
Lepomis cyanellus	Green sunfish	S	N, S
L. humilis	Orange-spotted sunfish	N, S	N, S
L. macrochirus	Bluegill	N, S	N, S
Micropterus dolomieu	Smallmouth bass	S	S[b]
M. salmoides	Largemouth bass	S	N, S
Pomoxis annularis	White crappie	S	S
P. nigromaculatus	Black crappie	N, S	N, S
Percidae			
Etheostoma exile	Iowa darter	N	N
E. nigrum	Johnny darter	N, S	N, S
Perca flavescens	Yellow perch	N, S	N, S
S. vitreum	Walleye	N, S	N, S
Sciaenidae			
Aplodinotus gruniens	Freshwater drum	S	S

Sources: Data from 1975 are from Elsen (1977) and data collected from 1998 to 2000 are from this study, the North Dakota Department of Health (unpublished data), and Blausey (2001).
[a]N = collected in North Dakota; S = collected in South Dakota.
[b]One specimen only.
[c]Exotic species.

(79%). Five species, Mississippi silvery minnow, hornyhead chub, blacknose shiner, brown bullhead, and blackside darter, have not been reported in the basin since 1929 (Table 3). Five species collected during 1998-2000—grass carp, longnose dace, highfin carpsucker, quillback, and stonecat—were not previously reported (Table 3).

Discussion

Main River, South Dakota

Comparison between the 1989-90 and 2000 study periods suggests that the fish community in the main river in South Dakota has remained fairly persistent even though hydrological conditions varied greatly for several years preceding each study. We did not find the tadpole madtom, creek chub, and johnny darter, but these species may not have been vulnerable to electrofishing and hoop nets used on the main river in 2000. These species are common in eastern South Dakota in small streams and tributaries (Bailey and Allum 1962; Pflieger 1997), which is where we found them.

TABLE 3
SUMMARY OF SPECIES THAT HAVE BEEN EXTIRPATED FROM OR EXPANDED INTO THE JAMES RIVER BASIN IN NORTH AND SOUTH DAKOTA

Species	Comment
Extirpated or reduced:	
Blackside darter	One specimen reported in 1896 in North Dakota, possibly misidentified. Recently collected in Big Sioux drainage (Dieterman and Berry 1995).
Blacknose shiner	Last reported in James River in 1896 and not collected in eastern South Dakota since 1957. Drought and land use may have restricted this species' distribution as it prefers clear, cool waters.
Brook stickleback	Last reported in South Dakota portion of James River in 1975, but is common in South Dakota wetlands and the headwaters of the James River.
Brown bullhead	Last reported in North Dakota in 1896, James River basin is on extreme western edge of species' range.
Hornyhead chub	Not collected in James River since 1929. James River basin may be extreme western edge of range. Last reported in Big Sioux drainage in 1890. Bailey and Allum (1962) only report species in Minnesota River drainage.
Mississippi silvery minnow	Last found in James River in 1929 in North Dakota. Possibly mistaken for western silvery minnow.
Spottail shiner	Previously reported in one tributary of James River in South Dakota. Possibly mistaken for sand shiner. Currently found in North Dakota portion of James River.
Expanded or introduced species:	
Grass carp	Exotic species introduced into Mississippi drainage. Extended range into eastern South Dakota rivers via the Missouri River.
Longnose dace	Ubiquitous in western South Dakota streams. Only collected in one James River tributary in South Dakota, possibly introduced by accidental stocking as this species is not found in other eastern South Dakota streams.
Highfin carpsucker	Native to Missouri River, may have extended range into James River basin as Schmulbach and Braaten (1993) report similar occurrence in Vermillion River.
Quillback	Common to Big Sioux and Missouri rivers, may have extended its range similar to highfin carpsucker.
Stonecat	Reported by Bailey and Allum (1962) in all major drainages of South Dakota. Often missed by sampling due to low occurrence and inactiveness during daylight.

These species may use the main river during dry years when some tributaries are intermittent, but otherwise they are associated with low-order streams. White crappie were not found during wet years in the main stem, but we collected them in a tributary. White crappie were relatively rare compared to black crappie (Table 1) and might have been missed or absent because they moved into tributaries to avoid high flows and turbidity (Jenkins and Burkhead 1993; Kelsch 1994).

Several factors may contribute to the presence of species reported in the main river only during wet years. River reaches near the confluence with the Missouri may have a different fish community because of the addition of Missouri River species (Bailey and Allum 1962; Berry et al. 1993). We had more sample sites in the lower river than did Walsh (1992), so we were more likely to find blue suckers and white bass, but we did not find them at middle river sites. Flooding from 1993 to 1999 would allow Missouri River fishes (e.g., stonecat, highfin carpsucker, quillback, smallmouth buffalo) to extend their distribution upstream. Lyons (1996) classified highfin carpsucker and quillback as riverine specialists, suggesting their preference for deep pools in large rivers. These species may only inhabit the James River during elevated flows when habitat conditions more closely resemble those of the Missouri River. Golden (1987) also reported increased species richness following a year of high discharge in a Nebraska tributary to the Missouri River. Spawning success of smallmouth buffalo increased significantly in the Ohio River after water levels inundated adjacent fields (Emery et al. 1999), possibly explaining the presence of smallmouth buffalo in the James River following wet years. Exotic grass carp have been expanding their range in the Mississippi River basin (Pflieger 1997). Our finding is the first report of this species in the James River. Grass carp and bighead carp (*Hypophthalmichthys nobilis*) have been recently found in the Big Sioux River (Berry unpublished data), suggesting that the latter species also may eventually be found in the James River.

Whole Basin, North and South Dakota

Examining fish community variation over the past 25 years also reveals a strong pattern of persistence, as only two species collected in South Dakota during 1975 were not found recently. The brook stickleback prefers sluggish to standing waters that are clear and well vegetated (Bailey and Allum 1962), and they typically inhabit small, headwater streams, alkali lakes, and marshes (Owen et al. 1981). Accordingly, Elsen (1977) found brook stickleback only in South Dakota at sites within or adjacent to the

Sand Creek National Wildlife Refuge (NWR). By impounding the James River, which created a marshy, lentic environment at the Sand Creek NWR, an ideal habitat for the brook stickleback was created. Since this section of river was not sampled from 1998 to 2000, the brook stickleback probably still exists within the Sand Creek NWR and many palustrine wetlands (Carlson and Berry 1990). Spottail shiner was found in Firesteel Creek during 1975. We sampled this creek during this study, but no spottail shiners were found.

The same pattern of species persistence over the past quarter century can also be observed in the North Dakota portion of the James River basin. Elsen (1977) reported bigmouth buffalo and river carpsucker at one site in North Dakota in 1975, but neither species was found in North Dakota in this study. These two species are commonly found in the James River in South Dakota, but they are rare in the upper James River watershed.

The presence of blue suckers in the lower James River may have been caused by the high, perennial flows of the mid- to late 1990s. Elsen (1977) sampled sites throughout the lower river during a drought (Fig. 2) and did not record the blue sucker. The native blue sucker is adapted to turbid, free-flowing rivers (Bailey and Allum 1962; Pflieger 1997). Impoundment of the Missouri River may have forced the blue sucker into unimpounded tributaries, such as the James River, where habitat was more favorable (Schmulbach and Braaten 1993).

Comparison to Vermillion and Big Sioux Rivers

The fish community in the James River basin has displayed a pattern of persistence similar to that in the Big Sioux and Vermillion basins over the latter half of the 20th century (Table 4). Multiple sites on these rivers and their tributaries have been sufficiently sampled to assess population trends over several decades. Native species, such as blacknose shiner, hornyhead chub, golden shiner, and Mississippi silvery minnow, have not been reported in the last half of the 20th century. The loss of such species that prefer clear vegetated waters may be due to the loss of habitat or diminishing water quality (Owen et al. 1981; Dieterman and Berry 1998). Conversely, some of these species may have been misidentified in historical collections while others are on the edge of their range and have always been rare in South Dakota (Dieterman and Berry 1998).

South Dakota streams have remained largely unchanged in their fish-assemblage structure when compared to most other midwestern systems. Many studies have documented degradation to aquatic systems throughout

TABLE 4
TEMPORAL CHANGE IN FISH COMMUNITY STRUCTURE IN THREE EASTERN SOUTH DAKOTA RIVERS

	James River 1975, 1998-00	Vermillion River 1956-59, 1991	Big Sioux River 1967-70, 1992-94
Number of species:	41, 50	40, 41	48, 48
Number of natives:	31, 39	32, 32	38, 40
Number of exotics:[a]	1, 2	1, 1	1, 1
Number of introduced species:[b]	9, 9	7, 8	9, 9
Number of rare and endangered species:[c]	2, 5	2, 2	6, 4
Number of large river species:[d]	13, 17	13, 14	13, 18
Number of species lost:	0	3	7
Number of species gained:	9	4	7
Percentage (%) of species persisting between study periods:	93[e]	93	85

[a] Those species introduced into South Dakota streams that are only native to waters outside the United States and Canada.
[b] Species that are native to South Dakota waters (i.e., lakes and reservoirs) or adjacent states but not originally found in eastern South Dakota rivers.
[c] Designated as rare, threatened, or endangered as of April 2000 by the South Dakota Natural Heritage Program of South Dakota Game, Fish, and Parks.
[d] Denotes species that typically occur in lotic systems whose watershed is greater than 2,000 mi^2 (Simon and Emery 1995).
[e] Average of species persisting in North Dakota (90%) and South Dakota (95%) portions of the basin.

the Midwest (e.g., degraded water quality, wetland drainage, channelization, and habitat fragmentation) that have contributed to the decline of native fishes. In Ohio and Illinois, Karr et al. (1985) reported that 44% of fish in the Maumee River and 67% of fish in the Illinois River have declined or been extirpated. Similarly, Larimore and Bayley (1996) report an absence of 18 species in recent collections in Champaign County, IL. Menzel (1981), Menzel et al. (1984), Cross and Moss (1987), Echelle et al. (1995), and Patton et al. (1998) indicate negative changes in the fish communities of Iowa, Kansas, Oklahoma, and Wyoming as a result of intensive agriculture, channelization, reservoir construction, and water withdrawal for irrigation.

Extensive extirpations have also been reported in other midwestern systems by Johnson (1995) and Karr and Chu (1999).

The rivers of eastern South Dakota remain relatively free-flowing and unaltered. South Dakota has lost 35% of its wetlands (Dahl 1990), and about 3% of its stream channels have been altered (Johnson and Higgins 1997). However, these estimates are still less than for wetlands and streams in any other midwestern state. Rivers in western South Dakota have also retained most of their native species (Hampton and Berry 1997; Loomis et al. 1999; Fryda 2001). While native fish are well adapted to prairie streams, the harsh nature of these systems most likely creates an environment unsuitable for introduced species (Gido et al. 2000). The adaptability of native prairie-stream fish fosters their persistence, but habitat conservation has likely been an important factor contributing to the persistence of South Dakota stream fishes. For example, the Topeka shiner (*Notropis topeka*), recently added to the federal endangered species list, is more abundant in South Dakota than in the other five midwestern states within its range (Blausey 2001).

Historical comparisons are often biased because sampling has been performed with different equipment and during different hydrologic phases. For example, most studies on the James River, such as Elsen (1977) and Walsh (1992), took place following several years of drought conditions, while our study took place during and following several years of flooding. Other studies dealing with long-term changes in fish communities, such as Hughes and Gammon (1987), Rutherford et al. (1992), and Dieterman and Berry (1998), have attempted to discern temporal trends in fish assemblages. Using multiple equipment, sampling multiple habitats, and examining only the presence of species are ways of reducing some of the biases. Even with the biases associated with long-term community comparisons, such studies have provided helpful insight into historical changes in the ichthyofaunal assemblages of lotic systems (Onorato et al. 2000).

In summary, the interannual variability in flow regime of the James River has resulted in a fish community capable of tolerating harsh physicochemical conditions. As in other South Dakota rivers, there have been some extirpations and introductions, yet most native species found there 25 years ago remain in the basin today. Although we expect fish populations to be unstable since habitat is unstable, species should persist as long as habitat complexity and a range of instream flows are maintained. Conservation goals for prairie-stream fishes should include protection of water flows, unique environments, dispersal routes, water quality, and management of nonnative fishes.

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