AD-A099 329 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG--ETC F/G 6/6
AQUATIC HABITAT STUDIES ON THE LOWER MISSISSIPPI RIVER, RIVER M--ETC(U)
APR 81 H L SCHRAMM, C H PENNINGTON
UNCLASSIFIED WES/MP/E-80-1-6 NL

1 OF 1
AD A
099329

END
DATE
FILMED
6-81
DTIC

AD A099329

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: Miscellaneous Paper E-80-1	2. GOVT ACCESSION NO.: AD-A099 329	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): AQUATIC HABITAT STUDIES ON THE LOWER MISSISSIPPI RIVER, RIVER MILE 480 TO 530; Report 6, LARVAL FISH STUDIES—PILOT REPORT. A094425		5. TYPE OF REPORT & PERIOD COVERED: Report 6 of a series
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Harold L. Schramm, Jr.; C. H. Pennington		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: U. S. Army Engineer Waterways Experiment Station, Environmental Laboratory, P. O. Box 631, Vicksburg, Miss. 39180		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: EWQOS Work Unit VIIB
11. CONTROLLING OFFICE NAME AND ADDRESS: Office, Chief of Engineers, U. S. Army, Washington, D. C. 20314		12. REPORT DATE: April 1981
		13. NUMBER OF PAGES: 74 (12) 79
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): WES/MP/E-80-1-6		15. SECURITY CLASS. (of this report): Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

9 Apr-Oct 78 10 11

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

ELECTE

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Fishes
Habitats
Larvae
Lower Mississippi River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Larval fish were collected in the Lower Mississippi River from 8 March to 13 November 1978 to describe variations in diversity and abundance of larval fish among nine types of habitats for the entire spawning season, investigate diel fluctuations in diversity and abundance, and evaluate replicate sampling procedures.

The abandoned channel and oxbow lake habitats had similar larval populations; these habitats showed relatively low diversity and high (Continued)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. ABSTRACT (Continued).

densities of clupeids and centrarchids. Natural banks and revetted banks had high and similar diversities and abundances of larval fish. There were considerable variations in density and diversity among the four revetted bank stations sampled. The dike field habitat was characterized by a high diversity and moderate density of larval fish. All families of larval fish collected during the entire study were represented in the dike field habitat. The diversity and density of larval fish differed greatly among the six dike field stations sampled. Three of the four main channel stations sampled showed low diversity and density of larval fish. The fourth main channel station had high diversity of larval fish and high densities were observed on two sampling dates. Density of larval fish was low but diversity of larval fish was relatively high in the temporary secondary channel habitat. Density and diversity of larval fish were low in the permanent secondary channel and the sandbar habitats.

The number of taxa and density of larval fish differed significantly (probability < 0.01) between time periods of the diel cycle. The number of taxa and the density were greatest at dusk. Twelve taxa were collected only in dusk, night, and dawn samples. *Aplodinotus grunniens*, *Carpiodes* spp., and clupeids accounted for 95 percent of the larvae collected during the diel sampling effort. *A. grunniens* and *Carpiodes* spp. were more abundant in dusk and night samples. Clupeids were more abundant diurnally.

A variance component analysis demonstrated that samples taken within a 1- to 2-hr time period of a diel cycle did not constitute significant (probability < 0.01) amounts of the variation in number of taxa or density of larval fish. The same analysis showed that samples collected with paired nets did not constitute a significant (probability < 0.01) portion of the variation in number of taxa, but did constitute a significant portion of the variation in density of larval fish.

Implications for future sampling are discussed.

This is report 6 of the series "Aquatic Habitat Studies on the Lower Mississippi River, River Mile 480 to 530." A complete listing of the reports is as follows:

Report 1: Introduction
Report 2: Aquatic Habitat Mapping
Report 3: Benthic Macroinvertebrate Studies--Pilot Report
Report 4: Diel Periodicity of Benthic Macroinvertebrate Drift
Report 5: Fish Studies--Pilot Report
Report 6: Larval Fish Studies--Pilot Report
Report 7: Management of Ecological Data in Large River Ecosystems
Report 8: Summary

PREFACE

The work described in this report is part of the Environmental and Water Quality Operational Studies (EWQOS) conducted by the U. S. Army Engineer Waterways Experiment Station (WES) for the Office, Chief of Engineers. This document is report 6 in a series which discusses the results of an aquatic habitat investigation on the Lower Mississippi River, mile 480 to 530 from April to October 1978.

This report presents results of a pilot survey of larval fish populations associated with each of nine major aquatic habitat types found within the leveed floodplain of the 50-mile study reach are discussed.

The report was prepared by Drs. Harold L. Schramm, Jr., and C. H. Pennington under the direction of Dr. Thomas D. Wright, Chief, Waterways Habitat and Monitoring Group; Mr. Bob Benn, Chief, Environmental Systems Division; Dr. Jerome L. Mahloch, Program Manager, EWQOS; and Dr. John Harrison, Chief, Environmental Laboratory, WES. Dr. Michael P. Farrell performed the statistical analyses. Larval fish were identified by the Cooperative Fishery Research Unit, Louisiana State University, Baton Rouge, Louisiana, under Interagency Agreement Number 79-12. Messrs. Michael Potter and Jerry Dahl assissted with the collection of samples.

COL John L. Cannon, CE, was Commander and Director of WES during the field conduct of this study. COL Nelson P. Conover, CE, was Commander and Director of WES during preparation of this report. Mr. Fred R. Brown was Technical Director of WES.

CONTENTS

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
acres	4046.873	square metres
cubic feet per second	0.02831685	cubic metres per second
feet	0.3048	metres
miles (U. S. statute)	1.609344	kilometres
square feet	0.09290304	square metres

AQUATIC HABITAT STUDIES ON THE LOWER MISSISSIPPI RIVER, RIVER MILE 480 TO 530

LARVAL FISH STUDIES--PILOT REPORT

PART I: INTRODUCTION

Background

1. The fish fauna of the Lower Mississippi River is highly diverse and supports an important commercial and recreational fishery. Perpetuation of this is contingent upon suitable spawning and nursery areas for larval fish. Since a goal of the Environmental and Water Quality Operational Studies (EWQOS) is to assess the effects of dikes and revetments on the aquatic ecosystem, it was necessary to evaluate the importance of different habitats in the Lower Mississippi River as fish spawning and nursery areas for larval fish. The pilot survey provided the opportunity to assess the spatiotemporal distribution and abundance of larval fish and to develop economical and effective sampling designs.

Objectives

2. The objectives of the larval fish pilot survey were:

- a. To describe variations in diversity and abundance of larval fish among habitats in the Lower Mississippi River for the entire spawning season.
- b. To investigate the effect of time of day on diversity and abundance (i.e., diel periodicity) of larval fish in the Lower Mississippi River.
- c. To determine error and variability of species composition and density estimates associated with paired net hauls and with net hauls taken at different times during a diel cycle.

PART II: METHODS OF SAMPLING AND ANALYSIS

Habitat Sampling

3. To describe variations in diversity and abundance of larval fish among habitats for the duration of a spawning season, larval fish were sampled in nine habitats in the Lower Mississippi River from river mile 506.6 to 531.0 during the period 8 March to 13 November 1978 (Table 1). These habitats included: (a) abandoned channels, (b) oxbow lakes, (c) natural banks, (d) revetted banks, (e) dike fields, (f) sandbars, (g) permanent secondary channels, (h) temporary secondary channels, and (i) the main channel. The inundated floodplain habitat discussed in some of the reports in this series was not sampled for larval fish.

4. Samples were collected approximately every two weeks from March through August and monthly during September, October, and November. Samples were collected with 0.5-m-diameter, 505-μ-mesh, 1/3-taper, nylon plankton nets. The nets were fitted into a yoke on an aluminum handle and fished 0.5 m below the surface of the water and 1 m away from the side of the boat at midship. With the gear used, the nets could be quickly raised and lowered into the water. The mouths of the nets were not impeded by towing bridles, and the nets were positioned away from any bow wake or prop wash of the sampling vessel.

5. Tows were made downstream at approximately 70 cm/sec faster than the current for 5 min. Either General Oceanics Model 2030 flowmeters or Marsh-McBirney electromagnetic current meters were mounted in the center of the mouth of the net to measure water velocity. These values were used to calculate the volume of water filtered through each net. When volume was calculated with the electromagnetic current meter, velocity measurements were recorded every 30 sec. Since velocity fluctuated during a tow because of difficulty in maintaining constant speed in the flowing, often turbulent water, distance travelled was estimated by integrating a velocity-time curve for each tow. After each 5-min tow was completed, the nets were washed to flush all larval fish adhering to

the net into the cod-end plankton bucket. Samples were immediately fixed with 5-percent buffered formalin. Larval fish were later identified to the lowest possible taxon.

Sampling Stations

6. The following paragraphs discuss the stations that were sampled for larval fish from March through November 1978 (Figure 1). Station locations are the point at which the downstream tow commenced.

7. The abandoned channel habitat was sampled at two stations in Matthews Bend. Matthews Bend station 1 was located at the edge of the willow trees on the left bank, 1.3 km below the entrance into Moon Chute. Matthews Bend station 2 was at the edge of the willow trees on the left bank, 3 km above the confluence with the river.

8. The oxbow lake habitat was sampled in Lake Lee. Lake Lee station 1 was located on the right bank, 1.5 km above the downstream end of the lake along the edge of the willow trees during high water and at the edge of inundated _Polygonum_ sp. during lower stages. Lake Lee station 2 was in the middle of the lake, 1.5 km above the downstream end of the lake. Lake Lee station 101 was located in the chute connecting Lake Lee with the river, 2.0 km below the downstream end of Lake Lee. The chute is well shaded by vegetation on the bank and has many log jams. During high water this chute is flanked by inundated floodplain. During lower stages this chute is a narrow (less than 15 m wide), steep-sided canal.

9. The natural bank habitat was sampled at Anconia Natural Bank (river mile 526, right bank) and Lakeport Natural Bank (river mile 527, left bank). At both habitats sampling was conducted as close to the bank as possible without fouling the net in the numerous trees and logs along the bank.

10. The revetted bank habitat was sampled at Carolina Revetment at river mile 508.8, Cracraft Revetment at river mile 511.4, Walnut Point-Kentucky Bend Revetment at river mile 519.1, and at Sunnyside Revetment at river mile 526.8. All samples were collected approximately 10 m from the bank.

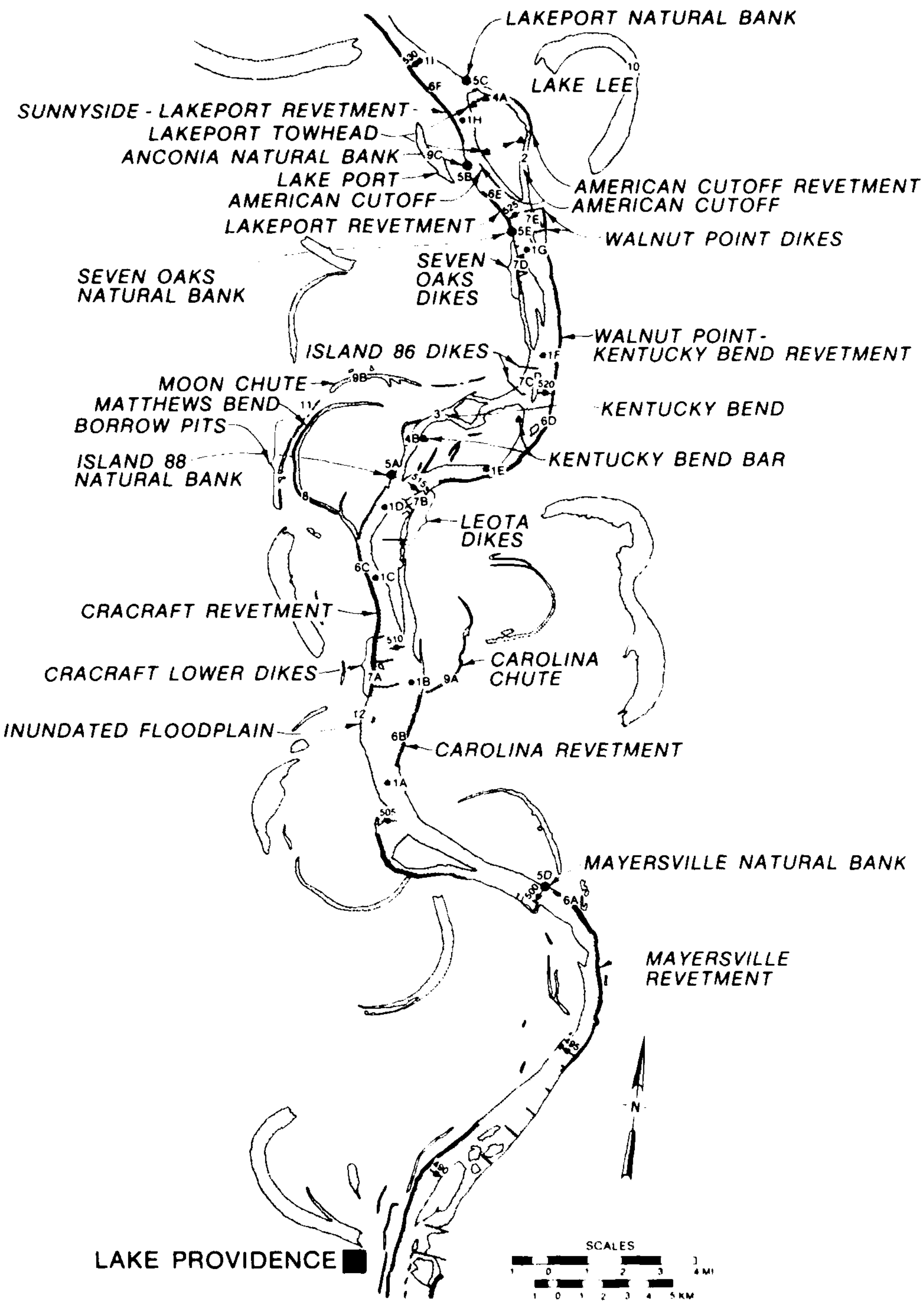

Figure 1. Study area

11. The dike field habitat was sampled at six stations in five dike fields. Lower Cracraft Dike Field was sampled 50 m off the right bank and 50 m below dike 3. Leota Dike Field was sampled below dike 3. The exact geographic location of this station fluctuated widely with water stage, but all samples were collected as close as possible to the left bank and the dike. Island 86 Dike Field was sampled below dike 2; samples were collected as close as possible to the right bank and the dike. Seven Oaks Dike Field station 1 was located between dikes 1 and 2, 30 m from shore. Seven Oaks Dike Field station 2 was below dike 5, 10 m from shore. Walnut Point Dike Field was sampled below dike 2, 10 m from shore.

12. The sandbar habitat was sampled along the east bank of Lakeport Towhead at approximately river mile 528. Samples were collected in 1.0 to 1.5 m deep water; hence, exact geographic location of this station varied with river stage.

13. The permanent secondary channel habitat was sampled in American Cutoff. The sampling station was located in the middle of the channel, 3 km above dike 1 of Walnut Point Dike Field.

14. The temporary secondary channel habitat was sampled in the chute behind Kentucky Bend Bar (Kentucky Bend Chute). Samples were collected 75 to 100 m from the right bank at approximately river mile 515.5.

15. The main channel habitat was sampled in the middle of the navigation channel at four locations: station 1, river mile 506.6; station 3, river mile 511.3; station 6, river mile 522.8; and station 9, river mile 531.0.

Classification of Relative Abundance Data

16. To condense the data and to facilitate the comparison of larval fish among habitats, the taxa in each habitat were categorized as "rare," "common," or "abundant." In addition, the densities of the representative taxa (genera, species, and unidentified) of each family were pooled so that the families could also be categorized as rare, common, or abundant. The simplest case is that of a habitat with a single

sampling station and each taxon collected on only one sampling date. In this simple case, "rare" is < 5 larvae/100 m^3, "common" is 5 to 30 larvae/100 m^3, and "abundant" is > 30 larvae/100 m^3. Only rarely did this simple case occur. When a taxon was collected on several dates, the taxon was considered abundant if > 30 larvae/100 m^3 were collected on at least two dates, and common if 5 to 30 larvae/100 m^3 were collected on at least two dates. If a taxon was collected on only two dates, the category was based on the average density. For habitats where several stations were sampled, a taxon was common or abundant if 5 to 30 larvae/100 m^3 or > 30 larvae/100 m^3, respectively, were collected at the majority of the stations. In the cases of a taxon collected on several dates in a habitat where several stations were sampled, the taxon was categorized as common or abundant if 5 to 30 larvae/100 m^3 or > 30 larvae/100 m^3, respectively, were collected on at least two dates in at least the majority of the stations.

Diel Sampling and Replicate Evaluation

17. To investigate the effect of time of day on diversity and abundance of larval fish, a diel sample of larval fish was collected at Sunnyside Revetment on 27-28 June. It was also the purpose of this sampling to determine whether samples collected with paired nets or samples collected during a 1- or 2-hr time period could be considered replicate samples.

18. On 27-28 June, the depth at Sunnyside Revetment ranged from 5 to 12 m along the transect. Water temperature was 27.5°C and dissolved oxygen was 6.9 ppm at 10 cm below the surface. Water clarity measured with a Secchi disc was 15 cm. Current velocity 10 m from the bank at river mile 526.8 was 70 cm/sec at 50 cm below the water surface, and the water was turbulent and several large eddies were present along the sampling transect. The river stage was 6.9 m at the Greenville, Mississippi, gauge and slowly rising.

19. Samples were collected at midday (1141 to 1410 hr), afternoon (1530 to 1608 hr), dusk (2048 to 2150 hr), night (0100 to 0158 hr), and

dawn (0515 to 0607 hr). The dusk samples commenced one-half hour before total darkness, and dawn samples commenced one-quarter hour before first light. Ten replicate samples were collected at midday, and five replicate samples were collected at each of the other time periods. Each replicate consisted of a pair of samples taken simultaneously from opposite sides of the boat. The sample collected from the side of the boat closest to shore is referred to as the "shore sample" and the sample from the opposite side of the boat is referred to as the "river sample." The midday and afternoon samples were collected from a 16-ft* john boat by towing downstream at approximately 70 cm/sec faster than the current; tows were started at river mile 526.8. The other samples were collected from a 40-ft launch by holding the boat under power at river mile 526.8. Individual samples were of 5-min duration. Forty to sixty m^3 of water per sample were filtered during the midday and afternoon sampling; 60 to 80 m^3/sample were filtered during the dusk through dawn sampling.

20. All sampling gear for the diel samples was identical to the equipment used for the habitat comparison sampling, except that a flowmeter was used to estimate the volume of water filtered.

21. Analysis of variance (ANOV) was used to test for differences in the number of taxa and the density of larval fish among the time periods. Variance component analysis was used to test for significant amounts of variation in time intervals within time periods; i.e., variation among samples collected during a 2-hr period at midday and during 1-hr periods for the afternoon, dusk, night, and dawn sampling periods. Variance component analysis was also used to test for significant amounts of variation between samples collected from opposite sides of the boats. All statistical analyses followed the Statistical Analysis System (SAS) procedures.

---

* A table of factors for converting U. S. customary units of measurement to metric (SI) units is presented on page 3.

PART III: RESULTS

General Conditions

22. Larval fish sampling commenced on 23 March 1978. No larval fish were collected during the sampling trips conducted on 23-24 March, or 7 April. Larval fish were first collected during the 19-20 April sampling effort and nine taxa were represented: unidentified clupeids, unidentified cyprinids, *Cyprinus carpio*, *Ictiobus* spp., *Morone* spp., *Lepomis* spp., *Micropterus* spp., *Pomoxis* spp., and *Stizostedion canadense*. The river stage had, in general, been rapidly rising since early March and peaked at 14.1 m on 7-11 April on the Greenville gauge. On 19 April the river stage was at 12.3 m at Greenville and falling slowly. Water temperature was 17.0°C. Larval fish were present throughout the summer. On 21 September seven taxa of larval fish were collected: unidentified clupeids, unidentified cyprinids, *Carpiodes* spp., *Menidia audens*, *Lepomis* spp., unidentified centrarchids, and *Aplodinotus grunniens*. The river stage at Greenville was 5.3 m and had been fluctuating between 5.2 m and 6.4 m during the preceding 30 days. Water temperature was 27.4°C. No larval fish were collected on 18 October or 13 November. Water temperature was 17.0°C on 18 October.

Diversity and Abundance of Larval Fish

23. In this section the diversity and abundance of larval fish populations in the Lower Mississippi River are described for each type of habitat and for each sampling station in each habitat. Data for the habitats are presented in Table 2, and data for each sampling station are presented in Tables 3 through 26.

Abandoned channel habitat

24. Matthews Bend station 1. Larval fish were first collected at Matthews Bend station 1 on 18 May (Table 3). Fifteen unidentified clupeids/100 m^3 were collected at this time. The density of clupeids rose quickly to a miximum density of 217 larvae/100 m^3 on 15 June and

fluctuated at low densities for the remainder of the summer. No clupeids were collected on 21 September. Clupeidae represented 50.2 percent of the total number of individuals collected at this station. Lepomis spp. accounted for 45.2 percent of the total number of larval fish collected. Lepomis spp. were first collected on 29 June. Density of Lepomis spp. peaked at 137 larvae/100 m^3 on 13 July. Four other taxa were collected in low numbers.

25. Matthews Bend station 2. Only unidentified clupeids and Lepomis spp. were collected at Matthews Bend station 2 (Table 4). Clupeids were first collected on 18 May and peaked at 46 larvae/100 m^3 on 31 May. Lepomis spp. were not collected until 13 July and peaked at 47 larvae/100 m^3 on 9 August.

26. Abundance and seasonal data for the habitat. Larval fish were collected in the abandoned channel habitat from 19 April to 21 September. Clupeidae and Centrarchidae were abundant (Table 2). Clupeids were not collected here as early in the spring as in other habitats. The families Atherinidae and Percichthyidae were common during single late summer sampling periods. The single collection of Percichthyidae was the latest time this family was collected.

Oxbow lake habitat

27. Lake Lee station 1. Larval fish were collected at Lake Lee station 1 during all sampling times from 20 April through 22 August, except 18 May (Table 5). Five taxa (unidentified clupeids and Dorosoma spp. counted as one taxon) and 1102 larvae were collected. Unidentified clupeids and Morone spp. were present on 20 April. The maximum density for total larvae was 952 larvae/100 m^3 on 14 June. Clupeidae constituted 93.6 percent of all larvae collected. Lepomis spp. was the only other taxon collected in appreciable numbers, constituting 4.5 percent of the total catch. Peak density of Lepomis spp. was 41 larvae/100 m^3 on 25 July.

28. Lake Lee station 2. Lake Lee station 2 was sampled from 20 April through 18 October; larval fish were collected on 3 May through 28 June and on 8 August (Table 6). A total of five taxa (unidentified clupeids and Dorosoma petenense counted as one taxon; unidentified

centrarchids and Lepomis spp. counted as one taxon) and 123 larvae were collected during these times. Unidentified clupeids and unidentified centrarchids were present in the 3 May sample. High densities of total larvae of 55 larvae/100 m^3 and 52 larvae/100 m^3 were collected on 3 May and 8 August, respectively. Clupeidae was the most abundant taxon at 84.6 percent of the total catch. Peak density of Clupeidae was 53 larvae/100 m^3 on 3 May.

29. Lake Lee station 101. Larval fish were collected in the chute connecting Lake Lee with the river in all samples from 18 May through 22 August, except 28 June (Table 7). Four taxa (unidentified cyprinids and Notropis spp. counted as one taxon) and 45 individuals were collected. Highest densities were 15 larvae/100 m^3 and 14 larvae/100 m^3 on 12 July and 25 July, respectively. Lepomis spp. was the most frequently collected taxon at 37.8 percent of the total catch. Maximum density of Lepomis spp. was 14 larvae/100 m^3 on 25 July. Clupeidae was the second most abundant taxon at 31.1 percent of the total catch. The peak density of Clupeidae was 10 larvae/100 m^3 on 12 July.

30. Abundance and seasonal data for the habitat. Larval fish were collected in the oxbow lake habitat (Lake Lee and the chute connecting Lake Lee to American Cutoff) from 20 April to 22 August. Clupeidae was the only abundant family in the oxbow lake habitat (Table 2). Dorosoma spp. and D. petenense were common. The family Centrarchidae and the genus Lepomis were also common. Centrarchids were not collected here as late in the summer as in most other habitats.

Natural bank habitat

31. Anconia Natural Bank. Larval fish were collected at this location on all sampling dates from 19 April through 21 September, except 23 August (Table 8). Eleven taxa (unidentified clupeids and Dorosoma petenense counted as one taxon, Morone spp. and M. chrysops counted as one taxon, and unidentified centrarchids and Pomoxis spp. counted as one taxon) and 394 larvae were collected. Unidentified clupeids, Ictiobus spp., Morone spp., Pomoxis spp., and Etheostoma spp. were collected on 19 April. Maximum density of total larvae, 110 larvae/100 m^3, was collected on 9 August. Constituting 48.7 percent of the total catch,

Aplodinotus grunniens was the most frequently collected taxon. Peak density of *A. grunniens* was 96 larvae/100 m^3 on 9 August; a second peak density of 52 larvae/100 m^3 was recorded on 28 June. Clupeidae was also caught in relatively high numbers and constituted 31.2 percent of the total catch. Clupeidae had high densities of 60 larvae/100 m^3 and 34 larvae/100 m^3 on 30 May and 19 April, respectively.

32. Lakeport Natural Bank. Larval fish were collected at this location during all sampling periods from 20 April through 21 September, except 18 May (Table 9). Ten taxa (unidentified clupeids, *Dorosoma cepedianum*, and *D. petenense* counted as two taxa; and unidentified catostomids, *Carpiodes* spp., *C. carpio*, and *Ictiobus* spp. counted as two taxa) and 206 individuals were collected. Unidentified clupeids and *Ictiobus* spp. were collected on 20 April. High densities of larvae were collected at three times: 38 larvae/100 m^3 on 20 April, 34 larvae/100 m^3 on 25 July, and 31 larvae/100 m^3 on 30 May. Catch frequencies were rather uniformly distributed among taxa. Clupeidae and *Carpiodes* spp. (including *C. carpio*) were the most frequently collected taxa, accounting for 34.0 and 24.2 percent of the total catch, respectively. Highest densities of Clupeidae were collected on 20 April and 28 June. The maximum density of *Carpiodes* spp. was 18 larvae/100 m^3 on 25 July. *Ictiobus* spp. was abundant on 20 April.

33. Abundance and seasonal data for the habitat. Larval fish were collected in the natural bank habitat from 19 April to 21 September. Clupeids were abundant during spring and early summer and sciaenids abundant throughout the summer (Table 2). Hiodontidae, Cyprinidae, Catostomidae, and Centrarchidae were common families.

Revetted bank habitat

34. Carolina Revetment. Larval fish were collected at Carolina Revetment from 18 May through 21 September. Six taxa (unidentified clupeids and *Dorosoma cepedianum* counted as one taxon, unidentified catostomids and *Carpiodes* spp. counted as one taxon, and unidentified centrarchids and *Lepomis* spp. counted as one taxon) and 157 individuals were collected (Table 10). Highest densities of total larval fish were 39 larvae/100 m^3 and 36 larvae/100 m^3 on 31 May and 26 July, respectively.

Centrarchidae was the most abundant taxon at 34.3 percent of the total catch. Peak density of Centrarchidae was 25 larvae/100 m^3 on 26 July. Clupeidae and Aplodinotus grunniens were the second and third most abundant taxa, constituting 27.4 and 24.8 percent of the total catch, respectively. The peak density of A. grunniens was 15 larvae/100 m^3 on 29 June, and the peak density of Clupeidae was 35 larvae/100 m^3 on 31 May.

35. Cracraft Revetment. Larval fish were collected at Cracraft Revetment from 18 May through 21 September. During this time, nine taxa (unidentified centrarchids, Lepomis spp., Pomoxis spp., and P. nigromaculatus counted as two taxa) and 290 individuals were collected (Table 11). Maximum density of total larvae was 80 larvae/100 m^3 on 29 June; high densities of 66 larvae/100 m^3 and 65 larvae/100 m^3 occurred on 31 May and 15 June, respectively. Aplodinotus grunniens, constituting 46.6 percent of the catch, was the most abundant taxon. Maximum density of A. grunniens was 57 larvae/100 m^3 on 29 June. High densities of this taxon were also recorded on 15 June and 9 August. Unidentified clupeids were the second most abundant taxon, constituting 28.6 percent of the total catch. Peak density of clupeids was 60 larvae/100 m^3 on 31 May.

36. Sunnyside Revetment. Fourteen taxa and 545 individual fish larvae were collected from 19 April through 9 August at Sunnyside Revetment (Table 12). The maximum density pooled over taxa was 263 larvae/100 m^3 on 14 June. Clupeidae, at 51.2 percent of the total larvae collected, was the most abundant taxon. Maximum density of Clupeidae was 158 larvae/100 m^3 on 14 June. A second peak in Clupeidae density of 62 larvae/100 m^3 occurred on 19 April. Aplodinotus grunniens was the second most abundant taxon, constituting 30.8 percent of the total larvae collected. The maximum density of A. grunniens was 93 larvae/100 m^3 on 14 June; a high density of 44 larvae/100 m^3 also occurred on 9 August.

37. Walnut Point-Kentucky Bend Revetment. Larval fish were collected at Walunt Point-Kentucky Bend Revetment on 20 April and 18 May through 21 September. During this time 13 taxa (unidentified clupeids, Dorosoma cepedianum, and D. petenense counted as two taxa; Pomoxis spp.

and P. annularis counted as one taxon) and 402 individuals were collected (Table 13). The maximum density of total larval fish was 140 larvae/ 100 m^3 on 28 June. Aplodinotus grunniens was the taxon collected in highest numbers, constituting 44.8 percent of the total larvae. Maximum density of A. grunniens was 128 larvae/100 m^3 on 28 June. Clupeidae was also collected in large numbers, constituting 22.3 percent of the total catch. High densities of Clupeidae were collected on 20 April and 14 June.

38. Abundance and seasonal data for the habitat. Larval fish were collected at the revetted bank habitat from 19 April to 21 September. Sciaenidae was the only family classed as abundant (Table 2). Clupeids were abundant on at least one date at each of the four sampling stations, but because of the protracted time of occurrence they were categorized as common. The families Hiodontidae, Cyprinidae, and Centrarchidae were common. Centrarchids were collected over the longest span of time in this habitat.

Dike field habitat

39. Lower Cracraft Dike Field. Two Pomoxis spp. larvae/100 m^3 collected on 18 May represented the first larval fish collected at this station (Table 14). During all sampling 10 taxa (unidentified clupeids, Dorosoma cepedianum, and D. petenense counted as two taxa; Pomoxis spp. and P. nigromaculatus counted as one taxon) and 170 individuals were collected between 18 May and 23 August. Aplodinotus grunniens and Clupeidae were the most abundant taxa. Maximum density of A. grunniens was 83 larvae/100 m^3 on 15 June. Maximum density of Clupeidae was 29 larvae/ 100 m^3 on 31 May. The remaining taxa were represented sporadically at very low densities.

40. Island 86 Dike Field. Larval fish were collected at Island 86 Dike Field from 19 April through 21 September. Unidentified clupeids, Cyprinus carpio, and unidentified cyprinids were collected on 19 April (Table 15). Ten taxa (unidentified catostomids and Ictiobus spp. counted as one taxon; unidentified centrarchids and Lepomis spp. counted as one taxon) were collected. Of the 166 total larvae collected, 44.0 percent were Aplodinotus grunniens, 20.5 percent were Clupeidae, and 13.9 percent

were Cyprinidae. Other taxa were present in low numbers. Maximum densities of A. grunniens occurred on 9 August, of Clupeidae on 23 August, of Cyprinidae on 9 August, and a maximum for all taxa on 9 August.

41. Leota Dike Field. Larval fish were collected in Leota Dike Field from 19 April through 23 August. Unidentified clupeids, Cyprinus carpio, Ictiobus spp., Morone spp., and Pomoxis spp. were collected on 19 April (Table 16). A total of 152 larvae were collected with a maximum density of 63 larvae/100 m^3 on 29 June. Clupeidae was the numerically dominant taxon, constituting 60.6 percent of the total larvae. Maximum density of Clupeidae was collected on 29 June. Ictiobus spp. (including I. cyprinellus) and Aplodinotus grunniens were the next most frequently collected taxa, accounting for 10.6 and 9.2 percent, respectively, of the total number of larvae collected. Each of these taxa was collected during only one or two sampling dates. No larval fish were collected in the 3 May, 18 May, and 9 August samples.

42. Seven Oaks Dike Field station 1. Larval fish were collected from 19 April through 21 September at Seven Oaks Dike Field station 1. Fourteen taxa (unidentified clupeids, Dorosoma cepedianum, and D. petenense counted as two taxa; unidentified centrarchids and Lepomis spp. counted as one taxon; Micropterus spp. and M. punctulatus counted as one taxon) were collected during this time period (Table 17). Unidentified clupeids, Cyprinus carpio, Ictiobus spp., and Morone spp. were collected on 19 April. A total of 1052 larvae were collected. The single-sample maximum density was 377 larvae/100 m^3 on 14 June. Aplodinotus grunniens was the most frequently captured taxon, constituting 43.8 percent of the total number of larvae. Densities of A. grunniens increased to a high density of 97 larvae/100 m^3 on 14 June, declined, and then increased to a maximum of 274 larvae/100 m^3 on 9 August. At 32.5 percent of the total larvae, Clupeidae was the only other frequently collected taxon. Peak densities of Clupeidae were 122 larvae/100 m^3 and 97 larvae/100 m^3 on 14 June and 28 June, respectively.

43. Seven Oaks Dike Field station 2. Sampling commenced at Seven Oaks Dike Field station 2 on 3 May and continued through 23 August, after which time this station was no longer accessible. Unidentified clupeids

and Etheostoma spp. were collected on 3 May (Table 18). No larvae were collected at this station on 23 August. Overall, seven taxa and 174 larvae were collected. The maximum density of larvae was collected on 14 June. Aplodinotus grunniens was the most frequently collected taxon, constituting 67.2 percent of the total larvae collected. The maximum density of A. grunniens occurred on 14 June. Clupeidae was the second most frequently collected taxon, representing 17.8 percent of the total number of larvae collected.

44. Walnut Point Dike Field. Larval fish were sampled at Walnut Point Dike Field on 20 April through 21 September. Larval fish were collected on all sampling dates except 3 May and 18 May (Table 19). During this time 11 taxa and 145 larvae were collected. Unidentified clupeids, Ictiobus spp., and Morone spp. were present on 20 April. The maximum density of larvae, pooled over species, was 43 larvae/100 m^3 on 14 June. Clupeidae was the most abundant taxon, constituting 53.1 percent of the total larvae collected. The peak density of Clupeidae was 27 larvae/100 m^3 on 14 June. Other frequently collected taxa were unidentified cyprinids, Ictiobus spp., and Lepomis spp.; the frequency of collection of these taxa was 9.0, 10.3, and 8.3 percent, respectively.

45. Abundance and seasonal data for the habitat. Larval fish were collected from 19 April to 21 September in the dike field habitat. All families collected during the 1978 larval sampling effort were collected in dike fields, although no single taxon was abundant (Table 2). Clupeids, hiodontids, cyprinids, centrarchids, and sciaenids were common. Dike fields were the only habitat where clupeids were collected later than August. Cyprinids, centrarchids, and sciaenids, which were collected through September in several habitats, were not collected in the dike fields after 9 August, 23 August, and 9 August, respectively.

Sandbar habitat

46. Sandbar at Lakeport Towhead. Larval fish were collected at Lakeport Towhead on 20 April, 3 May, 30 May through 25 July, and 23 August. Seven taxa and 63 larvae were collected during these sampling times (Table 20). The peak density of total larvae was 18 larvae/100 m^3 on 23 August. Cyprinidae was the most abundant taxon at 27.0 percent of

the total catch. The peak density of Cyprinidae was 14 larvae/100 m^3 on 23 August. Aplodinotus grunniens and unidentified clupeids were similar in abundance and represented 19.0 and 17.5 percent, respectively, of the total catch. Catches of both of these taxa were rather uniformly distributed over sampling periods.

47. Abundance and seasonal data for the habitat. Larval fish were collected at the sandbar habitat (Lakeport Towhead) from 20 April to 23 August. No taxa were abundant. Only two families were common: Catostomidae and Ictaluridae (Table 2). Catostomids, collected during August or September in all other habitats except for abandoned channels, were not collected at this sandbar after 12 July. Ictalurids were categorized as common, but were only collected on one sampling date. During the habitat comparisons, ictalurids were only collected at sandbars and in dike fields. Clupeids, common or abundant in all habitats except for the main channel, were rare at this sandbar.

Permanent secondary channel habitat

48. American Cutoff. Larval fish were collected at American Cutoff on 20 April, 30 May, 28 June, and 25 July through 23 August. Nine taxa and 181 individuals were collected (Table 21). The highest densities of total larvae were 66 larvae/100 m^3 and 64 larvae/100 m^3 on 20 April and 28 June, respectively. Aplodinotus grunniens was the most frequently collected taxon at 43.6 percent of the total larvae collected. The maximum density of A. grunniens was 58 larvae/100 m^3 on 28 June. Relatively large numbers of unidentified clupeids were also collected. Clupeidae constituted 24.9 percent of the total catch. The peak density of Clupeidae was 43 larvae/100 m^3 on 20 April.

49. Abundance and seasonal data for the habitat. Larval fish were sampled in the permanent secondary channel habitat (American Cutoff) from 20 April to 23 August. No species or families were collected in abundance (Table 2). Clupeidae was common only in spring and early summer and Hiodontidae was common on one sampling date. Although catostomids were categorized as rare, Ictiobus spp. was common on 20 April.

Temporary secondary channel habitat

50. Kentucky Bend Chute. Larval fish were collected at Kentucky

Bend Chute on 19 April and 31 May through 9 August. Ten taxa and 173 individuals were collected during these sampling times (Table 22). The maximum density of total larvae was 77 larvae/100 m^3 on 28 June. Aplodinotus grunniens was the most abundant taxon, representing 63.0 percent of the total larval fish collected. The peak density of A. grunniens was 68 larvae/100 m^3 on 28 June. Clupeidae, representing 23.7 percent of the total catch, was the only other abundant taxon. The maximum density of Clupeidae was 20 larvae/100 m^3 on 19 April.

51. Abundance and seasonal data for the habitat. The temporary secondary channel habitat (Kentucky Bend Chute) was sampled for larval fish from 19 April to 23 August, a considerably shorter period of time than for the other habitats. No taxa were abundant (Table 2). Clupeidae and Sciaenidae were common.

Main channel habitat

52. Main channel station 1. Larval fish were sampled from 3 May through 21 September at main channel station 1. Larval fish were first collected on 31 May and were represented by Clupeidae, Hiodon alosoides, and Pomoxis spp. (Table 23). No larval fish were collected in the 15 June sampling effort. Of the 121 individuals collected, 52.1 percent were Aplodinotus grunniens and 19.8 percent were Clupeidae. The peak density of A. grunniens was 33 larvae/100 m^3 on 13 July; and the peak density of Clupeidae was 24 larvae/100 m^3 on 31 May, the only date when Clupeidae was collected. The peak density pooled over species was 39 larvae/100 m^3 on 13 July.

53. Main channel station 3. Larval fish were collected at main channel station 3 on 19 April and 15 June through 23 August. Seven taxa and 97 individuals were collected at this station (Table 24). Clupeidae, Cyprinus carpio, and Ictiobus spp. larvae were collected on 19 April. The peak density of larvae was 55 larvae/100 m^3 on 29 June. Aplodinotus grunniens numerically dominated the catch, constituting 70.1 percent of the total larvae collected. The peak density of A. grunniens was 47 larvae/100 m^3 on 29 June. A second rise in density to 13 larvae/100 m^3 occurred on 9 August.

54. Main channel station 6. Main channel station 6 was sampled

from 3 May through 21 September. Larval fish were collected on all sampling dates from 3 May through 23 August, except 25 July (Table 25). Very few larvae were collected on 9 and 23 August. Overall, 11 taxa and 539 larvae were collected. Only unidentified clupeids were collected on 3 May. The maximum density of total larvae was 330 larvae/100 m^3 on 30 May. This maximum density coincided with the peak density of 260 unidentified clupeids/100 m^3. Clupeidae, at 52.5 percent of the total individuals, was the most frequently collected taxon. *Aplodinotus grunniens* was the second most frequently collected taxon, comprising 30.1 percent of the total catch. The peak density of *A. grunniens* was 135 larvae/100 m^3 on 28 June.

55. Main channel station 9. Larval fish sampling at main channel station 9 commenced on 3 May and continued through 21 September. Larval fish were collected at all sampling times except 25 July (Table 26). Eight taxa and 172 individuals were collected. Only low densities of unidentified clupeids were collected on 3 May. The peak density of total larvae (81 larvae/100 m^3) occurred on 28 June. *Aplodinotus grunniens* was the most frequently collected taxon, constituting 79.1 percent of the total larvae collected. The density of *A. grunniens* increased to a maximum of 76 larvae/100 m^3 on 28 June.

56. Abundance and seasonal data for the habitat. Larval fish were collected from 19 April to 21 September in the main channel habitat. No taxa were abundant and Sciaenidae was the only common taxa (Table 2).

Diel Periodicity and Replicate Evaluation

57. The data collected on 27-28 June from the Sunnyside Revetment was tested by a variance component analysis with a nested ANOV. The total variability of the data was partitioned into two parts: (a) variation that could be attributed to differences among time periods, and (b) variation caused by sampling at different time intervals within a time period. A separate analysis partitioned total variability into (a) variation attributable to differences among time periods, and (b) variation caused by sampling with paired nets. Results of the

analysis showed that time intervals within time periods did not constitute significant amounts of the variation in the number of taxa or density of larval fish (Table 27). Therefore, samples collected within a 1-hr time period in the afternoon, at dusk, night, and dawn and within a 2-hr time period at midday are considered to be replicate samples for each time period during this diel study.

58. The same analysis (Table 27) showed that samples collected with paired nets did not constitute a significant portion of the variation in number of taxa, but did constitute a significant portion of the variation in density of larval fish. Therefore, samples collected with paired nets were not considered replicate samples for analysis of diel differences in density of larval fish in this study.

59. Sixteen species, eleven genera, and eight families were collected (Tables 28 and 29). Aplodinotus grunniens (freshwater drum) was the most abundant taxon, comprising 66 and 72 percent of the total larvae collected in the shore and river samples, respectively. Unidentified clupeids and Carpiodes spp. each comprised about 10 percent of the total larvae in both shore and river samples; Dorosoma cepedianum and D. petenense were the next most prevalent, but they did not exceed 4 percent of the total larvae. Total clupeids (unidentified clupeids plus Alosa chrysochloris, Dorosoma spp., D. cepedianum, and D. petenense) comprised 21 and 13 percent of the total larvae in the shore and river nets, respectively. The remaining taxa were infrequent.

60. The number of taxa differed significantly during the diel cycle (Table 27). The number of taxa was lowest at midday (1200 hr), increased sharply to a maximum at dusk (2100 hr), then decreased through night (0100 hr) and dawn (0600 hr) (Figure 2).

61. Mean density/100 m^3 differed significantly between the time periods of the diel cycle (Table 27). Density was greatest at dusk and substantially less at both midday and dawn (Figure 3). Night and dawn densities for the shore samples were lower than afternoon and midday densities, respectively, for samples collected with the shore net. Night and dawn densities for the river samples were higher than

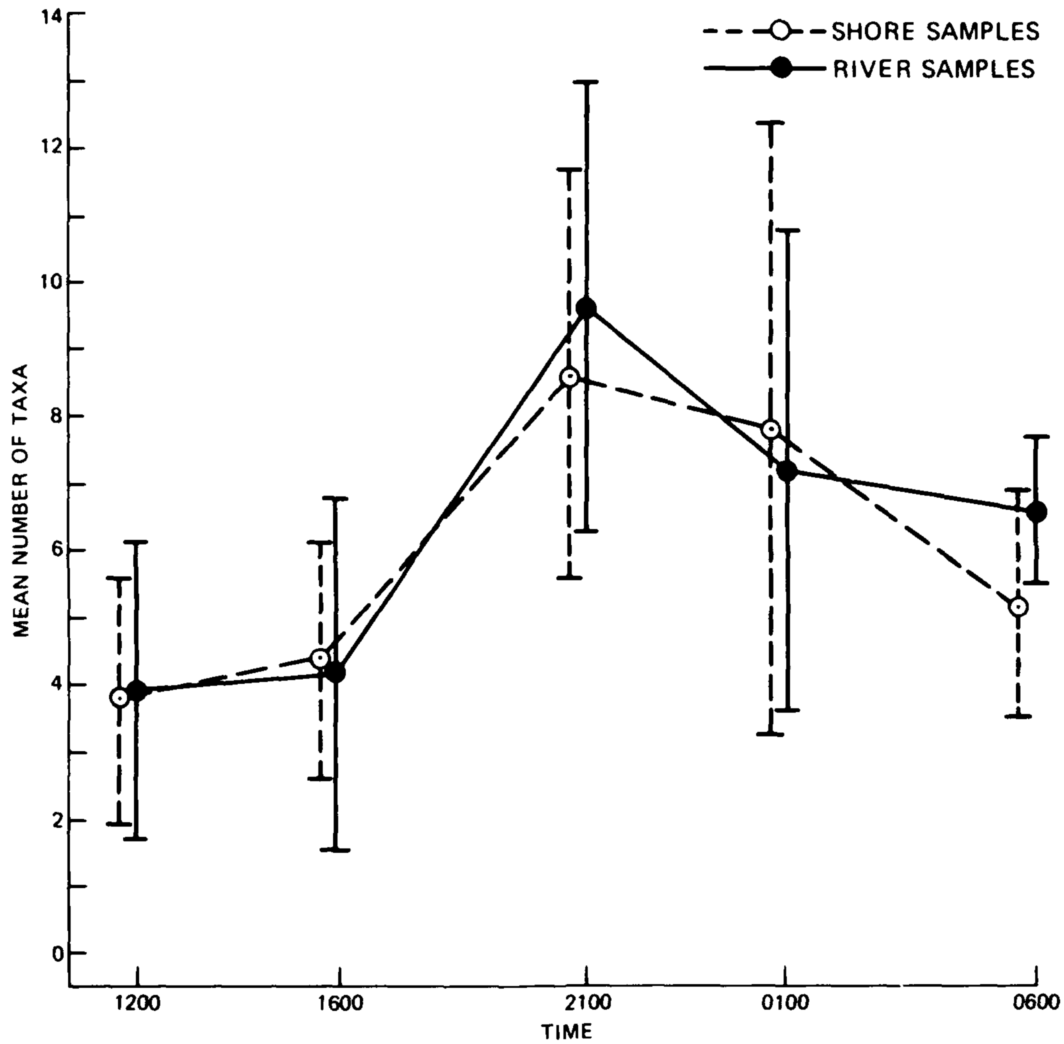

Figure 2. Mean number of taxa of larval fish collected during diel sampling at Sunnyside Revetment, 27-28 June 1978; verticle lines represent the 95-percent confidence interval.

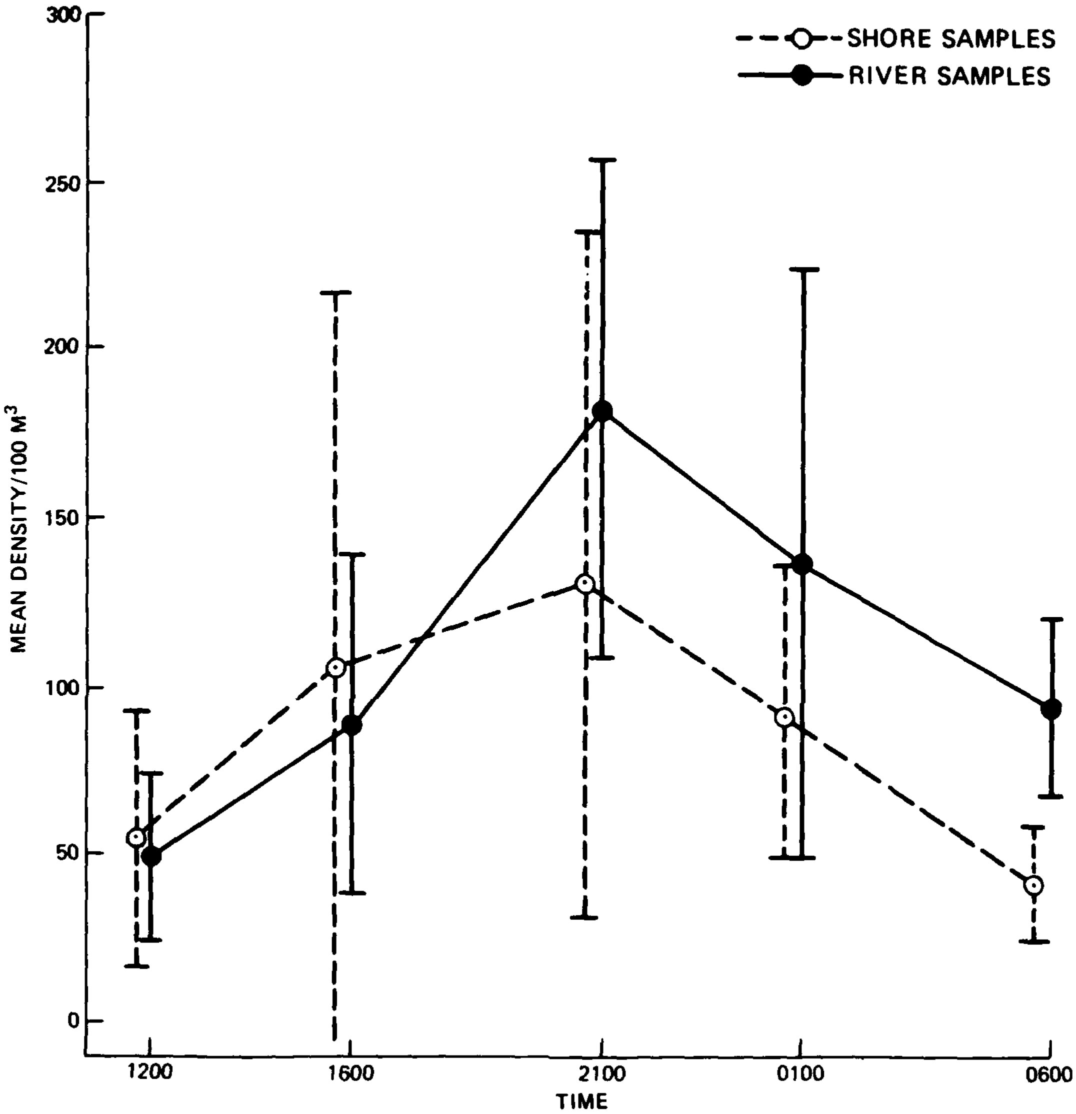

Figure 3. Mean density of larval fish (number/100 m^3) collected during diel sampling at Sunnyside Revetment, 27-28 June 1978; vertical lines represent the 95-percent confidence interval.

afternoon and midday densities, respectively.

62. The diel trend in density of *Aplodinotus grunniens* paralleled the diel trend for total larval fish. *A. grunniens* constituted 54 to 78 percent of the total density during the five time periods. At dusk, when the density of all taxa combined was highest, 76 percent (shore net) and 78 percent (river net) of the total number of larvae caught were *A. grunniens*.

63. Density of *Carpiodes* spp. declined from midday to afternoon, then increased to a maximum at dusk, and decreased through the night. Density at dawn was lower than at midday. *Carpiodes* spp. constituted 11 percent (shore net) and 13 percent (river net) of the total densities at midday and 7.6 percent (shore net) and 11 percent (river net) of the total densities at dusk.

64. Densities of total clupeids (unidentified clupeids, plus *Alosa chrysochloris*, *Dorosoma* spp., *D. cepedianum*, and *D. petenense*) were highest during midday and afternoon, declined to low densities at dusk and night, and increased at dawn. At midday total clupeids were 30 percent (shore) and 28 percent (river) of the total densities of larval fish. During the afternoon, total clupeids were 34 percent (shore) and 20 percent (river) of the total densities of larval fish. During dusk and nighttime samples, total clupeids constituted less than 14 percent of the total densities. At dawn total clupeid densities increased and constituted 22 percent (shore) and 24 percent (river) of the total densities of larval fish.

65. Densities of unidentified clupeids were highest during midday and afternoon, declined to minimum density at night, and increased at dawn. Unidentified clupeids were 29 percent (shore) and 28 percent (river) of the total larval fish at midday. In the afternoon, unidentified clupeids, although still abundant, constituted only 14 percent (shore) and 17 percent (river) of the total larval fish. In the dusk and night samples, unidentified clupeids never exceeded 5 percent of the total larvae. At dawn unidentified clupeids were 17 percent (shore) and 13 percent (river) of the total larvae.

66. The diel changes in densities of *Dorosoma cepedianum* and

D. petenense did not follow the diel trend in densities of total Clupeidae or unidentified clupeids. In the shore net, *D. cepedianum* was absent at midday, collected in highest density in the afternoon, and declined continuously to dawn. In the river net, *D. cepedianum* was absent at midday, collected at highest density at dusk, and was present in low densities during the remaining sampling periods.

67. In the shore net, *D. petenense* was not collected at midday, was collected at the highest density during the afternoon, and was collected at lower densities from dusk through dawn. *D. petenense* was not collected at midday, was collected in uniformly low densities in afternoon, dusk, and night samples, and was collected in relatively high densities at dawn in the river net.

PART IV: EVALUATION OF RESULTS

Habitat Comparison

68. The abandoned channel and oxbow lake habitats appeared to support similar larval fish populations. Representatives of five families were collected in both habitats: Clupeidae, Atherinidae, Percichthyidae, Centrarchidae, and Sciaenidae. Clupeids and centrarchids were the predominant taxa in both habitats. *Aplodinotus grunniens* (freshwater drum), common or abundant in all other habitats except sandbars, was rare in both abandoned channels and oxbow lakes.

69. *Menidia audens* and *Morone* spp. were common in the abandoned channel habitat and rare in the oxbow lake habitat. *Carpiodes* spp. was rare in the abandoned channel habitat and not collected in the oxbow lake habitat. It appears that spawning or nursery conditions are more favorable for these three taxa in the abandoned channel.

70. Cyprinidae and *Pomoxis* spp. were collected only in the oxbow lake habitat. These taxa were collected in the chute connecting Lake Lee with the river (Lake Lee station 101). This station was located in flowing water whereas the other two Lake Lee sampling stations and both stations in Matthews Bend were standing-water or very slowly flowing water. This suggests flowing-water habitats are more favorable spawning or nursery areas for these two taxa.

71. *Dorosoma* spp. and *D. petenense* were collected in the oxbow lake, but were not recorded in the abandoned channel. However, since identification of clupeid larvae to genus and species requires advanced stages, the same clupeids may have been present in both habitats, while more advanced clupeids were collected only in Lake Lee.

72. The natural bank habitats exhibited a relatively high diversity of larval fish. The same eight families were collected at both Anconia Natural Bank and Lakeport Natural Bank: Clupeidae, Hiodontidae, Cyprinidae, Catastomidae, Percichthyidae, Centrarchidae, Percidae, and Sciaenidae. This was the only flowing-water habitat where clupeids were abundant. Sciaenids were abundant only in the natural bank and revetted

bank habitats, both of which are flowing-water habitats. Cyprinids were common at natural banks, revetted banks, and dike fields. Catostomids were common only at natural banks and sandbars. Centrarchids, common at natural banks, were also common at oxbow lakes, revetted banks, and dike fields. It is interesting to note that natural banks, revetted banks, sandbars, dike fields, and oxbow lakes are all aquatic habitats that provide shelter from main channel flows. Hiodontids, on the other hand, were common at natural bank, revetted bank, dike field, and permanent secondary channel habitats. The data indicate that natural banks are an important habitat for larval clupeids, hiodontids, cyprinids, catostomids, centrarchids, and sciaenids.

73. Some differences existed between the two natural bank habitats. Mean density of larval fish was higher at Anconia Natural Bank than at Lakeport Natural Bank. *Aplodinotus grunniens* and Clupeidae were the most abundant taxa at Anconia, whereas Clupeidae and *Carpiodes* spp. were the most abundant taxa at Lakeport. The difference in density between the habitats is partly due to the low frequency of *A. grunniens* at Lakeport Natural Bank and the high frequency of this species at Anconia Natural Bank. Since both natural banks were similar habitats in that both were areas with caving banks with fallen trees and log jams, the difference may be a result of the densities of *A. grunniens* in the flowing water proximate to the habitat. The density of *A. grunniens* was low in American Cutoff, the nearest flowing water to Lakeport Natural Bank. Conversely, the density of *A. grunniens* was high at main channel stations 6 and 9, the flowing waters nearest to Anconia Natural Bank.

74. Revetted banks showed a high diversity of larval fish. The eight families of larval fish collected at the natural bank habitat plus Atherinidae were collected here, indicating similarity to the natural bank habitat. The abundance of *Aplodinotus grunniens* and the common occurrence of hiodontids, cyprinids, and centrarchids further indicate the similarity between revetted banks and natural banks. Clupeids and catostomids were, however, more abundant at natural banks than at revetted banks. Revetted banks were the only habitat where *Alosa chrysochloris* was collected. *Micropterus* spp. was collected only at

revetted banks and dike fields. The data indicate that revetted banks are an important habitat for larval clupeids, hiodontids, cyprinids, centrarchids, and sciaenids.

75. Differences and similarities existed among the four revetted banks sampled. Sunnyside Revetment and Walnut Point-Kentucky Bend Revetment appear to be valuable larval fish habitats and are similar in several ways. Both of these revetted banks had a high diversity of taxa, a high mean density of larvae, and maximum densities in middle to late June. *Aplodinotus grunniens* and Clupeidae were the most abundant taxa and together comprised over 52 percent of the larval fish collected in each revetted bank habitat. *Dorosoma petenense*, *Hiodon alosoides*, *Cyprinus carpio*, *A. grunniens*, unidentified clupeids, unidentified cyprinids, *Carpiodes* spp., *Ictiobus* spp., *Morone* spp., unidentified centrarchids, and *Pomoxis* spp. were common to both habitats.

76. As a larval fish habitat, Carolina Revetment appears to be different from Sunnyside Revetment and Walnut Point-Kentucky Bend Revetment. The diversity of taxa and mean larval density was much lower at Carolina Revetment. Unidentified centrarchids was the most abundant taxon. Although sampling did not commence at Carolina Revetment until 3 May, larval fish were not collected until 18 May, one month later than at Sunnyside or Walnut Point-Kentucky Bend Revetments.

77. Cracraft Revetment appears to be of intermediate value to larval fish when compared to the other revetted banks. The diversity of taxa and the mean density were intermediate. Cracraft Revetment was similar to Sunnyside Revetment and Walnut Point-Kentucky Bend Revetment in that *Aplodinotus grunniens* and clupeids were the most abundant taxa. Cracraft Revetment was similar to Carolina Revetment in that larval fish were first collected in mid-May, rather than mid-April as at Sunnyside and Walnut Point-Kentucky Bend Revetments.

78. The differences among revetted banks in apparent suitability as habitats for larval fish is striking. The causes of the differences are not known, but field observations suggest several possible factors. Transects at Sunnyside Revetment and Walnut Point-Kentucky Bend Revetment included highly turbulent areas and one large upstream-current area at

each station. Such water conditions, absent at the larval fish sampling stations at Carolina and Cracraft Revetments, may serve to concentrate larval fish. Length of the revetment upstream of the sampling site may also be a factor. Sunnyside and Walnut Point-Kentucky Bend Revetments are long revetments (10 km and 12 km, respectively), paving relatively straight stretches of the shoreline, and long distances of revetment were upstream of the sampling station. On the other hand, Carolina Revetment is a short revetment and sampling was conducted at the upstream end. Sampling at Cracraft Revetment was conducted approximately 1.8 km above the upstream end of the revetment.

79. The main channel habitat was characterized by a relatively low diversity of taxa. Three of the four main channel stations (stations 1, 3, and 9) had relatively low densities of larval fish with Aplodinotus grunniens the most numerically abundant taxon. In addition to A. grunniens, clupeids, Carpiodes spp., and unidentified centrarchids were collected at all three stations.

80. Main channel station 6, on the other hand, had a high diversity of taxa and relatively high densities of larval fish. Clupeidae was the most abundant taxon. A. grunniens was the second most abundant taxon and was only one-half as frequent in the total catch as at main channel station 1, and less than one-half as frequent as at main channel stations 3 and 9. Carpiodes spp. and unidentified centrarchids, which were collected at stations 1, 3, and 9, were also collected at station 6; however, Hiodon tergisus and Morone spp. were collected only at station 6. The greater abundance of larval fish at station 6 resulted largely from high densities of larval fish on 30 May and 28 June, whereas the densities of larval fish at the other main channel stations showed only minor fluctuations over time. The high density on 30 May was largely a result of Hiodon alosoides and Clupeidae, and the high density on 28 June was primarily due to A. grunniens. Peak abundance, although lower densities, of these species also occurred on these dates among the other main channel stations. An explanation for the higher densities only at station 6 is that high density aggregations of these taxa were sampled at station 6. If this is correct, replicate sampling may be necessary to estimate the

abundance of larval fish. Water flow patterns offer an additional explanation for the high densities and diversities at this station. This hypothesis is discussed below.

81. The density of larval fish was relatively low, and the diversity of taxa was intermediate in the permanent secondary channel habitat (American Cutoff). The density and diversity of larval fish in American Cutoff was similar to the main channel stations, which would be expected since both habitats are open, flowing-water habitats. As in the main channel habitat, Aplodinotus grunniens and Clupeidae were the most abundant taxa, constituting over 68 percent of the individuals collected. However, larval fish were first collected in American Cutoff during mid-April, earlier than at most main channel stations, but at the same time as at the natural bank stations.

82. In the temporary secondary channel (Kentucky Bend Chute) the density of larval fish was relatively low, but diversity of taxa was high. This habitat is similar to the main channel habitat, except for the generally reduced velocity of currents. Therefore, densities similar to the main channel and the high frequencies of Aplodinotus grunniens and Clupeidae were not unexpected. An important difference between the temporary secondary channel and the main channel is that a large portion of the water flowing through the temporary secondary channel Kentucky Bend Chute passes through one or two dike fields (Island 86 and Seven Oaks Dike Fields). The dike fields generally have a diverse larval fish fauna and, therefore, may account for the relatively high diversity of taxa encountered at Kentucky Bend Chute. Larval fish collected during mid-April shows the similarity with dike fields, supporting the possible contribution of the dike fields to the fauna collected at Kentucky Bend Chute.

83. The dike field habitat is characterized by relatively low mean densities of larval fish and a high diversity of taxa. All families of larval fish collected during this entire study were represented in the dike fields, including Lepisosteidae, which was collected only in dike fields, and Ictaluridae, which was collected only in dike fields and in the sandbar habitat. An interesting aspect about the diversity

in the dike fields is that taxa collected in the standing-water habitats (abandoned channel and oxbow lake) and the main channellike habitats (main channel, permanent secondary channel, and temporary secondary channel) were all represented in the dike field habitat, but the abundances of the various taxa show the strongest similarity to the river bank habitats (natural bank and revetted bank). For example, clupeids were abundant and common at natural bank and revetted bank habitats, respectively, and common in the dike field habitat; hiodontids, cyprinids, and centrarchids were common in natural bank, revetted bank, and dike field habitats; and percids were collected only in these three habitats. The most notable exception to the similarity among these three habitats is that Aplodinotus grunniens was abundant at the natural bank and revetted bank habitats, but was only common in the dike field habitat.

84. The high diversity of taxa of larval fish at all dike field stations, except at station 2 at Seven Oaks Dike Field, suggests that dike fields may be an important habitat for the production of larval fish.

85. Clupeidae and Sciaenidae were the only two taxa collected in all dike field habitats. Hiodon alosoides, Cyprinidae, and Centrarchidae were collected at five of the six dike field stations. Dorosoma cepedianum, Cyprinus carpio, and Ictiobus spp. were collected at four of the six dike field stations.

86. The most noticeably different dike field stations were stations 1 and 2 at Seven Oaks Dike Field. The density and diversity of taxa of larval fish at Seven Oaks Dike Field station 1 were markedly higher than in other dike field stations. Equally noteworthy were the low diversity at Seven Oaks Dike Field station 2 and the fourfold reduction in density compared to the upstream station 1 at Seven Oaks Dike Field. The high density at Seven Oaks Dike Field station 1 was partly due to very high densities of Clupeidae or Aplodinotus grunniens on two sampling dates; however, density was generally higher throughout the 1978 sampling effort at this station than at station 2. The high diversity and continued high density of larval fish suggest that Seven Oaks Dike Field station 1 is a very favorable spawning or nursery area,

whereas station 2 is a poor spawning or nursery area. Alternatively, the differences in density and diversity of larval fish between these two stations may be related to water flow patterns. Figure 4 shows that high densities and diversities of larval fish were collected at (from upstream to downstream) Sunnyside Revetment, Anconia Natural Bank, Seven Oaks Dike Field station 1, main channel station 6, and Walnut Point-Kentucky Bend Revetment. These sampling sites lie along the general line of the main flow of the river.

87. The density of larval fish and diversity of taxa were low at the sandbar habitat (Lakeport Towhead). This was the only habitat where Cyprinidae was the most abundant taxon; however, the seven taxa collected here were approximately equal in abundance compared to other habitats. *Ictalurus punctatus* was collected only here and at Leota Dike Field. The low density and diversity of larvae indicate generally that this flowing-water, sandbar habitat is a poor spawning or nursery area for fish.

Diel Periodicity and Replicate Evaluation

88. The diel distribution of taxa showed maximum diversity at dusk, high diversity at night and dawn, and low diversity in the daytime samples. Twelve taxa were collected only during the dusk, night, or dawn sampling periods. Therefore, sampling under conditions of darkness resulted in an important increase in the number of taxa collected. Nighttime samples was particularly important for collection of hiodontids, ictalurids, and percichthyids.

89. The three most frequently collected taxa--clupeids, *Carpiodes* spp., and *Aplodinotus grunniens*--accounted for 96 percent of the total larvae. Gallagher and Conner (1980) found clupeids, cyprinids, catostomids, and *A. grunniens* were 98 percent of the total larvae collected in diel samples on the Lower Mississippi River near St. Francisville, Louisiana.

90. There were significant differences in the density of larval fish collected during the 24-hr cycle. Total densities were lowest at

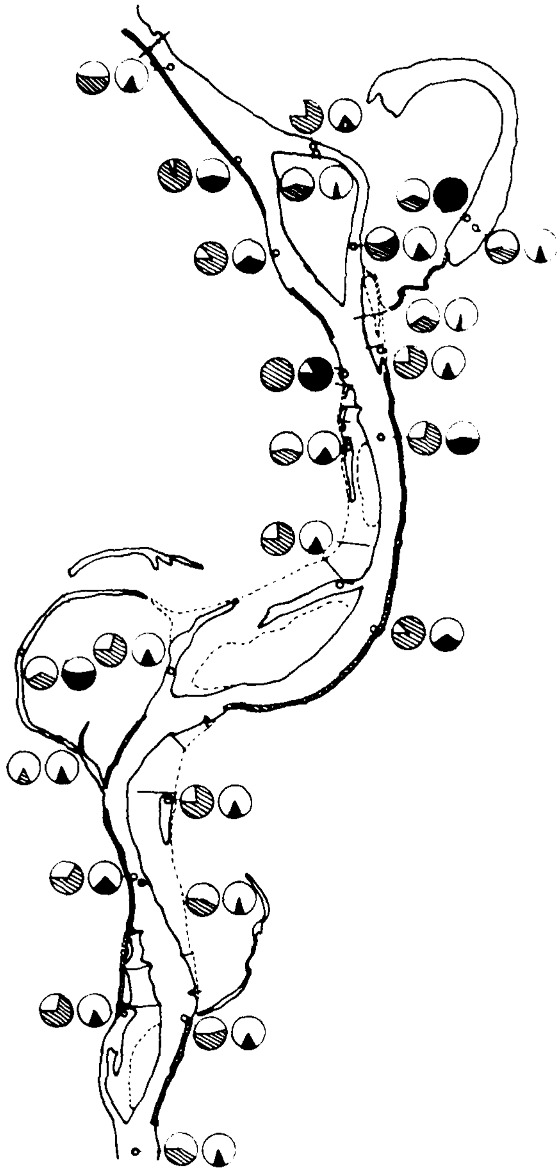

Figure 4. Relative number of taxa as a percentage of the number of taxa collected at a single station (cross-hatched circles) and relative mean density as a percentage of the maximum mean density collected at a single station (solid circles) at the larval fish sampling station in the Mississippi River in 1978

midday, increased during the afternoon to a maximum at dusk, and decreased during the night to a low (similar to midday) density at dawn. Increased nocturnal abundance of larval fish has been repeatedly observed (Faber 1963; Taber 1969; Netsch et al. 1971; Gale and Mohr 1978; Storck, Dufford, and Clement 1978; Graser 1979; Kindschi, Hoyt, and Overman 1979; Tuberville 1979; Gallagher and Conner (1980)). Although decreased net avoidance at night may possibly contribute to higher catch rates (Kindschi, Hoyt, and Overman 1979; Tuberville 1979), diel fluctuations in distribution would also influence the abundance of larvae collected in surface samples. Upward vertical migrations of larval fish at night have been documented for various species (Taber 1969; Netsch et al. 1971; Gale and Mohr 1978; Graser 1979; Kindschi, Hoyt, and Overman 1979; Tuberville 1979), and Tuberville (1979) has suggested diel horizontal migration for shad. In the highly turbid and turbulent water of the Mississippi River, daytime net avoidance is probably minimal; the increased abundance at dusk and night was most probably due to migrational patterns or to a change in behavior that makes the larvae more susceptible to drift.

91. The diel fluctuations in total density were largely a result of the diel fluctuation of density of Aplodinotus grunniens (freshwater drum). Tuberville (1979) found increased density of freshwater drum at night when samples from all depth strata were pooled. Larger drum larvae were present at the surface at night. Gallagher and Conner (1980) found that freshwater drum were four times more abundant in daytime samples than in nighttime samples, but noted that larger drum (metalarvae and juveniles) were collected in greater abundance at night. In this study the densities of different larval stages were not determined, but the findings of Gallagher and Conner (1980) suggest that the drum collected were in later larval stages.

92. The densities of Carpiodes spp. paralleled, in general, the densities of freshwater drum, except for the slightly higher density of Carpiodes spp. at midday. Gallagher and Conner (1980) also collected Carpiodes spp. in greater abundance in night samples in the Lower Mississippi River.

93. Total clupeids and unidentified clupeids were most abundant in dawn, midday, and afternoon samples. Gallagher and Conner (1980) and Tuberville (1979) also found clupeids more abundant during daylight hours in flowing-water systems. High densities of total clupeids at midday and dawn made important contributions to the total densities during these time periods; hence, the diel fluctuations of density of total clupeids reduced the magnitude of the fluctuations of the total larval fish density.

94. While total clupeids and unidentified clupeid larvae were most abundant in dawn through afternoon samples, Dorosoma cepedianum and D. petenense were absent at midday and of variable abundance in the afternoon through dawn samples. The identification of clupeids to species requires advanced larval stages, whereas younger larvae would be identified to higher taxa, viz., Dorosoma spp. or unidentified clupeids. This discrepancy between the diel trends of total clupeids and unidentified clupeids and the diel trends of D. cepedianum and D. petenense may result from the younger larval stages in the drift during the day and the advanced stages present from afternoon to dawn. Gallagher and Conner (1980) and Tuberville (1979) observed increased abundance of later larval stages of shad in nighttime larval fish samples; smaller larvae were abundant diurnally. Apparently the larger larvae exhibit a time-dependent behavior pattern that influences their abundance in surface samples. The threefold to fourfold lower abundance of unidentified clupeids at night would indicate that smaller larvae were also able to migrate or remain in a sheltered area despite the high velocity currents and turbulence in this section of the Mississippi River.

Sampling Implications

95. The habitat comparison provides information for future sampling programs. The diversity and abundance of larval fish changed during the spawning season (April through September). If short-term sampling were necessary, based on the reults of this 1978 study, June

would be the best time to sample. [illegible] the majority of taxa would be collected, several commonly [illegible] taxa would be missed or only rarely present--*Hiodon alosoides*, *H. tergisus*, *Cyprinus carpio*, *Ictiobus* spp., *Pomoxis* spp., *Etheostoma* spp., and *Stizostedion* spp.

96. Variation among habitats makes it impossible to adequately represent the diversity and abundance of larval fish by sampling a single habitat. The maximum diversity was collected in the dike fields, the only habitat where all families collected in this study were represented. However, several lower taxa were not collected, and, of those taxa collected in dike fields and in other habitats, abundance often differed. Therefore, sampling even the most diverse habitat provides incomplete information about diversity present in the river.

97. Variation within habitats was noticeable. The variations between the dike field stations and between the main channel stations provides the best indication that several stations in each site and several representatives of each habitat should be sampled.

98. The potential effect of water flow patterns on the distribution and abundance of larval fish, currently under investigation, may relate to variations in larval fish collections within a habitat. Information from this investigation may be useful for selecting a minimum number of sampling stations.

99. This single investigation of the diel occurrence of larval fish presents some important considerations for future larval fish sampling methods. The results suggest that densities of samples collected between dawn and midday are comparable. On the other hand, the number of taxa is comparable for samples collected between midday and midafternoon. Peak density and maximum number of taxa occurred at dusk. Further, five taxa were collected only during the dusk sampling period. Therefore, dusk is an important time to sample, and density and number of taxa do not differ significantly between samples taken over the time period one-half hour before dusk to one-half hour after dusk. However, since dusk is a rather unique temporal phenomenon, as shown by rapid increases and decreases in density and number of taxa before and after dusk, results

obtained during a large-scale sampling effort requiring several hours may not be comparable.

100. The second highest values of density and number of taxa were obtained in the night samples. Pending further investigation of temporal variation in density and number of taxa during nighttime hours, night sampling may be the most fortuitous time to sample larval fish in the Lower Mississippi River. Although high densities and number of taxa were collected at night, nighttime sampling must be considered a compromise since not all taxa were represented in these samples.

101. Analysis of the same data collected during the diel study indicated that significant variation in larval fish densities occurred between samples collected with paired nets. This was surprising since variation in the number of taxa between nets was not significant and the nets were separated by no more than 4 m. Johnson (1973) observed similar differences in larval fish density between paired nets despite the fact that nets were yoked together with only a 10-cm center-to-center separation. These data suggest that repeated sampling of larval fish at only one station in a given habitat over a short period of time would best be conducted with single net hauls. However, this may not be true when more than one station within a habitat or more than one habitat is sampled on a given day.

PART V: CONCLUSIONS AND RECOMMENDATIONS

Conclusions

102. Based on the results of this pilot study of larval fish, the following conclusions were made:

a. Considerable variation in diversity and abundance of larval fish occurred among the nine habitats sampled in the Lower Mississippi River. However, several habitats had similar diversity and abundance of larval fish. The abandoned channel and oxbow lake habitats were similar; natural bank and revetted bank habitats were similar; and the main channel and the permanent secondary channel habitats were similar also. The greatest diversity of larval fish was collected in the dike fields.

b. Diversity and abundance of larval fish varied among stations within a habitat.

c. Significant diel differences in diversity and abundance of larval fish occur. The highest diversity and density of larval fish occur at dusk. Diversity and density were also high at night.

d. Species composition is similar between nets towed in pairs, but density of larval fish in the two nets is different.

e. Larval fish samples collected from a single station during a 1-hr time period can be considered replicates.

Recommendations

103. Based on the results of this pilot study, the following recommendations are made:

a. A thorough description of the diversity and abundance of larval fish in the Lower Mississippi River requires the sampling of several types of habitats.

b. An adequate description of larval fish fauna in a habitat in the Lower Mississippi River requires sampling at several stations.

c. A thorough description of the diversity and abundance of larval fish in the Lower Mississippi River requires sampling during the entire spawning season.

d. Sampling to collect the highest diversity and abundance of larval fish in the Lower Mississippi River should be conducted at dusk. If several stations are to be sampled and sampling will require several hours, night sampling is recommended.

e. When larval fish are collected repeatedly from one station within a habitat over a short period of time, a single net should be used.

f. Although this study provided information about temporal changes in larval fish fauna of the Lower Mississippi River, the results should be applicable to other large rivers. However, additional studies would be required to show variation of larval fish populations among years and to quantify differences among large river systems.

REFERENCES

Faber, D. J. 1963. "Larval Fish from the Pelagial Region of Two Wisconsin Lakes," Doctoral dissertation, University of Wisconsin, Madison, Wis.

Gale, W. F., and Mohr, H. W., Jr. 1978. "Larval Fish Drift in a Large River with a Comparison of Sampling Methods," Transactions of the American Fisheries Society, 107:46-55.

Gallagher, R. P., and Conner, J. V. 1980. "Spatio-Temporal Distribution of Ichthyoplankton in the Lower Mississippi River, Louisiana," Proceedings of the Fourth Annual Larval Fish Symposium.

Graser, L. F. 1979. "Spatio-Temporal Distribution of Clupeid Larvae in Barkley Reservoir," in R. D. Hoyt, Ed., Proceedings of the Third Symposium on Larval Fish, Western Kentucky University, Bowling Green, Ky., pp 120-133.

Johnson, R. K. 1973. "Production and Distribution of Fish Eggs and Larvae in the C and D Canal," Appendix I, Hydrographic and Ecological Effects of Enlargement of the Chesapeake and Delaware Canal, Chesapeake Biological Laboratory, University of Maryland, Natural Resources Institute Reference Number 72-16, p 85.

Kindschi, G. A., Hoyt, R. D., and Overman, G. J. 1979. "Some Aspects of the Ecology of Larval Fishes in Rough River Lake, Kentucky," in R. D. Hoyt, Ed., Proceedings of the Third Symposium on Larval Fish, Western Kentucky University, Bowling Green, Ky., pp 139-166.

Netsch, N. F., et al. 1971. "Distribution of Young Gizzard and Threadfin Shad in Beaver Reservoir," in G. E. Hall, Ed., Reservoir Fisheries and Limnology, Special Publication No. 8, American Fisheries Society, pp 95-105.

Storck, T. W., Dufford, D. W., and Clement, K. T. 1978. "The Distribution of Limnetic Fish Larvae in a Flood Control Reservoir in Cental Illinois," Transactions of the American Fisheries Society, 107:419-424.

Taber, C. A. 1969. "The Distribution and Identification of Larval Fishes in the Buncombe Creek Arm of Lake Texoma with Observations on Spawning Habits and Relative Abundance," Doctoral dissertation, University of Oklahoma, Norman, Okla.

Tuberville, J. D. 1979. "Vertical Distribution of Ichthyoplankton in Upper Nickajack Reservoir, Tennessee, with Comparison of Three Sampling Methodologies," in R. D. Hoyt, Ed., Proceedings of the Third Symposium on Larval Fish, Western Kentucky University, Bowling Green, Ky., pp 185-203.

Table 1

Larval Fish Sampling Stations for 1978 Sampling Effort

Sampling Station	23-24 Mar	7 Apr	19-20 Apr	3 May	18 May	30-31 May	14-15 Jun	28-29 Jun	12-13 Jul	25-26 Jul	8-9 Aug	22-23 Aug	20-21 Sep	18 Oct	13 Nov
Abandoned Channel															
Matthews Bend station 1	x			x	x	x	x	x	x	x	x	x	x		
Matthews Bend station 2	x			x	x	x	x	x	x	x	x	x	x	x	
Oxbow Lake															
Lake Lee station 1		x	x	x	x	x	x	x	x	x		x			
Lake Lee station 2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Lake Lee station 101 (Chute)					x	x		x	x	x	x	x	x		
Natural Bank															
Anconia		x	x	x	x	x	x	x	x	x	x	x	x	x	x
Lakeport	x		x	x	x	x	x	x	x	x	x	x	x	x	x
Revetted Bank															
Carolina Revetment		x		x	x	x	x	x	x	x	x	x	x	x	x
Cracraft Revetment				x	x	x	x	x	x	x	x	x	x	x	x
Sunnyside Revetment	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Walnut Pt-Kentucky Bend Revetment			x	x	x	x	x	x	x	x	x	x	x	x	x
Dike Field															
Lower Cracraft	x	x	x	x	x	x	x		x	x	x	x	x	x	x
Island 86	x	x	x	x	x	x	x	x	x	x	x	x	x		
Leota		x	x	x	x	x	x	x	x	x	x	x			
Seven Oaks station 1	x	x	x	x	x	x	x	x	x	x	x	x	x		
Seven Oaks station 2				x	x		x	x	x	x	x	x			
Walnut Point	x		x	x	x	x	x	x	x	x	x	x	x		
Sandbar															
Lakeport Towhead		x	x	x	x	x	x	x	x	x	x	x	x		
Permanent Secondary Channel															
American Cutoff	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Temporary Secondary Channel															
Kentucky Bend Chute	x		x	x	x	x	x	x	x	x	x	x	x	x	x
Main Channel															
Station 1		x		x	x	x	x	x	x	x	x	x	x	x	x
Station 3	x		x	x			x	x	x	x	x	x	x	x	x
Station 6				x	x	x	x	x	x	x	x	x	x	x	x
Station 9				x	x	x	x	x	x	x	x	x	x	x	x

Table 2

Abundance and Dates of Collection of the Taxa of Larval Fish Collected in the Lower Mississippi River, 19 April Through 21 September 1978

Taxon	Dates and Relative Abundance*								
	Abandoned Channel	Oxbow Lake	Natural Bank	Revetted Bank	Dike Field	Sandbar	Permanent Secondary Channel	Temporary Secondary Channel	Main Channel
Lepisosteidae					R 6/14				
Lepisosteus spp.					R 6/14				
Clupeidae	A 5/18-8/23	A 4/20-8/22	A 4/20-7/25	C 4/19-7/25	C 4/19-9/21	R 4/20-6/28	C 4/20-5/30	C 4/19-6/28	R 4/19-6/29
Alosa chrysochloris				R 6/14					
Dorosoma spp.		C 6/14-8/8	R 6/28-8/9	A 6/14-8/9	R 6/14-7/12			R 6/28	R 6/14
D. cepedianum			R 6/28	R 5/18-6/14	R 6/14-7/26				
D. petenense		C 8/8	R 7/12-8/9	R 7/12-8/9					
Unidentified clupeids	A 5/18-8/23	C 4/20-8/22	C 4/19-7/25	C 4/19-7/25	R 4/19-9/21	C 4/20-6/28	C 4/20-5/30	C 4/19-6/28	C 4/19-6/29

Continued

* The symbols R , C , and A designate rare, common, or abundant taxa as classified by the method discussed in Part II.

Table 2 (Continued)

Taxon	Dates and Relative Abundance								
	Abandoned Channel	Oxbow Lake	Natural Bank	Revetted Bank	Dike Field	Sandbar	Permanent Secondary Channel	Temporary Secondary Channel	Main Channel
Hiodontidae			C 5/30	C 5/30-6/14	C 5/18-5/31		C 5/30	R 5/31	R 5/31
Hiodon alosoides			C 5/30	C 5/30-5/31	C 5/18-5/31			R 5/31	R 5/31
H. tergisus			R 5/30	R 5/31-6/14			C 5/30	R 5/31	R 5/31
Cyprinidae		R 7/12-8/22	C 5/3-9/21	C 4/20-9/21	C 4/19-8/9	R 6/28-8/23	R 4/20-8/23	R 4/19-8/9	R 5/18-8/23
Cyprinus carpio			R 5/30	C 4/20	R 4/19-6/15		R 5/30	R 4/19	R 5/18-6/14
Notropis spp.		R 8/22						R 8/9	
N. atherinoides								R 8/9	
Unidentified cyprinids			C 5/3-9/21	C 6/28-9/21	C 4/19-8/9	C 6/28-8/23	R 4/20-8/23	R 7/25-8/9	R 7/12-9/21
Catostomidae	R 7/13		C 4/19-9/21	R 4/20-8/23	R 4/19-8/9	C 4/20-7/12	R 4/20-8/9	R 8/9	R 6/28-8/9

(Continued)

Table 2 (Continued)

Taxon	Dates and Relative Abundance								
	Abandoned Channel	Oxbow Lake	Natural Bank	Revetted Bank	Dike Field	Sandbar	Permanent Secondary Channel	Temporary Secondary Channel	Main Channel
Carpiodes spp.	R 7/13		C 5/30-9/21	R 6/14-8/23	R 7/25-8/9	C 7/12	R 6/28-8/9	R 8/9	R 6/28-8/23
C. carpio			R 5/30						
Ictiobus spp.			R 4/20-5/18	R 4/20-5/18	R 4/19-5/31	C 4/20	C 4/20		R 4/19
I. cyprinellus					R 6/15				
Unidentified catostomids				R 5/31	R 5/3				
Ictaluridae					R 6/15-8/9	C 7/25			
Ictalurus furcatus					R 7/12-8/9				
I. punctatus					R 6/15	C 7/25			
Atherinidae	C 9/21	R 5/30-8/8		R 6/29	R 6/14				

(Continued)

Table 2 (Continued)

Taxon	Dates and Relative Abundance								
	Abandoned Channel	Oxbow Lake	Natural Bank	Revetted Bank	Dike Field	Sandbar	Permanent Secondary Channel	Temporary Secondary Channel	Main Channel
Menidia audens	C 9/21	R 5/30-8/8		R 6/29	R 6/14				
Percichthyidae	C 8/23	R 4/20-8/8	R 4/19-6/14	R 4/19-6/14	R 4/19-7/25			R 5/31	R 5/31
Morone spp.	C 8/23	R 4/20-8/8	R 4/19-6/14	R 4/19-6/14	R 4/19-7/25			R 5/31	R 5/31
M. chrysops		R 8/8	R 6/14		R 6/15				
M. saxatilis					R 6/14				
Centrarchidae	A 6/29-9/21	C 5/3-8/8	C 7/12-8/23	C 4/19-9/21	C 4/19-8/23	R 5/3	R 4/20-8/23	R 4/19-7/12	R 5/18-9/21
Lepomis spp.	A 6/29-9/21	C 6/28-8/8		R 4/19-8/23	R 6/29-8/23		R 7/25		R 6/14-7/12
Micropterus spp.				R 4/19	R 6/14				
M. punctulatus					R 6/14				

(Continued)

Table 2 (Concluded)

Taxon	Abandoned Channel	Oxbow Lake	Natural Bank	Revetted Bank	Dike Field	Sandbar	Permanent Secondary Channel	Temporary Secondary Channel	Main Channel
Pomoxis spp.		R 5/18	R 4/19	R 4/19-5/31	R 4/19-6/14		R 4/20	R 4/19	R 5/18-5/31
P. annularis				R 5/30					R 5/18
P. nigromaculatus				R 5/18	R 6/14				R 5/18
Unidentified centrarchids		R 5/3	C 7/12-8/23	C 6/29-9/21	R 5/3-8/23	R 5/3	C 8/23	R 7/12	R 8/23-9/21
Percidae			R 4/19-5/30	R 4/20-5/3	R 5/3-5/31				
Etheostoma spp.			R 4/19	R 5/3	R 5/3				
Stizostedion spp.			R 5/30	R 4/20	R 5/3-5/31				
S. canadense			R 5/30	R 4/20	R 5/31				
Sciaenidae	R 6/15	R 6/14-6/28	A 5/30-9/21	A 5/31-8/23	C 5/31-8/9	R 6/14-8/23	C 6/28-8/23	C 5/31-8/9	C 5/30-8/23
Aplodinotus grunniens	R 6/15	R 6/14-6/28	A 5/30-9/21	A 5/31-8/23	C 5/31-8/9	R 6/14-8/23	C 6/28-8/23	C 5/31-8/9	C 5/30-8/23

Note: "Dates and Relative Abundance" spans all habitat columns.

(Sheet 5 of 5)

Table 3

Density of Larval Fish (No./100 m^3) at Matthews Bend Station 1

Taxon	3 May	18 May	31 May	15 Jun	29 Jun	13 Jul	25 Jul	9 Aug	23 Aug	21 Sep	Total	Frequency
	Date											
Clupeidae												
Unidentified clupeids		15	30	217	18	3	7	4	6		300	50.2
Catostomidae												
Carpiodes spp.						3					3	0.5
Atherinidae												
Menidia audens										16	16	2.7
Percichthyidae												
Morone spp.										6	6	1.0
Centrarchidae												
Lepomis spp.					15	137	12	62	36	8	270	45.2
Sciaenidae												
Aplodinotus grunniens				3							3	0.5
Total	0	15	30	220	33	143	19	66	48	24	598	100.0
Frequency	0.0	2.5	5.0	36.8	5.5	23.9	3.2	11.0	8.0	4.0	100.0	

Table 4

Density of Larval Fish (No./100 m^3) at Matthews Bend Station 2

Taxon	Date										Total	Frequency
	3 May	18 May	31 May	15 Jun	29 Jun	13 Jul	25 Jul	9 Aug	23 Aug	21 Sep		
Clupeidae												
Unidentified clupeids		2	46	11				2			61	36.5
Centrarchidae												
Lepomis spp.						21	11	47	22	5	106	63.5
Total	0	2	46	11	0	21	11	49	22	5	167	100.0
Frequency	0.0	1.2	27.5	6.6	0.0	12.6	6.6	29.2	13.2	3.0	100.0	

Table 5

Density of Larval Fish (No./100 m^3) at Lake Lee Station 1

Taxon	Date 20 Apr	3 May	18 May	30 May	14 Jun	28 Jun	12 Jul	25 Jul	8 Aug*	22 Aug	20 Sep**	Total	Frequency
Clupeidae													
Dorosoma spp.					28							28	2.5
Unidentified clupeids	3	15		49	922			3		11		1003	91.0
Atherinidae													
Menidia audens				12	2							14	1.3
Percichthyidae													
Morone spp.	3											3	0.3
Centrarchidae													
Lepomis spp.						3	5	41				49	4.5
Sciaenidae													
Aplodinotus grunniens						5						5	0.5
Total	6	15	0	61	952	8	5	44		11		1102	100.00
Frequency	0.5	1.4	0.0	5.5	86.4	0.7	0.5	4.0		1.0		100.0	

* Not sampled.

** Station not present due to low water.

Table 6

Density of Larval Fish (No./100 m^3) at Lake Lee Station 2

Taxon	20 Apr	3 May	18 May	30 May	14 Jun	28 Jun	12 Jul	25 Jul	8 Aug	22 Aug	20 Sep	18 Oct	Total	Frequency
Clupeidae														
Dorosoma petenense									37				37	30.1
Unidentified clupeids		53	5	5					4				67	54.5
Atherinidae														
Menidia audens									2				2	1.6
Percichthyidae														
Morone spp.									2				2	1.6
Centrarchidae														
Lepomis spp.						3			7				10	8.1
Unidentified centrarchids		2											2	1.6
Sciaenidae														
Aplodinotus grunniens					3								3	2.4
Total	0	55	5	5	3	3	0	0	52	0	0	0	123	100.0
Frequency	0.0	44.7	4.1	4.1	2.4	2.4	0.0	0.0	42.3	0.0	0.0	0.0	100.0	

Table 7

Density of Larval Fish (No./100 m^3) at Lake Lee Station 101

Taxon	19 Apr*	3 May*	18 May	30 May	14 Jun*	28 Jun	12 Jul	25 Jul	8 Aug	22 Aug	20 Sep	Total	Frequency
Clupeidae													
Unidentified clupeids			2	2			10					14	31.1
Cyprinidae													
Notropis spp.										4		4	8.9
Unidentified cy nids							5		3			8	17.8
Centrarchidae													
Lepomis spp.								14	3			17	37.8
Pomoxis spp.			2									2	4.4
Total			4	2		0	15	14	6	4	0	45	100.0
Frequency			8.9	4.4		0.0	33.3	31.1	13.3	8.9	0.0	100.0	

* Not sampled.

Table 8

Density of Larval Fish (No./100 m^3) at Anconia Natural Bank

Taxon	19 Apr	3 May	18 May	30 May	14 Jun	28 Jun	12 Jul	25 Jul	9 Aug	23 Aug	21 Sep	Total	Frequency
Clupeidae													
Dorosoma petenense							9					9	2.3
Unidentified clupeids	34	14	2	60	2			2				114	28.9
Hiodontidae													
Hiodon alosoides				7								7	1.8
Cyprinidae													
Cyprinus carpio				2								2	0.5
Unidentified cyprinids		2				3	7	7	2			21	5.3
Catostomidae													
Carpiodes spp.								5				5	1.3
Ictiobus spp.	6	2	2									10	2.5
Percichthyidae													
Morone spp.	1											1	0.3
M. chrysops					5							5	1.3
Centrarchidae													
Pomoxis spp.	1											1	0.3
Unidentified centrarchids							7		12			19	4.8
Percidae													
Etheostoma spp.	3											3	0.8
Stizostedion canadense				5								5	1.3
Sciaenidae													
Aplodinotus grunniens				7		52	33	2	96		2	192	48.7
Total	45	18	4	81	7	55	56	16	110	0	2	394	100.0
Frequency	11.4	4.6	1.0	20.6	1.8	14.0	14.2	4.1	27.9	0.0	0.5	100.0	

Table 9

Density of Larval Fish (No./100 m^3) at Lakeport Natural Bank

Taxon	Date 20 Apr	3 May	18 May	30 May	14 Jun	28 Jun	12 Jul	25 Jul	9 Aug	23 Aug	21 Sep	Total	Frequency
Clupeidae													
Dorosoma cepedianum						2						2	1.0
D. petenense							3	4				7	3.4
Unidentified clupeids	19			14	2	19	3	4				61	29.6
Hiodontidae													
Hiodon alosoides				7								7	3.4
H. tergisus				5								5	2.4
Cyprinidae													
Unidentified cyprinids						2			2	5	10	19	9.2
Catostomidae													
Carpiodes spp.						2	5	18	13		7	45	21.8
C. carpio				5								5	2.4
Ictiobus spp.	19	2										21	10.2
Unidentified catostomids									2			2	1.0
Percichthyidae													
Morone chrysops					2							2	1.0
Centrarchidae													
Unidentified centrarchids								4		5		9	4.4
Sciaenidae													
Aplodinotus grunniens					2		8	4	2	5		21	10.2
Total	38	2	0	31	6	25	19	34	19	15	17	206	100.0
Frequency	18.4	1.0	0.0	15.1	2.9	12.1	9.2	16.5	9.2	7.3	8.3	100.0	

Table 10

Density of Larval Fish (No./100 m^3) at Carolina Revetment

Taxon	19 Apr*	3 May	18 May	31 May	15 Jun	29 Jun	13 Jul	26 Jul	9 Aug	23 Aug	21 Sep	Total	Frequency
Clupeidae													
Dorosoma cepedianum			5									5	3.2
Unidentified clupeids				35	3							38	24.2
Hiodontidae													
Hiodon alosoides				2								2	1.3
Cyprinidae													
Unidentified cyprinids								4	6		4	14	8.9
Catostomidae													
Carpiodes spp.									3			3	1.9
Unidentified catostomids				2								2	1.3
Centrarchidae													
Lepomis spp.										4		4	2.5
Unidentified centrarchids							11	25	6	8		50	31.8
Sciaenidae													
Aplodinotus grunniens						15	7	7	6	4		39	24.8
Total		0	5	39	3	1[illegible]	18	36	21	16	4	157	100.0
Frequency		0.0	3.2	24.8	1.9	9.6	11.5	22.9	13.4	10.2	2.5	100.0	

* Not sampled.

Table 11

Density of Larval Fish (No./100 m^3) at Cracraft Revetment

Taxon	19 Apr*	3 May	18 May	31 May	15 Jun	29 Jun	13 Jul	26 Jul	9 Aug	23 Aug	21 Sep	Total	Frequency
Clupeidae													
Unidentified clupeids			5	60	18							83	28.6
Hiodontidae													
Hiodon tergisus				2								2	0.7
Cyprinidae													
Cyprinus carpio			5		3							8	2.8
Unidentified cyprinids						11	3	17				31	10.7
Catostomidae													
Carpiodes spp.							3	5				8	2.8
Atherinidae													
Menidia audens						4						4	1.4
Centrarchidae													
Lepomis spp.						4	3					7	2.4
Pomoxis spp.				2								2	0.7
P. nigromaculatus			2									2	0.7
Unidentified centrarchids						4				2	2	8	2.8
Sciaenidae													
Aplodinotus grunniens				2	44	57	5	5	17	5		135	46.6
Total		0	12	66	65	80	14	27	17	7	2	290	100.0
Frequency		0.0	4.1	22.8	22.4	27.6	4.8	9.3	5.9	2.4	0.7	100.0	

* Not sampled.

Table 12

Density of Larval Fish (No./100 m^3) at Sunnyside Revetment

Taxon	19 Apr	3 May	18 May	30 May	14 Jun	28 Jun	12 Jul	25 Jul	9 Aug	23 Aug	21 Sep	Total	Frequency
Clupeidae													
Alosa chrysochloris					10							10	1.8
Dorosoma spp.					74							74	13.6
D. petenense							3	3	2			8	1.5
Unidentified clupeids	62	11		17	74	23						187	34.3
Hiodontidae													
Hiodon alosoides				5								5	0.9
Cyprinidae													
Cyprinus carpio	7											7	1.3
Unidentified cyprinids						8		5	23			36	6.6
Catostomidae													
Carpiodes spp.					5	3						8	1.5
Ictiobus spp.	7	2	2									11	2.0
Percichthyidae													
Morone spp.	2	2			7							11	2.0
Centrarchidae													
Lepomis spp.	2											2	0.4
Micropterus spp.	2											2	0.4
Pomoxis spp.	2											2	0.4
Unidentified centrarchids							5	5	2			12	2.2
Percidae													
Etheostoma spp.		2										2	0.4
Sciaenidae													
Aplodinotus grunniens					93	23	5	3	44			168	30.8
Total	84	17	2	22	263	57	13	16	71	0	0	545	100.0
Frequency	15.4	3.1	0.4	4.0	48.3	10.5	2.4	2.9	13.0	0.0	0.0	100.0	

Table 13

Density of Larval Fish (No./100 m^3) at Walnut Point-Kentucky Bend Revetment

Taxon	20 Apr	3 May	18 May	30 May	14 Jun	28 Jun	12 Jul	25 Jul	9 Aug	23 Aug	21 Sep	Total	Frequency
	Date												
Clupeidae													
Dorosoma cepedianum				2	5							7	1.7
D. petenense							2					2	0.5
Unidentified clupeids	26		3		41	9		2				81	20.1
Hiodontidae													
Hiodon alosoides				5								5	1.2
H. tergisus				2	2							4	1.0
Cyprinidae													
Cyprinus carpio	9											9	2.2
Unidentified cyprinids						3	6	5	2	22		38	9.5
Catostomidae													
Carpiodes spp.							4	2		6		12	3.0
Ictiobus spp.	12		3									15	3.7
Percichthyidae													
Morone spp.				7	5							12	3.0
Centrarchidae													
Pomoxis spp.	3											3	0.7
P. annularis				2								2	0.5
Unidentified centrarchids								5	10	11	3	29	7.2
Percidae													
Stizostedion canadense	3											3	0.7
Sciaenidae													
Aplodinotus grunniens					19	128	6	12	4	11		180	44.8
Total	53	0	6	18	72	140	18	26	16	50	3	402	100.0
Frequency	13.2	0.0	1.5	4.5	17.9	34.8	4.5	6.5	4.0	12.4	0.7	100.0	

Table 14

Density of Larval Fish (No./100 m^3) at Lower Cracraft Dike Field

Taxon	19 Apr	3 May	18 May	31 May	15 Jun	29 Jun*	13 Jul	26 Jul	9 Aug	23 Aug	21 Sep	Total	Frequency
Clupeidae													
Dorosoma cepedianum					2							2	1.2
D. petenense							8		2			10	5.9
Unidentified clupeids				29	10					4		43	25.3
Hiodontidae													
Hiodon alosoides				5								5	2.9
Cyprinidae													
Cyprinus carpio				2	2							4	2.4
Percichthyidae													
Morone chrysops					2							2	1.2
Centrarchidae													
Micropterus spp.					2							2	1.2
Pomoxis spp.			2									2	1.2
P. nigromaculatus					2							2	1.2
Unidentified centrarchids								5				5	2.9
Percidae													
Stizostedion canadense				2								2	1.2
Sciaenidae													
Aplodinotus grunniens				5	83		3					91	53.5
Total	0	0	2	43	103		11	5	2	4	0	170	100.0
Frequency	0.0	0.0	1.2	25.3	60.6		6.5	2.9	1.2	2.4	0.0	100.0	

* Not sampled.

Table 15

Density of Larval Fish (No./100 m^3) at Island 86 Dike Field

Taxon	Date 19 Apr	3 May	18 May	31 May	14 Jun	28 Jun	12 Jul	25 Jul	9 Aug	23 Aug	21 Sep	Total	Frequency
Clupeidae													
Unidentified clupeids	8	4		7	2			3		10		34	20.5
Hiodontidae													
Hiodon alosoides				5								5	3.0
Cyprinidae													
Cyprinus carpio	2											2	1.2
Unidentified cyprinids	2							8	11			21	12.7
Catostomidae													
Ictiobus spp.		4										4	2.4
Unidentified catostomids		2										2	1.2
Ictaluridae													
Ictalurus furcatus							2					2	1.2
Percichthyidae													
Morone spp.		2						3				5	3.0
Centrarchidae													
Lepomis spp.										3		3	1.8
Unidentified centrarchids								5	3			8	4.8
Percidae													
Stizostedion spp.		2		5								7	4.2
Sciaenidae													
Aplodinotus grunniens				5	22	9	11		26			73	44.0
Total	12	14	0	22	24	9	13	19	40	13	0	166	100.0
Frequency	7.2	8.4	0.0	13.2	14.5	5.4	7.8	11.4	24.1	7.8	0.0	100.0	

Table 16

Density of Larval Fish (No./100 m^3) at Leota Dike Field

Taxon	Date											Total	Frequency
	19 Apr	3 May	18 May	31 May	15 Jun	29 Jun	12 Jul	26 Jul	9 Aug	23 Aug	21 Sep*		
Clupeidae													
Dorosoma cepedianum								3				3	2.0
Unidentified clupeids	14			14	3	55				3		89	58.6
Hiodontidae													
Hiodon alosoides				5								5	3.3
Cyprinidae													
Cyprinus carpio	4											4	2.6
Unidentified cyprinids							2	3				5	3.3
Catostomidae													
Ictiobus spp.	13											13	8.6
I. cyprinellus					3							3	2.0
Ictaluridae													
Ictalurus punctatus					3							3	2.0
Percichthyidae													
Morone chrysops					3							3	2.0
Centrarchidae													
Lepomis spp.						8						8	5.3
Pomoxis spp.	2											2	1.3
Sciaenidae													
Aplodinotus grunniens					14							14	9.2
Total	33	0	0	19	26	63	2	6	0	3		152	100.0
Frequency	21.7	0.0	0.0	12.5	17.1	41.4	1.3	4.0	0.0	2.0		100.0	

* Not sampled; area inaccessible due to low water.

Table 17

Density of Larval Fish (No./100 m^3) at Seven Oaks Dike Field Station 1

Taxon	Date 19 Apr	3 May	18 May	31 May	14 Jun	28 Jun	12 Jul	25 Jul	9 Aug	23 Aug	21 Sep	Total	Frequency
Lepisosteidae													
Lepisosteus spp.					2							2	0.2
Clupeidae													
Dorosoma cepedianum					27							27	2.6
D. petenense							13	2	5			20	1.9
Unidentified clupeids	25	4		44	95	97	23	2	2		3	295	28.0
Cyprinidae													
Cyprinus carpio	2											2	0.2
Unidentified cyprinids					2	5	2					9	0.9
Catostomidae													
Carpiodes spp.								2	10			12	1.1
Ictiobus spp.	1			2								3	0.3
Atherinidae													
Menidia audens					2							2	0.2
Percichthyidae													
Morone spp.	1			2	24							27	2.6
M. saxatilis					24							24	2.3
Centrarchidae													
Lepomis spp.								2		3		5	0.5
Micropterus spp.					22							22	2.1
M. punctulatus					2							2	0.2
Pomoxis spp.					80							80	7.6
Unidentified centrarchids		4				3	8	17	24	3		59	5.6
Sciaenidae													
Aplodinotus grunniens				2	97	17	13	58	274			461	43.8
Total	29	8	0	50	377	122	59	83	315	6	3	1052	100.0
Frequency	2.8	0.8	0.0	4.8	35.8	11.6	5.6	7.9	29.9	0.6	0.3	100.0	

Table 18

Density of Larval Fish (No./100 m^3) at Seven Oaks Dike Field Station 2

Taxon	19 Apr*	3 May	18 May	31 May*	14 Jun	28 Jun	12 Jul	25 Jul	9 Aug	23 Aug	21 Sep**	Total	Frequency
Clupeidae													
Unidentified clupeids		6			5	17		3				31	17.8
Hiodontidae													
Hiodon alosoides			2									2	1.1
Cyprinidae													
Unidentified cyprinids								7	6			13	7.5
Catostomidae													
Ictiobus spp.			2									2	1.1
Centrarchidae													
Unidentified centrarchids							3		4			7	4.0
Percidae													
Etheostoma spp.		2										2	1.1
Sciaenidae													
Aplodinotus grunniens					63	7		37	10			117	67.2
Total		8	4		68	24	3	47	20	0		174	100.0
Frequency		4.6	2.3		39.1	13.8	1.7	27.0	11.5	0.0		100.0	

* Not sampled.
** Area inaccessible due to low water.

Table 19

Density of Larval Fish (No./100 m^3) at Walnut Point Dike Field

Taxon	20 Apr	3 May	18 May	31 May	14 Jun	28 Jun	12 Jul	25 Jul	9 Aug	23 Aug	21 Sep	Total	Frequency
Clupeidae													
Dorosoma spp.					10		3					13	9.0
D. cepedianum					5							5	3.4
Unidentified clupeids	12			9	12	17				4	5	59	40.7
Hiodontidae													
Hiodon alosoides					2							2	1.4
H. tergisus					2							2	1.4
Cyprinidae													
Unidentified cyprinids							8	5				13	9.0
Catostomidae													
Carpiodes spp.									2			2	1.4
Ictiobus spp.	12					3						15	10.3
Ictaluridae													
Ictalurus furcatus									2			2	1.4
Percichthyidae													
Morone spp.	3				5							8	5.5
Centrarchidae													
Lepomis spp.						8				4		12	8.3
Unidentified centrarchids								3	2			5	3.4
Sciaenidae													
Aplodinotus grunniens					7							7	4.8
Total	27	0	0	9	43	28	11	8	6	8	5	145	100.0
Frequency	18.6	0.0	0.0	6.2	29.7	19.3	7.6	5.5	4.1	5.5	3.4	100.0	

Table 20

Density of Larval Fish (No./100 m^3) at the Sandbar Area at Lakeport Towhead

	Date												
Taxon	20 Apr	3 May	18 May	30 May	14 Jun	28 Jun	12 Jul	25 Jul	9 Aug	23 Aug	21 Sep	Total	Frequency
Clupeidae													
Unidentified clupeids	3			2	3	3						11	17.5
Cyprinidae													
Unidentified cyprinids						3				14		17	:7.0
Catostomidae													
Carpiodes spp.							6					6	9.5
Ictiobus spp.	6											6	9.5
Ictaluridae													
Ictalurus punctatus								7				7	11.1
Centrarchidae													
Unidentified centrarchids		4										4	6.3
Sciaenidae													
Aplodinotus grunniens				2		3	3			4		12	19.0
Total	9	4	0	4	3	9	9	7	0	18	0	63	100.0
Frequency	14.3	6.3	0.0	6.3	4.8	14.3	14.3	11.1	0.0	28.6	0.0	100.0	

Table 21

Density of Larval Fish (No./100 m^3) at American Cutoff

Taxon	20 Apr	3 May	18 May	30 May	14 Jun	28 Jun	12 Jul	25 Jul	9 Aug	23 Aug	21 Sep	Total	Frequency
Clupeidae													
Unidentified clupeids	43			2								45	24.9
Hiodontidae													
Hiodon tergisus				7								7	3.9
Cyprinidae													
Cyprinus carpio				2								2	1.1
Unidentified cyprinids	3					3			2	3		11	6.1
Catostomidae													
Carpiodes spp.						3			4			7	3.9
Ictiobus spp.	17											17	9.4
Centrarchidae													
Lepomis spp.								4				4	2.2
Pomoxis spp.	3											3	1.7
Unidentified centrarchids										6		6	3.3
Sciaenidae													
Aplodinotus grunniens						58		4	2	15		79	43.6
Total	66	0	0	11	0	64	0	8	8	24	0	181	100.0
Frequency	36.5	0.0	0.0	6.1	0.0	35.4	0.0	4.4	4.4	13.3	0.0	100.0	

Table 22

Density of Larval Fish (No./100 m^3) at Kentucky Bend Chute

Taxon	19 Apr	3 May	18 May	31 May	14 Jun	28 Jun	12 Jul	25 Jul	9 Aug	23 Aug	21 Sep	Total	Frequency
Clupeidae													
Dorosoma spp.						3						3	1.7
Unidentified clupeids	20			5	7	6						38	22.0
Hiodontidae													
Hiodon alosoides				2								2	1.2
H. tergisus				2								2	1.2
Cyprinidae													
Cyprinus carpio	2											2	1.2
Notropis atherinoides									2			2	1.2
Unidentified cyprinids								3	4			7	4.0
Catostomidae													
Carpiodes spp.									2			2	1.2
Percichthyidae													
Morone spp.				2								2	1.2
Centrarchidae													
Pomoxis spp.	2											2	1.2
Unidentified centrarchids							2					2	1.2
Sciaenidae													
Aplodinotus grunniens				17	5	68	5		14			109	63.0
Total	24	0	0	28	12	77	7	3	22	0	0	173	100.0
Frequency	13.9	0.0	0.0	16.2	6.9	44.5	4.0	1.7	12.7	0.0	0.0	100.0	

Table 23

Density of Larval Fish (No./100 m^3) at Main Channel Station 1

Taxon	19 Apr*	3 May	18 May	31 May	15 Jun	29 Jun	13 Jul	26 Jul	9 Aug	23 Aug	21 Sep	Total	Frequency
Clupeidae													
Unidentified clupeids				24								24	19.8
Hiodontidae													
Hiodon alosoides				2								2	1.7
Cyprinidae													
Unidentified cyprinids							6		2	3	3	14	11.6
Catostomidae													
Carpiodes spp.						3			5			8	6.6
Centrarchidae													
Pomoxis spp.				2								2	1.7
Unidentified centrarchids										8		8	6.6
Sciaenidae													
Aplodinotus grunniens							33	3	2	25		63	52.1
Total		0	0	28	0	3	39	3	9	36	3	121	100.00
Frequency		0.0	0.0	23.1	0.0	2.5	32.2	2.5	7.4	29.8	2.5	100.0	

* Not sampled.

Table 24

Density of Larval Fish (No./100 m^3) at Main Channel Station 3

Taxon	Date 19 Apr	3 May	18 May*	31 May**	15 Jun	29 Jun	13 Jul	26 Jul	9 Aug	23 Aug	21 Sep	Total	Frequency
Clupeidae													
Unidentified clupeids	2					5						7	7.2
Cyprinidae													
Cyprinus carpio	2											2	2.1
Unidentified cyprinids								3				3	3.1
Catostomidae													
Carpiodes spp.						3		3	3			9	9.3
Ictiobus spp.	5											5	5.2
Centrarchidae													
Unidentified centrarchids										3		3	3.1
Sciaenidae													
Aplodinotus grunniens					5	47	3		13			68	70.1
Total	9	0			5	55	3	6	16	3	0	97	100.0
Frequency	9.3	0.0			5.2	56.7	3.1	6.2	16.5	3.1	0.0	100.0	

* Not sampled.
** Sample not analyzed.

Table 25

Density of Larval Fish (No./100 m^3) at Main Channel Station 6

Taxon	19 Apr*	3 May	18 May	30 May	14 Jun	28 Jun	12 Jul	25 Jul	9 Aug	23 Aug	21 Sep	Total	Frequency
Clupeidae													
Dorosoma spp.					2							2	0.4
Unidentified clupeids		2	2	260		16						280	52.1
Hiodontidae													
Hiodon alosoides				46								46	8.5
H. tergisus				5								5	0.9
Cyprinidae													
Cyprinus carpio			2	5								7	1.3
Unidentified cyprinids							10			3		13	2.4
Catostomidae													
Carpiodes spp.						5				3		8	1.5
Percichthyidae													
Morone spp.				12								12	2.2
Centrarchidae													
Lepomis spp.					2							2	0.4
Pomoxis spp.			2									2	0.4
Sciaenidae													
Aplodinotus grunniens				2	12	135	5		1	7		162	30.1
Total		2	6	330	16	156	15	0	1	13	0	539	100.0
Frequency		0.4	1.1	61.2	3.0	28.9	2.8	0.0	0.2	2.4	0.0	100.0	

* Not sampled.

Table 26

Density of Larval Fish (No./100 m^3) at Main Channel Station 9

Taxon	Date											Total	Frequency
	19 Apr*	3 May	18 May	30 May	14 Jun	28 Jun	12 Jul	25 Jul	9 Aug	23 Aug	21 Sep		
Clupeidae													
Unidentified clupeids		2	2	10								14	8.1
Cyprinidae													
Cyprinus carpio					2							2	1.2
Catostomidae													
Carpiodes spp.						5			4			9	5.2
Centrarchidae													
Lepomis spp.							3					3	1.7
Pomoxis spp.				2								2	1.2
P. annularis			2									2	1.2
P. nigromaculatus			2									2	1.2
Unidentified centrarchids											2	2	1.2
Sciaenidae													
Aplodinotus grunniens				2	24	76	13		18	3		136	79.1
Total		2	6	14	26	81	16	0	22	3	2	172	100.0
Frequency		1.2	3.5	8.1	15.1	47.1	9.3	0.0	12.8	1.7	1.2	100.0	

* Not sampled.

Table 27

Variance Component Analysis to Determine Sources of Variation in Number of Taxa and Density (No./100 m^3) of Larval Fish Collected During Diel Sampling at Sunnyside Revetment, 27-28 June 1978

Source	Percentage of Variance Accounted for: Density	Number of Taxa
Time periods	58*	74*
Interval (time periods)	0	0
Error	42	26
Time periods	52*	73*
Side (time periods)	17*	0
Error	31	26

* Statistically significant, probability F > 0.01.

Table 28

Mean Density* of Larval Fish (No./100 m^3) Collected in the Shore Net During Diel Sampling at Sunnyside Revetment, 27-28 June 1978

Taxon	Time of day 1200	1500	2100	0100	0600	Total	Frequency
Clupeidae							
Alosa chrysochloris	0.6	0.6	1.0	NC**	NC	2.2	0.01
Dorosoma spp.	NC	NC	4.0	2.8	NC	6.8	0.02
D. cepedianum	NC	9.4	4.2	3.0	0.8	17.4	0.04
D. petenense	NC	10.8	1.6	4.0	1.4	17.8	0.04
Unidentified clupeids	15.7	15.0	4.2	2.4	7.0	44.3	0.10
Hiodontidae							
Hiodon alosoides	NC	NC	NC	NC	NC	NC	NC
H. tergisus	NC	NC	NC	0.4	NC	0.4	<0.01
Cyprinoidei							
Unidentified cyprinoids	0.3	NC	1.4	2.6	2.2	6.5	0.02
Cyprinidae							
Hybopsis aestivalis	NC	NC	0.4	NC	NC	0.4	<0.01
H. storeriana	NC	NC	NC	NC	0.2	0.2	<0.01
Unidentified cyprinids	0.9	0.6	2.8	0.8	0.4	5.5	0.01
Catostomidae							
Carpiodes spp.	5.9	2.8	10.0	11.6	6.4	36.7	0.09
Unidentified catostomids	0.3	NC	NC	NC	NC	0.3	<0.01
Ictaluridae							
Ictalurus furcatus	NC	NC	0.2	NC	NC	0.2	<0.01
I. punctatus	NC	NC	NC	0.4	NC	0.4	<0.01
Pylodictus olivaris	NC	NC	0.2	0.2	NC	0.4	<0.01
Percichthyidae							
Morone spp.	NC	NC	NC	0.4	NC	0.4	<0.01
M. chrysops	NC	NC	0.2	NC	NC	0.2	<0.01
M. mississippiensis	NC	NC	0.2	NC	NC	0.2	<0.01
M. saxatilis	NC	NC	NC	0.2	NC	0.2	<0.01
Centrarchidae							
Lepomis sp.	NC	NC	0.8	0.4	0.2	1.4	<0.01
Pomoxis annularis	NC	NC	NC	NC	NC	NC	NC
P. nigromaculatus	NC	NC	0.2	NC	NC	0.2	<0.01
Unidentified centrarchids	0.8	NC	0.6	1.0	NC	2.4	0.01
Sciaenidae							
Aplodinotus grunniens	30.1	66.4	100.4	60.0	23.0	279.9	0.66
Total	54.6	105.6	132.4	90.2	41.6	424.4	1.00
Frequency	0.13	0.25	0.31	0.21	0.10	1.00	

* Each density value is the density of the taxon at the specified level of identification; e.g., the density of *Dorosoma* spp. is the density of larvae identified as *Dorosoma* spp. and is not the sum of larvae identified as *Dorosoma* spp., *D. cepedianum*, and *D. petenense*.

** Not collected.

Table 29

Mean Density* of Larval Fish (No./100 m^3) Collected in the River Net During Diel Sampling at Sunnyside Revetment, 27-28 June 1978

Taxon	Time of day					Total	Frequency
	1200	1500	2100	0100	0600		
Clupeidae							
Alosa chrysochloris	NC**	1.0	0.4	NC	NC	1.4	<0.01
Dorosoma spp.	NC	NC	0.4	NC	2.2	2.6	<0.01
D. cepedianum	NC	1.0	6.2	1.0	1.8	10.0	0.02
D. petenense	NC	1.4	1.6	1.0	6.2	10.2	0.02
Unidentified clupeids	13.9	14.8	5.4	4.0	12.2	50.3	0.09
Hiodontidae							
Hiodon alosoides	NC	NC	0.2	NC	0.2	0.4	<0.01
H. tergisus	NC	NC	0.2	0.2	NC	0.4	<0.01
Cyprinoidei							
Unidentified cyprinoids	0.9	0.4	1.0	6.0	4.4	12.7	0.02
Cyprinidae							
Hybopsis aestivalis	NC	NC	NC	NC	NC	NC	NC
H. storeriana	NC	NC	NC	NC	NC	NC	NC
Unidentified cyprinids	0.6	NC	1.2	0.4	NC	2.2	<0.01
Catostomidae							
Carpiodes spp.	6.5	3.6	20.4	15.4	7.6	53.5	0.10
Unidentified catostomids	0.2	0.4	NC	NC	NC	0.6	<0.01
Ictaluridae							
Ictalurus furcatus	NC	NC	0.2	NC	NC	0.2	<0.01
I. punctatus	NC	NC	0.6	1.6	NC	2.2	<0.01
Pylodictus olivaris	NC	NC	NC	0.2	NC	0.2	<0.01
Percichthyidae							
Morone spp.	NC	NC	0.4	0.4	NC	0.8	<0.01
M. chrysops	NC	NC	0.4	NC	NC	0.4	<0.01
M. mississippiensis	NC	NC	0.2	NC	0.2	0.4	<0.01
M. saxatilis	NC	NC	NC	0.2	0.4	0.6	<0.01
Centrarchidae							
Lepomis sp.	0.4	NC	0.2	0.2	1.0	1.8	<0.01
Pomoxis annularis	NC	NC	NC	0.2	NC	0.2	<0.01
P. nigromaculatus	NC	NC	NC	NC	NC	NC	NC
Unidentified centrarchids	0.4	NC	0.4	0.2	0.8	1.8	<0.01
Sciaenidae							
Aplodinotus grunniens	26.6	66.2	143.2	105.6	57.6	399.2	0.72
Total	49.5	88.8	182.6	[illegible].6	94.6	552.1	1.00
Frequency	0.09	0.16	[illegible]	[illegible]5	0.17	1.00	

* Each density value is the density of the taxon at the specified level of identification; e.g., the density of Dorosoma spp. is the density of larvae identified as Dorosoma spp. and is not the sum of larvae identified as Dorosoma spp., D. cepedianum, and D. petenense.

** Not collected.

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Schramm, Harold L., Jr.
Aquatic habitat studies on the Lower Mississippi River, river mile 480 to 530 : Report 6, larval fish studies--pilot report / by Harold L. Schramm, Jr., C. H. Pennington (Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station) ; prepared for Office, Chief of Engineers, U.S. Army. -- Vicksburg, Miss. : U.S. Army Engineer Waterways Experiment Station ; Springfield, Va. : available from NTIS, 1981.
41, [34] p. : ill. ; 27 cm. -- (Miscellaneous paper / U.S. Army Engineer Waterways Experiment Station ; E-80-1, Report 6)
Cover title.
"April 1981."
"Under EWQOS Work Unit VIIB."
Bibliography: p. 41.

1. Aquatic ecology. 2. Environmental engineering. 3. Fishes. 4. Larvae -- Fishes. 5. Mississippi River. 6. Water quality. I. Pennington, C. H. II. United

Schramm, Harold L.
Aquatic habitat studies on the Lower Mississippi : ... 1981.
(Card 2)

States. Army. Corps of Engineers. Office of the Chief of Engineers. III. United States. Army Engineer Waterways Experiment Station. Environmental Laboratory. V. Title VI. Series: Miscellaneous paper (United States. Army Engineer Waterways Experiment Station) ; E-80-1, Report 6.
TA7.W34m no.E-80-1, Report 6.

END

DATE FILMED

6-81

DTIC