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Lateral Movement and Use of Floodplain Habitat by Fishes of the Kankakee River, Illinois

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ABSTRACT.—Fishes were trapped moving between the river channel and two distinct floodplain habitats: an ephemeral ditch and a permanent pool. Twenty-five fish species were sampled by one-way traps and seine; dominant species were grass pickerel (*Esox americanus*), green sunfish (*Lepomis cyanellus*), pirate perch (*Aphredoderus sayanus*) and orangespotted sunfish (*L. humilis*). Numbers of fish trapped per day were positively correlated with river discharge yielding a significant exponential relationship. Recaptures of marked fish were rare indicating seasonal use of the floodplain. Juveniles made up 54.7% of the fish collected, revealing the value of floodplains as nursery areas. No significant migration trends of size or taxon occurred by date or discharge. Samples of fish leaving the ephemeral ditch and samples of those entering the permanent pool showed the highest similarity index value. These data suggest that flood-exploitative fishes, those species adapted to flooding, continue to seek favorable backwater habitat when forced off the floodplain.

INTRODUCTION

As early as 1925, S. A. Forbes recognized the importance of lateral floodplains of Illinois rivers as well as the significance of the natural flooding cycles to such "reservoirs of life." By this time, most of the artificial drainage that was to occur in Illinois had been accomplished (Bell, 1981). A generation after Forbes, Bennett (1958) confirmed the value of floodplain habitats and documented the benefits of backwaters and the dangers of their mismanagement. Scarcely a decade later, Smith (1971) correlated the reduction in range of 13 native Illinois fish species to the drainage of floodplain lakes and sloughs. Undesirable shifts in species composition and the decline in commercial and sport fishing catch were considered to be the direct result of habitat loss and sedimentation following leveeing and draining of Illinois River bottomlands (Sparks and Starrett, 1975). Studies in other states have shown similar detrimental effects from construction designed to suppress flooding (Beland, 1953; Lambou, 1963; Whitley, 1974; Holden and Stalnaker, 1975).

Field studies of floodplain habitat use by fishes and associated fish movements are rare. Wickliff (1945) investigated the lateral movement of fishes onto the floodplain as waters rose. Starrett (1951) found that backwater areas were important as spawning sites and attributed the fluctuations of minnow abundances to flooding. Larimore *et al.* (1973) studied physical and chemical conditions of floodplain pools and their biological communities. They noted the value of floodplain pools as fish spawning and nursery areas and found that fish assemblage and age structures were characterized by floodplain pool type. Guillory (1979) recorded the movement of fishes from the Mississippi River main channel onto lateral floodplain areas and indicated the use of these as spawning, nursery and feeding areas. Ross and Baker (1983) recorded lateral fish movements and diel fish activity patterns on the floodplain as related to community structure.

This study was initiated to determine which fish species used two different floodplain habitats. Species composition, frequency of fish movement between river channel and floodplain and the assemblage differences between natural and artificial floodplain areas were compared.

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SITE DESCRIPTION

The study was conducted in northeastern Illinois on the Kankakee River. Rising near South Bend, Indiana, the river flows southwest through Momence and Kankakee, Illinois, to join with the Des Plaines River to form the Illinois River. The Kankakee River is 241 km long and drains an area of 13,372 km^2. Its drainage basin is nearly level with a slope of 0.27 m/km in the study area (Barker *et al.*, 1967).

The study site drains an area of 5,946 km^2 and is located 11.6 km downstream of the Illinois-Indiana state line and 3.2 km upstream of Momence. The site lies within the Momence Wetlands, a productive wetland habitat created by bedrock outcrops that begin immediately downstream of the study site and form a natural dam. As it flows through this relatively undisturbed area of floodplain forest, the river is characterized by a sandy bottom with bars forming at many stream bends. A thorough description of the Momence Wetlands is found in Mitsch *et al.* (1979). Floods caused by excessive rainfall or ice jams are frequent. Permanent sloughs, marshes and pools remain after floodwaters subside.

The permanent oxbow pool studied was 140 m long with an area of 1700 m^2 and a maximum depth of 3 m, rarely exceeding 2 m. Surface area showed great fluctuation with minor changes in water level. Buttonbush (*Cephalanthus occidentalis*) and willows (*Salix* spp.) formed an understory around the pool, shaded by a forest canopy of silver maple (*Acer saccharinum*) and river birch (*Betula nigra*). The pool bottom consisted of black organic mud and detritus, composed of wood, leaf litter and decomposing aquatic macrophytes. The pool surface was often completely covered by a mat of duckweed (*Lemna* spp.). Abundant aquatic macrophytes, in combination with fallen trees and branches, root systems and other debris, provide cover and spawning habitat and are particularly valuable as feeding and nursery areas for fishes (*e.g.*, Forbes, 1925; Starrett, 1972; Larimore *et al.*, 1973; Guillory, 1979; Mitsch *et al.*, 1979).

The second floodplain habitat studied was a man-made drainage ditch 610 m long with a surface area of 1860 m^2. Depths over 1.5 m were uncommon. These dimensions varied dramatically through the study period. By 5 August 1982 most of the channel was dry. The canopy and understory of the ditch were similar to those of the study pool.

SAMPLING METHODS

Two, one-way fish traps were set in opposite directions in a small rivulet of the floodplain pool, which formed the only pool-river connection. Two traps were also placed at the mouth of the ditch system where it entered the river. The traps were wedge-shaped, 1.22 m long with a 0.61-m^2 entrance, reduced to a 0.36-m elliptical opening. V-shaped entry deflectors guided fish into the enclosure. The traps were constructed of Vexar®, 6.4-mm-diameter, plastic netting (gauge and type 601) with a square frame around the trap entrance of 1.27-cm-diameter, PVC tubing. Nylon twine was used to attach the frame and to close seams. The same plastic netting was used to block the remainder of each water passage to assess directional movement of fish between the river and the two lateral flood zones. The traps were lightweight and portable (although stationary during operation).

Trapping was not a practical sampling method when the floodplain was completely inundated, because a quantitative sample of fishes moving between the river channel and floodplain could not be collected under such conditions. Fishes were trapped during intermediate flood stages when fish movements were restricted to depressions in the floodplain that formed isolated connections to the river channel. Overall, floodwaters receded during the study period, but minor fluctuations occurred. Four traps, two at each location, were operated from 12 June until 28 July 1982 representing 4416 trap-hours of effort. By 28

July, the ditch was separated from the river. A river connection with the natural pool remained until 5 August, when the last fishes were trapped moving into the pool. The two remaining pool traps added an additional 384 trap-hours of effort yielding a total sampling effort of 4800 trap-hours. On 5 September 1982, fishes were sampled in the isolated floodplain pool, when it was obvious no immediate connections to the river would occur due to dry conditions and low water levels.

Traps were examined daily during periods of relatively high water when catches were large; otherwise traps were checked less frequently. Trapped fish were identified, measured (mm TL), fin clipped to identify recaptured fish, and returned on the side of the trap that the fish had been moving toward. The assemblage of fishes remaining in the isolated pool after floodwaters receded was assessed by sampling 125 m^2 surface area of the pool with a 15.2-m × 1.2-m (6.4-mm-diameter-mesh) seine.

Discharge data for the Kankakee River were obtained from a gauging station at Momence, Illinois, operated by the United States Geological Survey (Stahl *et al.,* 1982).

RESULTS AND DISCUSSION

Four hundred fishes were collected by trapping from 13 June to 5 August 1982 on 25 separate collection days (Table 1). Twenty-three species representing nine families (Table 1) were collected during the study, a period when water levels were generally receding. Fifteen fish species were trapped moving from the ditch to the river, while fewer species were represented in the total catch from other traps (10–11 species per trap). Seventy-six percent of the fish collected in traps were moving between the river and the ditch; the remainder were moving to and from the floodplain pool. An additional 81 fishes were seined on 5 September 1982 from the isolated floodplain pool. The sample of fishes remaining in the floodplain pool after floodwaters receded included 15 species. Grass pickerel (*Esox americanus*) was the most numerous species, and made up 28.3% of the total number of fish collected. The relative abundances of other dominant species were green sunfish (*Lepomis cyanellus*), 16.0%; pirate perch (*Aphredoderus sayanus*), 12.7%; and orangespotted sunfish (*L. humilis*), 10.6%. Largemouth bass (*Micropterus salmoides*) and pumpkinseed (*L. gibbosus*) were the only species taken from the isolated floodplain pool that were not collected in directional traps. No catostomids were collected, although nine sucker species were collected in the main river channel in July 1982 at the study site (Langbein *et al.,* 1983). One hundred thirteen crayfish (Cambaridae) were also collected in the traps.

The first week of trapping yielded 71.8% of the total number of trapped fish along with 68.1% of the crayfish; this high proportion was associated with high water levels that subsequently fell dramatically. Numbers of fish trapped per day were positively correlated with mean discharge in the Kankakee River during the sampling interval. The number of fishes in traps declined exponentially with decreasing river discharge ($P < 0.0005$, Fig. 1). Use of an exponential function is justified in this case, describing large changes in lateral fish movement associated with minor changes in discharge. Because of the flat topography of most floodplains, minor fluctuations in discharge can cause vast changes in the area of floodplain habitat available to fishes. This equation may be useful in determining a critical flow volume above which floodplain habitat is available for fishes. An appropriate estimate of this value would be the discharge volume where the lower 95% confidence limit of the corresponding number of trapped fish equals zero, in this case 44.5 m^3 s^{-1} (Fig. 1). This value corresponds well with field data as the critical discharge below which virtually no fish were able to enter or exit the flooding zones. Application of this model is limited, however, since it was derived from data collected only during the receding portion of the flooding cycle, and the relationship may differ during the rising portion. Additional studies,

TABLE 1.—Number of fishes collected and percent by number from each site from the Kankakee River floodplain representing a total effort of 4800 trap-hours. Fish were trapped moving from the first site to the second, where R = river, D = ditch, and P = pool

	Collection site											
	R–D		D–R		R–P		P–R		Isolated pool		Total	
Species	Number	(%)	Number	(%)	Number	(%)	Number	(%)	Number	(%)	Number	(%)
Petromyzontidae												
Lampetra appendix	—	—	—	—	1	(3.0)	—	—	—	—	1	(0.2)
Amiidae												
Amia calva	3	(7.0)	7	(2.7)	—	—	—	—	1	(1.2)	11	(2.3)
Umbridae												
Umbra limi	2	(4.7)	—	—	—	—	1	(1.6)	1	(1.2)	4	(0.8)
Esocidae												
Esox americanus	12	(27.9)	69	(26.4)	9	(27.3)	32	(50.8)	14	(17.3)	136	(28.3)
E. lucius	1	(2.3)	1	(0.4)	—	—	1	(1.6)	2	(2.5)	5	(1.0)
Cyprinidae												
Cyprinus carpio	1	(2.3)	1	(0.4)	—	—	—	—	—	—	2	(0.4)
Notemigonus crysoleucas	2	(4.7)	1	(0.4)	—	—	—	—	—	—	3	(0.6)
Notropis emiliae	—	—	1	(0.4)	—	—	1	(1.6)	—	—	2	(0.4)
N. texanus	—	—	—	—	2	(6.1)	—	—	—	—	2	(0.4)
Unidentified Cyprinidae	—	—	9	(3.4)	1	(3.0)	4	(6.3)	—	—	14	(2.9)
Ictaluridae												
Ictalurus melas	8	(18.6)	4	(1.5)	3	(9.1)	2	(3.2)	—	—	17	(3.5)
I. natalis	5	(11.6)	7	(2.7)	1	(3.0)	—	—	—	—	13	(2.7)
Noturus gyrinus	—	—	7	(2.7)	—	—	—	—	1	(1.2)	8	(1.7)
Aphredoderidae												
Aphredoderus sayanus	5	(11.6)	39	(14.9)	1	(3.0)	1	(1.6)	15	(18.5)	61	(12.7)
Centrarchidae												
Micropterus dolomieui	2	(4.7)	—	—	—	—	1	(1.6)	2	(2.5)	5	(1.0)
M. salmoides	—	—	—	—	—	—	—	—	5	(6.2)	5	(1.0)

TABLE 1.—Continued

Species	Collection site										Total	
	R–D		D–R		R–P		P–R		Isolated pool			
	Number	(%)	Number	(%)	Number	(%)	Number	(%)	Number	(%)	Number	(%)
Lepomis spp.	—	—	2	(0.8)	—	—	—	—	10	(12.3)	12	(2.9)
L. cyanellus	—	—	53	(20.3)	10	(30.3)	8	(12.7)	6	(7.4)	77	(16.0)
L. humilis	2	(4.7)	35	(13.4)	2	(6.1)	11	(17.5)	1	(1.2)	51	(10.6)
L. macrochirus	—	—	3	(1.1)	1	(3.0)	—	—	5	(6.2)	9	(1.9)
L. gibbosus	—	—	—	—	—	—	—	—	4	(4.9)	4	(0.8)
Ambloplites rupestris	—	—	10	(3.8)	—	—	—	—	10	(12.3)	20	(4.2)
Pomoxis annularis	—	—	—	—	2	(6.1)	—	—	2	(2.5)	4	(0.8)
P. nigromaculatus	—	—	—	—	—	—	1	(1.6)	2	(2.5)	3	(0.6)
Percidae												
Etheostoma nigrum	—	—	12	(4.6)	—	—	—	—	—	—	12	(2.9)
All fish species	43		261		33		63		82		481	
Cambaridae	80		10		14		9		—		113	

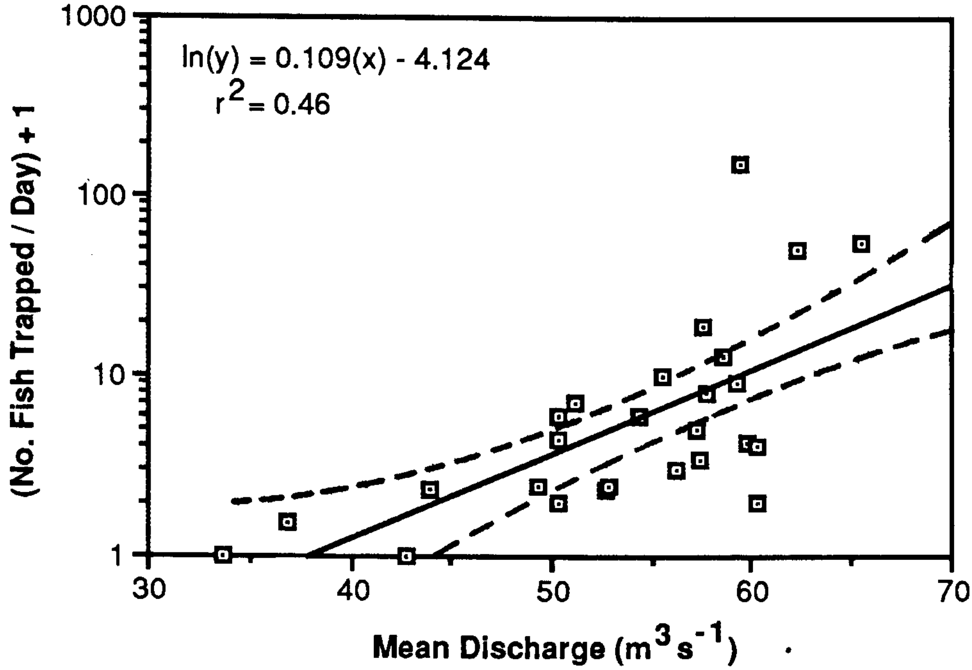

FIG. 1.—A semilogarithmic plot of number of fish trapped per day (96 trap-hours) versus discharge in the Kankakee River, including 95% confidence belts

particularly during the rising portion of a flood cycle, are needed to understand the complexities of this system before an empirical model can be developed for use by stream managers.

The majority of fish collected were trapped as they moved from the ditch to the river channel (D–R, Table 1). Their survival depended on movement to the the river before the ephemeral ditch habitat was isolated and desiccation occurred. Few crayfish were trapped in the same trap (D–R), but an influx of crayfish to the ditch occurred in the opposing trap (R–D). Plotting these cumulative net changes in the ditch over time reveals a seasonal succession that occurs with drainage of the ditch system (Fig. 2). As the area becomes unfavorable for fish, habitat suitability appears to improve for crayfish.

Only three fishes, all adults, were recaptured. One of the these, a green sunfish, was trapped on five separate occasions over a 13-day period. The floodplain pool traps may have been located in the home range of this fish, or this individual may have displayed a diel rhythm atypical of its conspecifics in the area. Few individual fishes moved between the floodplain and river more than once, a finding that suggests that lateral fish migration and floodplain use is seasonal.

Based on length and age estimates in the literature (Carlander, 1969, 1977; Pflieger, 1975; Smith, 1979; Trautman, 1981), 54.7% of all fish collected were juveniles. The ratio of juveniles to adults was similar when analyzed by study area. Length distributions for each species were similar for each trapping location and for the pool resident sample, and showed no trend except for green sunfish and pirate perch. These two species showed

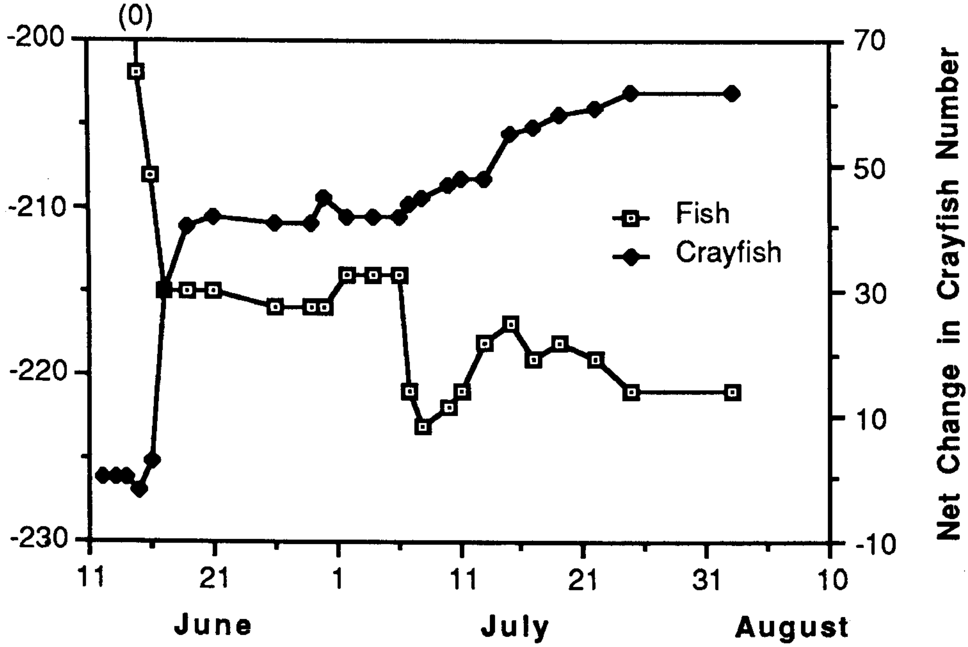

FIG. 2.—Cumulative net change in numbers of fish and crayfish in the ditch system during the study period. A leading negative sign preceding fish numbers indicates an increasing net loss of fish (more fish leaving than entering) occurring simultaneously with a net gain of crayfish

movement to and from the ephemeral ditch habitat at various sizes, but only adults of these species moved between the river and the floodplain pool. However, a large proportion of green sunfish and pirate perch juveniles were collected in the pool when it was isolated from the river channel. The high proportion of juveniles found on the floodplain and the tendency of juveniles of some species to remain in isolated backwaters indicate that floodplain habitats are important fish nursery areas.

Movements off the floodplain in other studies, as summarized by Welcomme (1979), suggest that fish leave in a distinct sequence. Larger adult fish migrate from the floodplain to the river channel before juveniles and smaller species. However, no significant migration trend by mean size (TL) or like taxon, by date or discharge, was observed in this study. The same was true when movements from the ephemeral ditch or permanent pool were regarded separately or in combination.

To measure the amount of overlap between samples, Morisita's index of community similarity was used (Horn, 1966; Wolda, 1981). This measurement expresses the degree to which samples differ in quantitative representation of species. Values range from 0, indicating complete distinctness, to about 1, the result of comparing identical samples. The isolated pool sample showed low similarity when compared to each trap sample except that of fishes moving from the ditch system to the river (Table 2). The most similar samples were of fishes passing from the ditch to the river and fishes moving from the river to the pool. As many temporary pools, depressions and channels drain into the river and desiccate, fishes adapted to a lentic environment are forced to migrate from these areas and may seek

TABLE 2.—Morisita's index of overlap values of trap samples and isolated pool sample from the Kankakee River floodplain. Fish were trapped moving from the first site to the second, where R = river, D = ditch, and P = pool

	Collection site				
Collection site	R–D	D–R	R–P	P–R	Isolated pool
R–D	1.00				
D–R	0.68	1.00			
R–P	0.60	0.86	1.00		
P–R	0.68	0.80	0.76	1.00	
Isolated pool	0.59	0.76	0.57	0.53	1.00

out more permanent floodplain habitat, thereby producing a higher similarity of species composition in these samples. Ross and Baker (1983) demonstrated the distinction between the floodplain fish assemblage and the river channel assemblage of a small Mississippi stream during floods. They classified individual species as flood-exploitative, those adapted to a flooded environment and active during floods, or flood-quiescent, referring to species not adapted to flooding that restrict their activity during floods. The high similarity of fishes leaving temporary floodplain habitat to those entering permanently flooded areas, suggests that flood-exploitative species in the Kankakee River repeatedly seek out floodplain habitat after being forced into less optimal channel surroundings, thereby adding support to the distinction between floodplain and channel communities.

This study further demonstrates the importance of fringing floodplains as components of the stream ecosystem and documents some of the dynamics of lateral fish movement. It was conducted over a 13-week period, a fraction of the natural flooding cycle of the river. I recognize the need for longer term investigations incorporating both rising and receding portions of the hydrologic cycle at different seasons. Continuing and future studies will provide a greater understanding of river floodplain ecology and support the need to preserve and protect these resources. More available information will aid those charged with making decisions concerning alteration or management of these areas and river discharge.

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