Distribution of Larval Fishes in a Lower Mississippi River Dike Field

Timothy R. Bosley, *United States Army Engineer Waterways Experiment Station, P.O. Box 631, Vicksburg, MS 39180*

C. H. Pennington, *United States Army Engineer Waterways Experiment Station, P.O. Box 631, Vicksburg, MS 39180*

Michael E. Potter, *United States Army Engineer Waterways Experiment Station, P.O. Box 631, Vicksburg, MS 39180*

Abstract: A study was conducted from April through October 1980 to characterize seasonal changes in distribution, diversity, and abundance of ichthyoplankton within the Cracraft dike field in the lower Mississippi River. During high river stages (April through June), diversity and abundance of larval fishes were greater at open-water than nearshore stations. Under moderate to low river stages (July through October), diversity was low and greatest densities of larval fishes were observed along the shoreline inside the middle bar rather than in the open-water.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 38:615-621

The Mississippi River and Tributaries Project provides for flood control and for navigation improvement of the lower Mississippi River. Modification of the mainstream for improvement of navigation include bank revetment to control erosion and placement of stone dikes for channel contraction and secondary channel closure. Dikes are typically constructed of retatively impermeable-stone riprap and are placed transverse to the river's flow; they may be solitary or placed one after another to form a dike field. Dike structures modify river morphology, sediment movement, and result in shifts in the types, sizes and variety of aquatic habitats on a yearly basis (Cobb and Clark 1981).

Mississippi River flows vary seasonally and affect water velocity, turbidity, depth, and surface area in dike fields. High flows submerge the dikes and as flow decreases, the water level drops below their crests forming pools that may be entirely isolated from the main river channel. In addition to the dramatic changes occurring as a result of water level fluctuations, there are other

important variations within the dike field at any given river stage. Depths may vary considerably within a given pool and differences will exist from pool to pool with respect to their degree of isolation from one another and the main river channel.

Dike pools along the Missouri River provide suitable habitat for development and growth of many fish species (Hey and Baldwin 1977, Kallemeyn and Novotny 1977, Jennings 1979, Persons 1979, Robinson 1980). Other studies indicate that dike fields support a greater diversity of fishes than other habitats common between the levees on the lower Mississippi River (Schramm and Pennington 1981, Pennington et al. 1983). However, the Mississippi River studies did not document distribution of larval fish in the pools that form behind the dikes. The objective of this study was to compare the distribution of larval fish within three dike pools with that of the adjacent channel border.

This investigation is part of the Environmental and Water Quality Operational Studies (EWQOS) Program sponsored by the Office of the Chief of Engineers and is being managed by the U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Methods

The work was conducted on the lower Mississippi River in the Cracraft dike field approximately 48 km downstream of Greenville, Mississippi. The dike field consists of 3 stone dikes on the right bank between river mile 506.3 and 510.4. Extensive sand and gravel middle bars occur between succeeding dikes and downstream from the third. The middle bars, the axes of which are parallel to the main channel, isolate pools between the riverbank and bars during low flows. Samples were collected from stations on transects located above dike 1 and below dikes 1, 2, and 3. There were normally 4 stations along each transect as follows: 1) adjacent to the natural bank, b) adjacent to the pool side of the middle bar, c) midway between the stations at the natural bank and the pool side of the middle bars, and d) adjacent to the river side of the middle bar (Fig. 1). Samples were not taken at stations when water was <1.0 m deep. Monthly sampling began in April and continued into early October 1980. All stations were sampled between 0900 and 1430 hours on the same day for each visit.

Samples were collected with paired plankton nets, 0.5 m in diameter with 0.505-mm nylon mesh. The nets were fitted with a yoke on an aluminum handle and pushed downstream for 5 minutes at 70 cm/second faster than the current, if any, 0.5 m below the water surface. Paired samples were taken simultaneously; 1 off the starboard side of the boat, the other off the port. A flow meter was mounted in the center of each net to estimate volume of water filtered. After each set of samples, nets were rinsed and samples immediately fixed in 10% formalin.

The larval fishes in each sample were identified to the lowest possible

taxon using reference series and published keys. Results are given as numbers/100 m^3 of water filtered and are reported as station means.

Results and Discussion

Collections made from April through June reflect high river flows (≥23,220 m^3/second, dikes are submerged, river stage of ≥9.1 m) and those from July through October were at moderate to low flows (≤13,310 m^3/second, pools isolated from main channel, river stage of ≤5.2 m). Analysis of variance tests revealed that among the 4 dike pool transects there was a significant difference in both diversity and concentration of larvae seasonally and spatially as river flow conditions changed (Tables 1, 2).

In April, samples contained a fairly high diversity of taxa but were dominated by shads (*Dorosoma* spp.) and buffalos (*Ictiobus* spp.). For each transect, total abundance estimates were similar at stations away from the shore (open-water) and for those nearshore (Table 1). Diversity was fairly high in May but with a preponderance of shads (about 83% overall). Abundance estimates tended to be higher at open-water stations than at stations nearshore (Fig. 1).

The highest overall catches were made on 12 June and reflected a mixture

Table 1. Abundance (N/100 m^3) and distribution of larval fishes (all taxa combined) within the Cracraft dike field from April through October 1980.

Stations	High river stages			Moderate to low river stages			
	17 Apr	16 May	12 Jun	10 Jul	8 Aug	4 Sep	2 Oct
Above Dike 1							
Nearshore	12	75	41	5	1	5	
Offshore	13	72	84	14	6	15	
Below Dike 1							
Nearshore	19	32	96	3	11	109	1
Midpool	13	19	159	9	3	6	NE[a]
Poolside of bar				NE	NE	19	NE
Riverside of bar				8	22	24	
Below Dike 2							
Nearshore	10	40	193	86	39	18	
Midpool	14	54	90	64	29	2	
Poolside of bar				42	88		
Riverside of bar				17	3	3	
Below Dike 3							
Upper nearshore	17	13	60	42	9	9	
Upper midpool	20	32	105	7	6		
Upper poolside of bar				13	3	2	
Upper riverside of bar				14	3	3	
Lower nearshore	24	12	356	21	8	4	
Lower midpool	19	20	95	7			
Lower poolside of bar				23	5	1	
Lower riverside of bar				42	1	11	1

[a] No effort.

Table 2. Abundance (N/100 m^3) of larval fishes captured from the Cracraft dike field from April through October 1980.

Taxonomic group	High river stages			Moderate to low river stages			
	17 Apr	16 May	12 Jun	10 Jul	8 Aug	4 Sep	2 Oct
Shads/Herring/Goldeye[a]	6.7	30.8	57.1	15.9	10.1	7.1	0.1
Ctenopharyngodon idella			0.3	0.1		0.1	
Cyprinus carpio	1.3	0.1	0.1				
Minnows[b]	1.3	0.7	1.3	0.8	0.2	0.5	
Carpsuckers[c]		0.5	3.8	5.0	0.8	0.1	
Buffalos[d]	4.1	0.9	0.7				
"Other" suckers[e]	0.5		0.2	0.1			
Silversides[f]					0.4	0.1	
Temperate basses[g]	0.4	0.2	0.8				
Sunfishes[h]	0.2	0.4	0.4		2.2	3.0	
Crappies[i]	1.0	0.3	0.1				
Etheostoma spp.	0.6						
Aplodinotus grunniens		3.0	52.3	1.1	0.1	1.0	
Total	16.1	36.9	117.1	23.0	13.8	11.9	0.1

[a] *Alosa chrysochloris, Dorosoma cepedianum, D. petenense, Hiodon tergisus, H. alosoides.*
[b] *Hybopsis aestivalis, H. storeriana, Hybopsis* spp., *Notropis atherinoides, N. shumardi, Notropis* spp., *Pimephales vigilax.*
[c] *Carpiodes carpio, C. cyprinus, Carpiodes* spp.
[d] *Ictiobus bubalus, I. cyprinellus, I. niger, Ictiobus* spp.
[e] *Cycleptus elongatus,* Immature/damaged carpsuckers or buffalos (genus indistinguishable).
[f] *Labidesthes sicculus, Menidia beryllina.*
[g] *Morone chrysops, M. mississippiensis.*
[h] *Lepomis gulosus, L. humilis, L. macrochirus, Lepomis* spp.
[i] *Promoxis annularis, P. nigromaculatus, Poxomis* spp.

of late spring and summer spawners which included shads (mainly *D. cepedianum*), minnows (*Hybopsis* spp., *Notropis* spp., and *Pimephales* spp.), carpsuckers (*Carpoides* spp.), freshwater drum (*Aplodinotus grunniens*). The collections were dominated by gizzard shad and freshwater drum. In general, samples were comparable at open-water versus nearshore stations (Fig. 1). However, shad usually dominated nearshore catches while freshwater drum dominated catches from the open-water stations.

Diversity of larval fishes was fairly low in July, August, and September samples (Fig. 1). The greatest concentrations of fish larvae in the dike field tended to be inside the middle bar, particularly at shoreline stations. Samples from inside the middle bar contained mainly shads, sunfishes (*Lepomis* spp.), and silversides (*Menidia beryllina* and *Labidesthes sicculus*), whereas those from along the riverside of the middle bar contained mainly minnows (especially *Hybopsis aestivalis* and some *Notropis* spp.), carpsuckers, and freshwater drum.

In October, larval fishes were absent at all but 2 stations. Gizzard shad, the only larvae represented, were collected nearshore below dike 1 and from the riverside along the downstream end of the middle bar (Tables 1, 2).

These data suggests that under low flow conditions (July through October), ichthyoplankton from the dike field consists of 2 distinct communities. The community of dike pools being dominated by sunfishes, silversides, and

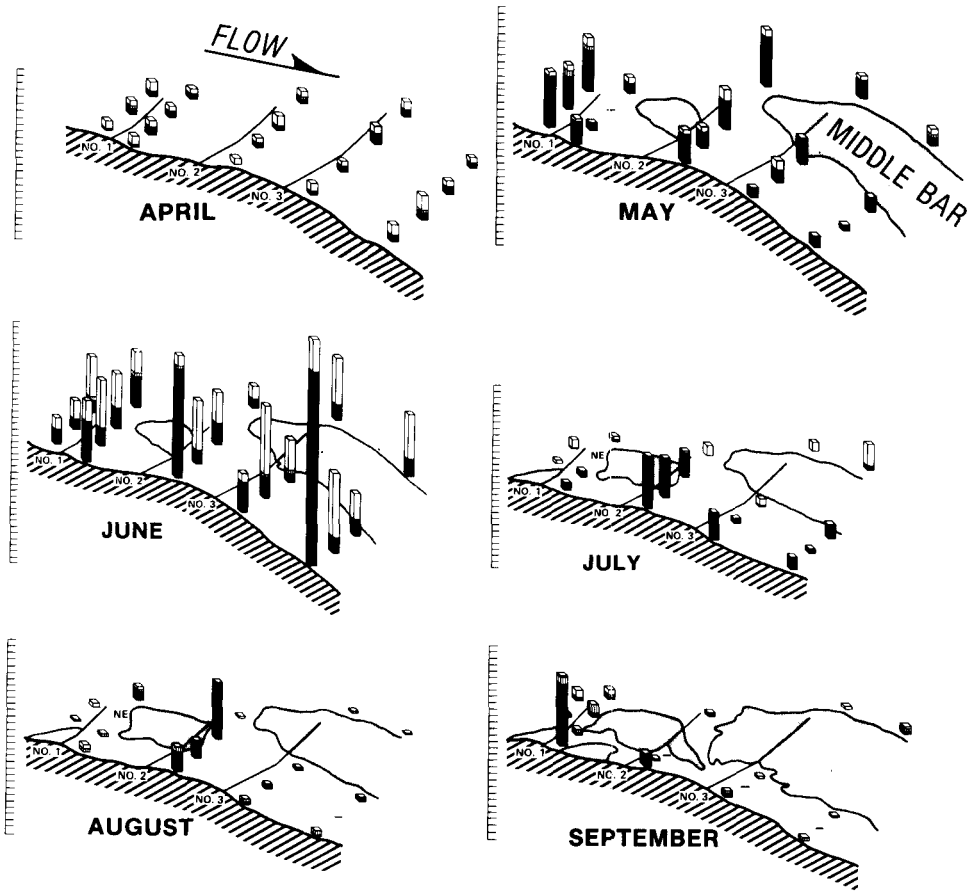

Figure 1. Monthly density (N/100m^3) of larval fishes in the Cracraft dike field from April through September 1980.

shads. The community along the riverside of the middle bar was not substantially different from the sandbar community described by Schramm and Pennington (1981) which contained high diversity but low density (freshwater drum and shads being abundant; cyprinids, hiodontids, and centrarchids were common; lepisosteids, catostomids, ictalurids, atherinids, percichthyids, and percids were rare). Fish larvae from the dike pools were more abundant and represented different species as compared with those in collections from the riverside of the middle bar.

The importance of shoreline and backwater habitat in large rivers as fish spawning and nursery areas has been investigated. Gallagher (1979) and Gallagher and Conner (1980), studying ichthyoplankton distribution in the Mississippi River near St. Francisville, Louisiana, hypothesized that some species prefer to use floodplain areas as spawning and nursery habitat. Boyer's (1982) subsequent study of the floodplain at St. Francisville strongly supported this hypothesis. Holland and Sylvester (1983) sampled larval fishes in pool 7 of the upper Mississippi River, near LaCrosse, Wisconsin, and reported greater densities of larvae in backwater and adjacent habitats than in other areas of the pool.

In a study of larval fish distribution in the Missouri River 40 km south of Sioux City, Iowa, Persons (1979) found that, compared to main channel collections, backwater ponds contained greater densities of larval fishes, including several species not collected in the main channel. He concluded that quiet off-channel areas serve as the principal spawning and nursery habitat for many species. The high diversity and density of larval fishes in the Cracraft dike pools suggest that these areas are important habitat in the lower Mississippi River as well.

Literature Cited

Boyer, B. E. 1982. Distribution and relative abundance of fish eggs, larvae, and early juveniles in the inundated Mississippi River floodplain near St. Francisville, Louisiana. Master's Thesis, La. State Univ., Baton Rouge.

Cobb, S. P. and J. R. Clark. 1981. Aquatic habitat studies on the lower Mississippi River, river mile 480 to 530; report 2, habitat mapping. Misc. Pap. E-80-1, U.S. Army Eng. Waterways Exp. Sta. CE, Vicksburg, Miss.

Gallagher, R. P. 1979. Distribution of ichthyoplankton in the lower Mississippi River, Louisiana. Master's Thesis, La. State Univ., Baton Rouge.

——— and J. V. Conner. 1980. Spatio-temporal distribution of ichthyoplankton in the lower Mississippi River, Louisiana. Pages 101–115 *in* L. A. Fuiman, ed. Proceedings of the Fourth Annual Larval Fish Conference. U.S. Dep. Int., Fish and Wildl. Serv., Biol. Serv. Prog., Natl. Power Plant Team, Ann Arbor, Mich. FWS/OBS-80/43.

Hey, J. and K. Baldwin. 1977. Aquatic ecology study (post operational survey—Unit III) of the Missouri River near the George Neal Station, Sioux City, Iowa, Jan–Dec 1976. Brair Cliff College, Sioux City, Iowa.

Holland, L. E. and J. R. Sylvester. 1983. Distribution of larval fishes related to potential navigation impacts on the upper Mississippi River, Pool 7. Trans. Am. Fish. Soc. 112(2B):293–301.

Jennings, D. K. 1979. An evaluation of aquatic habitat associated with notched dikes on the Missouri River, Missouri. Master's Thesis, Univ. Mo., Columbia.

Kallemeyn, L. W. and J. F. Novotny. 1977. Fish and fish food organisms in various habitats of the Missouri River in South Dakota, Nebraska, and Iowa. U.S. Dep. Int., Fish and Wildl. Serv., Biol. Serv. Prog., Natl. Stream Alteration Team, Columbia, Mo. FWS/OBS-77/25.

Pennington, C. H., J. A. Baker, and C. L. Bond. 1983. Fishes of selected aquatic habitats on the lower Mississippi River. Tech. Rep. E-83-2, U.S. Army Eng. Waterways Exp. Sta. CE, Vicksburg, Miss.

Persons, W. R. 1979. The use of open and closed backwater ponds of the Missouri River, Iowa, as spawning and nursery areas for fish. Master's Thesis, Iowa State Univ., Ames.

Robinson, J. W. 1980. An evaluation of aquatic habitats in the Missouri River. Mo. Dep. Conserv., Proj. 2-291-R-3, Jefferson City.

Schramm, H. L. and C. H. Pennington. 1981. Aquatic habitat studies on the lower Mississippi River, river mile 480 to 530; report 6, larval fish studies—pilot report. Misc. Pap. E-80-1, U.S. Army Eng. Waterways Exp. Sta. CE, Vicksburg, Miss.