Journal of the Arkansas Academy of Science

Volume 39 Article 24

1985

Response of Fishes to Revetment Placement

C. H. Pennington
U.S. Army Engineer Waterway Experiment Station

S. S. Knight
U.S. Army Engineer Waterway Experiment Station

M. P. Farrell
U.S. Army Engineer Waterway Experiment Station

RESPONSE OF FISHES TO REVETMENT PLACEMENT

C. H. PENNINGTON, S. S. KNIGHT, and M. P. FARRELL
U.S. Army Engineer Waterway Experiment Station
P.O. Box 631
Vicksburg, MS 39180

ABSTRACT

Routine fish sampling with hoop nets was conducted monthly from April through December 1978 along natural and revetted riverbanks on the lower Mississippi River near Eudora, Arkansas, to monitor changes in fish populations affected by placement of new revetment for bank protection. Eighteen species of fish were collected with four species comprising over 75% of the total catch. During the months prior to revetment placement, freshwater drum, *Aplodinotus grunniens*, was the most abundant (32.7% of the catch) species collected. Following in abundance were the flathead catfish, *Pylodictis olivaris*, (9.8%), common carp, *Cyprinus carpio*, (7.8%), and blue catfish, *Ictalurus furcatus*, (3.3%). After revetment placement in August 1978, the freshwater drum was again the most abundant component, comprising 9.7% of the catch. Gizzard shad, *Dorosoma cepedianum*, flathead catfish, and blue catfish followed in abundance and comprised 8.9, 4.1, and 3.4% of the total catch, respectively. Catch per effort data indicated that fish were generally more abundant at natural bank stations than revetted bank stations but the difference was not significant. The study suggests that fish inhabiting natural riverbank habitat recover quite rapidly from bank perturbation caused by the placement of revetment.

INTRODUCTION

The Mississippi River and Tributaries Project founded under the auspices of the Mississippi River Commission provides for flood control in the alluvial valley and for navigation improvement of the lower Mississippi River. The open channel method of navigation control employed on the lower Mississippi River consists of dike construction for channel contraction and secondary channel closure and placement of revetment to control bank erosion. Revetments have been constructed using stone riprap, wire fencing, fabriform mat, rubber tires, and a variety of other materials. Presently, most revetments in the lower Mississippi River are constructed of articulated cement mattress, with the upper bank covered by riprap (Keown et al., 1977).

Despite the ubiquity of revetments along the banks of many major U.S. rivers, the quality of this altered habit is not well known (Miller, 1981). The work reported here compares the fish along natural and revetted banks prior to and after placement of articulated cement mattress for bank stabilization.

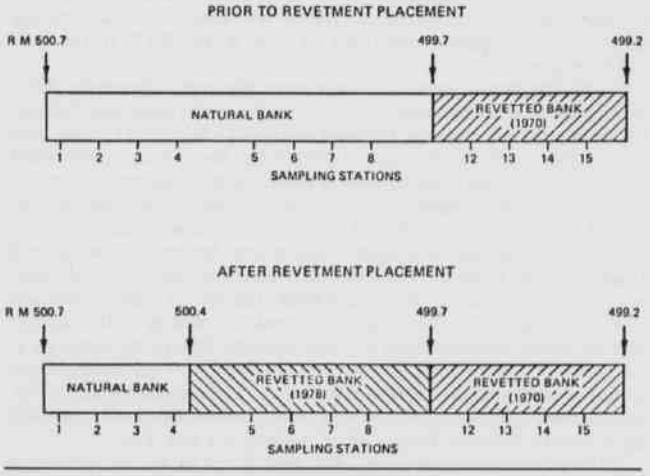

Figure 1. Diagram of Mississippi River left bank near Eudora, Arkansas, illustrating station locations prior to and after revetment placement in 1978.

MATERIALS AND METHODS

From April through December 1978, routine sampling was conducted to monitor changes in fish populations associated with natural and revetted riverbanks on the lower Mississippi River in the vicinity of Eudora, Arkansas. Three sections of the river bank were chosen for study (Figure 1):

a. An existing revetted bank composed of stone riprap and articulated cement mattress that was placed in 1970 and extends from river mile 449.2 to 499.7.
b. A reach of natural bank extending from river mile 499.7 to 500.4. This section of bank was modified for bank stabilization with the placement of 1066 m of revetment from August 1978 through December 1978.
c. A natural bank section that extends upstream of the new revetment to river mile 500.7.

There were four sampling stations within each riverbank section. Stations within each section were 100 m apart.

Monthly sampling was initiated on 17 April 1978 at the 12 permanent stations along the riverbank. Each station was sampled with two hoop nets, one 0.6-m (2-ft) and 0.9-m (3-ft) in diameter. The 0.6-m nets were always set near the river bank in shallow water, approximately 2m in depth, while 0.9m nets were placed in deeper water approximately 3.6 m in depth. Nets were set parallel to shore and to each other for two consecutive 24 hour periods. Fish from all samples were weighed, measured, and counted. At each net set made, water depth and surface measurements of dissolved oxygen, temperature, and water velocity were taken.

Catch per unit of effort (C/f) was used as an index of fish abundance and comparisons were made among banks over time. All mean C/f values are the number of fish caught divided by the number of units of effort (hoop net hours).

Response of Fishes to Revetment Placement

Table 1. Summary of mean catch per effort (C/f), current velocity, dissolved oxygen (D.O.), temperature, and depth by station group and type of gear used, April-December 1978, Eudora, Arkansas.

Station Group	Gear*	C/f	Velocity cm/sec	D.O. mg/l	Temperature °C	Depth m
1-4	HN2	0.60	39	7.8	19.9	2.1
	HN3	0.74	55	7.7	20.6	4.4
5-8	HN2	0.45	33	7.8	19.9	2.1
	HN3	0.58	47	7.7	20.2	4.2
12-15	HN2	0.28	18	7.7	19.7	2.0
	HN3	0.41	23	7.6	20.1	3.4

* HN2, Hoop net, 0.6 m diameter; HN3, Hoop net, 0.9 m diameter.

RESULTS AND DISCUSSION

Estimates of water quality parameters from the Mayersville Revetment indicate the similarity between the three river sections sampled. Water temperature and dissolved oxygen concentrations were fairly consistent, with no significant differences between the river sections sampled or the deep and shallow water sets. Monthly water temperatures from the area indicate that no unusual thermal conditions occurred during the study. Maximum temperatures occurred in August, and minimum temperatures were in December. Monthly temperatures rarely varied more than one degree among station groupings and between the shallow and deep sets at a station. Temperatures recorded from the shallow-water sets were generally slightly lower than temperatures at the deep-water sets. Also, temperatures from stations 12-15, located along the old revetment were slightly cooler than those recorded at the other stations. Dissolved oxygen determinations indicated a normal tendency toward winter maximum and summer minimum values. The shallow sets at a station had only slightly higher concentrations of dissolved oxygen than did the deeper sets. Analysis of variance did reveal a significant difference between the current velocities at the deep-water and shallow-water sets for old revetment stations 12-15 and stations 1-4 and 5-8 (Table 1). Monthly current measurements indicated that velocity at stations along the old revetment for both shallow and deep sets was less than at other stations grouped by bank type (Table 1). The data also demonstrated that currents along the shallow inshore sets were less than, but not significantly different from, the deep-water sets at each sampling station.

Hoop net catches varied considerably during the nine-month study along the Mayersville Revetment. Total catches ranged from zero in numerous net sets to over 16 fish captured at station 2 on 11 July. Greatest catches occurred during June and July as river stage decreased and water temperatures increased. Catches at all stations were consistently low from September-December. Some possible explanations for such low hoop net catches are: (a) a steady low water river stage during September and October; (b) decreased activity of fish caused by falling water temperatures; and (c) disturbance of the area when revetment was placed on 24 August along the riverbank at stations 5-8 or by upper bank grading that continued through December.

Total catches were generally greatest along the natural bank at stations 1-4 and 5-8 (prior to 24 August) and lowest at stations 12-15 downstream along the old revetment. Total catch along new revetment stations 5-8 after 24 August was approximately the same as at natural bank stations and slightly better than catches on the old revetment. Eddy currents along revetted bank stations 12-15 were consistently present, certainly causing some nets to fish improperly.

Table 2. Frequency of occurrence (percent) of fish captured with hoop nets at sampling stations 1-4, 5-8, and 12-15.

	Station Group						
	1-4		5-8		12-15		Total
Species	B*	A	B	A	B	A	
Scaphirhynchus platorynchus	0.2	0.9			0.2		1.3
Lepisosteus platostomus	0.5		1.7			0.2	2.4
Anguilla rostrata	0.2	0.6	0.2	0.2			1.3
Dorosoma cepedianum	1.4	3.7	0.6	3.5		1.7	10.9
Carassius auratus						0.3	0.3
Cyprinus carpio	4.0		2.4	0.5	1.4		8.3
Carpiodes carpio	1.7	0.5	0.2	0.6	0.5		3.5
Carpiodes cyprinus	0.2		0.2				0.4
Ictiobus bubalus	0.2	0.5		0.6	1.4		2.7
Ictiobus cyprinellus	0.6						0.6
Ictalurus furcatus	1.1	1.3	1.1	1.6	1.1	0.5	6.7
Ictalurus punctatus	0.9			0.6	0.3		1.8
Pylodictis olivaris	4.5	1.7	3.2	1.6	2.1	0.8	13.9
Morone chrysops	0.3	0.2					0.5
Lepomis macrochirus				0.2		0.3	0.5
Pomoxis annularis	0.6		0.2		2.0		1.0
Stizostedion canadense		0.2		0.6			0.8
Aplodinotus grunniens	17.7	4.9	7.5	3.4	7.5	1.4	42.4
TOTAL	34.1	14.5	17.3	13.4	14.7	5.4	99.4

* B = before revetment and A = after revetment placement at stations 5-8.

Eighteen species of fish were collected during the study, 16 from natural bank stations 1-4 and 14 each from natural or revetted bank stations 5-8 and old revetted bank stations 12-15. Four species of fish comprised over 75.5% of the total catch. Freshwater drum *(Aplodinotus grunniens)* was by far the most abundant species, representing 42.4% of the total fish catch (Table 2). Flathead catfish *(Pylodictis olivaris)*, gizzard shad *(Dorosoma cepedianum)*, and carp *(Cyprinus carpio)* followed in abundance comprising 13.9, 10.9, and 8.3% of the total catch, respectively.

During the months prior to the revetment placement, freshwater drum was the most abundant species (32.7% of the catch) collected. Following in abundance were the flathead catfish (9.8%), carp (7.8%), and blue catfish *(Ictalurus furcatus)* (3.3%). After the revetment placement in August, the freshwater drum was again the most abundant component of the catch, comprising 9.7%. Gizzard shad (8.9%), flathead catfish (4.1%), and blue catfish (3.4%) followed in abundance.

Mean C/f was used to compare relative abundance of fishes captured from the three types of riverbank. The data indicate that fishes were generally more abundant at natural bank stations 1-4 than at other station groupings (Table 1). Analysis of variance among station groupings by month indicated that C/f was not significantly different (α = 0.05) except during June and August. In June, C/f on natural bank stations 1-4 was significantly greater than C/f at stations 5-8 and 12-15. In October, C/f along old revetted bank stations 12-15 was zero and significantly different from C/f at stations 1-4 and 5-8.

C/f was generally greater in 0.9-m nets fished in deeper water than in the 0.6-m nets set in shallow water. However, analysis of variance of C/f between the two gears indicated no significant difference in mean C/f.

CONCLUSIONS

During this study, no major differences in water quality or C/f were documented along the three types of riverbanks (old revetment, new revetment, and natural bank). However, abundance estimates along revetted bank stations 12-15 were generally lower than along the other bank types. Pennington, Baker and Potter (1983), in a study of natural and revetted banks near Greenville, Mississippi, reported similar C/f for both riverbank types. This was consistent with C/f values reported by Burress, Krieger and Pennington (1982) and Kallemeyn and Novotny (1977), however, all authors reported C/F values to be higher along revetted banks. The low catches along revetted bank stations 12-15 could reflect a difference in fish abundance that may be governed by local variations in bank materials and water currents.

Total catch and C/f for the months revetting materials were deposited indicates a higher abundance of fish at stations 5-8 than at the old undisturbed revetment at stations 12-15. This indicates that fish susceptible to capture with hoop nets apparently respond and recover quite rapidly from bank perturbation caused by the placement of the revetment.

ACKNOWLEDGMENTS

This work is part of the Environmental and Water Quality Operational Studies, Project VA, sponsored by the Office, Chief of Engineers.

LITERATURE CITED

BURRESS, R. M., D. A. KRIEGER, and C. H. PENNINGTON. 1982. Aquatic biota of bank stabilization structures on the Missouri River, North Dakota. Technical Report E-82-6. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. 51 pp.

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. Fish and Wildlife Service, National Stream Alteration Team, FWS/OBS-77.25, Columbia, Missouri. 63 pp.

KEOWN, M. P., N. R. OSWALT, E. B. PERRY, and E. A. DARDEAU, JR. 1977. Literature survey and preliminary evaluation of streambank protection methods. Technical Report H-77-9. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. 94 pp.

MILLER, A. C. 1981. Aquatic habitat studies on the Lower Mississippi River, river mile 480 to 530: Report 1. Introduction. Miscellaneous Paper E-80-1. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. 34 pp.

PENNINGTON, C. H., J. A. BAKER, and M. E. POTTER. 1983. Fish populations along natural and revetted banks on the Lower Mississippi River. North Amer. J. Fish. Mgmt. 3(2):204-211.