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Distribution of Channel Catfish Life Stages in a Prairie River Basin

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ABSTRACT -- To describe the pattern of use by age 0, juvenile, and adult channel catfish (*Ictalurus punctatus*) in a prairie river basin, we collected concurrent samples from tributaries and mainstem study sites in the Grand River basin of northern Missouri. Using standardized methods, we made collections in June, August, and October of 1997 and 1998. Age 0 channel catfish were found in all three streams in August, but rarely were observed in the tributaries during October. Juveniles (ages 1-3) and adults were observed in all three streams in all three months sampled. Tag returns suggested that age 2 and over channel catfish moved to overwintering locations in deepwater habitats in the mainstem river.

Key words: Grand River, *Ictalurus punctatus*, life stage, Missouri, river basin, streams.

Presumably, channel catfish (*Ictalurus punctatus*) seasonal movements in streams are purposeful annual migrations from wintering areas to spawning areas to summer feeding areas with an autumn return to wintering areas (Hubert 1999). Radio telemetry and tag returns have been used by several investigators to propose a pattern of upstream movement in spring, localized movement in summer, and downstream movement in fall (Dames et al. 1989, Newcomb 1989, Peters et al. 1992, Pellett et al. 1998). Male channel catfish were radio tagged in the spring and tracked to spawning sites in the Powder River system of Wyoming-Montana (Gerhardt 1989, Gerhardt and Hubert 1990). Spawning sites were located in upper-watershed mainstem reaches as well as tributaries. In the lower Wisconsin River

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adults displayed homing behavior, and returned to the same summer home sites in more than one year. Smaller fish were more likely to stray from summer home sites than larger catfish (Pellett et al. 1998). Some channel catfish were known to overwinter in deepwater, low current habitats in the Missouri and Mississippi rivers (Hawkinson and Grunwald 1979, Newcomb 1989, Robinson 1994, Pellett et al. 1998).

Larval channel catfish were known to drift with the current after leaving the nest and were suggested either to be feeding directly on drifting invertebrates or are swept away by the current while feeding on benthic invertebrates (Armstrong and Brown 1983, Muth and Schmulbach 1984, Gerhardt 1989, Patton and Hubert 1996). The extent of downstream displacement from drifting is not known. Little information is available on the movements of fingerling-sized juvenile channel catfish. Larger juveniles often have been included in tagging studies but were not differentiated from sexually mature adults.

The variety of stream sizes, seasons, and broad range of size classes of channel catfish sampled in the Grand River basin of northern Missouri, coupled with the absence of major dams in the basin, offered a unique opportunity to characterize basin use and movement of channel catfish life stages. Our objective was to characterize the similarities and differences in the distributions of the age 0, juvenile, and adult life stages and to determine whether individual channel catfish move between tributaries and the mainstem river.

STUDY AREA and METHODS

The Grand River basin in northern Missouri (Fig. 1) is characterized by broad, flat stream valleys and rolling to undulating (occasionally hilly) uplands (Pfleiger 1989), historically characterized by long narrow prairies divided by wooded ridge tops and savanna near stream banks (Schroeder 1982). Land use today is predominantly agricultural with tilling in floodplain fields and channelization apparent in headwater and tributary reaches as well as major sections of the mainstem river.

Yellow Creek in Chariton County at the study reach was a fifth order stream with a base flow of approximately 1.9 m^3 per second and a wetted width of approximately 5 m. The streambed was a sand and silt mixture. Big Creek in Daviess County was also a fifth order stream, but had a base flow of approximately 3.4 m^3 per second and a wetted width of approximately 11 m. The streambed was a sand, silt, and gravel mixture due to bedrock outcrops associated with localized pool-riffle complexes. Grand River at the study reach, also in Daviess County, was a seventh order stream and had a base flow of approximately 7.1 m^3 per second and a wetted width of approximately 19 m. Substrates were dominated by sand and silt with gravel and clay particles locally abundant. Boulder-sized rock particles were

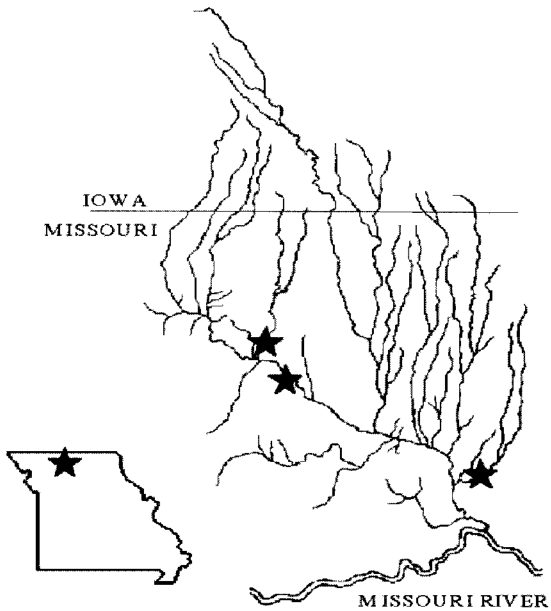

Figure 1. Location of the Grand River basin in Missouri with depiction of the basin showing locations of the three 10-km study reaches marked by stars with Big Creek, Grand River, and Yellow Creek left to right, respectively.

present as the result of bank stabilization riprap practices.

Our sampling design allowed for comparison of length-frequency histograms from streams of differing sizes. Sampling occurred by using standardized methods concurrently in the mainstem Grand River, a medium tributary (Big Creek), and a small tributary (Yellow Creek) within each of three months spaced throughout the growing season.

Within a 10-km reach of each stream, we designated three evenly distributed 200-m sampling sites. Sites were sampled during June, July, and October in 1997 and 1998. Sampling consisted of 15 hoop net sets consisting of ten 25.4-mm and five 13-mm mesh cheese-baited nets. See Vokoun and Rabeni (2001) for a detailed description of the sampling protocol. Hoop net sets were fished for 24-hr periods at all sample locations and equal effort was attempted at all locations however occasional flooding precluded some sampling. Sites were also electrofished with an AC raft that was found to be highly effective for collecting age 0 channel catfish

(Vokoun 1999). Channel catfish 200 mm and larger (n = 2766) were tagged with Carlin dangler tags, which requested return of location information at all sampling sites. Only the 55 tags returned during the calendar years 1997 and 1998 are considered in our manuscript.

Hoop net derived length-frequency histograms of collected channel catfish spanned all life stages except larval and postlarval, which offered a broad look at the population, and served as the basis of a description of channel catfish distribution in the basin. A subset of tag returns that were from fish tagged in fall and recaptured the following spring were used to provide individual examples of movement patterns suggested by the length-frequency histograms. Tag returns, which occurred in winter, provided information on winter locations and the net direction traveled towards and relative basin position of wintering sites.

Channel catfish length categories were assigned an age designation by using length-at-age data and back-calculated estimates. Pectoral spines were removed from a subsample of channel catfish from all sampling sites (n = 346) and aged by Missouri Department of Conservation personnel.

Grand River basin back-calculated length estimates combined for all months showed age 1 fish averaging 114 mm total length (Table 1). Lengths of age 0 channel catfish have been reported to average 66 mm in the Salt River of northeast Missouri (Purkett 1958). Using this information, we delineated age 0 channel catfish as fish up to 100 mm total length. Probably, 76 to 100 mm catfish captured during June sampling were actually age 1 catfish. Channel catfish begin spawning when water temperatures reach about 21° C (Hubert 1999) and the spawning period lasting from the second half of May into July in Missouri (Pflieger 1997) is protracted. Therefore, age 0-sized channel catfish captured in June hoop net sampling likely were the spawn of the previous year (Holland-Bartels and Duval 1988), and by convention became age 1 catfish on 1 January. Therefore, 51 to 100 mm fish were included in the age 1 category for June 1997 and 1998 length-frequencies.

By extrapolating Grand River basin age estimates and comparing with information from the literature (Pitchford and Kerns 1994, Pflieger 1997, Hubert 1999), age 1 catfish were delineated as lengths between 101 and 175 mm, age 2 catfish as 176 and 225 mm, age 3 catfish as 226 and 300 mm, and age 4 and over channel catfish as 301 mm and over. Age 4 and over catfish were not extrapolated into individual age classes based on back-calculated estimates because length-at-age data showed that growth had slowed, and overlap among length categories was common.

The channel catfish reaches sexual maturity at ages 2 to 12 across its natural range (Hubert 1999). Populations from the midwestern United States have reached maturity at ages 4 and 5, at lengths of 300 to 375 mm (Barnickol and Starret 1951, Muncy 1959, Ackerman 1965, DeVore 1982, Holland and Peters 1992). Therefore, age 4 and over length categories of 301 mm and up were considered adult channel

Table 1. Length-at-age and backcalculated length-at-age estimates for channel catfish (n = 346) from the Grand River Basin, Missouri. Fish aged from pectoral spine sections. Length in mm.

		Length-at-Age			Backcalculated	
Age	N	Mean	Min	Max	N	Mean
0	0	0	0	0	346	114
1	0	0	0	0	346	184
2	4	194	173	231	342	241
3	30	252	206	292	312	230
4	76	317	224	470	236	353
5	100	342	246	546	136	412
6	58	394	279	549	78	467
7	44	454	307	668	34	509
8	23	523	337	671	11	528
9	4	587	452	622	7	533
10	3	547	490	607	4	555
11	0	0	0	0	4	592
12	1	693	693	693		
13	0	0	0	0		
14	1	612	612	612		
15	1	706	706	706		
16	1	574	574	574		

catfish. Ages 1 to 3 channel catfish (length categories 101 to 300 mm) were considered the juvenile life stage.

RESULTS

In August 1997 samples, age 0 fish began to be recruited to the hoop nets and were distributed throughout the basin (Fig. 2). August 1998 showed the same pattern of age 0 distribution (Fig. 3).

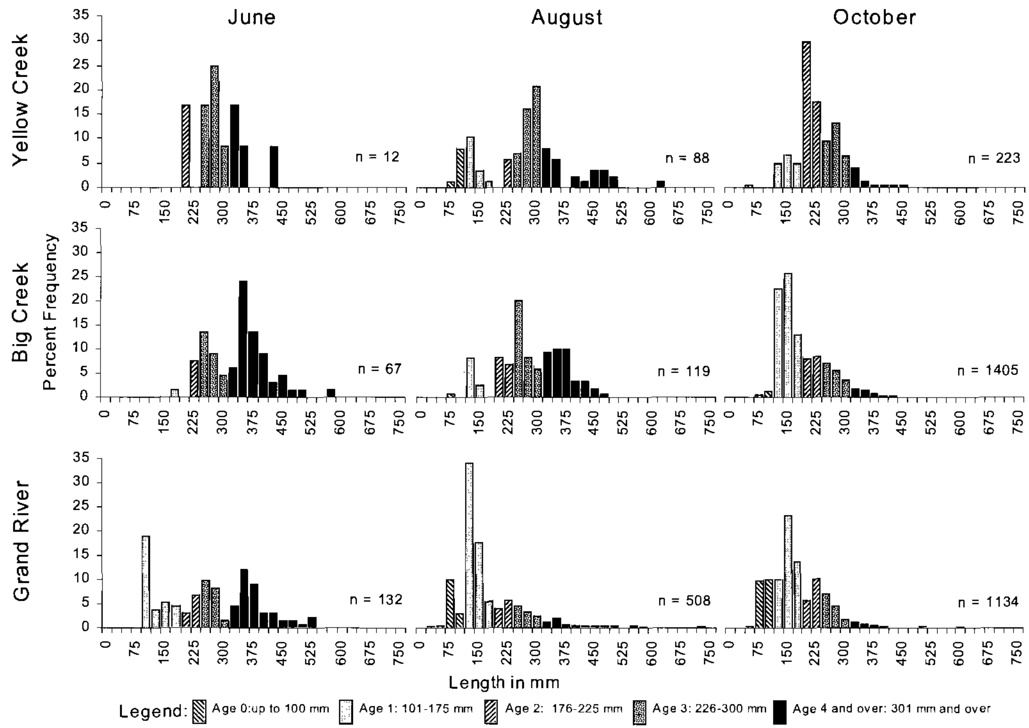

Figure 2. Length-frequency histograms generated by hoop net saturation sets during 1997, which are coded by length-at-age approximations based on a subsample of aged fish collected at all sampling locations. Approximately equal effort is represented for each histogram, except June Yellow Creek sampling which was largely flooded out.

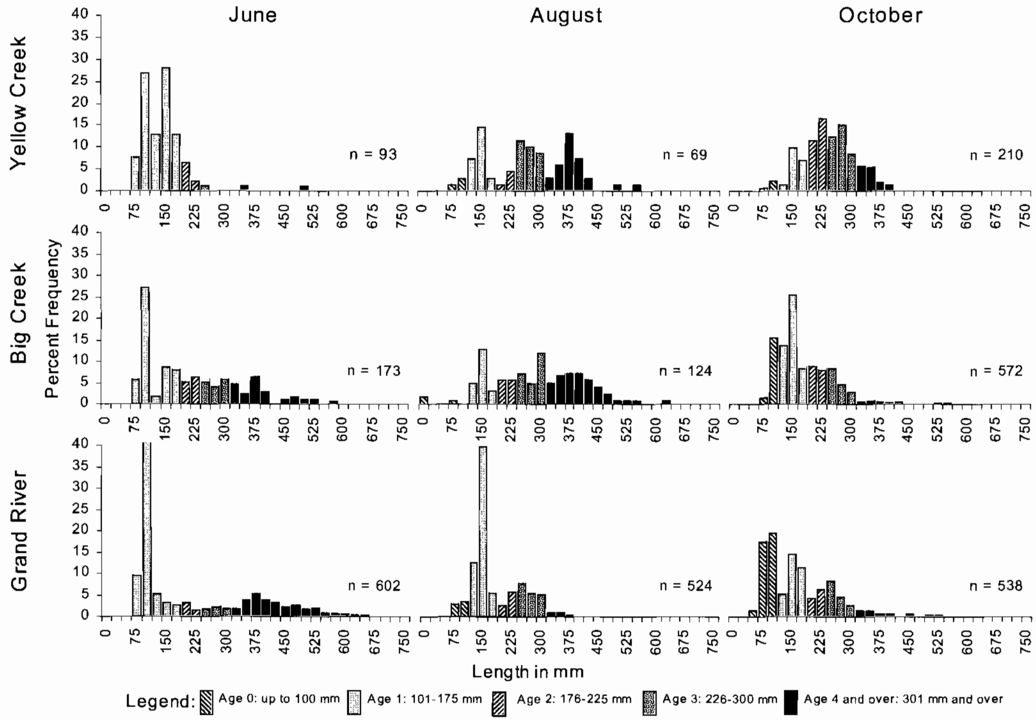

Figure 3. Length-frequency histograms generated by hoop net saturation sets during 1998, which are coded by length-at-age approximations based on a subsample of aged fish collected at all sampling locations. Approximately equal effort is represented for each histogram.

In October 1997, the majority of age 0 channel catfish were collected in the mainstem river. Sparse numbers of age 0 fish also were sampled in tributaries. AC raft electrofishing results also returned low numbers of age 0 channel catfish in the tributary streams. Electrofishing samples in the mainstem revealed age 0 fish to be using the shallow flats of sandbars and channel crossover areas. These habitats were commonly 200 mm or less in depth. Fall 1998 sampling revealed a similar pattern, although a greater number of age 0 catfish were found in Big Creek in October 1998 than in October 1997.

Age 0 catfish sampled in 1997 became the age 1 catfish of 1998. As fingerlings these fish concentrated in the mainstem during October 1997. As age 1 fish they were distributed throughout the three streams sampled in June 1998 (Fig. 3). This suggested some age 1 fish made upstream movements. No exact locations or overwintering habitats were identified for age 1 juveniles that might indicate the timing or extent of upstream dispersal.

Juveniles of age 1 and 2 were distributed throughout the basin in October 1997 (Fig. 2). In June 1998, as age 2 and 3 juveniles, they were distributed throughout the basin as well. Tag return data revealed that some age 2 and 3 juvenile channel catfish (n = 5) did leave the tributaries in fall 1997, congregated in deep, low current habitats, and overwintered in the mainstem river. Missouri Department of Conservation biologists sampled with gill nets a deepwater, low current habitat on Grand River on 19 November 1997. Three tagged channel catfish were recaptured; their lengths were 257, 221, and 211 mm, which delineated them as age 2 and 3 juveniles. All three catfish were originally tagged in the Big Creek tributary and moved downstream to reach the overwintering site. These tag returns indicated that migration toward overwintering habitats had begun by mid-November 1997.

Adult channel catfish were dispersed throughout the mainstem and tributaries in June 1997 and 1998 (Figs. 2 and 3). July sampling revealed adult catfish remaining in tributaries of the Grand River basin in summer. October sampling showed a similar pattern with adult fish remaining distributed throughout the tributaries and mainstem.

Angler tag returns demonstrated that some adult channel catfish (n = 6) moved from tributary streams and congregated at overwintering sites in the mainstem river. Age 2 and 3 juveniles also used these same sites. A single recapture demonstrated that adult catfish present in the mainstem also might move upstream to reach overwintering sites. Of five tag returns spanning fall to spring, four were from fish that were recaptured in the same stream, while the fifth was recaptured in a managed wetland complex located 80 km downstream. No floods capable of making the wetland available to the fish occurred during the capture to recapture dates, therefore it was likely sucked through bypass pumps that are used to fill the wetlands with river water each fall.

DISCUSSION

Channel catfish from the Grand River basin used tributary habitats for the entire growing season. Spring movements upstream have been attributed to spawning activities for adults (Smith and Hubert 1989). Suitable spawning habitats can have higher relative abundance in tributaries than in mainstem rivers (Gerhardt and Hubert 1990). The presence of age 0 catfish in both small and medium tributaries suggested that spawning occurred in both streams. Given that postlarval channel catfish drifted downstream with the current (Armstrong and Brown 1983), and rather unlikely that age 0 fish moved extensive distances back upstream, age 0 catfish found in a tributary probably were spawned upstream in that same tributary. The presence of immature juvenile catfish in tributaries suggested that some upstream movements occurred for purposes other than spawning. Adult fish also remained in tributary habitats beyond the spawning season, which suggested the suitability of these habitats for summer life requisites. Channel catfish in the Powder River basin of Wyoming-Montana moved downstream after spawning, although summer low flows in this high plains system dried up many upstream channels (Gerhardt 1989, Gerhardt and Hubert 1990). Smaller tributaries might have energetic or habitat limitations, as larger adult fish were present (but rare) in smaller streams. An Iowa survey reported that larger adults (> 500 mm) were less common in streams with a drainage area less than 1000 km^2 (Paragamian 1990).

The suggestion of fidelity to a tributary stream is difficult to address with our limited data. Tag returns only provide net movement. Channel catfish of the Wisconsin River showed fidelity to summer reaches (defined as a 4-km length of river), which they returned to after overwintering downstream in the upper Mississippi River and passed tributary habitats in the process (Pellett et al. 1998). However, work with salmonids has shown that even non-anadromous trout species that have long been described as residing in a single pool often have a fluid population structure and make substantial movements, and that mark-recapture studies by design bias against detecting movement (Gowan et al. 1994).

Grand River provides overwintering habitat for age 2 and over channel catfish. Other research has described overwintering habitats for channel catfish in large rivers like the Mississippi and Missouri (Newcomb 1989, Robinson 1994, Pellett et al. 1998, Fago 1999). Our results indicated that channel catfish can overwinter much farther up in the watershed. The habitats that were identified existed in association with bridge supports that confine and scour the river. Much of the mainstem Grand River and its principal tributaries have been channelized. Loss of pool depth was considered the most serious effect of settlement by Europeans in the streams of the Grand River basin (Pitchford and Kerns 1994). Overwintering habitats provided by bridge supports might have a major mitigative function. Radio-tracked channel catfish in the Wapsipinicon River in Iowa were found to congregate and overwinter in a dredged sandpit, which was the deepest habitat available (Gelwicks 1999). Some individual catfish in the lower Wisconsin River moved upstream to use overwinter habitat provided by a dam plunge pool (Pellett et al. 1998, Fago 1999). One recaptured channel catfish in the Grand River basin made a similar upstream movement toward an overwintering site.

The mainstem river also provided extensive shallow water habitat for age 0 and juvenile channel catfish. Research on habitat use by this species in the Platte River, Nebraska, found age 0 and juvenile fish up to 210 mm most often utilized depths of 100 to 300 mm over a sand-dominated substrate with no cover (Peters et al. 1989), although they showed preference for deeper habitats with cover. Observations from electrofishing in the Grand River concurred with Platte River findings. The greater relative abundance of this shallow habitat in the mainstem versus tributaries might explain the relatively large numbers of age 0 and age 1 channel catfish sampled in the mainstem versus tributary streams. In watersheds where the mainstem has a broad, shallow, sandbar-dominated channel, the mainstem might provide the majority of nursery habitat for the channel catfish population.

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LITERATURE CITED

Ackerman, G. L. 1965. Age structure of spawning catfish. Iowa Conservation Commission Quarterly Biological Report 17:52-58.

Armstrong, M. L., and A. V. Brown. 1983. Diel drift and feeding of channel catfish Alevins in the Illinois River, Arkansas. Transactions of the American Fisheries Society 112:302-307.

Barnickol, P. G., and W. C. Starrett. 1951. Commercial and sport fishes of the Mississippi River between Caruthersville, Missouri, and Dubuque, Iowa. Illinois Natural History Survey Bulletin 25:267-350.

Dames, H. R., T. G. Coon, and J. W. Robinson. 1989. Movements of channel and flathead catfish between the Missouri River and a tributary, Perche Creek. Transactions of the American Fisheries Society 118:670-679.

DeVore, L. A. 1982. Fecundity and sexual maturation of channel catfish from the Missouri and its tributaries. Pp. 30-32 *in* The Missouri River Channel Catfish. Sport Fish Restoration Project F-13-R. Technical Series no. 11. Nebraska Game and Parks Commission, Lincoln, Nebraska.

Fago, D. 1999. Movement of channel catfish in the lower Wisconsin River and pools 10 and 11 of the Mississippi River using radiotelemetry. Pp. 177-185 *in* Catfish 2000: Proceedings of the International Ictalurid Symposium. (E. R. Irwin, W. A. Hubert, C. F. Rabeni, H. L. Schramm Jr., and T. Coon, editors). American Fisheries Society Symposium 24, Bethesda, Maryland.

Gelwicks, G. T. 1999. Federal aid to fish restoration annual performance report stream fisheries investigation project no. F-160-R, study 7006, job 2. Iowa Department of Natural Resources, Des Moines, Iowa.

Gerhardt, D. R. 1989. Population dynamics, movement, and spawning of channel catfish in the Powder River system, Wyoming-Montana. M.S. Thesis. University of Wyoming, Laramie.

Gerhardt, D. R., and W. A. Hubert. 1990. Spawning habitat of channel catfish in the Powder River System Wyoming-Montana USA. Prairie Naturalist 22:155-164.

Gowan, C., M. K. Young, K. D. Fausch, and S. C. Riley. 1994. Restricted movement in resident stream salmonids: a paradigm lost? Canadian Journal of Fisheries and Aquatic Sciences 51:2626-2637.

Hawkinson, B., and G. Grunwald. 1979. Observation of a wintertime concentration of catfish in the Mississippi River. Fisheries Section Investigational Report 365. Minnesota Department of Natural Resources, St. Paul, Minnesota.

Holland, R. S., and E. J. Peters. 1992. Age and growth of channel catfish (*Ictalurus punctatus*) in the lower Platte River, Nebraska. Transactions of the Nebraska Academy of Science 19:33-42.

Holland-Bartels, L. E., and M. C. Duval. 1988. Variations in abundance of young-of-the-year channel catfish in a navigation pool of the upper Mississippi River. Transactions of the American Fisheries Society 117:202-208.

Hubert, W. A. 1999. Biology and management of channel catfish. Pp. 3-22 *in* Catfish 2000: Proceedings of the International Ictalurid Symposium (E. R. Irwin, W. A. Hubert, C. F. Rabeni, H. L. Schramm, Jr., and T. Coon, editors). American Fisheries Society Symposium 24, Bethesda, Maryland.

Muncy, R. J. 1959. Age and growth of channel catfish from the Des Moines River, Boone County, Iowa, 1955 and 1956. Iowa State Journal of Science 34:127-137.

Muth, R. T., and J. C. Schmulbach. 1984. Downstream transport of fish larvae in a shallow prairie river. Transactions of the American Fisheries Society 113:224-230.

Newcomb, B. A. 1989. Winter abundance of channel catfish in the channelized Missouri River, Nebraska. North American Journal of Fisheries Management 9:195-202.

Paragamian, V. L. 1990. Characteristics of channel catfish populations in streams and rivers of Iowa with varying habitats. Journal of the Iowa Academy of Science 97:37-45.

Patton, T. M., and W. A. Hubert. 1996. Water temperature affects smallmouth bass and channel catfish in a tailwater stream on the Great Plains. North American Journal of Fisheries Management 16:124-131.

Pellett, T. D., G. J. Van Dyck, and J. V. Adams. 1998. Seasonal migration and homing of channel catfish in the lower Wisconsin River, Wisconsin. North American Journal of Fisheries Management 18:85-95.

Peters, E. J., R. S. Holland, M. A. Callam, and D. L. Bunnell. 1989. Platte River suitability criteria: habitat utilization, preference and suitability criteria for fish and aquatic invertebrates in the lower Platte River. Technical Series 17. Nebraska Game and Parks Commission, Lincoln, Nebraska.

Peters, E. J., R. S. Holland, and B. C. Chapman. 1992. Studies of the channel catfish (*Ictalurus punctatus*) in the lower Platte River, Nebraska. Sport Fish Restoration Project F-78-R, Final Report. University of Nebraska, Lincoln, Nebraska.

Pflieger, W. L. 1989. Aquatic community classification systems. Missouri Department of Conservation Aquatic Series No. 19, Jefferson City, Missouri.

Pflieger, W. L. 1997. The fishes of Missouri. Missouri Department of Conservation, Jefferson City, Missouri.

Pitchford, G., and H. Kerns. 1994. Grand River basin inventory and management plan. Missouri Department of Conservation, Jefferson City, Missouri.

Purkett, C. A. Jr. 1958. Growth of fishes in the Salt River, Missouri. Transactions of the American Fisheries Society 87:116-131.

Robinson, J. W. 1994. Sampling procedures to capture flathead catfish and channel catfish in the Missouri and Mississippi rivers. Sport Fish Restoration Project F-1-R-43, Final Report. Missouri Department of Conservation, Fish and Wildlife Research Center, Columbia, Missouri.

Schroeder, W. A. 1982. Pre-settlement prairie of Missouri. Missouri Department of Conservation, Natural History Series 2, Jefferson City, Missouri.

Smith, J. B., and W. A. Hubert. 1989. Use of a tributary by fishes in a Great Plains river system. Prairie Naturalist 21:27-38.

Vokoun, J. C. 1999. A sampling protocol for channel catfish in small to medium prairie streams of Missouri including notes on watershed level movements. M.S. Thesis. University of Missouri, Columbia.

Vokoun, J. C., and C. F. Rabeni. 2001. A standardized sampling protocol for channel catfish in prairie streams. North American Journal of Fisheries Management 21:188-197.

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