Catfish Movement and Habitat Use in a Missouri River Tributary

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Abstract: Adult channel catfish *(Ictalurus punctatus)* and flathead catfish (*Pylodictis olivaris*) monitored by radiotelemetry made frequent movements within Perche Creek, a tributary of the lower Missouri River. Individuals of both species moved at a rate greater than 50 m/day in >50% of all observations. The favored depth for both species was 1 - 2 m, even though shallower and deeper habitats were available. Both species avoided open water habitat and selected complex woody structure over other cover types. Channel catfish movements were more restricted in Hinkson Creek, an upland tributary of Perche Creek, where habitats >1.5 m deep were rare. Catfish in Hinkson Creek selected the few deep pools available and favored cover types similar to those selected in Perche Creek. Channel catfish in Perche Creek tended to move to the Missouri River, but flathead catfish tended to remain in Perche Creek, even though these 2 species were equally mobile within Perche Creek. For both species, habitat management practices which provide permanently deep habitats (1 - 3 m) are essential, and maintenance of complex instream structure also is important. Flathead catfish populations appear to be more restricted to individual drainages than channel catfish populations. Habitat improvements in tributaries are likely to be of more benefit to Missouri River populations of channel catfish than flathead catfish, but habitat improvements will benefit the resident flathead catfish populations of the tributaries.

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Human manipulation of large rivers for navigation, flood control, and power generation have isolated river channels from their floodplain and reduced the amount of backwater habitat available in most North American large rivers (Funk and

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Robinson 1974, Karr et al. 1985, Hesse et al. 1989). Virtually no backwater habitat remains in the lower Missouri River due to extensive channelization and diversion of flow from backwater lakes and channels. The loss of backwaters has been related to declines in fish abundance, diversity, and harvest (Funk and Robinson 1974, Groen and Schmulbach 1978). Reasons for the declines include the reduced quantity and quality of fish food available in the channelized river (Russell 1965, Morris et al. 1968), reduced spawning and nursery habitat in the channelized river (Hesse et al. 1979, Hergenrader et al. 1982, Brown 1989), and the loss of slow moving water required for lentic species (Ellis et al. 1979).

Much of the remaining backwater habitat in the lower Missouri River is in the lower segments of tributaries. Gradients are extremely low in these habitats and current velocities are slow. Flow is influenced by the damming effect of the Missouri River as well as the runoff from tributary watersheds. The lower 5 - 10 km of most tributaries retain some riparian vegetation, which supplies instream woody structure and provides a more complex habitat than in the Missouri River main channel. Concentrated habitat management in these tributary backwaters, e.g. riparian corridor protection or installation of instream cover structures, may enhance reproduction, growth, and survival of Missouri River fishes by providing productive and complex habitats at crucial life history stages.

Adult channel catfish (TL >250 mm) move extensively between the Missouri River and its tributaries (Dames et al. 1989). Over 59% of all fish captured in the Missouri River within 6.4 km of the mouth of Perche Creek moved between the creek and the river. When we captured these transient fish in Perche Creek, most (72%) were in the lower 8 km of the creek, and nearly all (95%) were within the lower 20 km of the creek. The purpose of the study reported here was to determine which habitat characteristics are selected by adult catfish in Perche Creek. We have compared the habitats selected by radio-tagged catfish to the habitats available and described the seasonal movements of radio-tagged catfish in the tributary. We compared the movements and habitat use of channel catfish and flathead catfish in the lower 18 km of Perche Creek to test the null hypothesis that the 2 species use the tributary in similar ways. We also compared the movements and habitat use of channel catfish in the lower tributary and in a segment farther upstream in the watershed to test the null hypothesis that channel catfish use of floodplain tributary habitats is no different from their use of other tributary habitats.

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Methods

The study area included segments of Perche and Hinkson creeks in central Missouri. Perche Creek drains a watershed of 1,049 km^2 and enters the Missouri

River 273 km upstream of the Missouri River confluence with the Upper Mississippi River. Hinkson Creek is a tributary of Perche Creek which enters Perche approximately 18 km above its mouth. We confined our study area to the lower 18 km of Perche Creek and the lower 15 km of Hinkson Creek.

Perche Creek is a sluggish, floodplain stream over its lower 18 km. Its width increases in a downstream direction from 20 m to 55 m and mean depth increases uniformly from 1.5 m to 4.0 m over this segment. The substrate is primarily sand and silt (Dames 1988). Hinkson Creek is smaller (width 9–14 m, mean depth 0.1–0.5 m) and has a steeper gradient, with a pool-riffle morphology. The substrate of Hinkson Creek includes more gravel, boulder, and bedrock than Perche Creek.

We collected adult channel catfish and flathead catfish with baited hoop nets, a boat-mounted electrofishing unit and bank lines in Perche and Hinkson creeks. We surgically implanted 2-stage radio transmitters (Advanced Telemetry Systems, Isanti, Minn.) connected to a whip antenna into fish weighing 900 g or more (air weight). The transmitters were powered by 1 or 2 ⅔ A lithium batteries and operated at frequencies between 48 and 50 MHz. We used 3 different sizes of transmitters (45 g, 27 g, and 18 g) with life expectancies of 400, 225, and 225 days, respectively. We put a transmitter in a fish only if the transmitter weighed 2% or less of the fish weight in air (Winter 1983). Our surgical procedures were similar to those described by Hart and Summerfelt (1973) with the exception that fish were returned to the creek at the capture location as soon as they had recovered from anesthesia (Dames 1988).

We attempted to locate each fish 1 to 3 times weekly during daylight by use of a boat-mounted yagi antenna and a hand-held loop antenna. We determined the exact location of the fish by moving the loop antenna directly over the fish. At each location, we recorded date, time, depth, distance from the mouth of Perche Creek, and cover type. We determined the distances from the mouth of Perche Creek by use of measured landmarks, maps, and a 1,200-m rangefinder (Ranging, Inc., Rochester, N.Y.). We distinguished between the following cover types based on the cover visible from the water surface: open water (no visible cover), log (1 or 2 logs, lacking branches), log complex (aggregate of 3 or more logs and branches), fallen tree (single tree complete with branches), standing tree (upright and rooted tree with trunk surrounded by water), root complex (root system of fallen or standing tree), rock (large boulder in stream or along shore of stream), overhanging bank, and vegetation (living terrestrial or aquatic herbaceous plants).

To describe movements of the fish, we calculated the daily movement rate (stream distance moved between successive locations divided by number of days between locations) for each location determined after release. Preliminary tests showed that the daily movement rate data were not normally distributed and that statistical tests based on measures of central tendency were not appropriate. Instead, we divided these values into 4 distance categories: 0 –1.0 m/day, 1.1–50.0 m/day, 50.1–250 m/day and >250 m/day and used χ^2 analysis to determine if the distributions of movement types differed between species and between seasons for each species (Stang and Nickum 1985). When we found a significant difference in distributions, we separated the contingency tables into smaller tables to determine which species or seasons were responsible for the difference (Snedecor and Cochran 1982). We also divided daily movement rate observations into directional categories (upstream, downstream, no move) to determine if direction of movements varied with seasons.

We compared use and availability of habitat types by recording the frequency of fish locations in different habitat categories. Each location of a fish was used as an observation of habitat use for that fish. We calculated the frequency of occurrence (%) in different habitat types for each fish and then averaged over all fish to obtain a representative utilization distribution for each species in each season. We described habitat availability distributions based on measurements taken at 6 randomly selected 100-m segments of Perche Creek and 3 100-m segments in Hinkson Creek during June and July 1986. At each segment, we measured and recorded depth and the type and amount of cover along 11 cross-channel transects spaced 10 m apart. For each stream, we combined the data from the sample segments to obtain depth and cover availability distributions for the entire stream. Although the depth availability distribution varied with discharge, we made our measurements at a time that represented the median flow conditions for the study period.

We tested the similarity of availability and utilization distributions for each species with a χ^2 goodness-of-fit test to determine if the distributions of use and availability differed (Neu et al. 1974). When the initial test showed a significant difference between distributions, we used the Bonferroni z-statistic (Miller 1966) to determine which habitat categories were used proportionately more or less than their availability. We evaluated all statistical tests an α level of 0.05.

Results

We made 258 observations on 7 flathead catfish in Perche Creek, 213 observations on 12 channel catfish in Perche Creek, and 279 observations on 7 channel catfish in Hinkson Creek from October 1985 to November 1987 (Table 1). We did not find any flathead catfish in Hinkson Creek. We documented expulsion of transmitters from all

Table 1. Summary of observations and movements of flathead catfish and channel catfish receiving transmitter implants in Perche and Hinkson creeks. Values in parentheses are 95% confidence limits.

Location and species	*N* fish	Mean *N* observations	Mean *N* days tracked	Mean total distance moved (km)	Mean stream length covered (km)
Perche Creek					
Flathead	7	36.9 (± 19.7)	129.7 (± 66.7)	43.4 (± 27.2)	12.5 (± 3.7)
Channel	12	17.8 (± 10.6)	63.7 (± 21.8)	26.3 (± 23.4)	10.2 (± 3.1)
Hinkson Creek					
Channel	7	39.9 (± 15.0)	178.1 (± 64.2)	3.2 (± 3.3)	1.0 (± 0.5)

7 channel catfish in Hinkson Creek and from 3 of the 12 channel catfish in Perche Creek. Of the 6 fish that we observed after expulsion had occurred, all showed signs of a well-healed incision, suggesting that the transmitter expulsion was transintestinal (Marty and Summerfelt 1986). A necropsy on a seventh fish showed that the transmitter had been enveloped by new growth of intestinal tissue. We did not observe transmitter expulsion from any of the flathead catfish receiving implants.

In general, we had more difficulty tracking channel catfish in Perche Creek than we did with flathead catfish in Perche Creek or channel catfish in Hinkson Creek. Flathead catfish tended to stay within Perche Creek but channel catfish tended to move from Perche Creek into the Missouri River. Thus, we tracked more channel catfish in Perche Creek, obtained a smaller number of observations per fish and tracked each fish for a shorter period of time than for flathead catfish in Perche Creek or for channel catfish in Hinkson Creek (Table 1). Both species of catfish used a greater length of stream segment in Perche Creek than channel catfish used in Hinkson Creek (Table 1). Channel catfish in Hinkson Creek confined their movements to a few pools and the riffles separating the pools.

We classified our observations into seasons, based on water temperature data and information on the annual cycle of these fishes (Pflieger 1975). Weekly mean water temperature remained at or below 5° C in winter (1 Dec to 28 Feb). Spring (1 Mar–30 Jun) was distinguished as a period during which weekly mean temperature increased from 5° to 25° C, and included the spawning period for both species in the study area (Pflieger 1975, Brown 1989). Weekly mean temperature was less variable during summer (1 July - 15 Sep), ranging between 24° and 30° C, and then declined from 25° to 5° C during the fall period (15 Sep–30 Nov).

Movement Patterns

We concentrated our sampling efforts in the spring and fall seasons for both species and collected winter and summer data as transmitter lifespan and fish behavior allowed. We had sufficient sample sizes ($\geq$15 observations on $\geq$2 fish) to describe Perche Creek movements of flathead catfish in summer and channel catfish in winter in addition to spring and fall. Sample sizes were sufficient to describe movements of channel catfish in Hinkson Creek over all 4 seasons (Table 2). Because spring and fall were the only seasons equally represented in all 3 species-location groups of fish, we combined data from these 2 seasons to compare the daily movement rates between groups. The distribution of daily movement rates among distance categories was significantly different among species-location groups. However, when we removed the Hinkson fish from the analysis, we did not find a difference between flathead catfish and channel catfish in Perche Creek. For both species, >50% of all daily movement rate observations were >50 m/day in Perche Creek. In Hinkson Creek, only 17% of the observations were >50 m/day. Channel catfish in Hinkson Creek made a greater proportion of short movements (daily movement rate <1 m/day) than either species in Perche Creek.

All 3 groups of fish tended to move downstream. In comparing direction of movements, we disregarded all movements that were too small to reliably indicate

Table 2. Distribution of movements among distance and direction classes by flathead catfish and channel catfish in Perche and Hinkson creeks.

Species and season	*N* fish	*N* observations	Frequency of observation (%) Daily movement rate (m/day) ≤1	1.1–50	50.1–250	>250	Frequency of observation (%) Direction of movement Upstream	No move	Downstream
			Perche Creek						
Flathead									
Fall	5	18	22	0	28	50	11	22	67
Spring	7	69	22	16	22	40	26	22	52
Summer	6	54	18	26	13	43	35	18	47
Channel									
Fall	2	22	9	36	19	36	51	9	40
Winter	3	42	26	50	17	7	26	26	48
Spring	7	56	30	16	20	34	18	30	52
			Hinkson Creek						
Channel									
Fall	4	21	62	24	9	5	5	62	33
Winter	7	31	45	55	0	0	32	45	23
Spring	7	170	52	30	16	2	16	52	32
Summer	3	30	40	47	10	3	27	40	33

direction (≤1 m/day). The proportion of moves that were downstream ranged from 64% to 71% for the 3 groups, and the proportions of upstream and downstream movements did not differ between groups.

Flathead catfish showed no seasonal effect on movement rates or direction. Over 55% of all movement rates were >50 m/day, regardless of season. The frequency of downstream movements was greater than upstream movements for all 3 seasons, however the frequency of upstream movements appeared to increase from fall to spring and summer.

Movement rates differed among seasons for channel catfish in Perche Creek. Fall and spring movement rates did not differ, but when combined, they were different from the winter movement rates. Most (76%) of the winter movements were ≤50 m/day, but <46% of fall and spring movements were this short. The proportion of upstream and downstream movements did not differ among seasons.

Channel catfish in Hinkson Creek did not show a seasonal effect on movement rates or direction. Over 80% of the movements were ≤50 m/day in all seasons. The only apparent seasonal effect was that we observed no movements >50 m/day in winter, in contrast to the few observations of movements this long that we made in other seasons.

Habitat Use

Flathead catfish and channel catfish selectively used habitats in Perche Creek. Both species used water depths differently than if they had used them in proportion to their availability. Depth availability was uniformly distributed among the 4 depth categories (Table 3), yet flathead catfish and channel catfish used depths in a non-uniform distribution. Both species avoided shallow water (0–1 m) and both favored water 1–2 m deep. The depth distribution of the 2 species differed significantly, based on the combination of fall and spring observations. Flathead catfish showed a greater preference for 1–2 m depths and channel catfish showed a greater preference for 2–3 m.

Flathead catfish made greater use of shallow water (<2 m) in the spring than in the summer or fall (Fig. 1a). Channel catfish did not use depths differently between fall, winter, and spring (Fig. 1b).

In comparing cover type use to the availability distribution, we removed open water habitats from the analysis to allow comparison of the fish's use of structural cover types to their availability. Over 90% of the habitat in Perche Creek was open water, yet both species avoided open water. Only 33% of all flathead catfish observations and 40% of all channel catfish observations were recorded from open water. Both catfish species used structural cover types in proportions different from their availability (Table 3). In fact, when we combined spring and fall data, the utilization distributions did not differ between species. Both species preferred the more complex cover types, log complex, and standing tree/root complex, over other cover types.

Flathead catfish used cover types in similar proportions over the 3 seasons observed (Fig. 2a), but channel catfish use differed between seasons (Fig. 2b). Channel catfish used open water and miscellaneous cover types (mostly rock) more in winter than in spring and fall.

We analyzed the utilization data for Hinkson Creek separately from the Perche Creek data because the availability of water depths and cover types differed substantially between creeks. Most of the habitat in Hinkson Creek was no more than 0.5 m deep, yet we rarely observed channel catfish in water this shallow. The depth utilization distribution differed substantially from the availability distribution (Table 3). Channel catfish preferred the deepest habitats available in Hinkson Creek throughout the year, but did select habitats <1.5 m deep more frequently in spring, summer, and fall than in winter (Fig. 1c).

Over 80% of the habitat in Hinkson Creek was open water, yet channel catfish used this habitat in only 44% of all observations. Channel catfish utilization of structural cover types differed from the availability distribution (Table 3), largely due to a much greater use of rock cover than represented in the availability distribution. Channel catfish underutilized miscellaneous cover types (instream vegetation, single logs, and overhanging banks). Cover use varied with the seasons in Hinkson Creek (Fig. 2c), largely due to greater use of open water and less use of rock cover in summer than in other seasons.

Discussion

In spite of the many similarities in movements and habitat use by flathead catfish and channel catfish, they differed in their use of Perche Creek in several

Table 3. Availability and utilization of habitat depth categories and structural cover types by flathead catfish and channel catfish in Perche and Hinkson creeks. Values in parentheses are 95% confidence limits.

	Habitat				Habitat		
	Availability (%)	Utilization by (%)			Availability (%)	Utilization by (%)	
Depth (m)		Flathead catfish	Channel catfish	Cover type		Flathead catfish	Channel catfish
				Perche Creek			
0–1	22.0	7.6 (±5.6)	11.5 (±7.7)	Fallen tree	54.3	19.2 (±10.2)	24.8 (±11.7)
1–2	25.2	48.1 (±10.6)	38.0 (±11.8)	Log complex	6.8	35.2 (±12.4)	33.6 (±12.8)
2–3	23.1	19.9 (±8.5)	31.2 (±11.3)	Standing tree/rootwad	13.1	33.4 (±12.2)	27.6 (±12.1)
≥3	29.6	24.5 (±9.1)	19.4 (±9.6)	Miscellaneous	25.8	12.2 (±8.5)	13.4 (±9.2)
				Hinkson Creek			
0–0.5	92.5		4.4 (±3.8)	Fallen tree	12.9		8.8 (±6.0)
0.6–1.0	7.3		38.3 (±9.0)	Log complex	4.7		8.7 (±6.0)
1.1–1.5	0.6		50.9 (±10.3)	Rock	1.3		68.0 (±9.9)
>1.5	0.1		6.5 (±4.6)	Standing tree/rootwad	17.2		8.8 (±6.0)
				Miscellaneous	63.9		5.9 (±5.0)

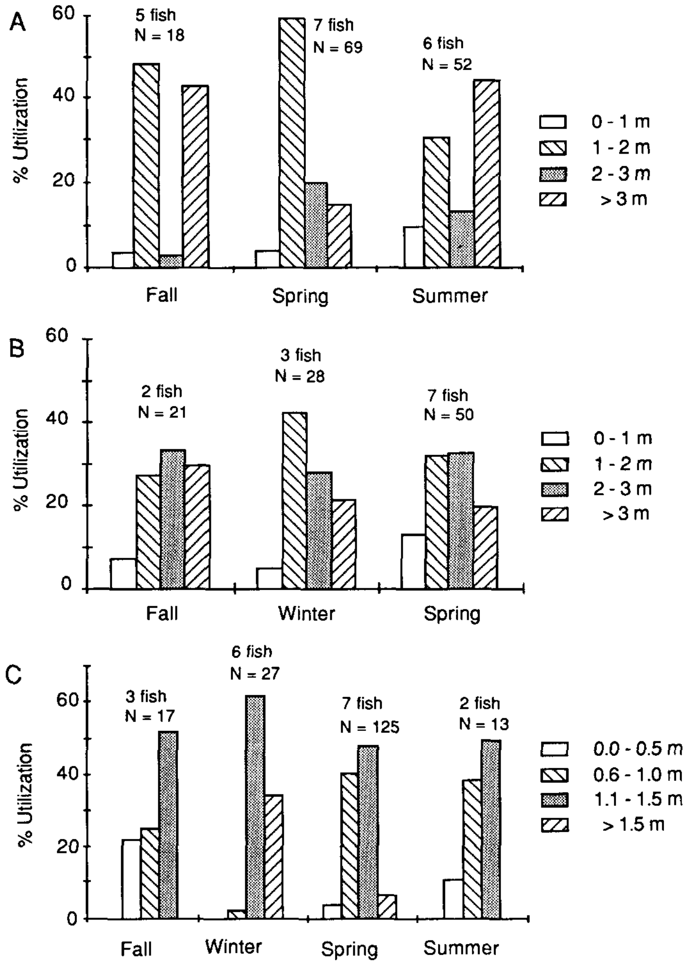

Figure 1. Distributions of water depth utilization by flathead catfish in Perche Creek (a), channel catfish in Perche Creek (b), and channel catfish in Hinkson Creek (c), separated by seasons. *N* = total number of observations.

important ways. Channel catfish in Perche Creek were more abundant by nearly 2 orders of magnitude than flathead catfish in Perche Creek (Dames et al. 1989). Furthermore, the channel catfish in Perche Creek appeared to be more transient than flathead catfish: a greater proportion of the channel catfish than flathead catfish moved into the Missouri River beyond the area of the Perche Creek mouth while being monitored. In addition, we lost the signal on most of the Perche Creek channel catfish (83%) in less than 100 days, yet we maintained contact with 79% of the flathead catfish beyond 100 days. Several factors may account for the loss of transmitter signal, but the other information obtained on channel catfish suggests

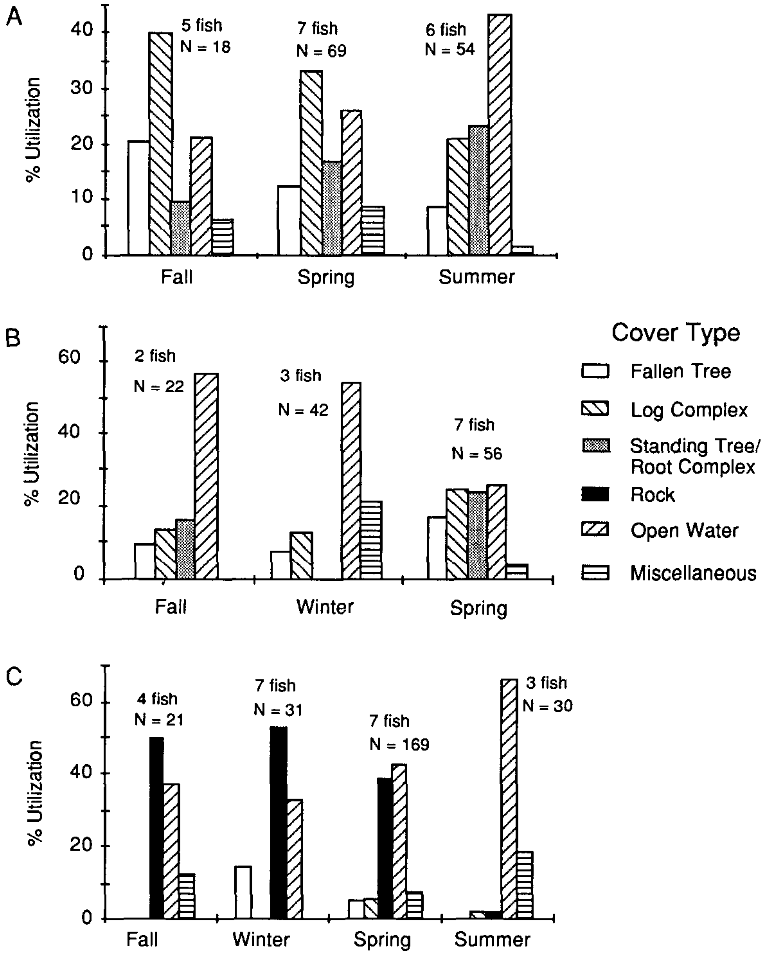

Figure 2. Distributions of cover type utilization by flathead catfish in Perche Creek (a), channel catfish in Perche Creek (b), and channel catfish in Hinkson Creek (c), separated by seasons. N = total number of observations.

that our failure to maintain contact with channel catfish was partially due to their tendency to move out of the study area quickly. The greater frequency of transmitter expulsion in channel catfish cannot explain the difference. Expelled transmitters remained stationary over a long time (weeks), and continued to transmit a signal after being shed by the fish. Stang and Nickum (1985) found a similar distinction in the Upper Mississippi River: channel catfish tended to move between the river and backwaters more frequently than flathead catfish did.

The tendency of flathead catfish to remain in Perche Creek was best illustrated by a 1,420-g fish captured and tagged on 4 April 1986 and tracked for 165 days before the signal expired. The fish never left Perche Creek during the observation period, although it did travel at least 85 km over a 15 km segment of the creek. We found the carcass of this fish after a fish kill in Perche Creek, 220 days after our last contact. It was about 10 km upstream from the mouth of Perche Creek, and it still contained the expired transmitter.

The differences in movement patterns between channel catfish in Perche Creek and Hinkson Creek were more obvious. Channel catfish were extremely sedentary in Hinkson Creek, with their movements confined to a 1-km segment of the stream. This difference in behavior probably can be attributed to differences in the habitats available in the 2 streams. In both streams, channel catfish selected water 1 - 2 m deep and selected complex woody structure and large rocks. These habitat traits were extremely rare in Hinkson Creek, and movement between the few pools that exceeded 1.5 m in depth may have been restricted by the shallow riffles present. Our electrofishing efforts were fruitless except in the deepest pools.

Others have described similar habitat use patterns for one or both of these species. Minckley and Deacon (1959), Welker (1967), Hickman (1975), Grace (1985), and Bunnell and Peters (1987) have documented the importance of depth and instream structure for channel catfish and flathead catfish. Layher and Maughan (1985) did not include instream structure as a habitat trait in their analysis, but they did find that the greatest standing stocks of channel catfish in Kansas streams were at sites with a mean depth between 1.0 - 1.5 m. Angermeier and Karr (1984) demonstrated an attraction to instream woody debris by a variety of large fishes.

Habitat characteristics other than those we measured (e.g., current velocity, water temperature, turbidity, and dissolved oxygen) may be important to channel catfish and flathead catfish populations (McMahon and Terrell 1982). We focused on depth and instream cover in this study primarily because these 2 parameters were the most variable habitat characteristics, both in time and space. Lee and Terrell (1988) concentrated on these same parameters in defining habitat suitability criteria for flathead catfish in riverine habitats.

Because much of the lower 18 km of Perche Creek is a backwater of the Missouri River, current velocity usually is slow (<0.3 m/sec.), and often is undetectable or even reversed. Furthermore, water quality characteristics are relatively uniform over most of the study area. Turbidity is high: secchi disk depths usually measure <0.3 m. However, the magnitude and source of turbidity varies seasonally and may have influenced the use of depth and cover attributes that our analysis could not detect. Dissolved oxygen also varies seasonally. As in many Missouri River backwater streams, surface dissolved oxygen concentrations reach a morning minimum of 3 - 5 mg/liter during much of the summer (J. Howland, Mo. Dep. Nat. Resour., unpubl. data), but exceeds 5 mg/liter in the afternoon. This characteristics may be important in determining the growth and reproductive success of catfishes in these streams.

Although we did not measure dissolved oxygen and turbidity at the time and location of each fish observation, most of the variation in these parameters corresponds to the seasonal distinctions that we based on water temperature. Seasonal effects that we observed may correspond to changes in temperature, turbidity, dissolved oxygen, or other water quality parameters, or perhaps some combination of these parameters.

Based on the observations of Welker (1967) and our study, it appears that while depth and structure were both important, depth was the more important of the 2 parameters. If depths of at least 1–2 m were not available, adult channel catfish were not present, regardless of the amount of instream structure. Channel catfish used some deep habitats even when cover was not present; however, they were more likely to use deep water with structure than deep water without structure.

Because the habitat traits of these species are so similar, managers can use one habitat management approach for both species. In streams lacking pools at least 2 m deep, creating deep habitats that will persist (e.g., Cederholm et al. 1988) promises to increase the abundance of adult catfish as long as water quality is acceptable. Installing instream structures that are hydraulically secure, such as cabled tree falls, may offer the best results by increasing scouring action to create deeper habitats and providing complex structure within the deep habitats. The mobility of both species is sufficient to provide colonists for improved habitats, even in small streams, although channel catfish may respond more rapidly than flathead catfish.

Channel catfish appear to be a more widely dispersant species than flathead catfish, even though both may be mobile on a local scale (i.e., distances of 1–10 km; cf. Funk 1955). This distinction is especially important in considering population management practices for stream dwelling catfish populations. Flathead catfish populations may be more localized and discrete between confluent streams, but channel catfish populations appear to be more widespread among stream systems. It may be possible to manage flathead catfish populations in units based on local drainages or to distinguish between Missouri River and tributary populations, but channel catfish populations probably should be managed on a broader regional basis. However, habitat management plans developed and applied at any level are likely to be effective for both species.

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