US Army Corps of Engineers
Mississippi River Commission

AN ECOLOGICAL EVALUATION OF FIVE SECONDARY CHANNEL HABITATS IN THE LOWER MISSISSIPPI RIVER

LOWER MISSISSIPPI RIVER ENVIRONMENTAL PROGRAM

REPORT 7

DECEMBER 1987

PREPARED FOR: PRESIDENT, MISSISSIPPI RIVER COMMISSION
PO BOX 80
VICKSBURG, MISSISSIPPI 39180-0080

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S) Lower Mississippi River Environmental Program, Report 7
6a. NAME OF PERFORMING ORGANIZATION USAEWES Environmental Laboratory 6b. OFFICE SYMBOL *(If applicable)*	7a. NAME OF MONITORING ORGANIZATION President, Mississippi River Commission
6c. ADDRESS *(City, State, and ZIP Code)* PO Box 631 Vicksburg, MS 39180-0631	7b. ADDRESS *(City, State, and ZIP Code)* PO Box 80 Vicksburg, MS 39180-0080
8a. NAME OF FUNDING / SPONSORING ORGANIZATION Mississippi River Commission 8b. OFFICE SYMBOL *(If applicable)*	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS *(City, State, and ZIP Code)* PO Box 80 Vicksburg, MS 39180-0080	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.

11. TITLE *(Include Security Classification)*

An Ecological Evaluation of Five Secondary Channel Habitats in the Lower Mississippi River

12. PERSONAL AUTHOR(S)

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13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT *(Year, Month, Day)*	15. PAGE COUNT
Final report	FROM ______ TO ______	December 1987	147

16. SUPPLEMENTARY NOTATION

Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

17. COSATI CODES			18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*
FIELD	GROUP	SUB-GROUP	

19. ABSTRACT *(Continue on reverse if necessary and identify by block number)*

Chemical, physical, and biological attributes of the aquatic habitat of five Lower Mississippi River secondary channels were surveyed during summer (July) 1984; two of the channels were resurveyed during fall (October). Dikes at least partially restricted flow through two of the channels (Lakeport Towhead and Cottonwood Bar, river miles 470 and 528, respectively); flow through the remaining three (Wolf Island, river mile 935; Island 8, river mile 915; Profit Island, river mile 250) was not restricted.

The channel at which flow was most restricted, Lakeport Towhead, showed both physical and chemical differences from the others. Current speeds were relatively high at four of the channels in summer, but were only about one-half as high at Lakeport Towhead. Water quality variables measured (turbidity, conductivity, pH, temperature, and dissolved oxygen concentration) showed little difference among channels in summer. Of the two secondary channels

(Continued)

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE *(Include Area Code)* / 22c. OFFICE SYMBOL

19. ABSTRACT (Continued).

resurveyed in fall, Cottonwood Bar showed little change in any measured physical or chemical variable; changes at Lakeport Towhead were considerable, however. Almost no current was present at this time, and the sediments consisted almost entirely of fines. Water quality was also changed, with turbidity being considerably lower than in summer and dissolved oxygen depletion occurring in the deepest areas.

Electroshocking catches of fish were highest at Profit Island due to unusually large collections of catfishes. Available evidence suggested that baiting by commercial fishermen may have been occurring there, however. Excluding Profit Island, only small differences in catch rate among the remaining four channels were found. Seining indicated differences among the channels, but the differences could not be related to any measured physical variable, including the presence or absence of a dike. Hydroacoustic data, though not statistically significant, suggested higher fish densities at the two diked secondary channels. Within individual channels, both electroshocking and hydroacoustics indicated the highest average fish densities to be along the natural bank side. Fish catches increased in both channels sampled in fall, but they increased much more in Lakeport Towhead than in Cottonwood Bar. In contrast to summer, densities of fish appeared to be greatest along the secondary channel sandbar at Lakeport and along the dike at Cottonwood Bar.

The macroinvertebrate assemblages found within the channels were similar overall, and they appeared to reflect the current speed and substrate conditions. The dike macrofauna was similar to that noted in earlier studies on the Lower Mississippi River.

Dikes that block or greatly restrict flow through secondary channels produce habitats in which the macroinvertebrate and fish assemblages are quite different from undiked channels, at least when river stages are near or lower than the controlling elevation of the dikes.

PREFACE

The Lower Mississippi River Environmental Program (LMREP) is being conducted by the Mississippi River Commission (MRC), US Army Corps of Engineers. It is a comprehensive program of environmental studies of the leveed floodplain of the Lower Mississippi River. Results will provide the basis for recommending environmental design considerations for the navigation and flood control features of the Mississippi River and Tributaries Project.

One component of the LMREP is the Dike System Investigation. This report presents results of a study documenting the physical and biological characteristics of five secondary channels in the Lower Mississippi River, three of which have had dikes constructed at the upstream end to restrict the conveyance of flow. Data were collected from the river between miles 935 and 250 during the period July through October 1984.

Data were collected by individuals from the Aquatic Habitat Group (AHG), Environmental Laboratory, US Army Engineer Waterways Experiment Station. The report was prepared by Mr. John A. Baker, Dr. C. H. Pennington, Mr. C. Rex Bingham, and Mrs. Linda E. Winfield of the AHG.

The investigation was managed by the Planning Division of the MRC and was sponsored by the Engineering Division, US Army Engineer Division, Lower Mississippi Valley. Mr. Stephen P. Cobb, MRC, was the program manager for the LMREP. The investigation was conducted under the direction of the President of the Mississippi River Commission, BG Thomas A. Sands, CE.

CONTENTS

CONVERSION FACTORS, NON-SI TO SI (METRIC)
UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
acres	4,046.873	square metres
cubic feet	0.02831685	cubic metres
feet	0.3048	metres
inches	25.4	millimetres
miles (U.S. statute)	1.609347	kilometres
pounds	0.4535924	kilograms
square miles	2.589998	square kilometres

LOWER MISSISSIPPI RIVER ENVIRONMENTAL PROGRAM

An Ecological Evaluation of Five Secondary Channels
in the Lower Mississippi River

PART I: INTRODUCTION

Background

MR&T Project

Along the course of the Lower Mississippi River and on the associated floodplain, flooding has historically been a major deterrent to development. For example, destructive floods occurred in 1849, 1858, 1882, 1897, 1912, 1913, 1916, 1922, 1927, 1937, and 1973. The Mississippi River Commission (MRC) was established by Congress in 1879 to develop and carry out flood control and navigation measures for the Lower Mississippi River that would be financed by the Federal Government.

The devastating flood of 1927, the flood of record, destroyed many existing levees, flooded large areas of farmland and numerous municipalities, and caused loss of livestock and human life in the Lower Mississippi Valley. This flood motivated the Congress to pass the Flood Control Act of 1928, which authorized the Mississippi River and Tributaries (MR&T) Project. The MR&T Project is a comprehensive plan for flood control and navigation works on the main stem Lower Mississippi River and tributary streams and consists primarily of levee systems, channel improvement works, and floodways. The MRC is responsible for carrying out the project.

Lower Mississippi River Environmental Program (LMREP)

The LMREP is being conducted by the MRC. This 7-year program has as objectives the development of baseline environmental resources data on the river and associated leveed floodplain and the formulation of environmental design considerations for channel training works (dikes and revetments) and the main stem levee system. The LMREP was initiated in fiscal year 1981 and is scheduled for completion in fiscal year 1987. Fishery and wildlife populations and habitat are the main focus of the LMREP. The LMREP is made up of five work units: levee borrow pit investigations, dike system investigations, revetment investigations, habitat inventories, and development of the Computerized Environmental Resources Data System (CERDS), a geographic information system containing environmental data. This investigation is part of the habitat inventories work unit dealing with secondary channels.

There are numerous secondary channels on the Lower Mississippi River that are separated from the main navigation channel by large islands. The aquatic habitat within these channels comprises approximately 6 percent of the total water surface acreage at any given river stage (Cobb and Clark 1981). Flow through permanent secondary channels is maintained year round, while flow is restricted at the upstream opening of temporary secondary channels so that flow through the channels does not occur during low river stages.

Objectives

The work reported herein was undertaken in 1984 to document the chemical, physical, and biological characteristics of five secondary channels on the Lower Mississippi River between river miles 935 and 250. Dike structures were in place at the upstream opening of two channels, while the other three channels did not contain dike structures. This work had the following objectives:

- a. Obtain baseline data on the physical and chemical characteristics of five secondary channels.
- b. Describe the distribution and abundance of fishes and benthic macroinvertebrates in five secondary channels.
- c. Evaluate, to the extent possible, effects of dikes on fishes and benthic invertebrates in secondary channels.

More detailed evaluations of the effects of dike structures on ecological characteristics of secondary channels would be necessary to fully achieve objective c. Such analyses are beyond the scope of this report but are planned as part of the overall LMREP.

Study Area

The Mississippi River is the fourth largest drainage basin in the world (1,245,000 square miles*), exceeded in size only by the watersheds of the Amazon, Congo, and Nile Rivers. The river drains 41 percent of the contiguous 48 States and a portion of Canada.

The Lower Mississippi River flows from the confluence of the Ohio and Middle Mississippi Rivers at Cairo, Ill., to the Gulf of Mexico, a distance of approximately 975 river miles (RM). At Vicksburg, Miss. (RM 437), approximately midway along the Lower Mississippi River, the mean annual discharge of the river is 552,000 cubic feet per second (cfs); the mean monthly maximum and minimum flows are 948,000 cfs in April and 261,000 cfs in September, respectively. The maximum flow recorded at the Vicksburg gage was 1,806,000 cfs during the flood of 1927; the discharge during this flood has been estimated to have been 2,278,000 cfs if the mainline levees upstream of Vicksburg had not crevassed (Tuttle and Pinner 1982). The difference in river stage between the average minimum discharge and average maximum discharge is about 27 ft on the Vicksburg, Miss., gage although river stage may fluctuate more than 45 ft in stage in a particular year. Suspended sediment transported by the river averages 161 million tons per year (Keown, Dardeau, and Causey 1981).

Flooding along the river may occur during the fall, winter, and spring and varies considerably in time, stage, and duration from year to year. Highest stages are typically reached from March through May; peak flows occur in April on the average.

The approximately 2.5 million acres of leveed floodplain are composed of 81 percent land and 19 percent water, including abandoned channels, oxbow lakes, levee borrow pits, and the main river channel (Ryckman et al. 1975). The floodplain of the Lower Mississippi River is leveed along both banks. The main stem levees are continuous on the west bank except at the confluences of the St. Francis River and the Arkansas-White Rivers. Levee segments and bluffs alternate on the east bank. A system of dikes and revetments is being constructed throughout the river for navigation and flood control purposes.

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

The five secondary channels (Wolf Island, Island 8, Lakeport Towhead, Cottonwood Bar, and Profit Island) investigated in this study are located along the main stem Lower Mississippi River between river miles 935 and 250 (Figure 1). The percentage of total flow carried by the secondary channels has varied with time and with river stage. The secondary channels themselves are morphologically active to varying degrees, exhibiting scour, deposition, and bank caving. To stabilize the river for flood control and navigation purposes, dikes either have been or will be constructed in the secondary channels to partially restrict flow through them.

Wolf Island secondary channel has its upstream end at RM 935, less than 20 miles from the confluence of the Ohio River (Figure 1). This secondary channel is shorter than the adjacent main channel, being only about 2.75 miles in length. It is also relatively wide, being nearly 1 mile near the downstream end at the time of sampling (Figure 2). No dikes have been constructed at this channel, although they are planned.

Island 8 secondary channel is located at RM 910.7 to 915, approximately 20 miles downstream of Wolf Island (Figure 1). The length of the secondary channel, over 7.5 miles, is considerably greater than that of the adjacent main channel due to its position on a large bend. The Bend of Island 8 revetment, built in 1928-30, protects about a 2-mile reach of bankline near the upstream end of the channel (Figure 3). The Island 8 dikes are buried near the upstream end of the island. These two structures are remnants of channel training activities when the present secondary channel was the main navigation route. A dike is planned for the upstream end of this channel, although construction is not scheduled for the near future.

Lakeport Towhead secondary channel (also known as Refuge secondary channel, and earlier as American Cutoff) diverges from the main navigation channel at about RM 528.5, less than 10 miles downstream from the mouth of the Greenville, Miss. harbor (Figure 1). The secondary channel is about 4.25 miles in length, slightly longer than the navigation channel at this site (Figure 4). In 1979, Refuge Dike was constructed across the upper end of this channel at RM 528.3. This 5,040-ft-long L-head dike has a bankhead crown elevation of 29.0 ft (LWRP), a crown elevation of 18 ft for 75 percent of its length, and a 19 ft elevation at the end of the dike. The dike extends completely across the end of this secondary channel so that, at river stages below the lowest crown elevations, little flow enters the channel. The remnants of the American Cutoff Revetment are present in the downstream end of the channel.

The secondary channel at Cottonwood Bar (Figure 1) is located along the left bank of the river in the vicinity of RM 470. This channel was about 3 miles long at the time of sampling. In 1983 two dikes were constructed as the initial phase of a long-range plan to develop a third channel through the island between the bendway channel and the secondary channel. This third channel is on a more stable alignment and will eventually become the main channel. The L-head dike at the immediate upstream end of the secondary channel, Arcadia Dike, is 4,000 ft long, has a bankhead crown elevation of 33 ft, and a crown elevation thereafter of 22 ft. This dike did not completely block flow during the year of the study (Figure 5). In 1985, however, this dike was extended, and another dike was constructed in the downstream portion of the secondary channel. Additional work to raise the dikes was accomplished in 1986.

The upstream end of the 3-mile-long Profit Island secondary channel (Figure 6) is located near RM 252 (Figure 1). This channel, located along the left bank of the river, is relatively narrow. A dike was constructed at the upstream end of this channel in 1986, but no training works were in place at this site during the study.

The general secondary channel habitat is comprised of several recognizable components, or microhabitats. For the purposes of this study, microhabitats present within all five channels were the natural bank, the midchannel, and the sandbar. The sandbar was additionally divided into the portion bordering the secondary channel, termed the secondary channel sandbar, and the portion bordering the main channel, termed the main channel sandbar. In secondary channels with dikes, the area immediately adjacent to the dike was considered a separate microhabitat.

PART II: METHODS

Physical/Chemical

Five to seven transects (designated by letters A through G) were established at each secondary channel (Figures 2-6). Transects A and B were located along the upstream and downstream faces of the dike, if a dike was present in the channel. Transects C through G were positioned perpendicular to the axis of flow in each channel, with transect C being nearest the upstream end and transect G nearest the downstream end. Five sampling stations were established along transects A, B, C, E, and G. Station 1 was located at the natural bank, stations 2 and 3 in midchannel, station 4 at the secondary channel sandbar, and station 5 along the main channel sandbar. Only natural and secondary channel sandbar stations were located on transects D and F.

All five secondary channels were sampled during July 1984. River stage at the time of collecting was 16 to 18 ft at the Vicksburg gage and 23 to 25 ft at the Greenville gage. Lakeport Towhead and Cottonwood Bar were resampled during October 1984, at which time the river stages were 6 to 6.5 ft and 13 to 16 ft at the Vicksburg and Greenville gages, respectively.

Dissolved oxygen concentration, temperature, specific conductance, and pH measurements were taken at stations 1 through 4 on transects C, E, and G in each channel. At stations having a maximum depth less than 1 m, single, middepth measurements were taken for each variable. For stations with maximum depths of 1 to 2 m, surface and bottom measurements were obtained; if depth exceeded 2 m, measurements were taken from the surface, middepth, and bottom. All measurements were made in situ using a Hydrolab 8000 unit. Water samples for optical turbidity determination were taken from each depth with a Van Dorn bottle and were immediately placed on ice. Turbidity determinations were made for all samples at the end of the day using a Hach 2100 Turbidimeter. Current velocities were obtained at each water quality station and sampling depth using an Endeco Type 110 ducted impeller meter. One sediment sample was collected for grain-size analysis from each station. Sediment grain sizes were grouped into five general categories: particles larger than 4.76 mm constituted gravel; particles 2.00 to 4.76 mm were coarse sand; those 0.42 to 2.00 mm comprised medium sand; particles 0.074 to 0.42 mm were fine sand; and fines were particles less than 0.074 mm.

Biological

Macroinvertebrates

Two grab samples were taken at each station on transects C-F (24 samples per channel). Most samples were obtained with a Shipek dredge; however, at a few stations a petite ponar sampler was used. Samples were sieved (500-μ mesh) in the field and the macroinvertebrates immediately preserved in 5-percent formalin. Substrates (mostly coarse sands) that did not pass through the sieve were placed in 5-percent formalin and the macroinvertebrates separated from these substrates by elutriation. All macroinvertebrates were transferred to 80-percent ethanol and stained for at least 48 hr with Rose Bengal. Initial sorting was done under 3X circline lamps. Macroinvertebrates were identified to the lowest possible taxon.

In addition to the bottom samples, macroinvertebrates were also collected from the dikes at Lakeport Towhead and Cottonwood Bar during July. Three rocks were obtained from approximately 0.5-m depth at each station on each side of the dike. Invertebrates were brushed and picked from the rocks and sieved with a 500-μ sieve. After sorting and identification were completed, macroinvertebrates obtained from the rocks were dried to constant weight at 65° C. Total weight for each major taxon except the Chironomidae was determined to the nearest 0.001 g using a Mettler Model H54AR analytical balance. Chironomid biomasses were not estimated because these invertebrates must be permanently mounted on slides for identification. The rocks from which the invertebrates were removed were returned to the lab and their surface areas estimated by covering the rocks with tin foil, then weighing the foil and converting to area using an empirically determined ratio.

Fishes

Data on fish populations were collected by electroshocking, seining, and hydroacoustic techniques. A Coffelt boat-mounted electroshocker was operated in pulsed-DC mode and adjusted to output 4 to 6 amps at 250 to 400 V. Electroshocking samples consisted of 10-min runs made moving with the current, parallel to and near the shoreline or dike. Samples were taken in the vicinity of stations 1, 4, and 5 on transects C, E, and G in each channel. If a dike was present, two samples each were collected from above and below the structure. Where conditions permitted, seine samples were collected at all bank stations within the secondary channel and at a minimum of three stations along the main channel sandbar. If a dike was present, and if conditions permitted, at least two hauls were made along both upstream and downstream faces. The seine measured 15 by 4 ft and had 3/16-in. Delta mesh. Hauls were 50 ft in length and were always made in a downstream direction if a current existed.

Most fish collected with the electroshocker were identified, measured (total length to the nearest millimetre), and weighed (to the nearest gram) in the field. Smaller fish taken with the shocker, and all fish collected with the seine, were immediately preserved in 10-percent formalin and returned to the lab for processing. Total lengths and blotted wet weights were obtained to the nearest 0.1 mm and 0.1 g, respectively. Fish returned to the lab for processing were stored in 50-percent isopropanol.

Hydroacoustic data were collected using a BioSonics Model 101 Dual-Beam Echo Sounder operating at 420 kHz, a BioSonics Model 121 Digital Echo Integrator, a BioSonics Model 171 Tape Recorder Interface, a Sony Model PCM-F1 Digital Audio Processor, a Sony Model SL-2005 Portable Video Cassette Recorder, an Otrona Attache microcomputer, an EPC Model 1600 Chart Recorder, an oscilloscope, and a 420-kHz 6-deg/15-deg dual-beam transducer mounted in a BioSonics Towed Body.

The dual-beam transducer was towed at a depth of approximately 1 m and aimed straight down. All pulses were transmitted on the 6-deg transducer element. For echo integration, the echo signals received on the 6-deg element were then amplified by the echo sounder at 20 log (R) time-varied-gain (TVG) and relayed to the echo integrator. For dual-beam processing, echoes were received on both the 6- and 15-deg elements. The signals were amplified at 40 log (R) TVG and directed to the tape recorder interface, then to the signal digitizer and a video cassette recorder. Signals on both channels were recorded for later dual-beam analysis in the laboratory. The echo sounder was configured so that echo integration and dual-beam recording could take place simultaneously.

The acoustic system was calibrated prior to sampling to ensure that target echoes of known acoustic size produced a specific output voltage from the echo sounder. The minimum voltage threshold was set so that only targets with acoustic sizes greater than -60 db (equivalent to approximately 1.7-cm fish) would be accepted for further processing. Postproject calibration verified that the sensitivities remained constant throughout the study. At each secondary channel, five cross-channel samples were collected: C01 to C04, D01 to

D04, E01 to E04, F01 to F04, and G01 to G04. Samples were also taken parallel to and near the natural bank (C01, D01, E01, F01, and G01) and the secondary channel sandbar (C04, D04, E04, F04, and G04). Sample transects along the banks were run in a zigzag fashion to and from the shore. The hydroacoustic data were recorded on digital video cassettes and returned to the laboratory for analysis.

Analytical

Fish, macroinvertebrate, and water quality data were evaluated by analysis of variance (ANOVA) to determine if there were differences among channels, differences between months of sampling, or trends within each secondary channel from upstream to downstream or across the channel from natural bank to sandbar. For some analyses, stations were grouped by microhabitat within each secondary channel: natural bank, dike (if present), secondary channel sandbar, main channel sandbar, and midchannel. Water quality variables were additionally examined for differences due to depth. Means for significant effects ($P < 0.05$) were separated using Duncan's Multiple Range Test. Differences between diked and nondiked channels were evaluated using specific linear contrasts.

For electroshocker and seine samples, evaluations were made of the per-sample numbers and weights of all fish species combined and for the major species separately. Seine and electroshock data were analyzed separately. For the macroinvertebrate grab samples the total number of organisms and total number of species identified were evaluated. Fish and benthic data were log-transformed prior to analysis. Diversity of fishes and macroinvertebrates at each secondary channel and for each month was measured by the total number of taxa and by the Shannon-Weiner diversity index.

Macroinvertebrates taken from the dikes at Lakeport Towhead and Cottonwood Bar in July were analyzed separately from the grab samples. Total numbers of organisms, total number of taxa, and numbers of organisms for dominant species were evaluated by ANOVA for differences between the upstream and downstream side of the dike and for differences between the two channels.

The relationship between sediment grain size and benthic macroinvertebrate distribution was examined by cluster analysis using Ward's minimum hierarchical algorithm on the Statistical Analysis System. Sediment samples were clustered on the basis of the percentage of material retained in 18 standard sieve sizes ranging from 1.00 in. to >No. 200. July macroinvertebrate samples were clustered based on the percentage of organisms in each of 17 selected categories. Only July samples were used because in October only two of the five channels were sampled. Sixteen of the categories represented the taxa which cumulatively accounted for more than 90 percent of all organisms identified during the study; the final category represented all remaining taxa combined. Macroinvertebrate samples were included in the analysis only if they contained at least 15 organisms; this significantly reduced the chance that anomalous samples containing very few organisms would unduly affect the results. Finally, sediment and macroinvertebrate clusters were compared to determine the degree of correspondence, and the individual macroinvertebrate samples were examined to elucidate the relationship of sediment grain size to the distribution of specific taxa.

Hydroacoustic data were analyzed as fish densities by depth strata along each transect and as fish target strengths (acoustic sizes) along each transect. Because of the relatively low fish densities, the shallow water (0 to 10 m), and frequently changing bottom depth, fish densities were estimated using echo counting techniques. Individual fish counts were determined from the chart-recorded echograms. The dual-beam processor was used to assist in developing the criteria for identifying fish from the acoustic returns.

Hydroacoustic detection of fish is generally precluded within 1 m of the transducer, within approximately 15 cm of the bottom, and in turbulent water. The composite vertical distribution of fish along the different banks and in the open channel reflects the relative position of the fish from shore, the relative position of the fish between the surface and bottom, and the contour of the bottom. The composite vertical distribution data combined with information from echograms suggest that the fish distribution patterns reflect the relative position from surface to bottom in most cases. Briefly, dual-beam target strength measurements are made as follows. A pulse is transmitted on a narrow-beam element, and echo signals are received on both the narrow- and wide-beam elements. The outputs from both elements are made equal for an on-axis target. The system is constructed so that the peak voltages from the two elements can be used to calculate target strengths.

Although many variables can affect a fish's reflecting properties, an empirical relationship between average fish length and average target strength has been derived (Love 1971). This relationship is given by:

$$\log (L) = (0.052)\ TS + (0.047) \log (f) + 3.246$$

where L = fish length (cm) and f = hydroacoustic frequency (kHz) . This relationship is based on measurements of eight species of fish and data from at least 16 other species (Love 1971). Using the dual-beam system, Burczynski and Johnson (1983) have found that this relationship applies well to in situ measurements of target strengths for salmon. However, target strength/fish length comparisons for the species from the Mississippi River have not been made, and this relationship may not hold.

The data were organized in files corresponding to individual transects for the five secondary channels. Target strength frequency distributions were calculated for each transect, for groups of similar transects (i.e., natural bank transects), and for all the data combined for each channel.

Average fish density (number/100 m^3 of water) was evaluated by ANOVA for differences among microhabitats (secondary channel sandbar, natural bank, and open channel) and among the five secondary channels. Differences between diked and nondiked channels were evaluated by specific linear contrasts. Density values represented a vertically integrated sample across all depth strata. Sample density values at each secondary channel site were obtained for five different segments of a long zigzag transect oriented upstream to downstream along the natural bank shore, five similarly oriented transect segments along the secondary channel sandbar, and three transverse transects oriented across the channel. The transverse transects were used to provide sample values of fish density for the open channel.

PART III: RESULTS

Data referenced in the following sections have been compiled into four appendixes. Appendix A summarizes the basic water quality and current velocity data for the five secondary channels; Appendixes B and C present summary fish and macroinvertebrate information, respectively; and Appendix D gives sediment grain size data.

Physical/Chemical

Current speed and water quality

Mean current speeds in July were relatively high at Wolf Island, Island 8, Cottonwood Bar, and Profit Island but they were significantly lower at Lakeport Towhead (Table 1). Considerable variation in current speeds was observed both at individual sampling stations within each channel and also among channels (see Appendix A tables). Wolf Island currents, for example, were highest along the downstream transect, and they tended to be lowest along the natural bank. Lakeport Towhead, Cottonwood Bar, and Profit Island all showed general upstream to downstream decreases in current speed, but they differed in cross-channel current patterns. At Island 8 and Cottonwood Bar, the slowest currents were generally found along the secondary channel sandbar, while at Lakeport the slowest currents were along the natural bank. Island 8 currents were consistent upstream to downstream, but showed some cross-channel variability, being lowest along the secondary channel sandbar.

Virtually no current existed in Lakeport Towhead secondary channel during the October sampling (Table 1). At Cottonwood Bar, however, neither current speeds nor their within-channel pattern changed appreciably from July (Table A13). Although dikes were in place in both these channels and were built to nearly the same elevation, the dike at Cottonwood Bar allowed flow around its channelward end, and through the channel, at most river stages.

Temperature, pH, and dissolved oxygen concentration were similar at all five channels during July (Table 1), and these variables showed few within-channel differences (Appendix A). Temperatures averaged from 27.5 to 28.0° C; pH ranged only from 7.3 to 7.5; and mean dissolved oxygen varied among channels only from 5.5 to 6.0 mg/ℓ.

Conductivity values were similar at three of the channels in July, but they were significantly higher at Island 8 and significantly lower at Lakeport Towhead (Table 1). Conductivity generally showed low variability at each channel, with the exception of Wolf Island, where values increased consistently from upstream to downstream and from natural bank to secondary channel sandbar (Table A1).

Turbidity levels were different among channels in July (Table 1), and turbidity also showed relatively great within-channel variability at two sites, Wolf Island and Lakeport Towhead (Tables A1 and A3). Turbidity was consistently high throughout Island 8 secondary channel, and consistent, though significantly lower, at Cottonwood Bar and Profit Island. At Wolf Island, turbidity measurements closely tracked conductivity, increasing from upstream to downstream and from natural bank to sandbar. At Lakeport turbidity declined significantly between transects E and G (Table A3).

In October, temperature was lower, as expected, in both Lakeport Towhead and Cottonwood Bar (Tables A4 and A6), and presumably as a consequence, dissolved oxygen readings were consistently higher. Conductivity and turbidity values were similar to those found in July at Cottonwood Bar, but mean values for both these variables changed significantly at Lakeport. Conductivity increased, and turbidity decreased, presumably due to the reduction in current speeds. Mean pH did not change appreciably in either channel.

Sediments

Fine sand (particles 0.074 to 0.42 mm) was the dominant sediment grain size fraction at all five secondary channels in both sampling periods (Figures 7 and 8). However, differences among channels were apparent both in terms of overall substrate composition and in the variability among individual stations (Table D1). At Wolf Island, all five sediment grain size fractions were present in appreciable amounts, and variability among individual stations was great. Island 8 sediments consisted mostly of fine and medium sands, and station-to-station variability was small compared to that at Wolf Island. Lakeport Towhead sediments were well sorted, consisting mostly of fine sands and/or fines at all stations in both sampling periods. Both Cottonwood Bar and Profit Island exhibited an intermediate level of variation in July, sediments consisting primarily of medium sands, fine sands, and fines. In October, Cottonwood Bar sediments were more varied among the individual stations, although overall composition was only slightly changed from July.

<u>Fishes</u>

Both numerical and weight catches per unit effort were tested for differences among channels, and among microhabitats within channels. The numbers of samples collected were generally not sufficient to demonstrate statistical significance, even though in several instances the observed differences were several orders of magnitude. Failure to find significant differences does not mean that fish catch rates are equal in all channels or microhabitats. In fact, they probably are not, but the low number of samples precluded statistically demonstrating this.

<u>Wolf Island</u>

Fifteen species and 112 fish, with a total weight of over 47 kg, were captured by electroshocking at Wolf Island (Table B1). Channel and flathead catfish (see Table 2 for common and scientific names of species collected) were the dominant species both numerically and by weight. Although blue catfish, common carp, and longnose gar were each represented by five or fewer fish, they contributed substantially to the weight. Differences in the numerical and weight catches among microhabitats (natural bank, secondary channel sandbar, and main channel sandbar) were relatively large, but they were not statistically significant.

Seventeen species of fish were represented in the seine collections from Wolf Island (Table B2). Emerald shiner dominated the collections, accounting for 457 of 590 fish, although freshwater drum, channel catfish, and silver chub were also common. Shortnose gar was the dominant species by weight, even though it was represented by only a single specimen. The most numerous species, emerald shiner, comprised 18 percent of the weight. Numbers and weight per unit effort did not differ significantly among the three microhabitats.

Numbers of fish detected acoustically ranged from 0.1/100 m^3 along transect C01 to 20.4/100 m^3 along the transect crossing the channel at F01 to F04 (Table B3). Although there were no statistically significant differences among either transects or habitats, considerable differences were observed. The greatest concentration of fish at Wolf Island was detected at upstream transects, followed by transects located near the channel midpoint; downstream transects had the fewest fish. Mean number of fish/100 m^3 indicated a high-to-low ranking from natural bank, to secondary channel sandbar, to within the channel.

The vertical distribution of fishes in the water column tended to be surface-oriented at Wolf Island (Figure 9), although there were some differences among microhabitats. Along the natural bank, the number of fish was greater in the surface strata and decreased with depth. Fish densities along the secondary channel sandbar remained relatively constant as depth increased, and distributions were consistent among samples. The composite distribution for midchannel transects showed slightly greater numbers of fish as depth increased.

The target strength distribution at Wolf Island tended to be slightly skewed and centered around -54 db (3.5 cm) to -50 db (5.7 cm) (Figure 9). Target strengths along the natural bank were uniformly distributed and slightly higher at samples taken near the center than at transects upstream and downstream. Most fish detected along the natural bank were smaller than -50 db. Target strengths were more widely distributed along the secondary channel sandbar and were similar for all samples except C04, where the majority of fish were smaller than -50 db. In midchannel, small fish (target strengths of less than -50 db) were encountered most frequently, and their distributions were similar among samples.

Island 8

Thirteen species of fish were captured by electroshocker from Island 8 secondary channel during July, with the 101 total fish weighing over 23 kg (Table B4). Channel catfish, flathead catfish, gizzard shad, goldeye, and shortnose gar were most abundant, accounting for 85 percent of the numbers. The remaining eight species were each represented by three or fewer fish. Common carp dominated by weight, with shortnose gar, channel catfish, gizzard shad, and flathead catfish also contributing substantially. Electroshocking catches did not differ significantly among microhabitats.

Seine collections from the secondary and main channel sandbars at Island 8 yielded 12 species and 297 fish weighing a total of only about 150 g (Table B5). Seining was not possible along the natural bank due to the steep slope, deep water, high current velocities, and submerged brush. Emerald shiner dominated the catch by both numbers and weight. Though not very abundant, gizzard shad, shipjack herring, and river shiner contributed appreciably to the weight. No significant differences in catch per unit effort were found among microhabitats.

Hydroacoustic fish densities at Island 8 ranged from 0.2 to 4.5 fish/100 m^3 of water (Table B6). There were no statistically significant differences in numbers of fish among transects or microhabitats. However, the greatest concentrations of fish were found at upstream samples along the secondary channel sandbar and at the center transect along the natural bank, while lower numbers of fish were found at open channel transects, particularly those upstream. Among microhabitats, the natural bank had the greatest mean density of fish, and the lowest mean density was detected in the open channel.

The composite distribution of fish at Island 8 was similar at all stations in each microhabitat. Fish at natural bank stations tended to be surface-oriented (Figure 9) compared to those in other microhabitats. Target strength distributions (Table B6) for natural bank samples were relatively uniform and averaged -45.4 db (10.1 cm). Target strengths were highly variable for most transects along the secondary channel sandbar, although in general fish were larger here (Table B6) than in other areas of the channel. Fish were smallest along the open-water transects, with the majority of target strengths being -50 db (5.7 cm) or less.

Lakeport Towhead

A total of 116 fish, weighing over 33.5 kg, were captured with the electroshocker at Lakeport Towhead during July. Thirteen species were represented in the collections (Table B7), but blue and flathead catfishes accounted for most of the numbers. Flathead catfish comprised most of the weight collected, the remainder being evenly distributed among a number of species. The numerical catches for the dike and natural bank microhabitats were significantly higher than for the secondary channel and main channel sandbars (Table B7). Catch in terms of weight showed no significant differences.

Blue catfish were significantly more abundant along the natural bank than along the secondary channel or main channel sandbars, or along the dike (Table B7). Weight per transect did not differ significantly for this species.

Nearly 10 times as many fish (and nearly twice the weight) were collected by electroshocking from Lakeport Towhead during October than were collected in July (Table B8). Species composition was also considerably different. Gizzard shad, threadfin shad, and skipjack herring, species virtually absent in

July, accounted for 94 percent of the catch; white bass, also rare in July, was the fourth most abundant species. Catch per effort for catfishes, which had dominated July collections, was lower by a factor of nearly ten. Shads were the dominant group by weight, although nine other species contributed at least 2 percent. No significant differences in either numerical or weight catch were detected among the microhabitats.

The four most commonly collected species suggested microhabitat-specific preferences at Lakeport Towhead (Table B8), although the differences were not demonstrable statistically. Gizzard shad were most abundant in terms of both number and weight along the secondary channel sandbar. Threadfin shad also exhibited a numerical preference for this microhabitat, and for the secondary channel sandbar and dike in terms of weight. This number-weight difference was due to a distinction in the microhabitats inhabited by adults and juveniles, with large threadfin shad being collected along the dike and small ones along the sandbar. Skipjack herring and white bass were clearly most abundant along the dike.

Seining at Lakeport Towhead in July produced 704 fish representing 26 species (Table B9). Four species (emerald shiner, mimic shiner, inland silverside, silver chub) accounted for over 66 percent of the catch. Numerical catches at the natural bank were over four times that of the other areas, and weight catch was over 1.5 times greater, though these differences were not statistically significant.

Fewer species and fish were captured by seining at Lakeport Towhead during October than during July (Table B10). Total weight of fish increased considerably, however. Emerald shiner and inland silverside were again among the four most abundant species. Threadfin shad and silverband shiner, rare in July, were abundant in October collections, replacing the previously common mimic shiner and silver chub. These four species accounted for 81 percent of the numbers and 79 percent of the weight. Seine catches did not differ significantly among microhabitats within this channel.

Fish densities estimated by hydroacoustics ranged from 0.5 to 15.2 fish/100 m^3 (Table B11) and averaged 3.5/100 m^3 at Lakeport. Densities along the natural bank were significantly greater than those along the secondary channel sandbar and in the open channel. There were no differences in fish densities among cross-channel transects.

Vertical distribution patterns indicated that fish tended to be deep at Lakeport (Figure 9). Densities were relatively high for all depth strata along the natural bank and tended to increase with depth until about 9.5 m. The vertical distribution was relatively uniform for samples collected along the secondary channel sandbar, and there was no obvious trend in the distribution among open-channel samples.

Target strengths for natural bank transects showed relatively even distributions with a peak of -54 db (3.5 cm). Peak target strength at transect C01 (14.8 cm) was greater than for other natural bank samples. Target strengths for samples along the secondary channel sandbar showed a monodispersed distribution centered around -50 db (5.7 cm) for samples D04, E04, and G04. The sample at C04 had a peak target strength of -30 db (63.0 cm). Target strength distributions for the open-water samples were extremely variable.

Cottonwood Bar

Eighty-five fish, weighing over 18 kg, were collected by electroshocker from Cottonwood Bar during July. Thirteen species were represented (Table B12). Over 75 percent were catfishes, with blue and flathead catfish dominating both numbers and weight. No other species was represented by more than three fish. Catch rates did not differ significantly among the three shoreline microhabitats and the dike.

The total electroshocking catch at Cottonwood Bar during October was much greater than during July despite nearly equal effort being expended in both months. This collection yielded 17 species and 178 fish weighing a total of nearly 44 kg (Table B13). Gizzard shad and threadfin shad, nearly absent during July, dominated the numbers, and of the species dominant in July only flathead catfish remained abundant. These three species, along with skipjack herring and blue catfish, accounted for nearly 86 percent of the fish. Although only five blue suckers were captured, they comprised the largest portion of the catch by weight. Also important by weight were gizzard shad, flathead catfish, smallmouth buffalo, blue catfish, longnose gar, common carp, and bigmouth buffalo. All microhabitats yielded greater mean numbers and weights of fish during October (Table B13), although again, differences in catch rates were not significant. Although several species showed large differences in abundance among habitats, none were statistically significant.

A total of 246 fish, representing 15 species, were collected by seining at Cottonwood Bar during July (Table B14). Emerald shiner, gizzard shad, and inland silverside accounted for over 85 percent of the numbers, and these species were also important by weight. White bass, although represented by only two fish, dominated the catch by weight. Although considerable differences in numerical and weight catch rates occurred among microhabitats, none were statistically significant.

The number of fish taken by seine at Cottonwood Bar was lower in October than in July, although total weight catch remained nearly the same (Table B15). A number of species were relatively abundant, including gizzard shad, inland silverside, and river, emerald, silverband, and blacktail shiners. Gizzard shad, inland silverside, and emerald shiner again accounted for most of the weight. No significant differences in catch rates were observed among microhabitats.

Numbers of fish detected acoustically ranged from 0.5/100 m^3 to 14.7/100 m^3 within this channel (Table B16), and density averaged 3.4/100 m^3. Densities of fish were significantly greater along the natural bank than along the secondary channel sandbar or in the open channel. There was no significant difference in fish densities among cross-channel transects.

Fish densities were relatively low and uniformly distributed throughout the water column along the sandbar and in the open channel (Figure 10). There was more variation in the vertical distribution of fish among individual samples along the natural bank, although the composite distribution was very even among depths. Fish tended to be surface-oriented at upstream transects (C01 and D01), bottom oriented at transects E01 and F01, and middepth-oriented at the downstream transect (G01). Target strengths of natural bank samples showed relatively even distributions, with no major peaks, and averaged -47 db (ca. 9 cm). Fish target strengths were highly variable among samples taken along the secondary channel sandbar and averaged -51.3 db (ca. 5 cm). Fish were relatively small ($\bar{x}$ = -52.6 db [ca. 4.2 cm]) in the open channel.

Profit Island

Ten species of fish were taken by electroshocker from Profit Island secondary channel during July, with the 314 fish weighing a total of over 37 kg (Table B17). Blue and flathead catfishes comprised the majority of the catch in terms of both numbers and weight. Numerical and wieght catches were not significantly different among microhabitats. Commercial fishermen use the

Profit Island area extensively during much of the year and may have baited the area within the channel. The effect of this practice (if it actually occurred) on our catch rates is unknown, but could have been considerable.

A total of 115 fish weighing approximately 160 g were taken by seining at Profit Island (Table B18). Inland silverside was the most commonly collected of the 17 species, but four other species were also abundant. Six species each made up at least 10 percent of the catch by weight, with blacktail shiner, river shiner, and longear sunfish dominating. Although relatively large differences in catch rates occurred among microhabitats, they were not statistically significant. No species demonstrated a significant preference for any habitat.

Acoustically determined fish densities ranged from 0.2 to 8.5 fish/100 m^3 (Table B19). Mean number of fish/100 m^3 indicated a general high-to-low ranking of natural bank, sandbar, and open channel, although no statistically significant differences were found.

The composite distribution of fish was uniform with depth along both banks and in the open channel (Figure 10). Target strengths of fish along the natural bank were normally distributed and averaged -47.1 db (ca. 10 cm). Along the secondary channel sandbar, most fish were small, with a target strength peak at -54 db (3.5 cm). Most of the fish detected in the open channel were smaller than -50 db (5.7 cm).

Comparisons among channels

Significant differences ($P < 0.02$) in electroshocking catch rates were found among the five secondary channels sampled during July (Tables 3 and 5). Mean numbers were highest by far at Profit Island; Wolf Island and Island 8 catch rates were similar and intermediate; and Lakeport Towhead and Cottonwood Bar values were lowest. In terms of weight, Profit Island and Wolf Island were highest, Island 8 and Lakeport Towhead were intermediate and similar, and Cottonwood Bar was lowest. As a group, secondary channels without dikes had significantly higher mean numbers ($P < 0.03$) and weights ($P < 0.005$) per unit effort than secondary channels with dikes. These findings must be interpreted with caution because of the possibility that baiting had influenced the catches at Profit Island. When data from Profit Island were omitted, electroshocking catches at the remaining two undiked channels were not significantly greater than at the diked channels.

The ANOVA also indicated significant overall differences among microhabitats within the secondary channels in July ($P < 0.03$), with the natural bank having the highest numerical catch rate. Differences in weight were not significant, however, and no differences were detected in either numbers or weights among transects (positions upstream to downstream within channels).

Seining indicated significant differences among the five secondary channels in terms of numbers ($P < 0.01$). Catches at Wolf Island, Island 8, and Lakeport Towhead were highest, catches at Cottonwood Bar were lower, and at Profit Island they were extremely low (Table 4). No significant difference among channels was indicated for weight (Table 6). No differences were found among microhabitats within channels, although in general, seine catches were greater at the two banks inside the secondary channel than along the main channel sandbar. Due to the pattern of missing data (no seine hauls were possible along the natural bank at Island 8), no statistical test of differences between secondary channels with and without dikes could be made. The mean values for the two types of channels were similar, however.

Lakeport Towhead and Cottonwood Bar were resampled during October 1984, at which time river stage was approximately 10 ft lower than in July, and when conditions in Lakeport Towhead had changed considerably (see previous section, Physical/Chemical). Both secondary channels showed several-fold increases in electroshocking catch rates (Tables 3 and 5), with those at Lakeport Towhead increasing more. Significant differences existed both between channels (Lakeport Towhead highest) and between months ($P < 0.001$) for numbers; weight showed a significant difference only between months. The difference between these two channels was significantly greater in October than in July in terms of numbers, as indicated by a significant interaction F-value ($P < 0.001$).

Seining at Lakeport Towhead and Cottonwood Bar (Tables 4 and 6) indicated no statistically significant effect due to month, channel, or microhabitat. However, catches along the natural bank and secondary channel sandbar were considerably higher than those along either the dike or the main channel sandbar.

The fish assemblages sampled by electroshocker at the five secondary channels differed considerably during July (Table 3). Catfishes dominated, and variations in the relative percentages of the three catfish species largely accounted for the overall differences among channels. Gizzard shad and goldeye, both common only at Island 8, accounted for most of the remaining difference among channels. Percent composition by weight showed a general pattern similar to that for numbers (Table 5), with flathead, channel, and blue catfishes comprising most of the weight. However, several numerically uncommon species, including common carp, gars, river carpsucker, and freshwater drum, also comprised substantial percentages of the weight due to their large adult sizes.

Species diversity for electroshocking samples was highest at Wolf Island, Island 8, and Cottonwood Bar in July (Table 7). Diversity at Lakeport Towhead was somewhat lower, and at Profit Island it was very low. These diversities primarily reflected the combined relative percentages of blue and flathead catfishes (from 8.1 to 93.6 percent).

Seining also indicated large differences in species composition among channels in July (Table 4), with variations in the percentages of emerald shiner and inland silverside accounting for much of the distinction. Emerald shiner comprised over 75 percent of the fish collected at Wolf Island and Island 8, but less than 10 percent at Profit Island; Lakeport Towhead and Cottonwood Bar had intermediate percentages of this species. Inland silverside ranged upriver only as far as Lakeport Towhead, and its relative abundance increased steadily from this secondary channel to Profit Island. The pattern of percent weight composition generally resembled that of numbers (Table 5).

Seine samples (Table 7) from Lakeport Towhead and Profit Island produced the highest diversity values, while values at the remaining three secondary channels were lower to very low. The lowest diversities reflected the relative dominance of emerald shiner. The two highest diversities reflected not only a more even percent composition among species but also a greater number of species (25 and 17 at Lakeport Towhead and Profit Island, respectively).

Fish assemblages found at Lakeport Towhead and Cottonwood Bar during October, as indicated by electroshocking, were very different from those of July (Table 3). Gizzard shad, threadfin shad, and skipjack herring replaced the catfishes as the dominant group, accounting for 63 percent (Lakeport) and 94 percent (Cottonwood Bar) of the fish. Diversity was only slightly changed at each channel, but the net effect of the changes was to increase the difference between them (Table 7). As noted earlier, overall catches increased significantly at both channels. Weight composition also changed considerably between July and October (Table 5). Although the percent weight of shad increased, it did not nearly match the change in numbers. Several less common species, including blue sucker, smallmouth and bigmouth buffalo, and white bass, contributed substantially to the weight during October. Weight of catfishes declined greatly, while weight of common carp increased at Lakeport Towhead and decreased at Cottonwood Bar.

The species compositions of seine collections at Lakeport Towhead and Cottonwood Bar did not change as much between months as those derived from electroshocking. Threadfin shad and silverband shiner increased in relative abundance at Lakeport Towhead, while mimic shiner and silver chub decreased (Table 4). At Cottonwood Bar, the primary decrease in relative abundance occurred for emerald shiner and inland silverside; river shiner, silverband shiner, blacktail shiner, and bullhead minnow all increased in number. The change in relative numbers exhibited by these species was generally reflected in their changes in weight at Lakeport Towhead, but not at Cottonwood Bar (Table 6), where the large weight catch of gizzard shad decreased the relative contributions of the other species.

Species diversity for seining decreased appreciably at Lakeport and increased by a like amount at Cottonwood Bar. The resulting diversities of these two channels were, thus, more nearly equal during October (Table 7).

Average fish densities derived from hydroacoustics ranged from 1.9/100 m^3 at Island 8 to 3.5/100 m^3 at Lakeport Towhead. Although there were no statistically significant differences among the five channels, the two with the greatest densities of fish, Lakeport Towhead and Cottonwood Bar, were the only channels that had been partially closed by dikes. There were overall differences among habitats within channels, with fish densities being significantly greater along the natural banks than along secondary channel sandbars or in the open channel.

Fish were uniformly distributed throughout the water column at Island 8 and Profit Island. Fish were more surface-oriented at Wolf Island and Cottonwood Bar, while at Lakeport Towhead fish were generally bottom-oriented.

Target strength distributions were consistent among the secondary channels and showed a slightly skewed distribution centered around -54 to -50 db. Mean target strength varied only slightly among the channels and ranged from -47.1 db (ca. 8 cm) at Lakeport Towhead to -50.6 (ca. 6 cm) at Wolf Island.

Macroinvertebrates

Both density of organisms and number of taxa varied considerably across sampling stations within each secondary channel. However, due to the great natural variability and the low number of samples available for each station, the significance of any apparent trends could not be statistically tested.

Wolf Island

A total of 34 taxa of benthic macroinvertebrates were collected at Wolf Island secondary channel during July 1984 (Table C1), with the number of taxa taken at individual stations varying from 1 to 15. Mean density of organisms was 1,200/m^2 (Table 8) and ranged from 24 to 7,942/m^2 at individual stations (Figure 11).

Tubificid worms, hydropsychid caddisflies, and chironomids made up over 93 percent of all organisms collected (Figure 22). Tubificid worms were abundant only at one station (Figure 11), although 10 taxa of Tubificidae were collected overall (Table C1). Most of these were immature worms with no capilliform chaetae, and they probably represented those species for which adults were most numerous (*Limnodrilus maumeensis*, *L. hoffmeisteri*, *L. cervix*, *L. claparedianus*, and *L. udekemianus*). Hydropsychid caddisflies, represented by *Potamyia flava* and *Hydropsyche orris*, were numerous at three stations but were rare elsewhere. *Potamyia* was the more abundant of the two species. Chironomids were found in moderate to high numbers at most stations (Figure 11). Although 11 taxa of Chironomidae were identified, only three (*Robackia claviger*, *Chernovskiia orbicus*, and *Polypedilum convictum*) were common. The only other taxa reaching moderate to high densities at any of the sampling stations were microturbellarians and enchytraeid worms, both of which were low in overall abundance.

Island 8

Twenty-four macroinvertebrate taxa were collected from the Island 8 secondary channel during July (Tables 8 and C2), with the number of taxa taken at individual stations ranging from 0 to 10 (Figure 12). Densities ranged from 0 to 2,313/m^2 (Figure 12) and averaged 576/m^2 (Figure 22).

Hydopsychid caddisflies, chironomids, and microturbellarians were the dominant taxa collected at Island 8 (Figure 22 and Table C2). The hydropsychid species, *P. flava* and *H. orris*, were numerically dominant at only a single station (G01; Figure 12). Chironomids, on the other hand, were dominant or codominant at 8 of the 12 sampling stations and were particularly abundant on the upstream transect. Although eight taxa of Chironomidae were taken, *R. claviger* and *C. orbicus* comprised most of their numbers. Microturbellarians were abundant only at midchannel stations. The polymitarcyid mayfly *Tortopus incertus*, nematode worms, and enchytraeid worms comprised most of the remainder of the benthos (Figure 7), although each was common at only a few stations (Figure 12). *Tortopus incertus* was collected only at the station where consolidated clay was found. Similarly, enchytraeid worms (*Barbidrilus paucisetus*) were common only at one station, and nematodes were abundant at only three stations.

Lakeport Towhead

Lakeport Towhead yielded 22 taxa of macroinvertebrates in July (Tables 8 and C3), with numbers of taxa at the individual stations ranging from 0 to 8 (Figure 13). Number of taxa was highest at station 3 on each transect within this channel. Densities at individual stations ranged from 0 to 751 organisms/m^2 (Figure 13) and averaged 158 organisms (Figure 22).

Chironomids dominated the overall benthic community during July at this secondary channel (Figure 22) and were particularly abundant along the upstream transect (Figure 13). *Chernovskiia orbicus* and *R. claviger* were the most abundant of the six chironomid species collected (Table C3), comprising over 88 percent of the total. The phantom midge *Chaoborus punctipennis*, hydropsychid caddisflies, ephemerid mayflies, and the polymitarcyid mayfly *T. incertus* accounted for most of the remaining numbers of benthic organisms. *Chaoborus punctipennis* was common only at the two midchannel stations on the downstream transect. In contrast, *H. orris* and *P. flava* were abundant only at midchannel stations on the upper and middle transects. Ephemerid mayflies, represented in this channel by *Pentagenia vittigera* and *Hexagenia* sp., were found primarily along the middle transect. *Tortopus incertus* was collected only where consolidated clay substrate occurred.

Twenty taxa of macroinvertebrates were identified from the dike samples collected at Lakeport Towhead secondary channel in July. *Hydropsyche orris* and *P. flava* were the dominant species numerically (Table C6). The first and second instar hydropsychids collected probably also represented primarily these two species. The Ephemeroptera (mayflies) and Chironomidae were represented by the largest numbers of species, but as groups they were low in total abundance. Little difference was noted in the species composition of the upstream and downstream dike faces (Figure 14). Considerable distinctiveness was evident among stations along the dike, however. Hydropsychid caddisflies were dominant at stations 1, 2, and 5, near the two ends of the dike, while ephemeropterans were the most abundant organisms at middike stations 3 and 4.

Densities of macroinvertebrates/m^2 of rock surface ranged from 190 to 97,236 organisms (Figure 14) and averaged higher on the upstream side of the dike than on the downstream side (Table 9). Overall densities were highest at the weir and outermost dike stations at which caddisflies were dominant, and much lower at the other two stations. Macroinvertebrate biomass averaged 3,482 mg/m^2 of rock surface at Lakeport Towhead (Figure 15). Individual station biomasses ranged from 25 mg to 25,619 mg/m^2. The correlation between biomass and density was highly significant ($r = 0.999$, $n = 10$, $P < 0.01$).

October benthic samples at Lakeport yielded 31 macroinvertebrate taxa (Tables 8 and C3), with from 1 to 12 taxa found at individual stations (Figure 16). Station densities ranged from 12 to 1,562 organisms/m^2 (Figure 16), and overall mean density was 632 organisms/m^2 (Figure 22).

Chironomidae was again the dominant taxon overall at Lakeport Towhead (Figure 22), and chironomids were collected in at least moderate abundance at most of the stations (Figure 16). Of the nine species encountered, *Chironomus plumosus* gr, *Coelotanypus scapularis*, and *Ablabesmyia annulata* were the most abundant, a finding quite different from that of July (Table C3). Six other taxa were collected in substantial numbers overall: the Asian clam *Corbicula fluminea*, the ephemerid mayfly *Hexagenia* sp., tubificid and naidid worms, microturbellarians, and hydropsychid caddisflies. Each of these taxa was abundant at only a few stations, however.

Cottonwood Bar

The number of macroinvertebrate taxa collected at stations in this channel in July ranged from 1 to 6 (Figure 17), and 20 taxa were collected overall (Tables 8 and C4). Mean density was 142 organisms/m^2 (Figure 22), and individual station values ranged from 12 to 472 organisms/m^2 (Figure 17).

Tubificid worms, chironomids, microturbellarians, and the polymitarcyid mayfly *T. incertus* were the most abundant taxa collected (Figure 22 and Table C4). Chironomids were common at 8 of the 12 stations (Figure 17). Of the five chironomid taxa identified, *C. orbicus* and *R. claviger* comprised the majority of the individuals. Tubificids dominated the invertebrate numbers, although they were abundant only at one station. *Limnodrilus maumeensis* and

L. cervix were the most numerous of the identifiable, mature tubificids. Most immature worms that lacked capilliform chaetae probably represented primarily these two species. Additionally, Branchiura sowerbyi and immature tubificids with capilliform chaetae were taken in lower numbers. Since the immatures with capilliform chaetae were recognized as distinct from B. sowerbyi (the only other worm with such chaetae), a total of at least four taxa of these worms were represented. Microturbellarians were common at two stations on each of the two downstream transects, and T. incertus was the dominant invertebrate at one natural bank station.

Rock samples taken from the dike at Cottonwood Bar during July yielded at least 16 taxa of macroinvertebrates (Table C7), with 12 taxa taken from the upstream side and 10 taxa from the downstream side (Figure 18). Hydropsyche orris, P. flava, and first and second hydropsychid instars were the most abundant taxa. The flatworm Dugesia tigrina and the chironomid P. convictum accounted for most of the remaining numbers. Due to this dominance by caddisflies, only minor percent composition differences were noted among stations along the dike or from upstream to downstream at individual stations. Sample densities ranged from 98 to 9,984 organisms/m^2 of rock surface (Figure 18). Mean density was much greater upstream than downstream (Table 9), but the pattern among the individual stations was not consistent. Similarly, no trend in numbers was found longitudinally along the dike. Mean macroinvertebrate biomass on Arcadia Dike at Cottonwood Bar was 651 mg/m^2 and ranged from 44 to 3,721 mg (Figure 19). Biomass and density were highly correlated among stations ($r = 0.990$, $n = 10$, $P < 0.01$). Hydropsyche orris and P. flava comprised the bulk of the biomass at most stations. However, ephemeropterans were dominant at A01 and were found in moderate abundance at several other stations. Odonates and D. tigrina were abundant at one station.

Twenty-one taxa of macroinvertebrates were taken from Cottonwood Bar bottom samples during October (Tables 8 and C4). Numbers of taxa taken at the 12 stations ranged from 0 to 10 (Figure 20). Density averaged 1,157 organisms/m^2 (Figure 22) and ranged from 0 to 4,565 at individual stations (Figure 20).

Taxa present in relative abundance (Table C4) included microturbellarians, hydropsychid caddisflies, and chironomids (Figures 20 and 22). Microturbellarians were dominant or codominant at six stations, and they were especially numerous at the upstream and downstream ends of the channel.

Hydropsychids were represented by relatively high numbers of P. flava and relatively low numbers of H. orris; these species, though second in abundance overall, were numerous at only two natural bank stations. Chironomids were found in low, but consistent, numbers at many stations. Dominant chironomid species included R. claviger, P. convictum, C. orbicus, and Axarus sp. Pelecypoda (clams) and ephemerid mayflies (primarily Hexagenia sp.) were present in low numbers overall but dominated the macroinvertebrate fauna at stations at which they occurred.

Profit Island

Nineteen macroinvertebrate taxa (range one to five taxa per station) were identified from the bottom samples taken at Profit Island (Table 8 and C5). Mean density for the channel was only 158 organisms/m^2 (Figure 22), with station densities ranging from 12 to 363/m^2 (Figure 21).

The most abundant taxa included chironomids, tubificid worms, and the mayfly T. incertus (Figure 21). Chironomids were collected at most stations and were the most abundant invertebrates at six stations. The most common species identified were, in decreasing order of abundance, C. orbicus, R. claviger, Paratendipes nr connectens, and Polypedilum halterale (Table C5). The Tubificidae, represented primarily by L. cervix and L. maumeensis, were relatively common only at the two bank stations on the downstream transect. Tortopus incertus was again relatively abundant only at bank stations where consolidated clay substrates occurred. Minor taxa found in substantial numbers at only one station each included nematode worms, the ephemerid mayfly P. vittigera, and the Asian clam C. fluminea.

Comparisons among channels

Wolf Island yielded a relatively high number of benthic taxa in July; the remaining channels yielded progressively fewer taxa (Figure 22). The average density of macroinvertebrates in bottom samples showed a similar trend. The Shannon-Wiener diversity index (Table 8), in contrast to numbers of taxa, showed relatively high values at four of the channels in July and a low value at one (Lakeport Towhead).

Chironomids were an important part of the benthos at all five secondary channels in July (Figure 22). Several other taxa, though taken at most channels, were more variable in importance. Tubificids, for example, were relatively abundant only at Wolf Island, Cottonwood Bar, and Profit Island. Hydropsychid caddisflies were very common at the two upstream channels, less so at the two centrally located channels, and of only minor importance at Profit Island. The pattern of relative abundance of T. incertus was opposite that for the hydropsychids. Most other taxa were numerically abundant at only one or two of the secondary channels. The dominant species in each of these major taxa did not differ appreciably among the sites, however.

The benthic communities at both Lakeport Towhead and Cottonwood Bar changed appreciably from July to October (Figure 22). Mean density of organisms in the bottom samples increased fourfold at Lakeport Towhead and eightfold at Cottonwood Bar. Considerable changes were also observed in the taxonomic compositions, with the result that the taxonomic diversity increased considerably at Lakeport Towhead and decreased slightly at Cottonwood Bar. At Lakeport Towhead the Chironomidae was the dominant taxon in both months; however, the species comprising this taxon were quite different. In July the rheophilic C. orbicus and R. claviger comprised most of the numbers; in October the slack-water forms C. plumosus, C. scapularis, A. annulata, and Procladius sp. were most abundant. Other major taxa, principally the tubificids, ephemerids, and C. fluminea increased in relative abundance from July to October, while the hydropsychid caddisflies, C. punctipennis, and T. incertus decreased. The Cottonwood Bar macrofauna also showed a very distinct overall seasonal change. Chironomids declined considerably in percent abundance, although the overall numbers collected remained comparatively high. In contrast to Lakeport, the most abundant chironomid species at Cottonwood Bar remained C. orbicus and R. claviger. Tubificids and T. incertus, very common in the July benthic samples, were nearly absent in October. Hydropsychid caddisflies and microturbellarians, in contrast, greatly increased in abundance. The changes in hydropsychid and tubificid relative abundances were exactly opposite between months in these two secondary channels.

More taxa, and higher densities of macroinvertebrates, were collected from the dike at Lakeport Towhead (Table C6) than from the dike at Cottonwood Bar (Table C7). Taxonomic diversity was higher at Cottonwood Bar, however (Table 8), due to the greater evenness in numbers among taxa. Eight taxa were unique to Lakeport and four to Cottonwood Bar. At both dikes the highest densities and greatest numbers of taxa were found on the upstream dike faces (Table 9), but the pattern was not consistent across all stations. Nine taxa occurred exclusively on the upstream face, while only two were unique to the downstream face. Biomass was highly correlated with density on both dikes.

Hydropsychidae was the dominant taxon at both dikes (Tables C6 and C7), with H. orris being the single dominant species at both sites, and another hydropsychid caddisfly, P. flava, ranking second. Potamyia flava comprised a somewhat greater relative percentage at Cottonwood Bar than at Lakeport Towhead, although greater numbers were taken at the latter site. Trichoptera dominated the epifauna at Lakeport Towhead dike stations at which water was flowing over the dike in July. However, at stations at which water was flowing parallel to and not over the dike, Ephemeroptera were dominant. Dipteran larvae were best represented on the downstream dike face and, in general, at the two outermost dike stations. Trichoptera were also dominant at all Cottonwood Bar stations except A01. Dugesia tigrina was the only relatively common organism found only at this channel.

Macroinvertebrate - sediment relationships

Sediment samples clustered into three groups representing primarily medium sand and gravel, fine sand, and fines (Table 10). Similarly, the 26 macroinvertebrate samples which met the inclusion criterion of having at least 15 organisms clustered into three groups (Table 10). Nearly 81 percent of the samples in the two clusters (21 of 26) showed perfect correspondence (Table 11), and the taxonomic composition of the macroinvertebrate samples collected in the three general sediment types confirmed the known or suspected substrate preferences of the organisms. Macroinvertebrate cluster 1, for example, contained immature tubificids, several species of Limnodrilus, C. fluminea, and T. incertus, and corresponded to sediment cluster 1, which consisted primarily of fines. In the sediment grain-size analyses, fines included both silts and consolidated clays, which are composed of very tiny individual particles when dried and sieved. However, sediment composition of all macroinvertebrate samples was noted during the sampling, and these two sediments are quite distinct. The macroinvertebrates inhabiting these two sediment types are different. The tubificids and C. fluminea typically were collected in silts, while T. incertus, a large, burrowing mayfly, was taken exclusively in consolidated clays. Macroinvertebrate cluster 2 consisted principally of P. flava, R. claviger and C. orbicus, microturbellarians, nematodes, and B. paucisetus. This group corresponded to sediment cluster 3, fine sand. The medium sand and gravel sediments, cluster 2, corresponded to macroinvertebrate cluster 3, which consisted mainly of P. flava, H. orris, *C. orbicus*, *R. claviger*, microturbellarians, and nematodes. The major differences in macroinvertebrate clusters 2 and 3 were in the relative percentages of the constituent taxa.

The five sampling stations (Table 11) for which the macroinvertebrates collected did not correspond to one of the three distinctive sediment clusters were examined to determine, if possible, the reasons for the lack of correspondence. In all five cases the reasons for the lack of correspondence were easily identifiable. Station PCC-G01 and PCP-E02 sediments consisted of both medium and fine sands, but no gravel, and this mixture did not fit perfectly into any of the three sediment grain size clusters. The macroinvertebrate taxa found at these stations (primarily microturbellarians, *R. claviger* and *C. orbicus*) were typical of such sediments, however. Stations PCI-G01 and PCW-C04 were dominated by hydropsychids, a taxon that did not contribute very strongly to any of the three macroinvertebrate clusters (Table 10). This is because hydropsychids inhabit stable, hard substrates such as dikes or submerged logs, and thus did not often occur in large numbers in the sediment grab samples used in the cluster analysis. Occasionally, however, these organisms colonize gravel or consolidated clay banks. This was the case at these two stations: PCI-G01 sediments consisted of medium sand and gravel; sediments at PCW-C04 consisted of consolidated clay. The last instance of poor macroinvertebrate-sediment correspondence, PCL-G03, fit poorly because the macroinvertebrates collected comprised an unusually heterogeneous group of relatively rare taxa, including *C. punctipennis*, *Polypedilum* nr *scalaenum*, a dragonfly, tubificids, chironomid pupae, and a naidid worm.

PART IV: DISCUSSION

Physical/Chemical

Cobb and Clark (1981) recognized two types of secondary channels within the Lower Mississippi River. Permanent secondary channels are those in which flow is maintained throughout the year, while flow through temporary secondary channels is blocked, either by a naturally occurring sandbar or by a dike, during at least part of the year. At the time of our sampling in 1984, Wolf Island, Island 8, Cottonwood Bar, and Profit Island were permanent secondary channels, although dikes had been installed at Cottonwood Bar the previous year. The dikes did not completely block flow through this secondary channel at low river stages. Lakeport Towhead was the only true temporary secondary channel of the five. The distinction between permanent and secondary channels is an important one both from physical/chemical and biological standpoints.

In a synthesis report on Lower Mississippi River aquatic resources, Beckett and Pennington (1986) concluded that the presence or absence of current was a major factor affecting water quality and substrate characteristics in Lower Mississippi River habitats. They noted that the secondary channel at Lakeport Towhead (then a permanent secondary channel) was similar in physicochemical makeup to the main channel at all seasons. However, a nearby temporary secondary channel was similar in physicochemical makeup to the main channel at high flows but was more similar to dike field pools at low flows.

Current speed dictates, to a large degree, the grain size of sediments found in most channel environment habitats, the exception being natural banks. Various particle sizes of bedload sediments are deposited at different current speeds, and local variations in currents produce a mosaic sediment pattern that may vary considerably with river stage, a phenomenon that has been documented for several Lower Mississippi River dike systems (Beckett et al. 1983). Current speeds remain relatively high year round within permanent channels, while it is negligible or even eliminated within temporary channels at low river stages. Under flowing water conditions, substrates in both permanent and temporary channels consist largely of sands and/or gravels in midchannel areas, and fine sands and silts along the sandbar. In temporary channels, when flow is blocked, fine sediments accumulate. Natural bank substrates are more heterogeneous, ranging from consolidated clays to sand-gravel in exposed point bar deposits. However, the natural bank microhabitat comprises only a small percentage of the total substrate available for colonization by benthic invertebrates (Cobb and Clark 1981). In permanent channels sandy sediments probably predominate throughout the year (Beckett et al. 1983). These generalizations are supported by our physical data for Cottonwood Bar and Lakeport Towhead. Cottonwood Bar, at the time of sampling a permanent channel, was similar in substrate and current speed characteristics during both July and October. Lakeport Towhead, a temporary channel, changed appreciably (and predictably) in both substrate and current when flow was blocked by the dikes.

Changes in several water quality variables are also related to the change from flowing to slack-water conditions. As with the main channel, dissolved oxygen concentration remains high in permanent secondary channels. As Beckett et al. (1983) and Beckett and Pennington (1986) have noted, and as observed in this study, bottom waters in the deeper areas of slack-water habitats (temporary secondary channels, dike pools, abandoned channels) may become anoxic, or nearly so, when flow through them is eliminated; changes in pH, turbidity, and conductivity may also occur. Changes in free carbon dioxide, plankton, major and minor nutrients, and many other physicochemical variables not measured in this study also occur (Beckett and Pennington 1986).

The rapidity with which these changes can take place is illustrated in this study. Mathis et al. (1981) described Lakeport Towhead secondary channel (American Cutoff in their study, done prior to dike placement) as essentially riverine in nature, with high current velocities and shifting coarse sand and gravel sediments encountered at all sampling stations. In the 5 years following dike construction, this channel has changed considerably, showing almost no current at low river stages and having a substrate composed mainly of fine sand and silt-clays.

Fishes

Even though this study examined only a single river habitat, the fish species list compiled in this study was similar to lists reported earlier for the Mississippi River by both the Corps of Engineers (Cobb et al. 1984; Dahl 1981; Emge et al. 1974; Nailon and Pennington 1984; Pennington et al. 1981; Pennington, Baker, and Bond 1983; Ragland 1974; Schramm and Lewis 1974) and other researchers (CDM/Limnetics 1976; Ellis, Farabee, and Reynolds 1979;

Federal Water Pollution Control Administration 1969; NUS Corporation 1974; Robinson 1972). Most of the species collected are relatively ubiquitous throughout the Lower Mississippi River.

The species composition of secondary channels appears to change appreciably and predictably both with season and changes in habitat conditions. At Lakeport Towhead and Cottonwood Bar, catches changed from those reflecting a flowing-water fauna to those indicating a slow- or slack-water fauna as river stage declined in the fall. Three dike fields in the Lower Mississippi River (Pennington, Baker, and Bond 1983) showed a similar change in species composition as habitat conditions changed. Also, three secondary channels in the Middle Mississippi River supported species assemblages consistent with their physical characteristics (Ellis, Farabee, and Reynolds 1979). Seasonal changes are best illustrated by the great increase in catches of gizzard and threadfin shad in October. Shad spawn in the late spring through midsummer, and by late summer or fall large numbers of juveniles are found in most river habitats. However, these species are typically much more abundant in slack-water habitats such as Lakeport Towhead than in more riverine areas like Cottonwood Bar (Beckett and Pennington 1986, Rasmussen 1979). Because the three undiked secondary channels were not sampled in October, it is not known if they also showed seasonal changes in species composition. However, since the dike at Cottonwood Bar did not completely block flow through the secondary channel (current speeds and substrates were nearly the same in both July and October), this provides some indication that the fish assemblages of permanent channels also undergo at least some seasonal changes.

Although significant differences among channels were found for both electroshocking and seining, these differences cannot be correlated with the simple presence or absence of a dike at the upstream end of a channel. For example, the dike at Cottonwood Bar appeared to have little effect during either July or October, at least as evidenced by the high current speeds and coarse substrates. Omitting Profit Island, where baiting may have occurred, electroshocking catches at open channels (Wolf Island and Island 8), though generally higher than those at diked channels (Lakeport Towhead and Cottonwood Bar), were not statistically greater. Seine catches, though different among channels, were not related to dike presence or absence. Finally, the hydroacoustic surveys detected no significant quantitative differences among channel types.

Differences in catch rates among habitats within secondary channels were suggested by this study. Overall, the natural bank produced the highest electroshocking catches in July, with four of five channels showing this pattern. Cottonwood Bar was the only exception, catches there being highest along the dike. The natural bank area of most channels, whether diked or open, usually contains more submerged trees and brush than do other areas. The species collected by electroshocker in July were primarily catfishes, which show an affinity for such cover (Cross 1967, Pflieger 1975). The high catch rate at the Cottonwood Bar dike is not surprising, since dike structures are known to provide habitat for many species of fishes. In October the high catches along the secondary channel sandbar and dike were attributable to the change in species composition which occurred in the channels. At this time, density of catfishes was apparently low, while the density of clupeids was very high. Threadfin and gizzard shad are found in greatest abundance in shallow, quiet areas such as occur along the sandbar. Skipjack herring are apparently attracted to dikes where water flows only slightly over the rocks (Pflieger 1975), and flathead catfish have been shown to prefer cover such as rocks and logs. No other studies were identified which have directly compared catches among different areas within secondary channels.

Macroinvertebrates

Macroinvertebrate assemblages of the five secondary channels were similar overall. Differences among channels primarily reflected quantitative variations in the relative percentages of major taxa rather than qualitative distinctions in the presence or absence of taxa. In most instances the same species comprised the major taxa in all five channels. Thus, at least within the 685-mile reach of the lower Mississippi River sampled, river mile position does not appear to be an overriding factor influencing the composition of the benthos.

Variations in the taxa of macroinvertebrates found in our bottom samples were noticeably and predictably related to differences in current speed and substrate type. These two physical factors have previously been suggested to be the most important ones regulating the composition of macroinvertebrate assemblages in large rivers (Beckett et al. 1983, Mathis et al. 1981, Wells and Demas 1979).

The larvae of the caddisflies H. orris and P. flava and chironomids such as Rheotanytarsus require at least a moderate current and a firm and relatively clean surface for attachment of their cases (Hynes 1972). Gravel, woody debris, fish nets, concrete, and rocks are all suitable for these species, so long as they remain free from sediment deposits. Dikes, particularly, provide considerable amounts of suitable habitat for these taxa (Beckett and Pennington 1986; Mathis, Bingham, and Sanders 1982) when at least moderate currents are present. Larvae of the mayflies P. vittigera and T. incertus are confined to consolidated silt-clay substrates across which a current exists. In the macroinvertebrate-sediment analysis performed in this study, these organisms clustered with those inhabiting unconsolidated silt-clays. This occurred because the grain size analysis did not distinguish between the consolidated and unconsolidated fine sediments. The visual classification of sediment samples allowed these instances to be resolved. Their close relative Hexagenia, however, requires softer sediments such as the mud and fine sands which accumulate in slow-current areas. Many tubificid worms, such as L. maumeensis, L. claparedianus, L. hoffmeisteri, L. cervix, and Ilyodrilus templetoni, thrive in the high-organic content silt-clays characteristically found in slack water. Most of the slack-water, soft-bottom habitat in the Lower Mississippi River is associated with floodplain lakes and borrow pits. As both the sediment and macroinvertebrate samples taken in this study show, similar conditions also occur in some secondary channels at low flows. Other tubificid and naidid worms, particularly Aulodrilus piqueti and several species of Nais and Dero, prefer a layer of silt-clay sediments over a base of sand. Many chironomid species reach great abundance in soft substrates and slack water, especially Chironomus, Ablabesmyia, Tanypus, Procladius, Glyptotendipes, Cryptochironomus, and Coelotanypus. Other Chironomidae occur primarily within sandy substrates in areas of high current; R. claviger and C. orbicus are the two most abundant such chironomids in the Lower Mississippi River.

The kinds and densities of invertebrates found on the dikes were comparable to those found by Mathis, Bingham, and Sanders (1982), who calculated an average density of 101,968 organisms/m^2 of dike surface. Although this is considerably higher than our highest average density (13,483 organisms/m^2 at Lakeport Towhead), their method of estimating surface area was much different from ours. Approximate calculations indicate that their estimates of area were too low by a factor of at least 10, and thus their densities, for comparison to our study, were on the order of $10{,}200/m^2$. Their study, like this one, found hydropsychid caddisfly larvae to be the dominant taxon on dikes, though they found considerably higher numbers of taxa overall.

Although sampling error alone could be responsible, some combination of habitat, annual, or seasonal variability may also have accounted for the differences observed between the findings of Mathis, Bingham, and Sanders (1982) and this study. Habitat characteristics were almost certainly important, as the dike sampled in the 1982 study had considerable flow over it at all stations. The presence or absence of current has already been noted as one of the primary factors affecting the distribution of aquatic invertebrates. This point is also illustrated by the difference in the macroinvertebrate densities estimated for Cottonwood Bar and Lakeport Towhead. Seasonal effects probably account for the relatively lower numbers of dipteran larvae taken in our samples. The 1982 study used a greater number of samples, and the individual samples consisted of a greater number of rocks than did ours. The effect of sample number and size on estimates of species richness and diversity is well documented. Additionally, the rock baskets used in the 1982 study tended to accumulate silt and debris, which are colonized by a very different macrofauna than the rocks themselves. Evidence for this is found in the species list (Mathis, Bingham, and Sanders 1982), which includes such organisms as *T. incertus*, *Hexagenia* sp., *P. vittigera*, Lumbricidae, and *Limnodrilus*, noted earlier as typical inhabitants of sediments, not rocks.

Effects of Dikes on Secondary Channel Biota

It is apparent that either natural or anthropogenic alterations in secondary channels that result in changes in current velocity and substrate will profoundly affect the fish and benthic macroinvertebrate assemblages. Placement of dikes to restrict flow is one alteration for which the biotic changes may be predictable. Knowledge of the elevation, length, and orientation of the dike, combined with knowledge of the seasonal hydrograph for the reach, might allow general statements about the river stage/current/substrate functional curves. Given this information, it might then be possible to predict the approximate composition of the macroinvertebrate fauna. Predicting fish assemblage structure is more difficult, since fish are relatively mobile and may move among habitats frequently. Also, the full range of variables to which fish may respond in large river systems has not yet been carefully studied. Gizzard shad, for example, may respond to as yet unknown short-term fluctuations in plankton abundance, and predators such as white and striped bass may respond more closely to shad (their primary food item) abundance than to any habitat variable. Despite this, it is probably still possible to at least approximate fish assemblage composition given currently available habitat information.

PART V: SUMMARY

Fine sand was the dominant substrate size fraction observed in all channels. However, variability existed both among channels and among stations within individual channels. Of the two diked channels, Lakeport Towhead substrates are now different than prior to dike construction because the secondary channel is isolated from the main river for longer periods of time. Cottonwood Bar substrates do not appear to have changed as much.

Conductivity and turbidity showed some differences among the five channels in July, while temperature, pH, and dissolved oxygen were essentially the same at all sites. Mean current speed was 90 to 100 cm/sec at four of the channels, but only about one half as high at Lakeport. Most water quality variables showed changes between July and October at Lakeport Towhead and Cottonwood Bar. Temperature decreased, and dissolved oxygen and conductivity increased at both channels; the bottom strata at two Lakeport stations showed oxygen depletion. Turbidity decreased significantly at Lakeport in October but not at Cottonwood Bar. Current speeds were unchanged at Cottonwood Bar compared to July, while at Lakeport Towhead there was essentially no current in October.

In July, undiked secondary channels had significantly higher electroshocking catch rates than did diked channels. This difference was eliminated when data from Profit Island, where baiting by commercial fishermen may have occurred, were excluded. Although differences were not statistically significant, hydroacoustics indicated higher fish densities at diked channels. Seine collections indicated differences among channels, but they were not related to the presence or absence of dikes.

During July, both electroshocking and hydroacoustics indicated highest fish densities along the natural bank microhabitat. Seining indicated no differences among banks within channels.

Electroshocking catches increased significantly in the two diked channels between July and October. At this time, catches were also significantly higher at Lakeport Towhead, where lentic conditions were observed, than at Cottonwood Bar, where more riverine physical conditions were found. Seining catches indicated no significant differences between the two channels in October, nor between months. In contrast to July, October electroshocking catches were highest along the secondary channel sandbar at Lakeport and along the dike at Cottonwood Bar. This observation can be related to the change in species composition which occurs in river habitats due to changes in season and habitat characteristics.

Composition of the fish assemblages at Lakeport and Cottonwood Bar changed considerably from July to October. Electroshocker catches in July consisted mainly of catfishes, while shads dominated in October. Seining catches showed similar, though less dramatic, changes.

The macroinvertebrate assemblages of the five secondary channels were similar. Differences among channels reflected variations in the relative percentages of the common taxa rather than qualitative distinctions in the presence or absence of species.

The macroinvertebrate taxa that are found at a particular station are a function primarily of substrate and current conditions. Stone dikes also provide habitat for rheophilic net-spinning filter feeders, and dikes in which sediment has accumulated among the rocks may harbor species of macroinvertebrates which normally inhabit the bottom sediments.

Dike structures that block or severely restrict flow through secondary channels produce habitats in which the biotic communities are different from areas which remain flowing. Secondary channels in which the dikes restrict current only slightly show correspondingly little change in their biotic communities across seasons.

Given sufficient information on hydrodynamics, secondary channel physical attributes, and (if present) dike specifications, reasonable predictions of the composition of the biota of Lower Mississippi River secondary channels should be possible.

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Table 1

Ranges of Physical and Water Quality Characteristics of Five Lower Mississippi River Secondary Channels, July and October 1984

Channel	Maximum Depth m	Current Speed m/sec		Temperature, °C		Dissolved Oxygen, mg/ℓ	
		Mean	Range	Mean	Range	Mean	Range
Wolf Island	9.0	0.98	0.20-2.32	28.0	27.7-28.3	5.5	4.9-5.8
Island 8	11.0	0.93	0.36-1.39	27.9	27.0-28.0	5.6	5.1-6.0
Lakeport Towhead	12.0	0.46	0.20-0.72	27.9	27.6-28.5	5.7	5.1-6.0
Cottonwood Bar	9.0	0.98	0.10-1.75	27.9	27.7-28.2	5.9	5.3-6.2
Profit Island	15.0	0.93	0.15-1.90	27.5	27.3-27.6	6.0	4.9-6.3
July mean	11.2	0.88	0.10-2.32	27.8	27.0-28.5	5.7	4.9-6.3
Lakeport Towhead	10.5	0.0	0.0-0.10	21.4	18.7-22.7	6.9	0.5-9.8
Cottonwood Bar	10.0	0.93	0.10-1.60	20.6	20.4-21.3	7.3	6.5-7.9
October mean	10.3	0.46	0.0-1.60	21.0	18.7-22.7	7.1	0.5-9.8

Channel	Conductivity µmhos/cm		Turbidity NTU		pH	
	Mean	Range	Mean	Range	Mean	Range
Wolf Island	442.8	403.0-484.0	52.9	20.0-117.0	7.3	6.2-7.5
Island 8	484.4	471.0-493.0	82.0	67.0-87.0	7.5	7.5-7.6
Lakeport Towhead	415.9	413.0-418.0	87.0	23.0-147.0	7.4	7.3-7.6
Cottonwood Bar	445.1	432.0-452.0	50.5	24.0-59.0	7.5	7.3-7.6
Profit Island	443.3	422.0-445.0	50.5	43.0-54.0	7.6	7.5-8.1
July mean	446.7	403.0-493.0	64.5	20.0-147.0	7.5	6.2-8.1
Lakeport Towhead	485.2	391.0-643.0	19.5	8.0-103.0	7.5	6.6-8.2
Cottonwood Bar	468.5	459.0-480.0	42.1	31.0-59.0	7.3	7.3-8.8
October mean	476.8	391.0-643.0	30.8	8.0-103.0	7.4	6.6-8.8

Table 2

Common and Scientific Names of Fishes Captured in Five Lower Mississippi River Secondary Channels

Polyodontidae - paddlefishes

Paddlefish (*Polyodon spathula*)

Lepisosteidae - gars

Longnose gar (*Lepisosteus osseus*)

Shortnose gar (*Lepisosteus platostomus*)

Clupeidae - herrings

Skipjack herring (*Alosa chrysochloris*)

Gizzard shad (*Dorosoma cepedianum*)

Threadfin shad (*Dorosoma petenense*)

Hiodontidae - mooneyes

Goldeye (*Hiodon alosoides*)

Mooneye (*Hiodon tergisus*)

Cyprinidae - minnows and carps

Common carp (*Cyprinus carpio*)

Mississippi silvery minnow (*Hybognathus nuchalis*)

Speckled chub (*Hybopsis aestivalis*)

Silver chub (*Hybopsis storeriana*)

Emerald shiner (*Notropis atherinoides*)

River shiner (*Notropis blennius*)

Silverband shiner (*Notropis shumardi*)

Weed shiner (*Notropis texanus*)

Blacktail shiner (*Notropis venustus*)

Mimic shiner (*Notropis volucellus*)

Bullhead minnow (*Pimephales vigilax*)

(Continued)

Table 2 (Continued)

Catostomidae - suckers

River carpsucker (*Carpiodes carpio*)

Blue sucker (*Cycleptus elongatus*)

Smallmouth buffalo (*Ictiobus bubalus*)

Bigmouth buffalo (*Ictiobus cyprinellus*)

Ictaluridae - freshwater catfishes

Blue catfish (*Ictalurus furcatus*)

Channel catfish (*Ictalurus punctatus*)

Flathead catfish (*Pylodictis olivaris*)

Cyprinodontidae - killifishes

Blackstripe topminnow (*Fundulus notatus*)

Poeciliidae - livebearers

Mosquitofish (*Gambusia affinis*)

Atherinidae - silversides

Brook silverside (*Labidesthes sicculus*)

Inland silverside (*Menidia beryllina*)

Percichthyidae - temperate basses

White bass (*Morone chrysops*)

Striped bass (*Morone saxatilis*)

Centrarchidae - sunfishes

Bluegill (*Lepomis macrochirus*)

Longear sunfish (*Lepomis megalotis*)

Largemouth bass (*Micropterus salmoides*)

White crappie (*Pomoxis annularis*)

Black crappie (*Pomoxis nigromaculatus*)

(Continued)

Table 2 (Concluded)

Percidae - perches
Bluntnose darter (*Etheostoma chlorosomum*)
River darter (*Percina shumardi*)
Sauger (*Stizostedion canadense*)
Sciaenidae - drums
Freshwater drum (*Aplodinotus grunniens*)
Mugilidae - mullets
Striped mullet (*Mugil cephalus*)

Table 3

Numerical Percent Composition of Fish Taken by Electroshocker from Five Mississippi River Secondary Channels

Species	July					October	
	Wolf Island	Island 8	Lakeport Towhead	Cotton-wood Bar	Profit Island	Lakeport Towhead	Cotton-wood Bar
Paddlefish			0.9				
Longnose gar	4.5	1.0	3.4				0.6
Shortnose gar	0.9	7.9	0.9	1.2		0.1	
Skipjack herring	1.8	1.0		2.4	1.3	8.9	9.6
Gizzard shad	3.6	25.7			1.0	62.2	36.5
Threadfin shad					0.6	22.9	16.9
Goldeye	1.8	10.9		1.2		0.3	0.6
Mooneye							0.6
Common carp	3.6	4.0		3.5		0.2	1.1
Mississippi silvery minnow							
Speckled chub							
Silver chub	0.9				0.3		1.1
Hybopsis sp.							
Emerald shiner			0.9			0.2	
River shiner							
Silverband shiner							0.6
Weed shiner							
Blacktail shiner							
Mimic shiner							
Notropis sp.							
Bullhead minnow							
River carpsucker	0.9	2.0	2.6	3.5		0.4	
Blue sucker						0.2	2.8
Smallmouth buffalo				2.4	0.3	0.3	1.7
Bigmouth buffalo	0.9					0.2	0.6

(Continued)

Table 3 (Concluded)

Species	July					October	
	Wolf Island	Island 8	Lakeport Towhead	Cotton-wood Bar	Profit Island	Lakeport Towhead	Cotton-wood Bar
Ictiobus sp.							
Catostomidae							
Blue catfish	4.5	1.0	41.4	41.2	72.3	0.3	6.2
Channel catfish	38.4	19.8	2.6	9.4	1.0	0.1	0.6
Flathead catfish	29.5	19.8	39.7	24.1	21.3	0.5	15.7
Blackstripe topminnow							
Mosquitofish							
Brook silverside							
Inland silver-side							
White bass	1.8	2.0	0.9	2.4	1.3	2.2	3.9
Striped bass						0.1	
Bluegill			0.9			0.1	
Longear sunfish							
Lepomis sp.							
Largemouth bass						0.2	
White crappie			0.9				
Black crappie						0.1	
Centrarchidae							
Bluntnose darter							
River darter							
Sauger	0.9	2.0	1.7	2.4		0.4	1.1
Freshwater drum	6.3	3.0	3.4	4.7			
Striped mullet				1.2	0.6	0.4	
Number of Species	15	13	13	13	10	21	17
Number of Fish	112	101	116	85	314	1097	178
Catch Per Effort	12.4	11.2	9.0	7.1	34.9	91.4	16.2

Table 4

Numerical Percent Composition of Fish Taken by Seine from Five Mississippi River Secondary Channels

Species	July					October	
	Wolf Island	Island 8	Lakeport Towhead	Cotton-wood Bar	Profit Island	Lakeport Towhead	Cotton-wood Bar
Paddlefish							
Longnose gar							
Shortnose gar	0.2						
Skipjack herring	2.0	3.7	0.6				
Gizzard shad	1.0	4.0	3.7	12.2	3.5	3.3	13.5
Threadfin shad	0.8	4.0	2.0	3.3	2.6	24.0	
Goldeye		0.6		1.7			
Mooneye							
Common carp			0.2				
Mississippi silvery minnow	1.9	1.7	4.3				2.3
Speckled chub			0.6				
Silver chub	3.9	1.3	10.6	1.2	3.5		0.8
Hybopsis sp.	0.2						
Emerald shiner	77.5	80.1	23.4	54.1	8.7	21.7	24.8
River shiner	2.4	2.7	4.6	1.2	13.0	3.3	10.5
Silverband shiner	0.8	0.3	1.5	1.2	3.5	22.9	21.1
Weed shiner			4.3	1.6			0.8
Blacktail shiner			0.5	0.8	7.8	8.7	5.3
Mimic shiner			23.1	0.8	8.7	1.7	0.8
Notropis sp.	0.3						
Bullhead minnow			0.8		2.6	0.4	5.3
River carpsucker		0.3	0.3				
Blue sucker							
Smallmouth buffalo	0.2						
Bigmouth buffalo							

(Continued)

Table 4 (Concluded)

Species	July					October	
	Wolf Island	Island 8	Lakeport Towhead	Cotton-wood Bar	Profit Island	Lakeport Towhead	Cotton-wood Bar
Ictiobus sp.	0.2						
Catostomidae			0.2				
Blue catfish			1.4		1.7		
Channel catfish	3.1		2.8	0.4			
Flathead catfish							
Blackstripe topminnow				1.7	0.4		
Mosquitofish				0.4	3.5		
Brook silverside	0.3	0.2	1.2	1.7	1.5	1.5	
Inland silver-side			10.9	20.3	33.9	12.1	13.5
White bass	1.0	1.0	0.5	0.8			
Striped bass							
Bluegill	0.2		0.3				
Longear sunfish					0.9		
Lepomis sp.			1.7	0.4			
Largemouth bass							
White crappie					0.9		
Black crappie							
Centrarchidae	0.2						
Bluntnose darter			0.2				
River darter	0.2		0.3				
Sauger							
Freshwater drum	3.4	0.3	0.8				
Striped mullet							
Number of Species	15	12	25	14	17	11	12
Number of Fish	590	297	653	246	115	520	133
Catch Per Effort	45.4	37.1	34.4	20.5	8.9	28.9	12.3

Table 5

Weight Percent Composition of Fish Taken by Electroshocker from Five Mississippi River Secondary Channels

Species	July					October	
	Wolf Island	Island 8	Lakeport Towhead	Cotton-wood Bar	Profit Island	Lakeport Towhead	Cotton-wood Bar
Paddlefish			6.0				
Longnose gar	18.2	2.6	8.3				5.5
Shortnose gar	1.0	14.0	4.4	4.2		0.6	
Skipjack herring	0.0	0.0		1.1	0.7	4.1	1.2
Gizzard shad					0.2	39.5	11.9
Threadfin shad					0.1	2.8	1.2
Goldeye	0.2	1.2		0.0		0.4	0.1
Mooneye							0.1
Common carp	21.3	37.0		34.3		9.3	6.9
Mississippi silvery minnow							
Speckled chub							
Silver chub	0.0				0.0		0.1
Hybopsis sp.							
Emerald shiner			0.0			0.0	
River shiner							
Silverband shiner							0.0
Weed shiner							
Blacktail shiner							
Mimic shiner							
Notropis sp.							
Bullhead minnow							
River carpsucker	0.8	7.0	5.0	4.8		0.7	
Blue sucker						7.3	30.3
Smallmouth buffalo				2.4	1.1	7.1	9.9
Bigmouth buffalo						5.0	2.4

(Continued)

Table 5 (Concluded)

Species	July					October	
	Wolf Island	Island 8	Lakeport Towhead	Cotton-wood Bar	Profit Island	Lakeport Towhead	Cotton-wood Bar
Ictiobus sp.							
Catostomidae							
Blue catfish	7.3	0.2	4.2	5.1	25.4	1.1	4.4
Channel catfish	17.1	11.1	0.0	0.5	0.2	0.3	0.1
Flathead catfish	29.8	14.9	60.9	35.6	69.4	3.0	14.6
Blackstripe topminnow							
Mosquitofish							
Brook silverside							
Island silver-side							
White bass	1.5	1.9	3.7	1.9	2.3	10.3	10.1
Striped bass						1.4	
Bluegill			0.1			0.3	
Longear sunfish							
Lepomis sp.							
Largemouth bass						1.7	
White crappie			1.5				
Black crappie						0.7	
Centrarchidae							
Bluntnose darter							
River darter							
Sauger	1.2	0.4	2.3	1.3		1.1	1.3
Freshwater drum	0.9	1.3	3.6	7.7			
Striped mullet				1.2	0.7	3.2	
Number of Species	15	13	13	13	10	21	17
Weight of Fish	47.219	23.399	33.567	18.404	37.341	60.745	43.643
Catch Per Effort	5.246	2.600	2.582	1.534	4.149	5.062	3.968

Table 6

Weight Percent Composition of Fish Taken by Seine from Five Mississippi River Secondary Channels

Species	July: Wolf Island	July: Island 8	July: Lakeport Towhead	July: Cotton-wood Bar	July: Profit Island	October: Lakeport Towhead	October: Cotton-wood Bar
Paddlefish							
Longnose gar							
Shortnose gar	56.7						
Skipjack herring	1.2	9.4	0.3				
Gizzard shad	0.9	18.7	10.5	17.5	7.5	14.5	52.7
Threadfin shad	0.5	6.3	1.5	0.5	0.4	36.2	
Goldeye	2.5		2.5		6.4		
Mooneye							
Common carp			2.4				
Mississippi silvery minnow	1.7	3.0	5.0				5.8
Speckled chub			0.1				
Silver chub	2.1	1.7	4.6	0.4	0.9		1.1
Hybopsis sp.	0.0						
Emerald shiner	21.6	46.7	7.9	12.3	2.4	24.5	18.0
River shiner	1.7	7.5	16.6	1.6	19.2	1.5	3.0
Silverband shiner	2.2	0.9	3.3	1.8	5.1	3.0	2.4
Weed shiner			2.0	0.5			0.3
Blacktail shiner			0.6	1.6	21.4	1.7	1.0
Mimic shiner			13.0	0.3	3.1	0.1	0.1
Notropis sp.	0.0						
Bullhead minnow			0.8		0.4	0.0	0.3
River carpsucker		0.7	10.6				
Blue sucker							
Smallmouth buffalo	0.2						
Bigmouth buffalo							

(Continued)

Table 6 (Concluded)

Species	July					October	
	Wolf Island	Island 8	Lakeport Towhead	Cotton-wood Bar	Profit Island	Lakeport Towhead	Cotton-wood Bar
Ictiobus sp.	0.2						
Catostomidae			0.0				
Blue catfish			3.4		3.1		
Channel catfish	3.2		4.2	0.3			
Flathead catfish							
Blackstripe topminnow					0.9	0.3	
Mosquitofish				0.0	0.9		
Brook silverside		0.2	0.1	0.5	0.9	2.6	1.5
Island silver-side			6.6	9.0	11.5	15.6	13.7
White bass	2.7	4.4	2.0	54.1			
Striped bass							
Bluegill	0.1		0.1				
Longear sunfish					15.6		
Lepomis sp.	0.3	0.0					
Largemouth bass							
White crappie					0.4		
Black crappie							
Centrarchidae	0.0						
Bluntnose darter		0.0					
River darter	0.1		0.1				
Sauger							
Freshwater drum	2.4	0.6	1.4				
Striped mullet							
Number of Species	16	12	25	14	17	11	12
Weight of Fish	494.1	148.6	425.3	327.9	160.5	783.3	271.3
Catch Per Effort	38.01	18.58	22.38	27.33	12.34	43.52	20.87

Table 7

Fish Species Diversity of Five Secondary Channels

in the Lower Mississippi River

Sampling Period	Secondary Channel	Shannon-Wiener Diversity	
		Electroshocker	Seine
July 1984	Wolf Island	0.80	0.47
	Island 8	0.88	0.39
	Lakeport Towhead	0.63	1.03
	Cottonwood Bar	0.79	0.65
	Profit Island	0.38	0.99
October 1984	Lakeport Towhead	0.50	0.81
	Cottonwood Bar	0.86	0.88

Table 8

Density, Number of Taxa, and Diversity of Macroinvertebrates Collected from Five Secondary Channels in the Lower Mississippi River, July and October 1984

Secondary Channel	Mean Density (Numbers per m^2)					Total Taxa					Shannon-Wiener Diversity Index
	Natural Bank	Midchannel Stations 02	Midchannel Stations 03	Secondary Channel Sandbar	Channel Mean	Natural Bank	Midchannel Stations 02	Midchannel Stations 03	Secondary Channel Sandbar	Channel Total	
Wolf Island	2,987	597	295	923	1,200	22	11	11	11	34	1.03
Island 8	1,029	767	416	93	576	16	8	11	5	24	0.99
Lakeport Towhead	113	101	379	40	158	10	6	16	5	22	0.54
Cottonwood Bar	323	93	97	57	142	11	6	7	7	20	0.87
Profit Island	206	109	186	133	158	9	9	9	4	19	1.04
July mean	932	333	275	249	447	34	17	23	23	50	
Lakeport Towhead	468	569	682	807	632	15	11	11	14	31	0.96
Cottonwood Bar	2,127	775	1,086	637	1,157	14	6	5	8	21	0.80
October mean	1,298	672	884	723	894	26	17	19	18	39	

Table 9

Density, Number of Taxa, and Diversity of Macroinvertebrates Collected from Dikes at Two Lower Mississippi River Secondary Channels

Channel	Mean Density (Number per m^2 Surface Area)			Total Taxa			Shannon-Wiener Diversity
	Upstream Face	Downstream Face	Channel Mean	Upstream Face	Downstream Face	Channel Total	
Lakeport Towhead	23,642	3,325	13,483	18	14	20	0.50
Cottonwood Bar	3,136	849	1,993	12	10	16	0.64
Total	13,389	2,087	7,738	22	15	24	

Table 10

Composition of Clusters Derived from a Ward's Minimum Hierarchical Cluster Analysis of Benthic Macroinvertebrate and Sediment Grain Size Samples from Five Lower Mississippi River Secondary Channels, July 1984

Taxon	Mean Macroinvertebrate Composition			Sieve Size	Mean Particle Size Composition*		
	Cluster 1	Cluster 2	Cluster 3		Cluster 1	Cluster 2	Cluster 3
Tubificidae (nc)**	27.5	0.9	0.0	1.00-in.	0.0	7.4	0.0
Potamyia flava	4.0	6.7	2.3	0.75-in.	0.0	3.4	0.0
Robackia claviger	0.6	46.5	9.4	0.50-in.	0.4	4.1	0.3
Chernovskiia orbicus	0.9	7.9	68.0	0.38-in.	0.6	2.3	0.0
Microturbellarians	0.0	21.1	3.6	no. 3	0.4	2.9	0.3
Hydropsyche orris	1.4	0.2	2.1	no. 4	0.2	1.9	0.3
Tortopus incertus	38.6	0.0	0.0	no. 6	0.1	2.7	0.1
Hydropsychidae early instars	0.0	1.8	0.5	no. 10	0.2	4.8	0.3
Limnodrilus maumeensis	4.3	0.0	0.0	no. 16	0.1	9.8	0.6
Nematoda	0.0	2.8	9.0	no. 20	0.1	11.5	1.0
Barbidrilus paucisetus	0.0	5.9	0.0	no. 30	0.1	17.5	3.1
Corbicula fluminea	3.9	1.2	0.7	no. 40	0.2	16.7	14.2
Limnodrilus hoffmeisteri	1.0	0.9	0.0	no. 50	1.0	8.2	31.1
				no. 70			
Chaoborus punctipennis	0.6	0.3	0.0		2.3	3.7	33.9
Limnodrilus cervix	1.6	0.0	0.0	no. 100	8.4	1.4	10.9
Polypedilum convictum	0.0	0.8	0.9	no. 140	10.9	0.7	2.4
All others	15.5	3.0	3.5	no. 200	11.5	0.2	0.6
				>no. 200	63.7	0.8	1.0

* Cluster 1 represents fines, but in this analysis, silts cannot be separated from consolidated clays after drying and sieving; Cluster 2 represents medium sands and gravels; cluster 3 represents fine sands.

** nc indicates that these are tubificid immatures of species lacking capilliform chaetae.

Table 11

Distribution of Selected Sampling Stations Relative to Combinations of Macroinvertebrate and Sediment Grain Size Clusters*

Macroinvertebrate 1 **Sediment 1**	**Macroinvertebrate 1** **Sediment 2**	**Macroinvertebrate 1** **Sediment 3**
PCI - E01 PCC - C01 PCC - C02 PCP - E04 PCP - G01 PCL - E01 PCW - C01		
Macroinvertebrate 2 **Sediment 1**	**Macroinvertebrate 2** **Sediment 2**	**Macroinvertebrate 2** **Sediment 3**
PCL - G03 PCP - E02	PCC - G01	PCI - C02 PCI - C03 PCI - C04 PCI - E03 PCL - C03 PCP - C03 PCW - C02
Macroinvertebrate 3 **Sediment 1**	**Macroinvertebrate 3** **Sediment 2**	**Macroinvertebrate 3** **Sediment 3**
PCI - G01	PCI - E02 PCI - G02 PCI - G03 PCW - E02 PCW - E03 PCW - G01 PCW - G03	PCW - C04

Note: The first heading is printed as "Macroinvertebrate 1**".

* Acronyms represent: PCW (Wolf Island), PCI (Island 8), PCL (Lakeport Towhead), PCC (Cottonwood Bar), PCP (Profit Island).

** Refers to macroinvertebrate and sediment grain size clusters shown in Table 10.

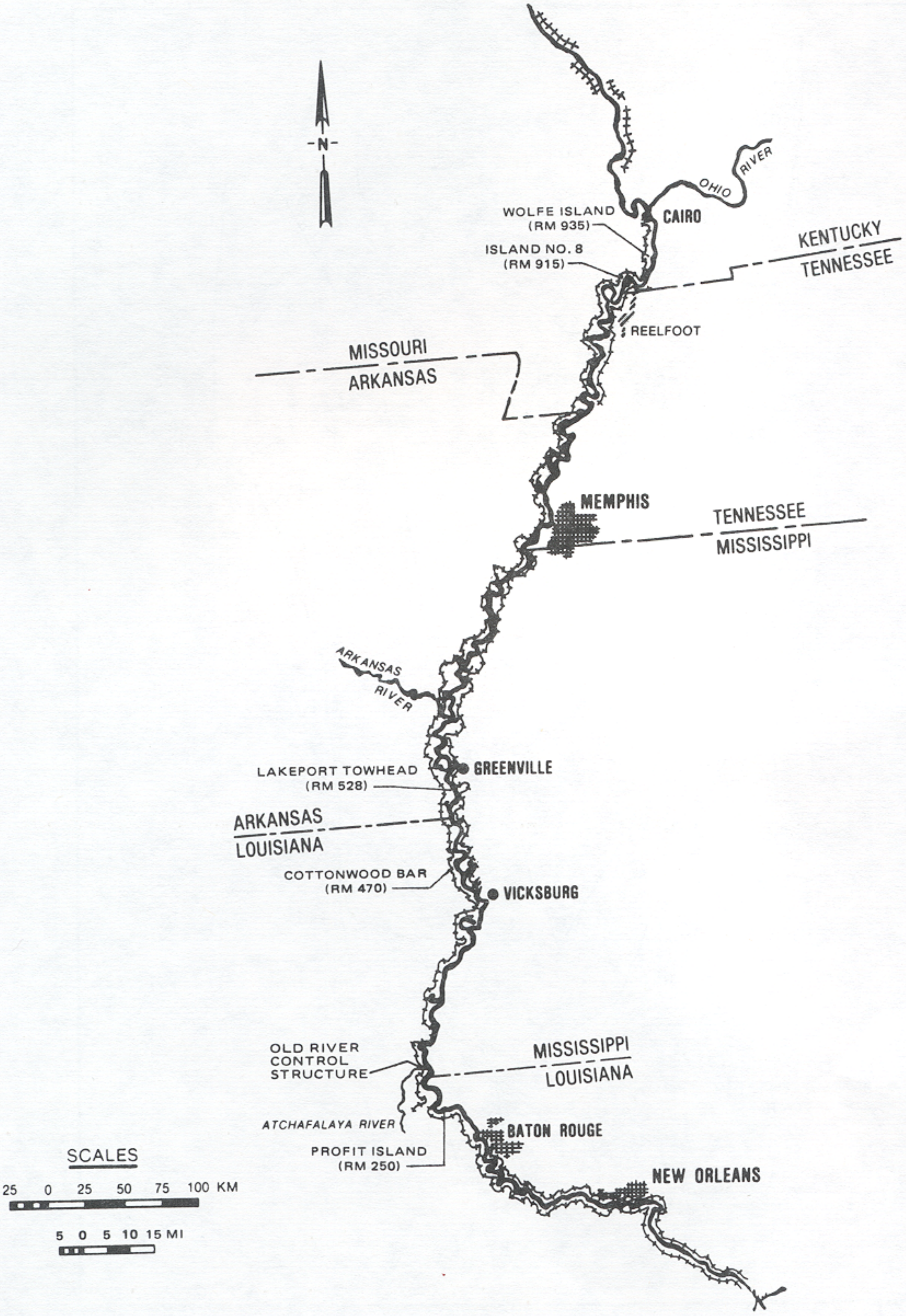

Figure 1. Location of the five secondary channel study sites within the Lower Mississippi River

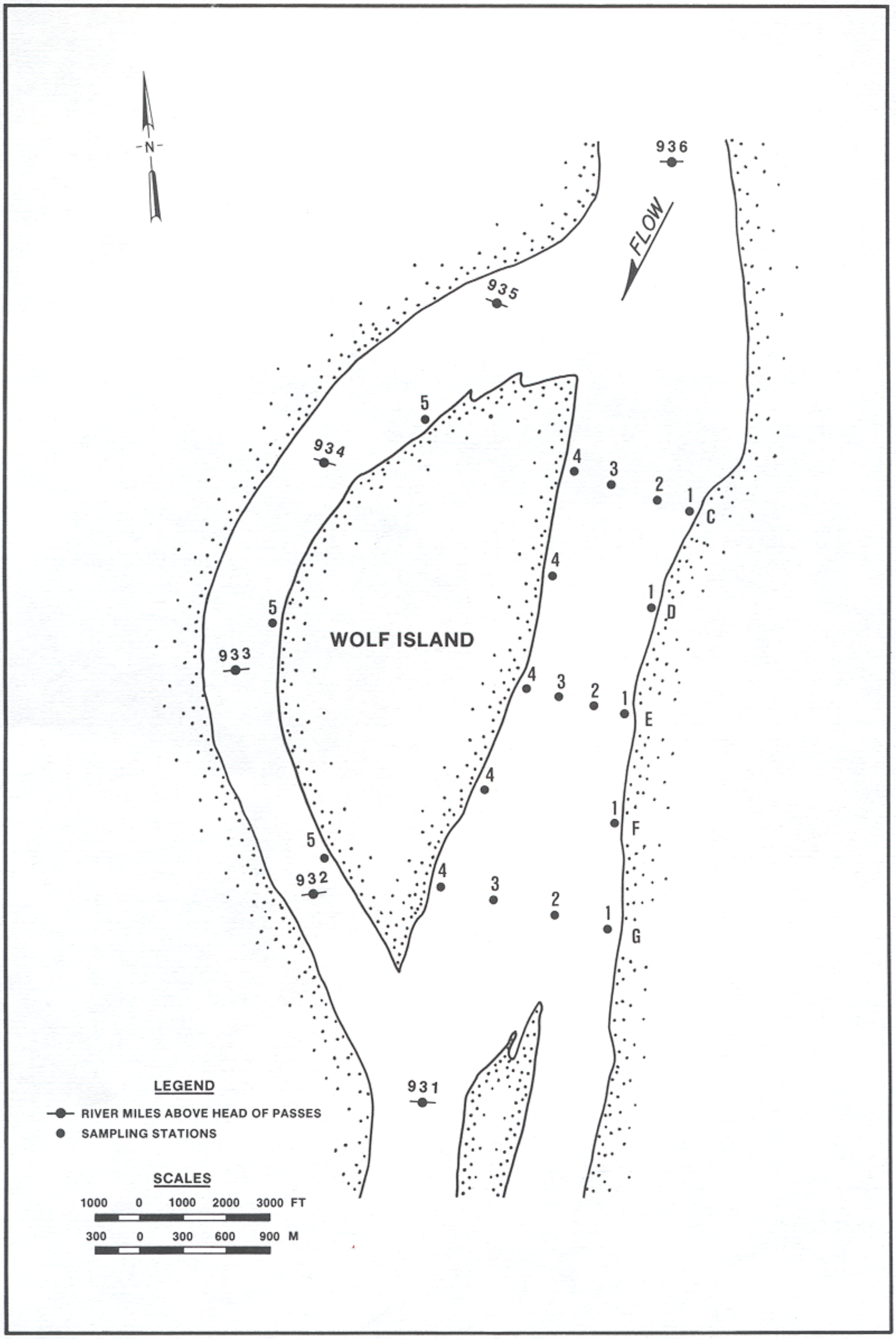

Figure 2. Location of sampling transects and stations within Wolf Island secondary channel, Lower Mississippi River

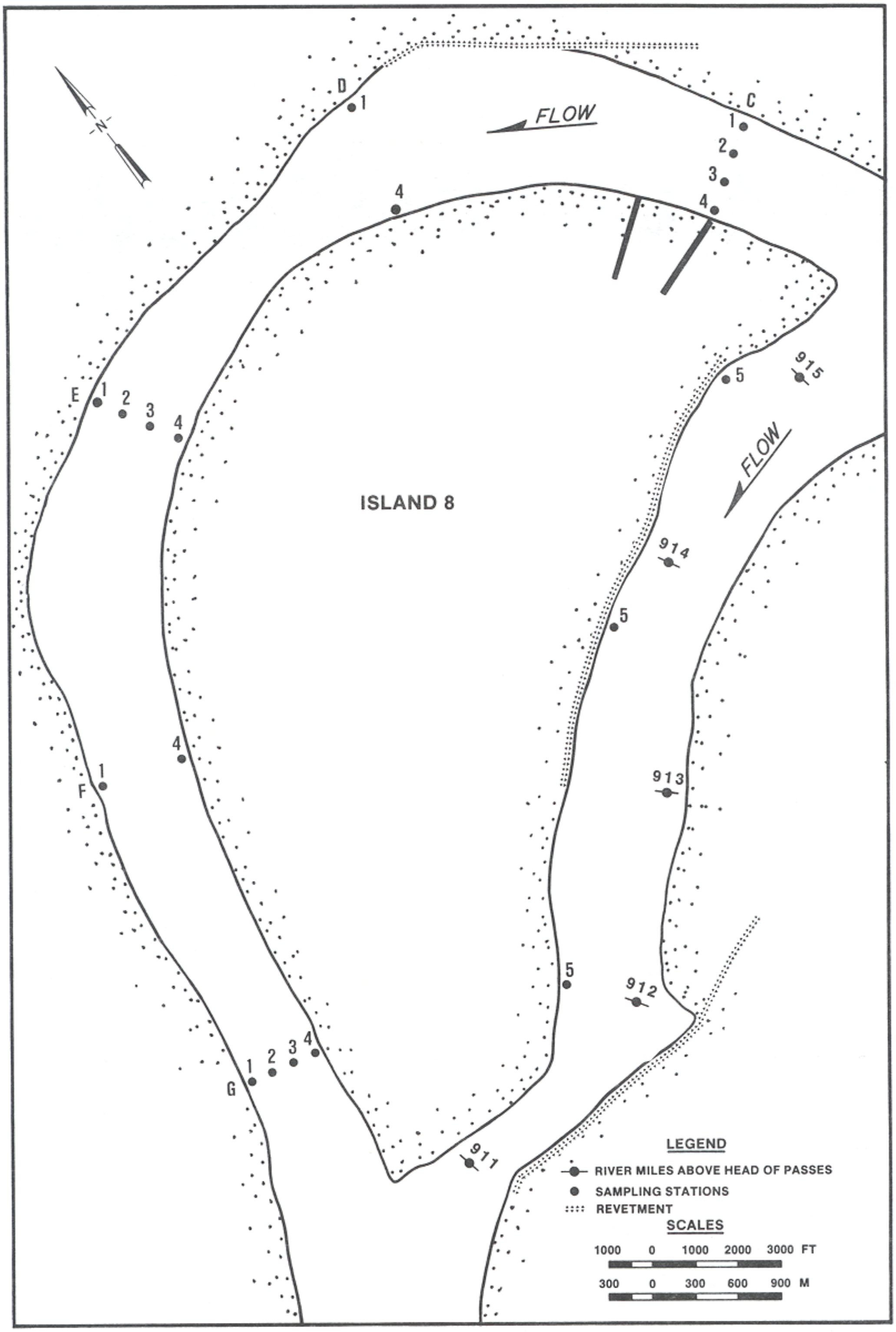

Figure 3. Location of sampling transects and stations within Island 8 secondary channel, Lower Mississippi River

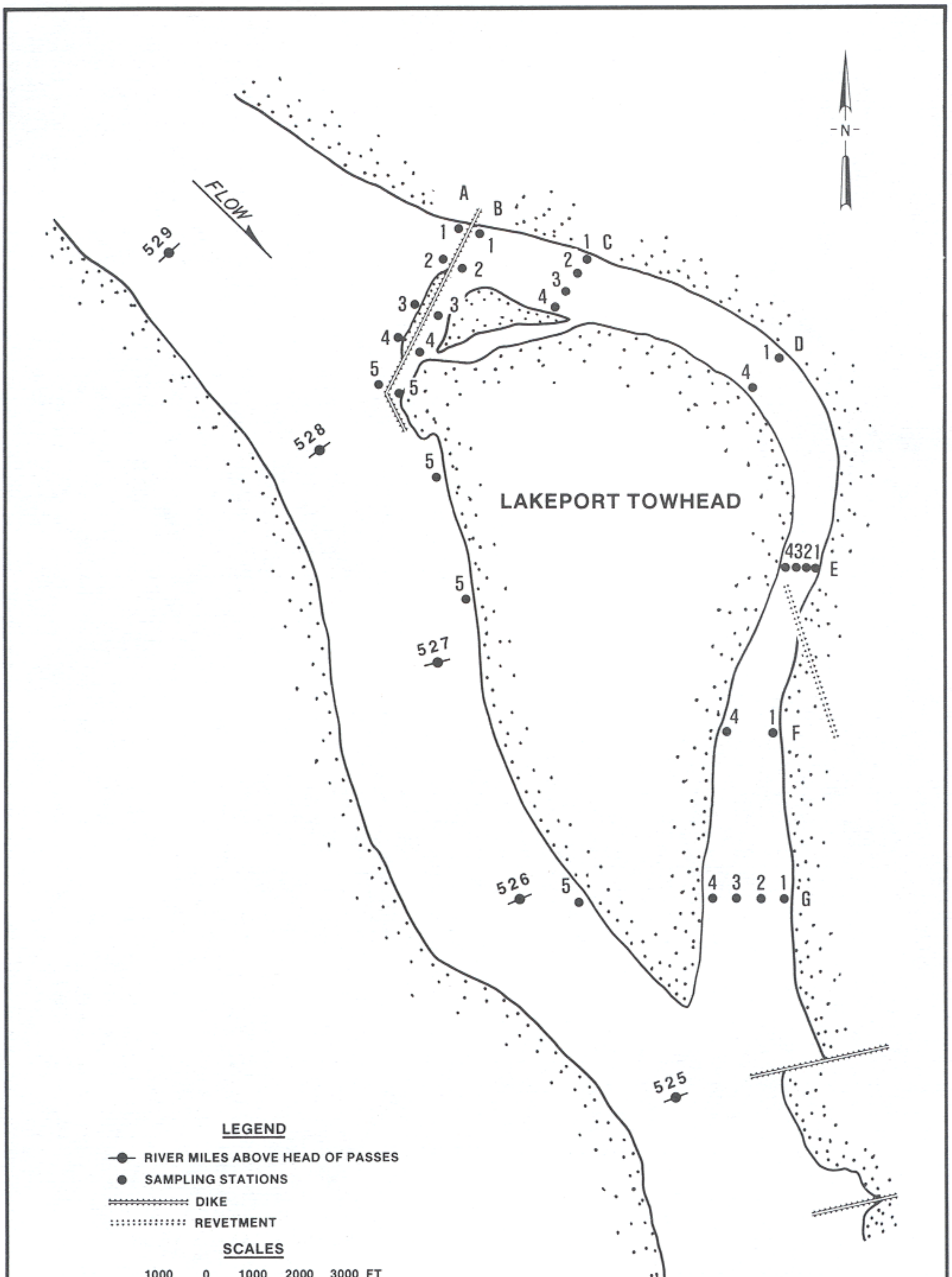

Figure 4. Location of sampling transects and stations within Lakeport Towhead secondary channel, Lower Mississippi River

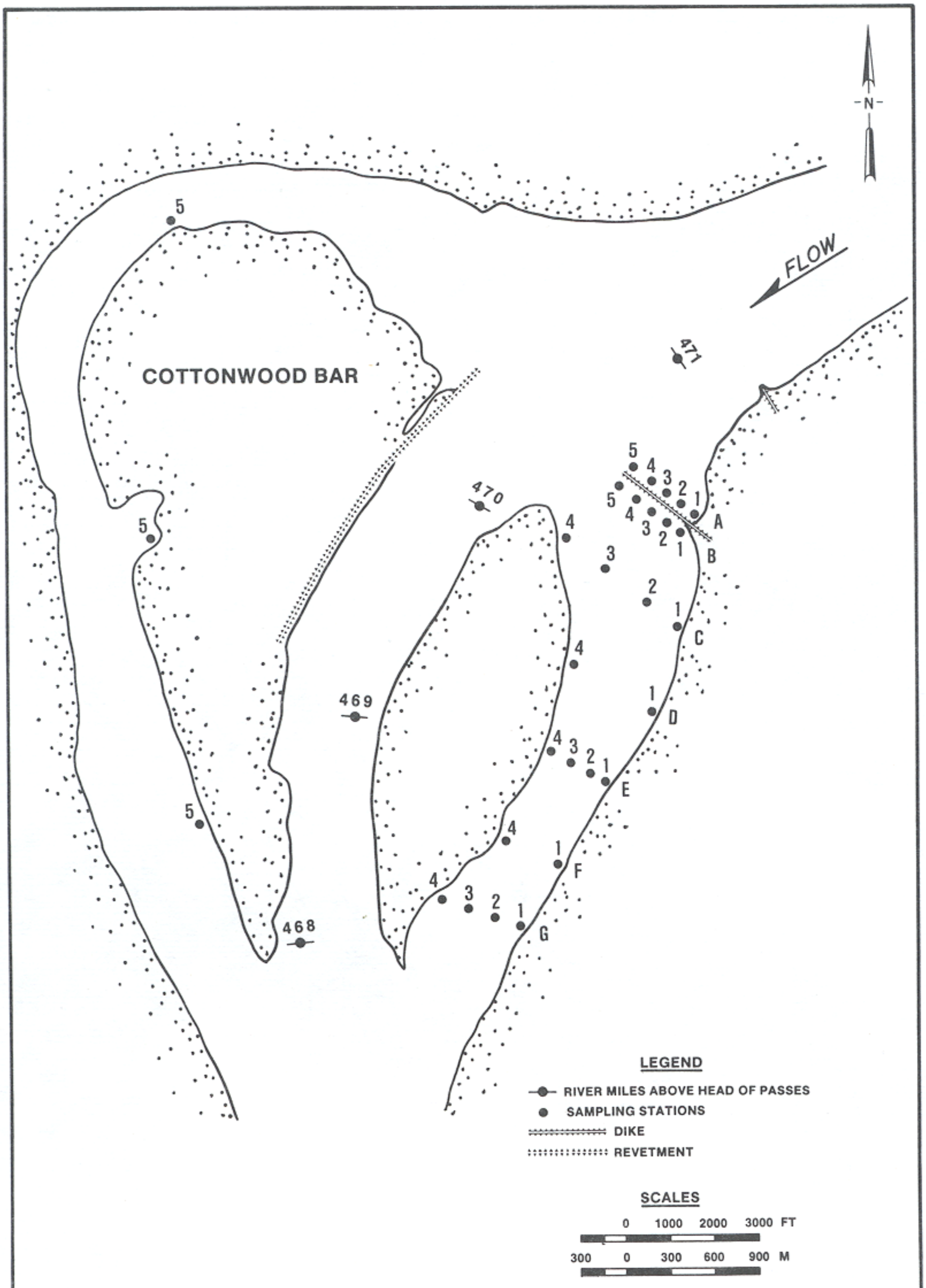

Figure 5. Location of sampling transects and stations within Cottonwood Bar secondary channel, Lower Mississippi River

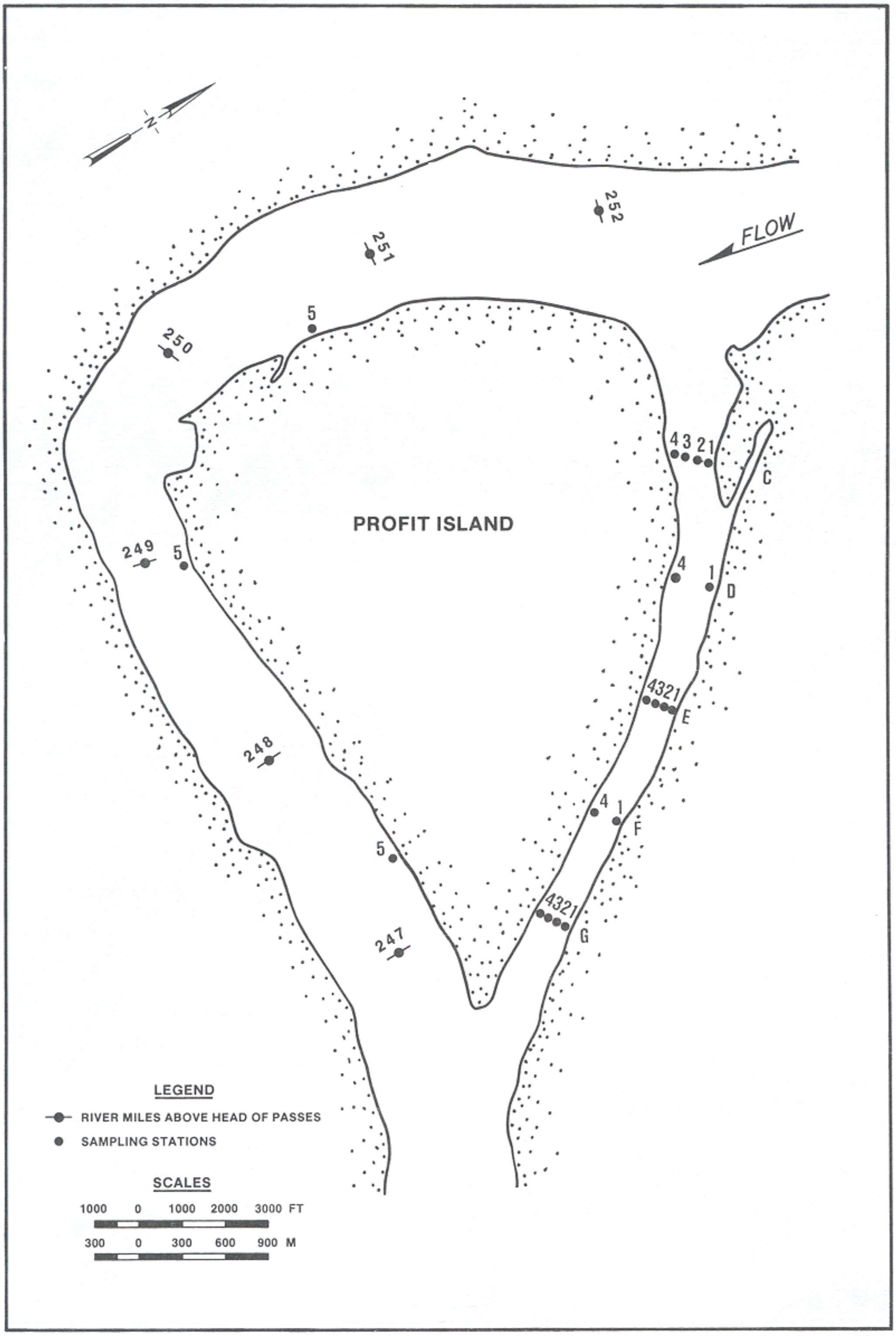

Figure 6. Location of sampling transects and stations within Profit Island secondary channel, Lower Mississippi River

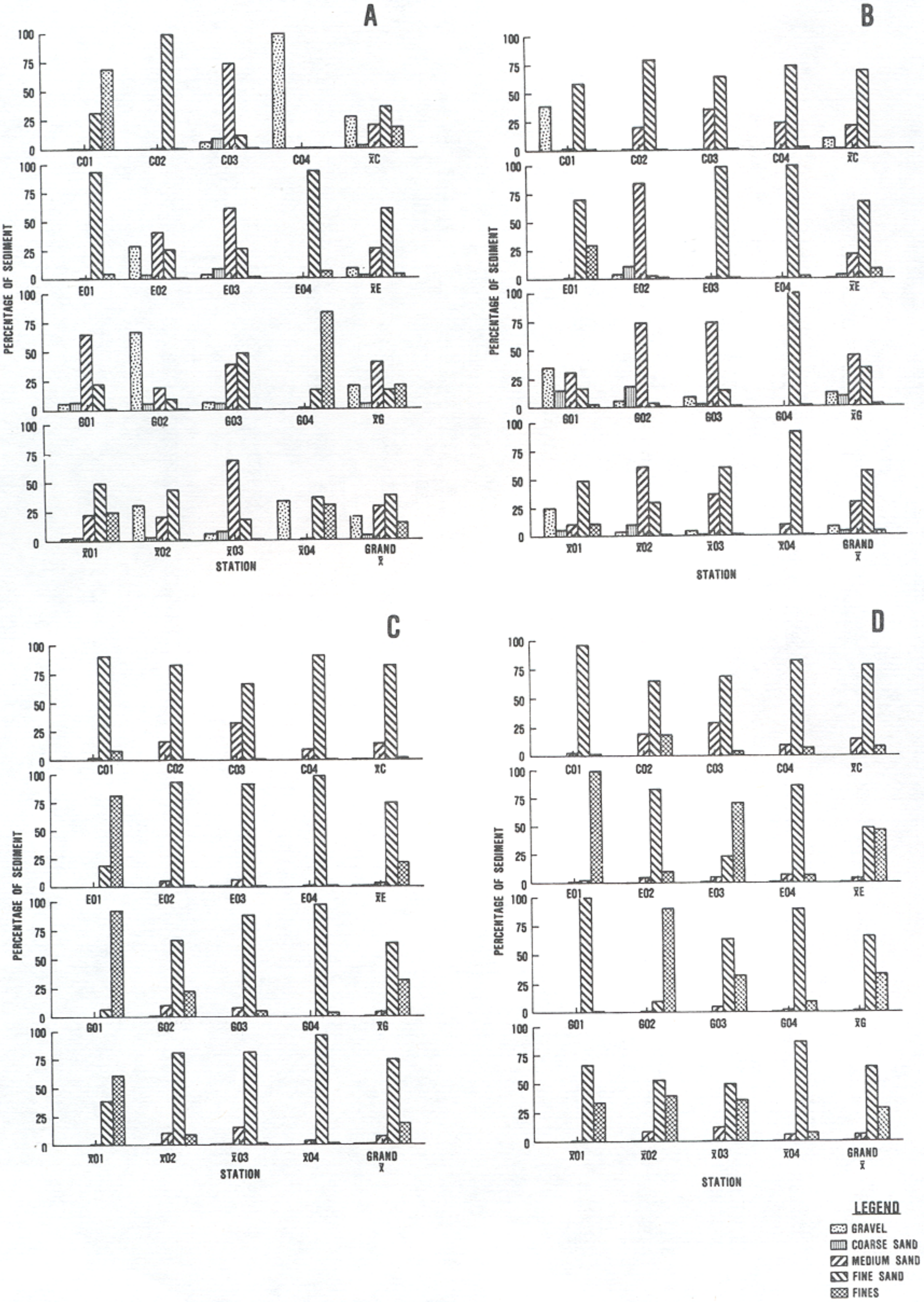

Figure 7. Distribution of sediment grain sizes within Wolf Island (A) and Island 8 (B) secondary channels in July 1984, and within Lakeport Towhead secondary channel in July (C) and October (D) 1984

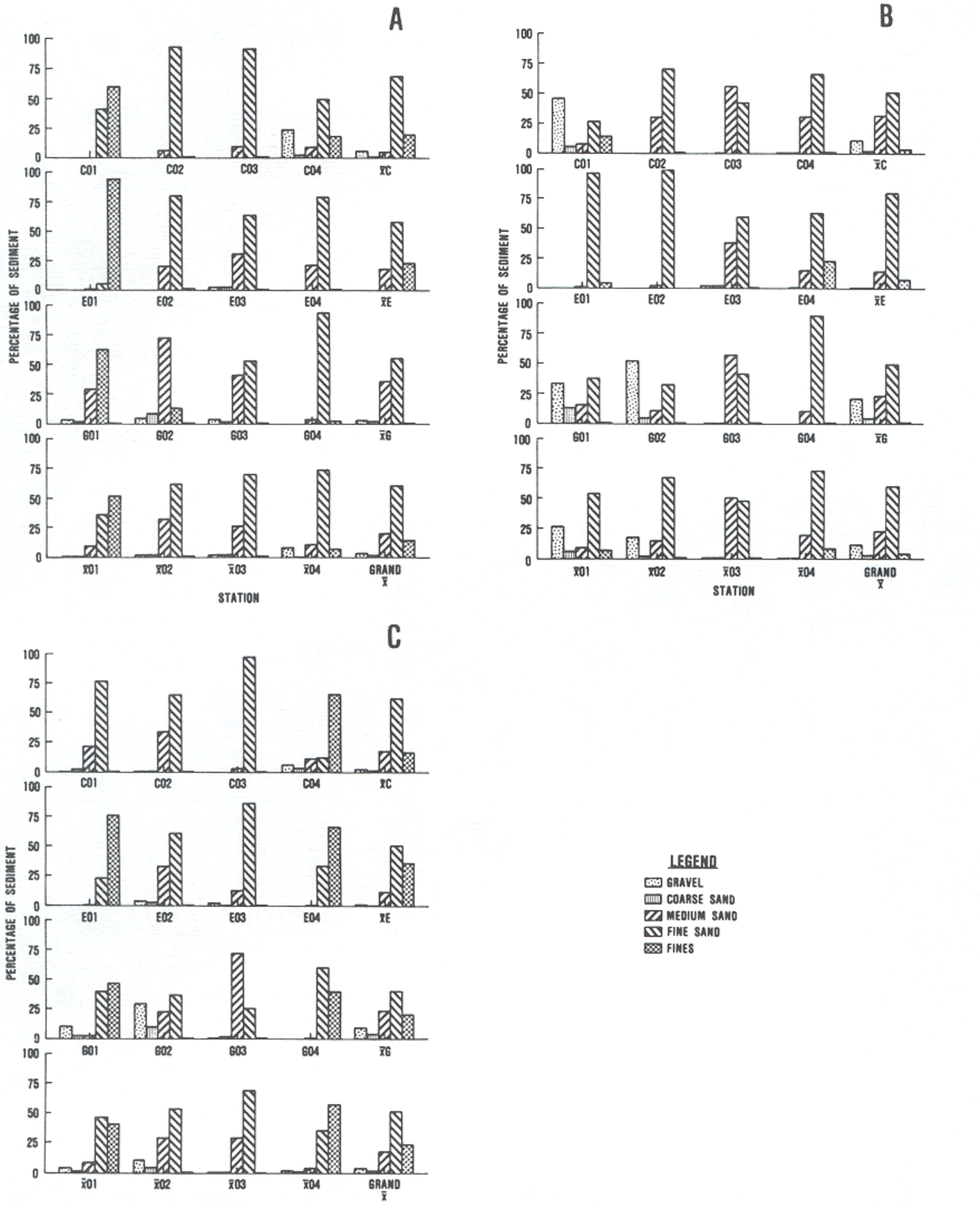

Figure 8. Distribution of sediment grain sizes within Cottonwood Bar secondary channel in July (A) and October (B) 1984, and within Profit Island secondary channel in July 1984 (C)

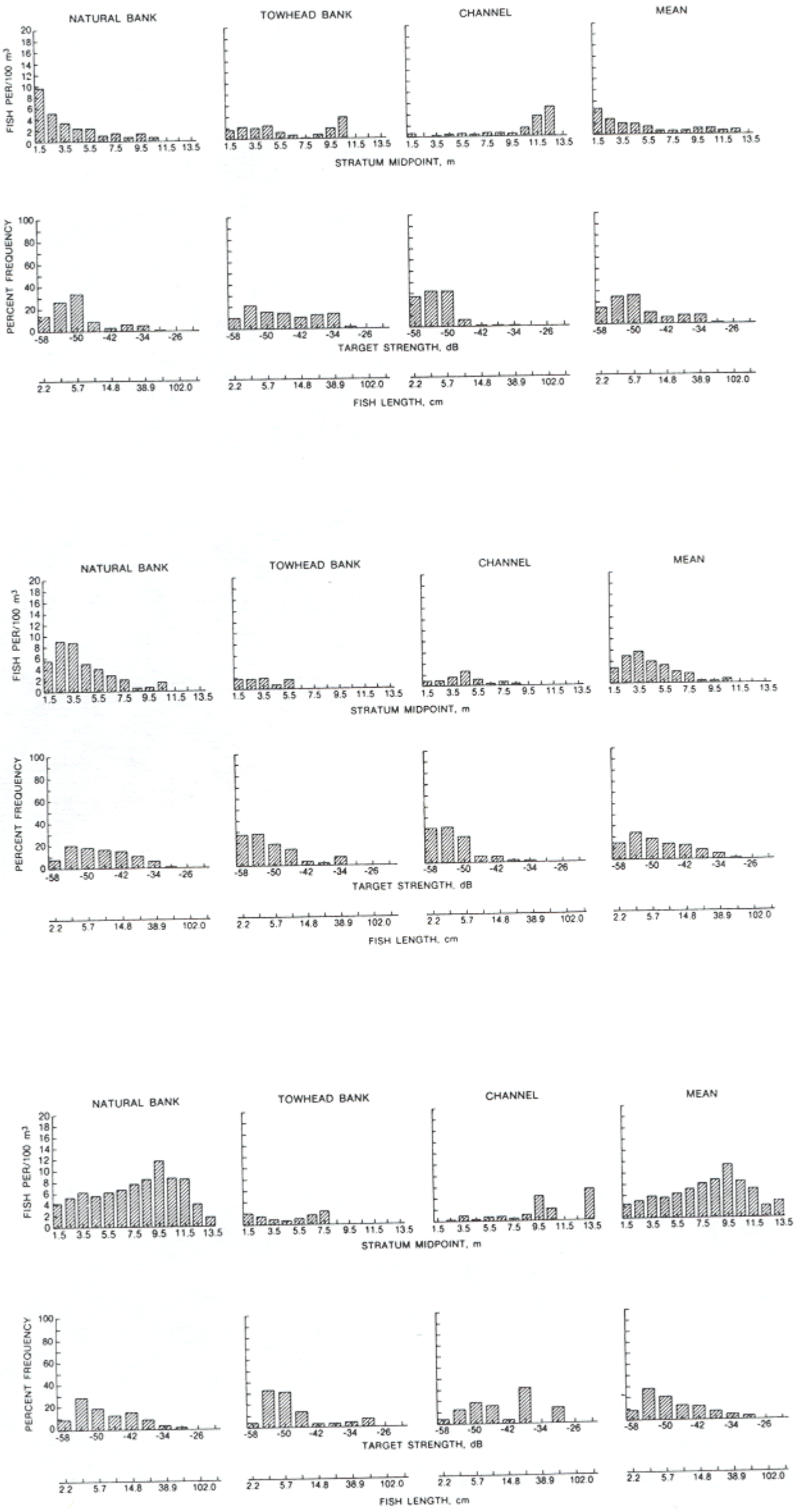

Figure 9. Estimated densities of fish within depth strata and the frequency distributions of target strengths and corresponding fish sizes for Wolf Island (top), Island 8 (center), and Lakeport Towhead (bottom) secondary channels, July 1984

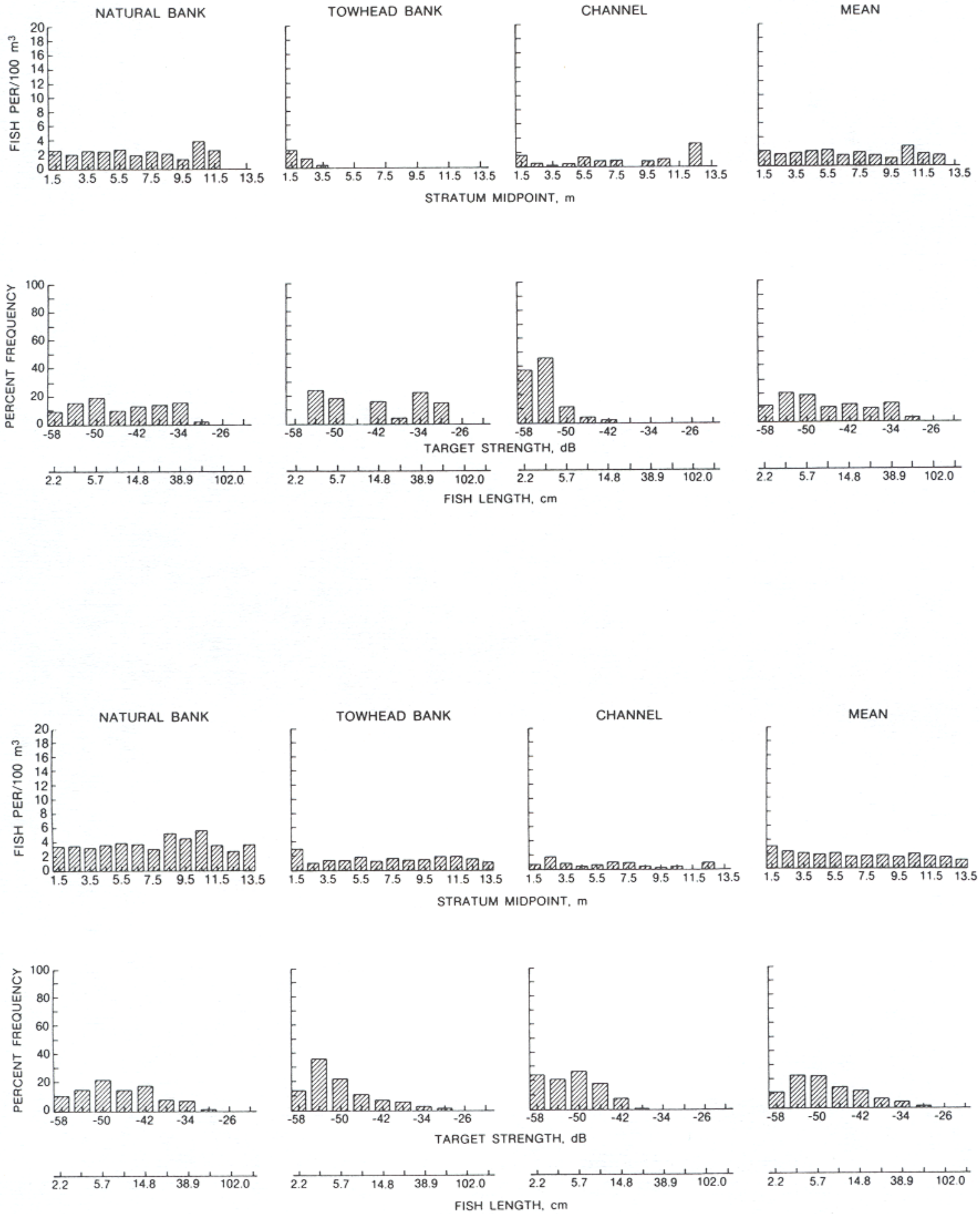

Figure 10. Estimated densities of fish within depth strata and the frequency distributions of target strengths and corresponding fish sizes for Cottonwood Bar (top) and Profit Island (bottom) secondary channels, July 1984

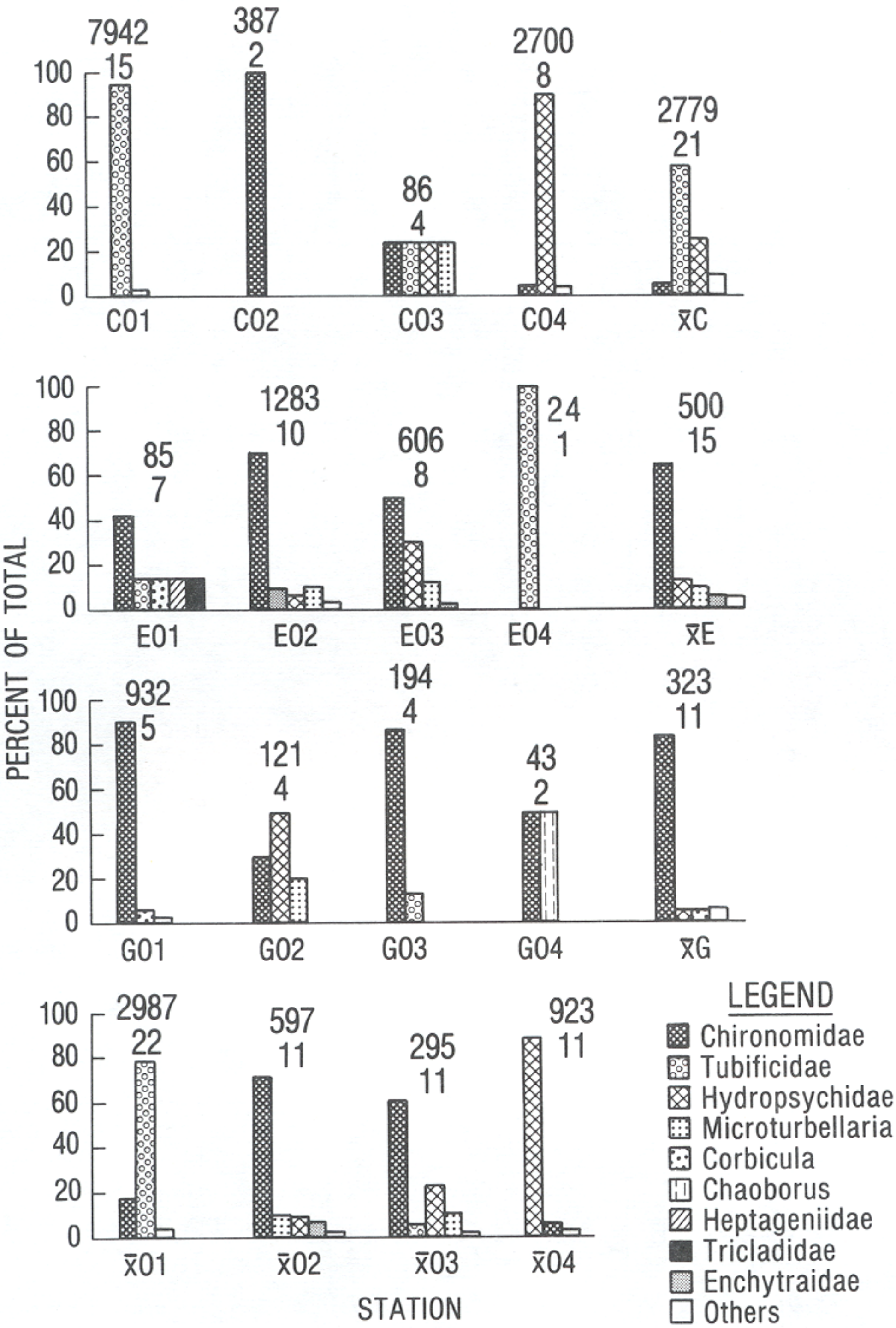

Figure 11. Macroinvertebrates collected from sediments within Wolf Island secondary channel, July 1984. Upper numbers represent the mean density of macroinvertebrates per square metre calculated from two samples per station; lower numbers represent total numbers of taxa collected. Location of sampling stations is shown in Figure 2

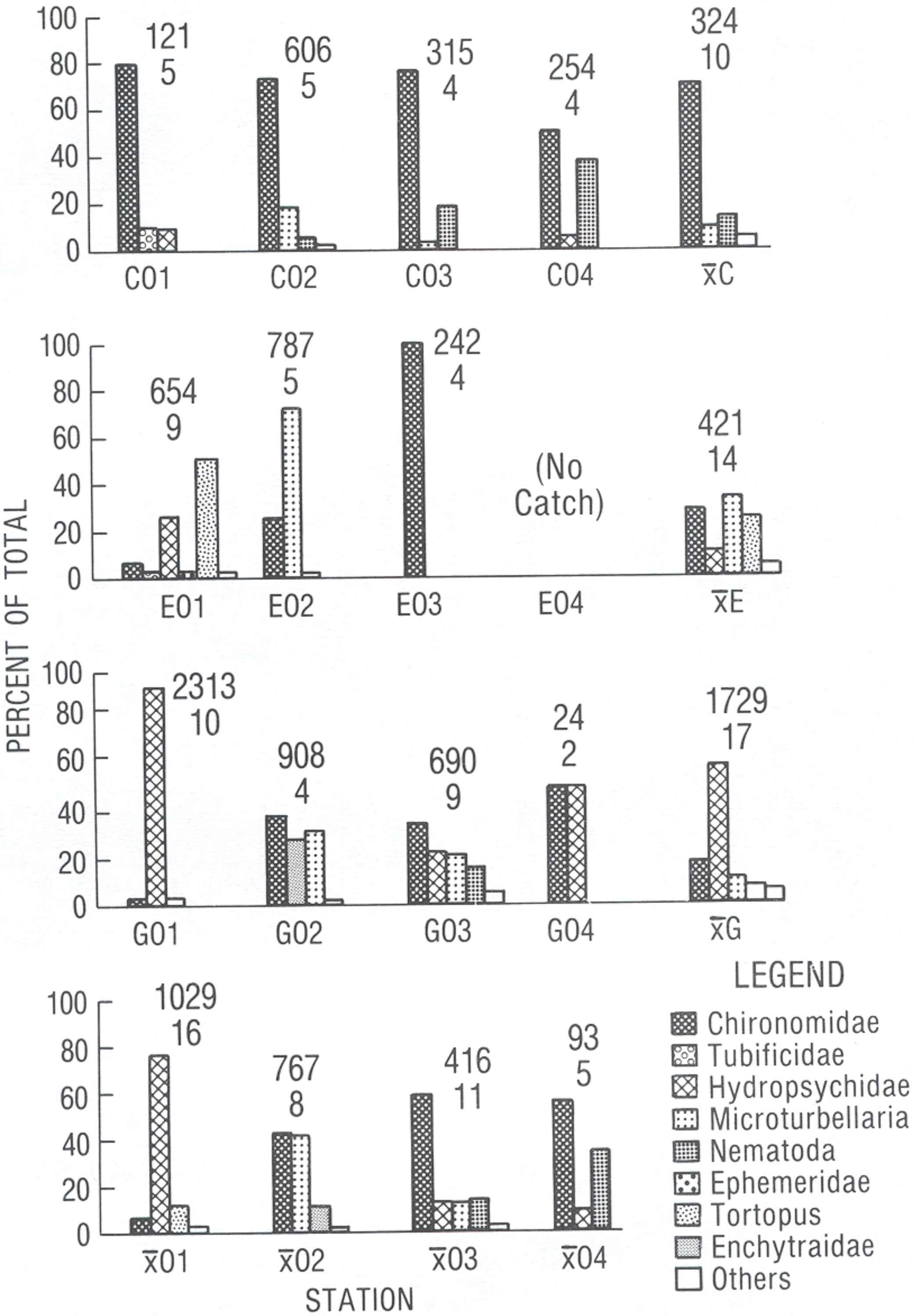

Figure 12. Macroinvertebrates collected from sediments within Island 8 secondary channel, July 1984. Upper numbers represent the mean density of macroinvertebrates per square metre calculated from two samples per station; lower numbers represent total numbers of taxa collected. Location of sampling stations is shown in Figure 3

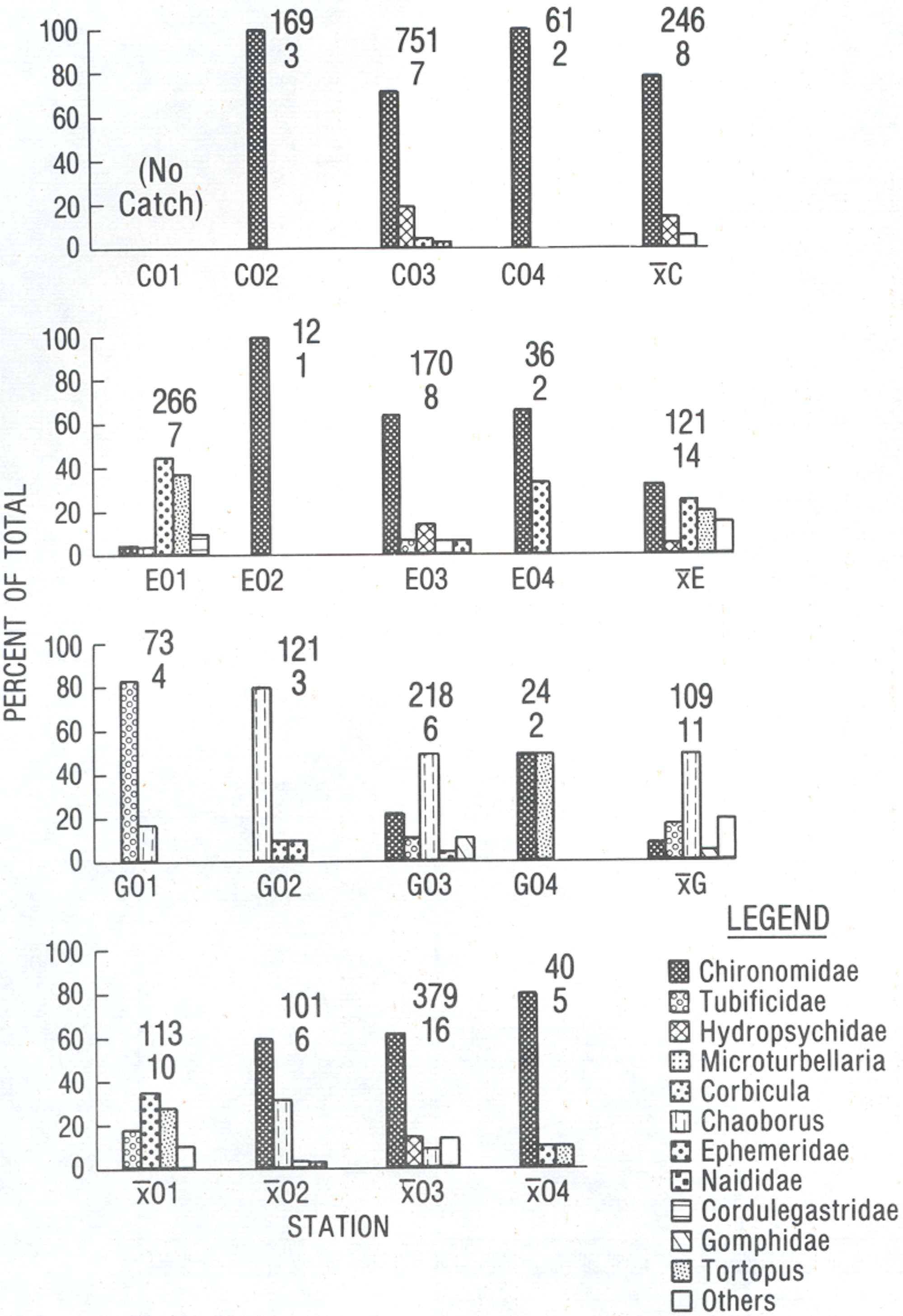

Figure 13. Macroinvertebrates collected from sediments within Lakeport Towhead secondary channel, July 1984. Upper numbers represent the mean density of macroinvertebrates per square metre calculated from two samples per station; lower numbers represent total numbers of taxa collected. Location of sampling stations is shown in Figure 4

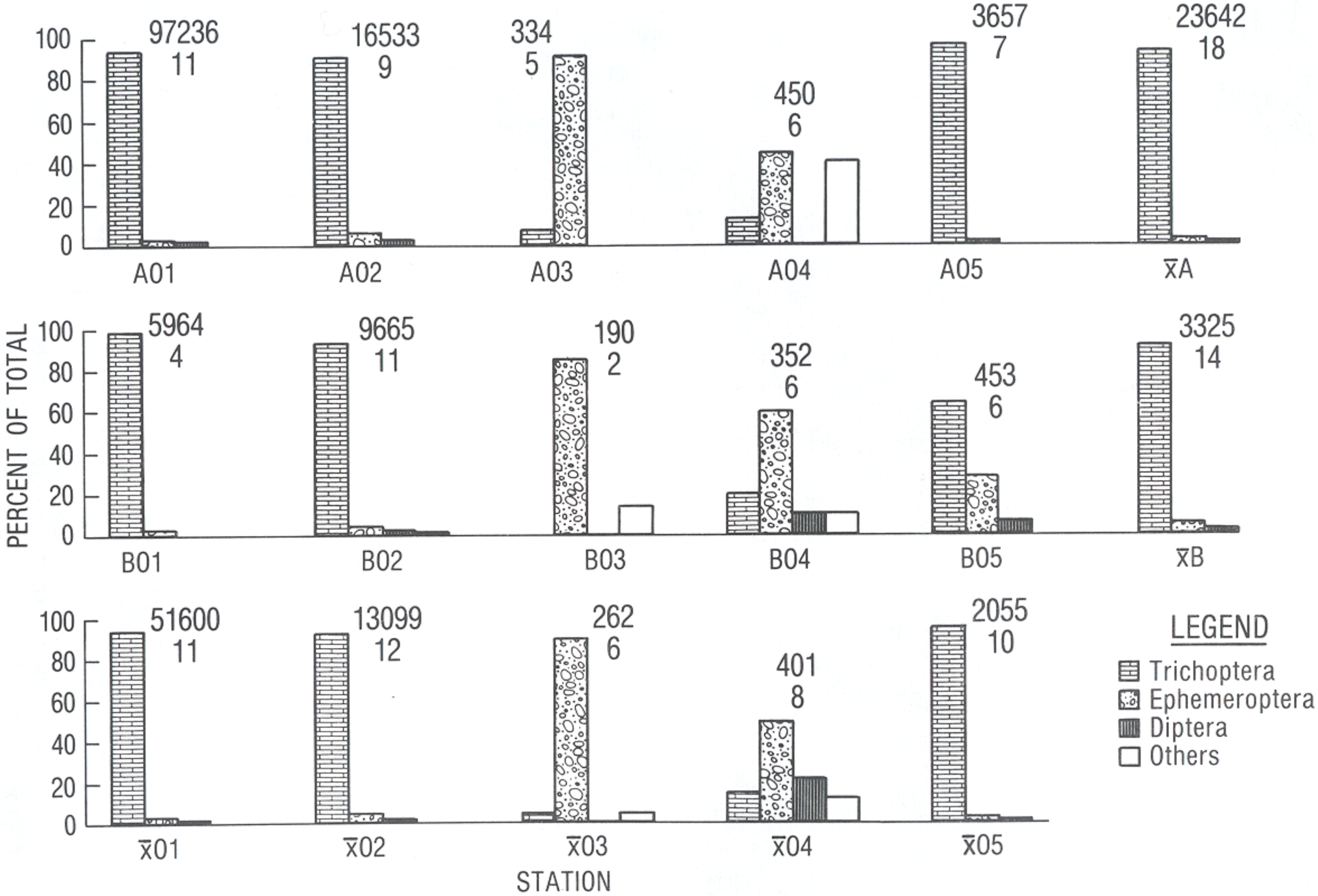

Figure 14. Macroinvertebrates collected from dikes at Lakeport Towhead secondary channel, July 1984. Upper numbers represent the mean density of macroinvertebrates per square metre calculated from two samples per station; lower numbers represent total numbers of taxa collected. Location of sampling stations is shown in Figure 4

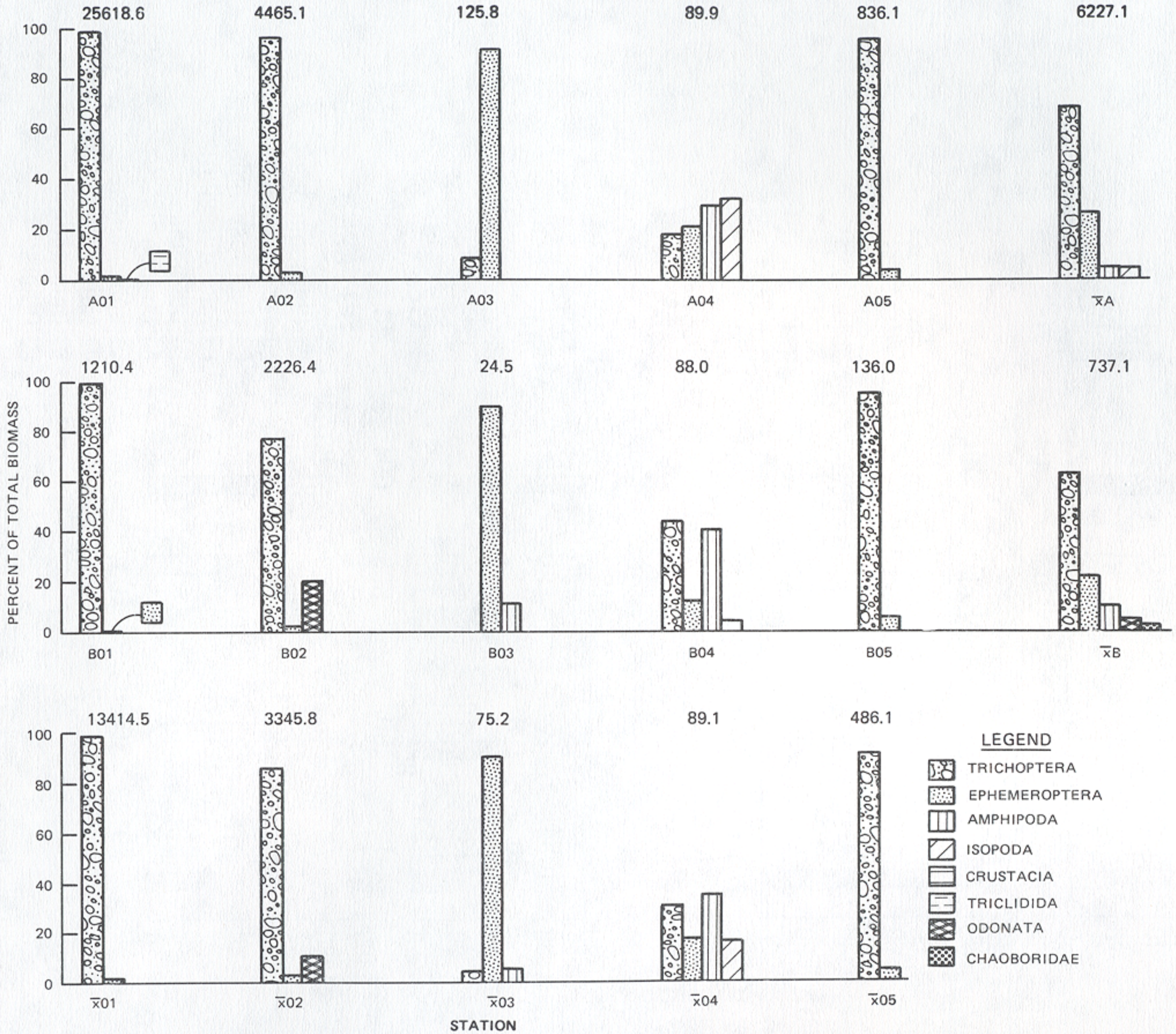

Figure 15. Dry weight biomasses of macroinvertebrates, excluding Chironomidae, collected from dikes at Lakeport Towhead secondary channel, July 1984. Numbers above histograms indicate total dry weight (grams) of sample

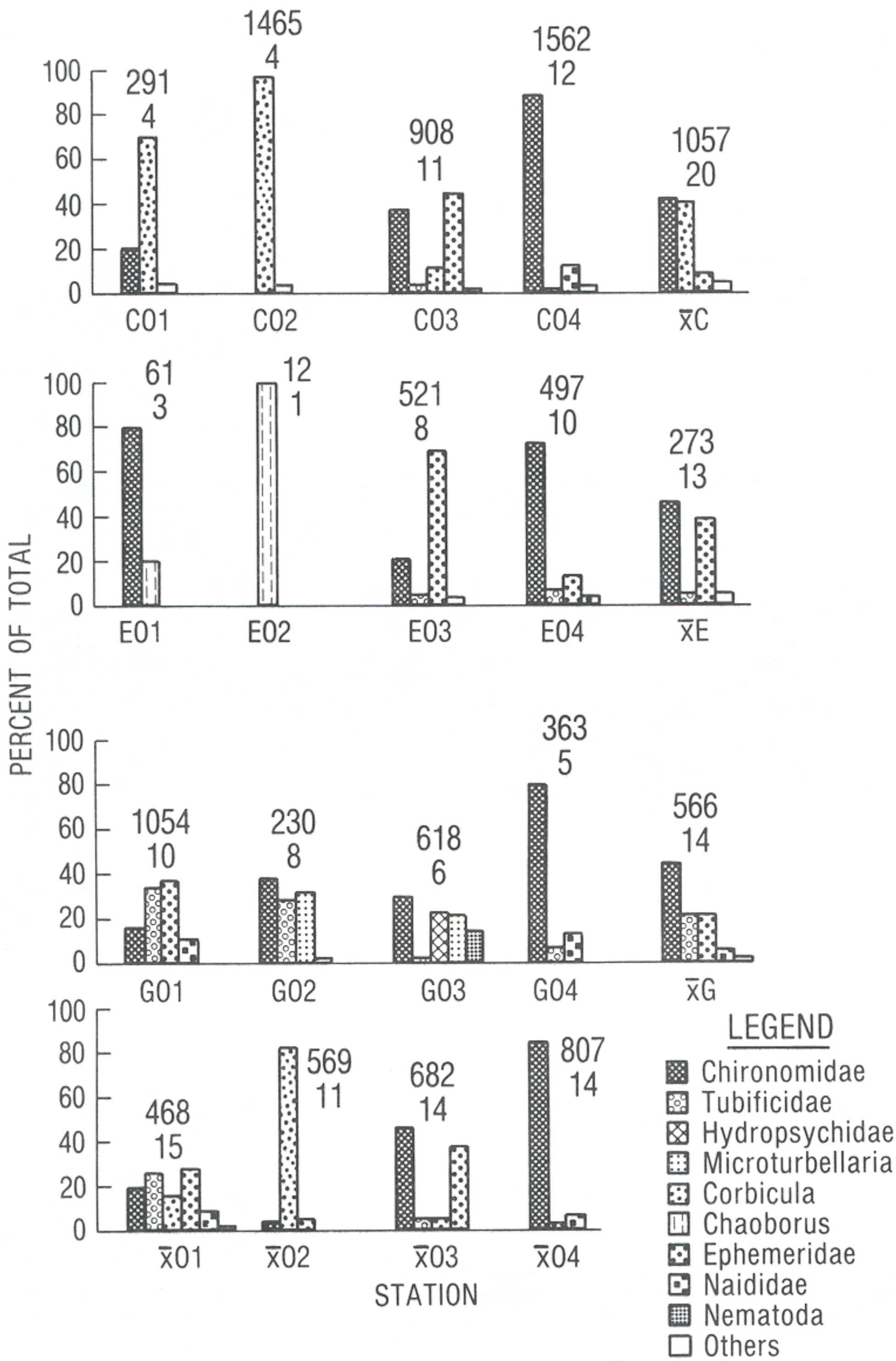

Figure 16. Macroinvertebrates collected from sediments within Lakeport Towhead secondary channel, October 1984. Upper numbers represent the mean density of macroinvertebrates per square metre calculated from two samples per station; lower numbers represent total numbers of taxa collected. Location of sampling stations is shown in Figure 4

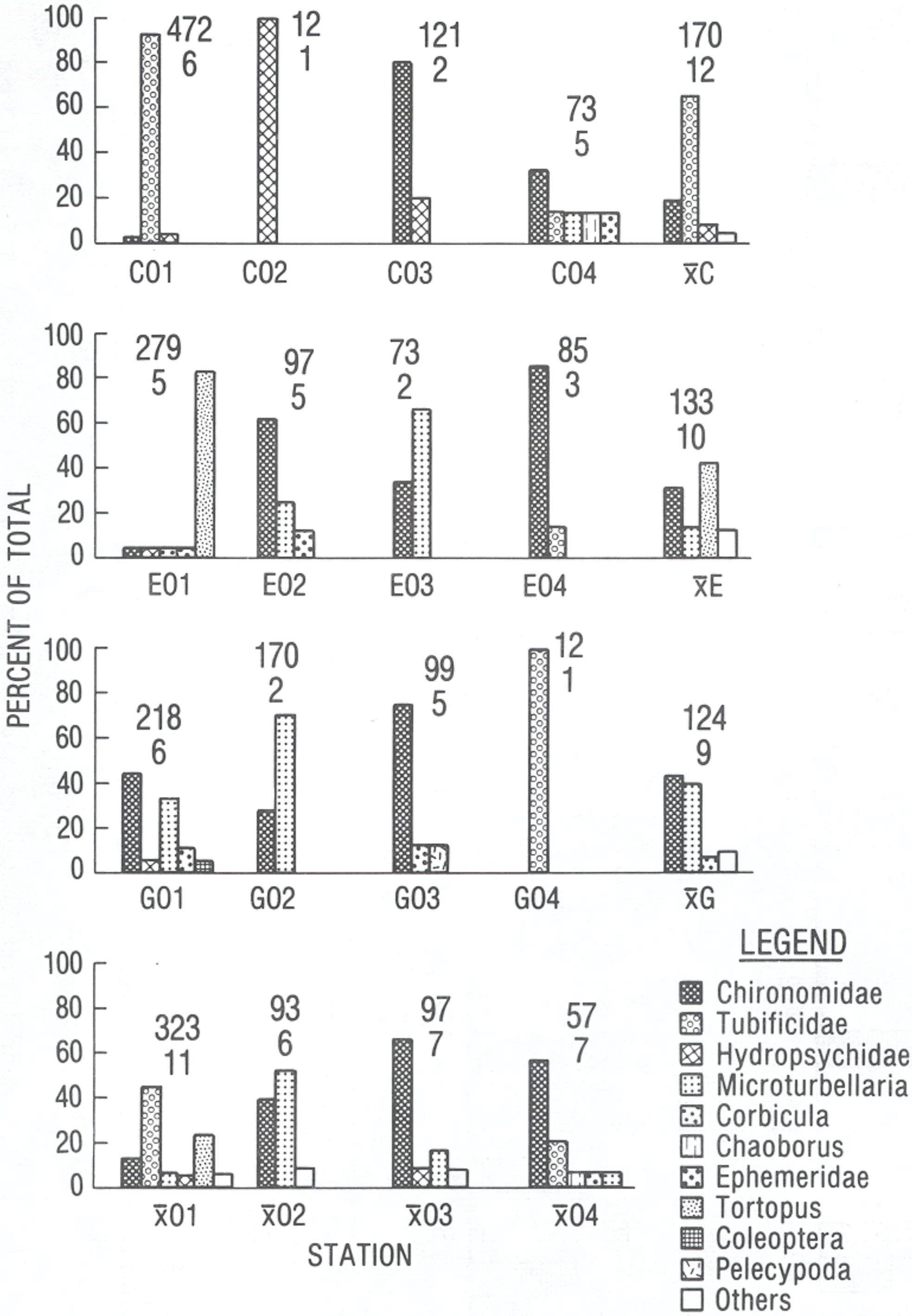

Figure 17. Macroinvertebrates collected from sediments within Cottonwood Bar secondary channel, July 1984. Upper numbers represent the mean density of macroinvertebrates per square metre calculated from two samples per station; lower numbers represent total numbers of taxa collected. Location of sampling stations is shown in Figure 5

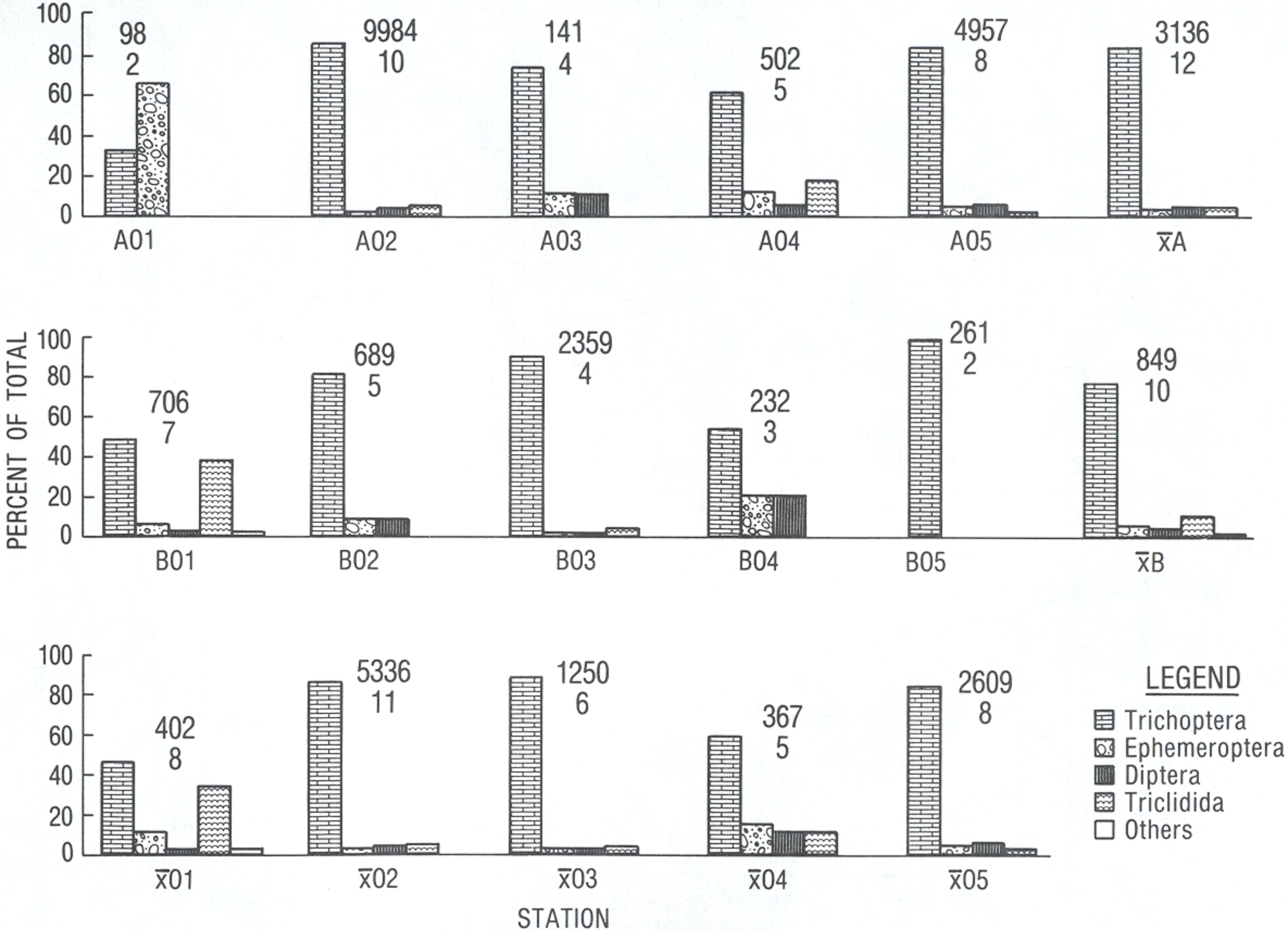

Figure 18. Macroinvertebrates collected from dikes at Cottonwood Bar secondary channel, July 1984. Upper numbers represent the mean density of macroinvertebrates per square metre calculated from two samples per station; lower numbers represent total numbers of taxa collected. Location of sampling stations is shown in Figure 5

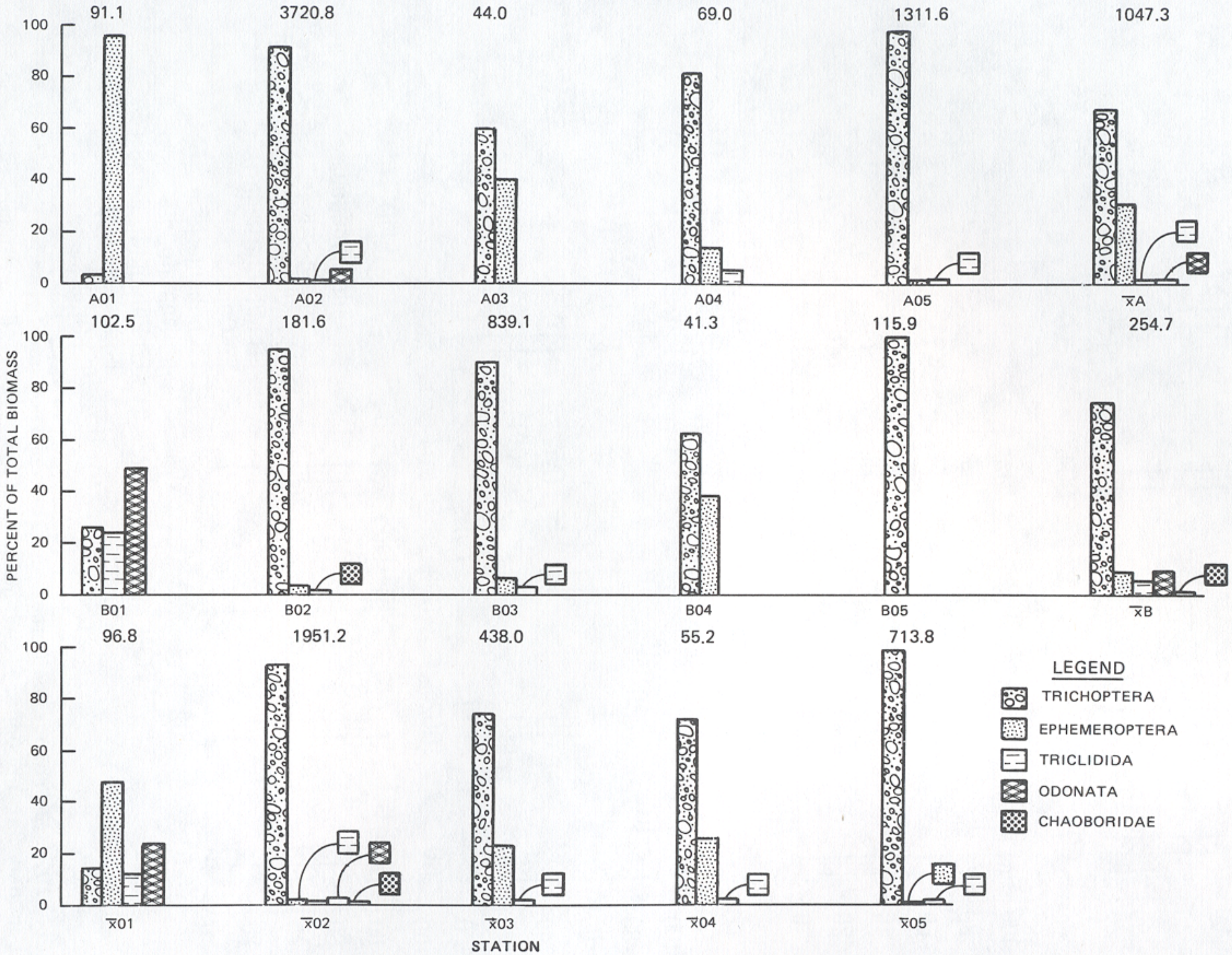

Figure 19. Dry weight biomasses of macroinvertebrates, excluding Chironomidae, collected from dikes at Cottonwood Bar secondary channel, July 1984. Numbers above histograms indicate total dry weight (grams) of sample

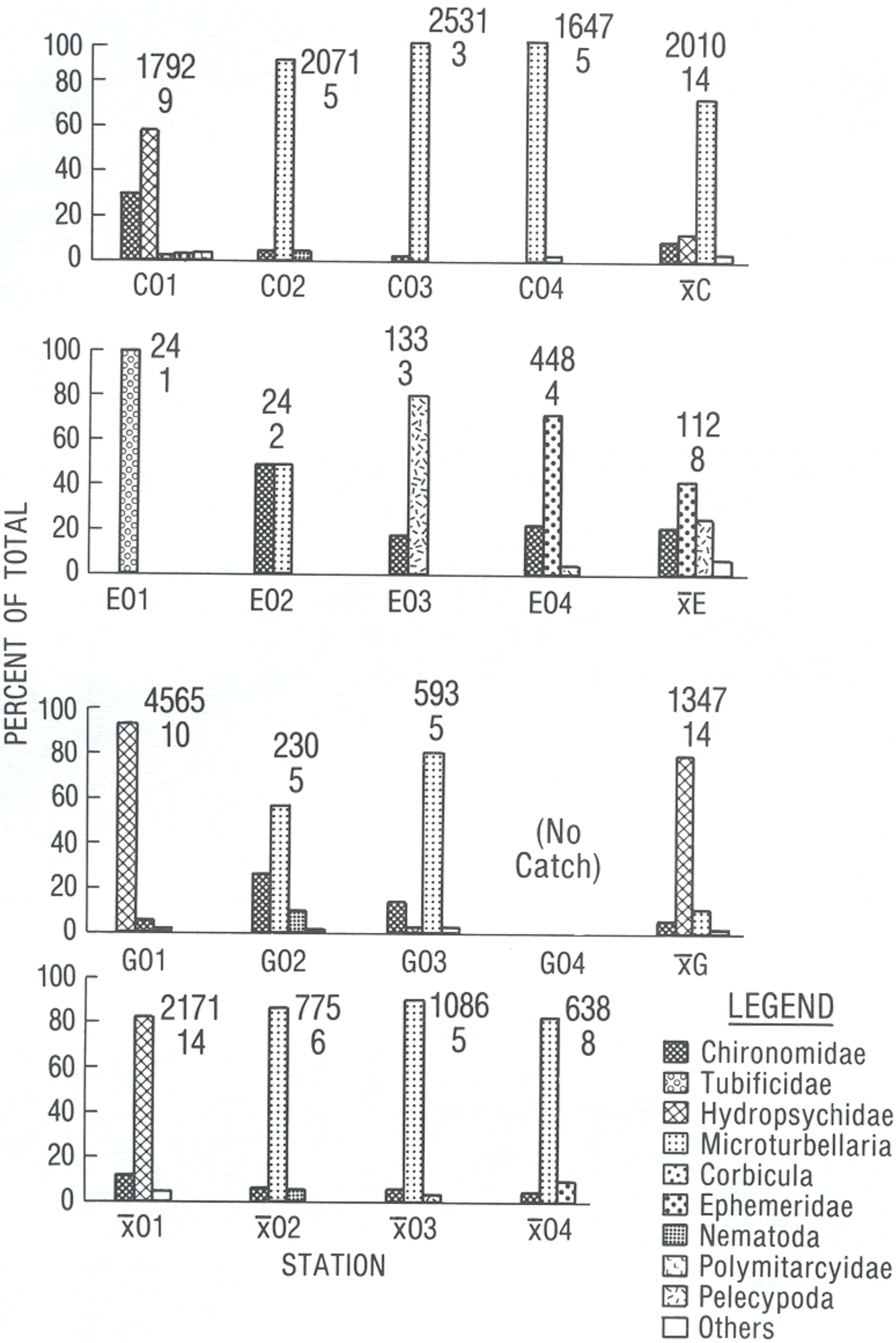

Figure 20. Macroinvertebrates collected from sediments within Cottonwood Bar secondary channel, October 1984. Upper numbers represent the mean density of macroinvertebrates per square metre calculated from two samples per station; lower numbers represent total numbers of taxa collected. Location of sampling stations is shown in Figure 5

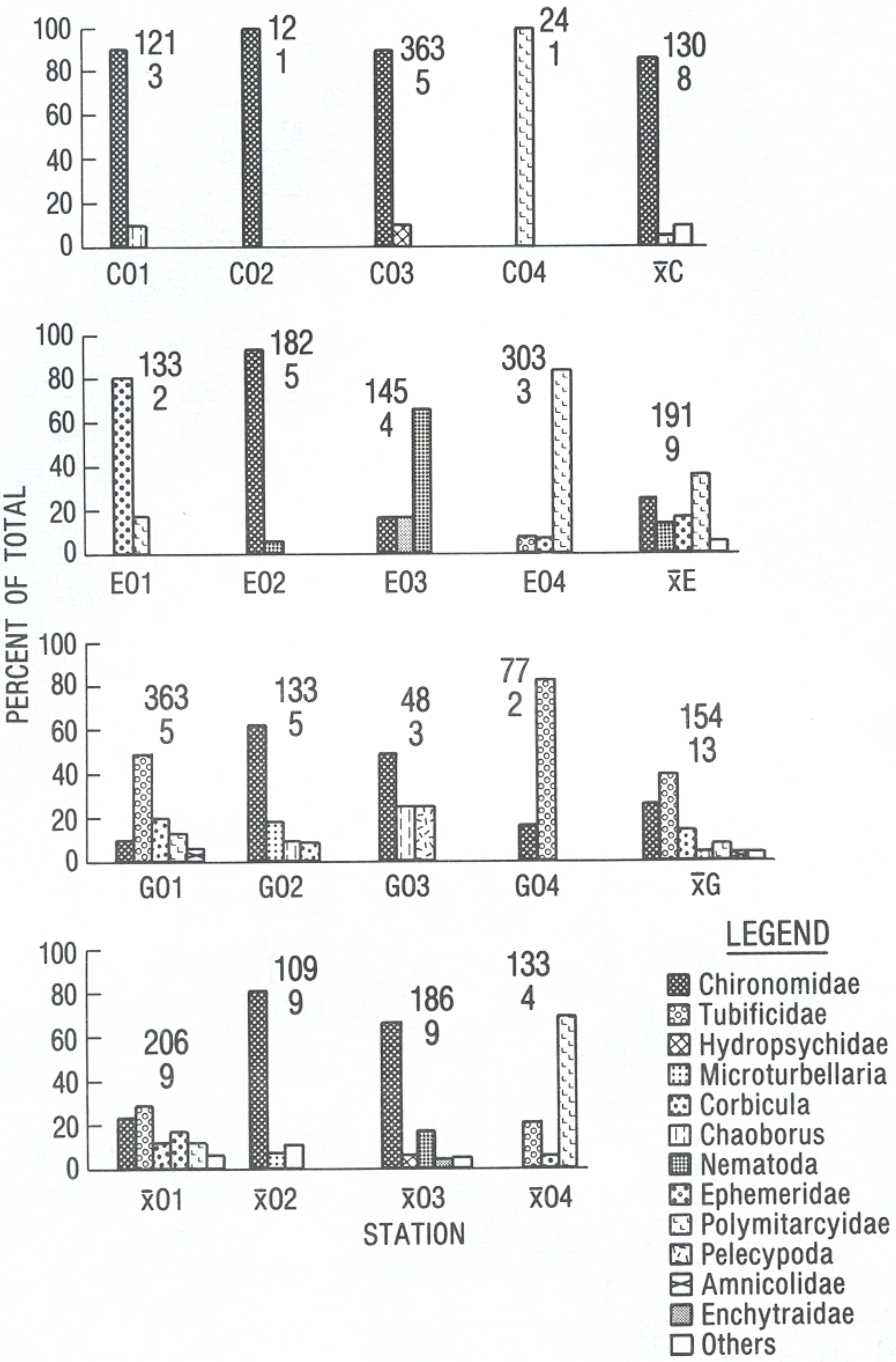

Figure 21. Macroinvertebrates collected from sediments within Profit Island secondary channel, July 1984. Upper numbers represent the mean density of macroinvertebrates per square metre calculated from two samples per station; lower numbers represent total numbers of taxa collected. Location of sampling stations is shown in Figure 6

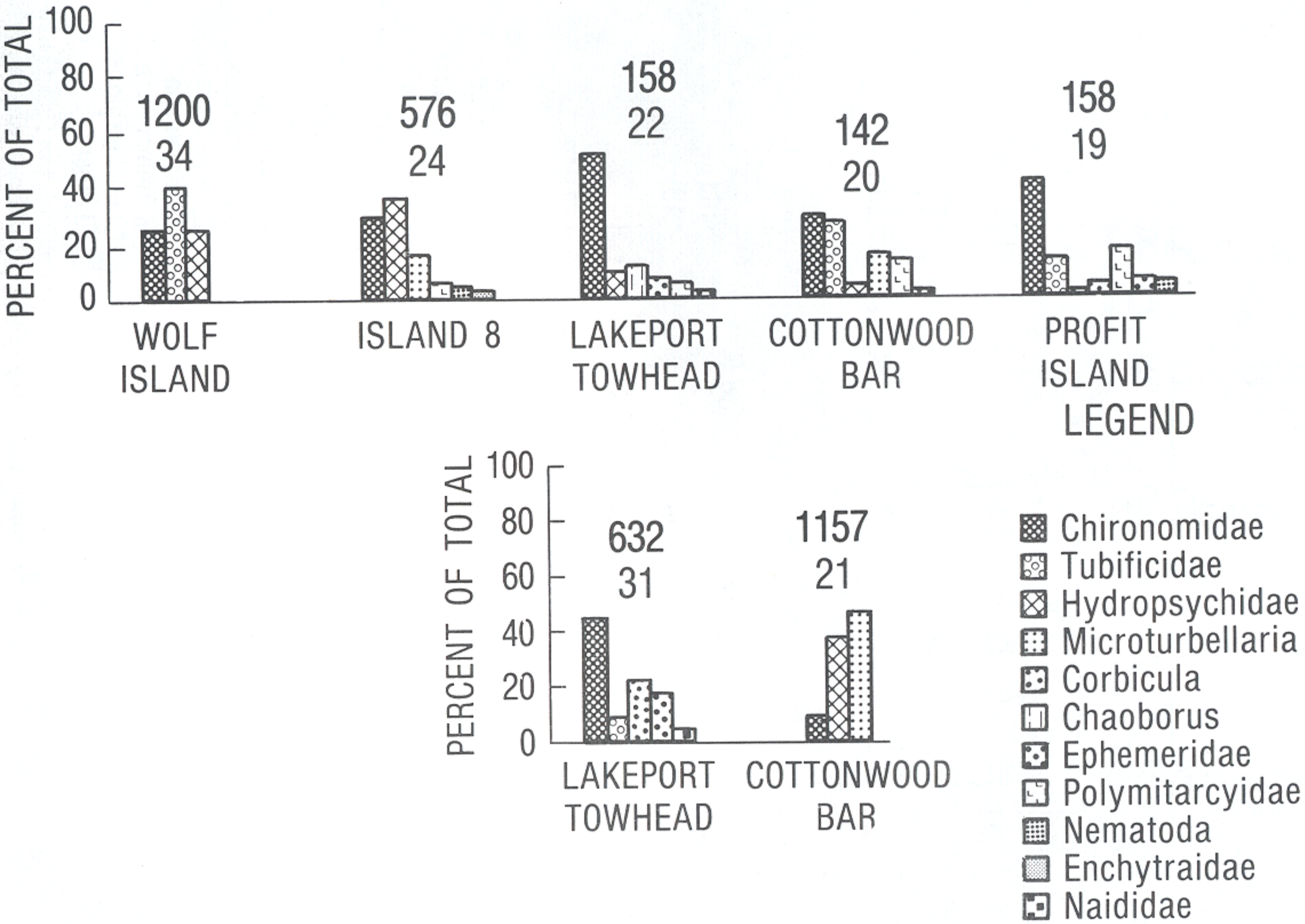

Figure 22. Composition of the macroinvertebrate assemblages collected at five Lower Mississippi River secondary channels, July and October 1984

APPENDIX A: PHYSICAL/CHEMICAL MEASUREMENTS FROM FIVE LOWER MISSISSIPPI RIVER SECONDARY CHANNELS JULY AND OCTOBER 1984

Table A1

Summary of Five Water Quality Variables Measured at Wolf Island Secondary Channel (River Mile 935) in July 1984*

Variable	Station				
	C01	C02	C03	C04	$\bar{x}$C
Temperature	27.7	27.7	27.8	27.9	27.8
Dissolved oxygen	5.2	5.5	5.4	5.6	5.5
Conductivity	403	412	425	471	428
pH	6.7	7.3	7.3	7.4	7.2
Turbidity	31	36	40	42	37
	E01	E02	E03	E04	$\bar{x}$E
Temperature	28.7	27.9	27.9	27.9	28.0
Dissolved oxygen	5.4	5.7	5.6	5.3	5.5
Conductivity	419	436	459	476	448
pH	7.5	7.4	7.4	7.1	7.3
Turbidity	47	23	52	74	49
	G01	G02	G03	G04	$\bar{x}$G
Temperature	28.2	28.1	28.1	28.0	28.1
Dissolved oxygen	5.6	5.6	5.5	5.6	5.6
Conductivity	428	450	462	482	455
pH	7.5	7.4	7.5	7.4	7.4
Turbidity	64	65	72	100	77
	$\bar{x}$01	$\bar{x}$02	$\bar{x}$03	$\bar{x}$04	Grand $\bar{x}$
Temperature	28.1	27.9	27.9	27.9	28.0
Dissolved oxygen	5.4	5.6	5.5	5.5	5.5
Conductivity	417	430	447	476	443
pH	7.2	7.4	7.4	7.3	7.3
Turbidity	47	38	52	72	53

* Units of measurement for the five variables are: temperature, °C; dissolved oxygen, mg/ℓ; conductivity, µmhos/cm; pH, standard units; turbidity, Nephelometric Turbidity Units (NTU).

Table A2

Summary of Five Water Quality Variables Measured at Island 8 Secondary Channel (River Mile 915) in July 1984*

Variable	Station C01	C02	C03	C04	$\bar{x}$C
Temperature	27.8	28.0	28.0	27.6	27.9
Dissolved oxygen	5.5	5.6	5.5	5.8	5.6
Conductivity	491	486	473	471	482
pH	7.5	7.5	7.5	7.5	7.5
Turbidity	84	84	87	87	85
	E01	E02	E03	E04	$\bar{x}$E
Temperature	27.9	28.0	27.9	27.0	27.8
Dissolved oxygen	5.3	5.6	5.6	6.0	5.6
Conductivity	491	486	473	480	483
pH	7.6	7.5	7.6	7.6	7.6
Turbidity	80	84	70	77	78
	G01	G02	G03	G04	$\bar{x}$G
Temperature	27.9	27.9	28.0	28.0	27.9
Dissolved oxygen	5.6	5.6	5.6	5.7	5.6
Conductivity	493	492	479	487	488
pH	7.6	7.6	7.6	7.5	7.6
Turbidity	84	84	84	80	83
	$\bar{x}$01	$\bar{x}$02	$\bar{x}$03	$\bar{x}$04	Grand $\bar{x}$
Temperature	27.9	27.9	28.0	27.7	27.9
Dissolved oxygen	5.4	5.6	5.6	5.8	5.6
Conductivity	492	488	475	482	484
pH	7.6	7.5	7.5	7.5	7.5
Turbidity	83	84	80	81	82

* Units of measurement for the five variables are: temperature, °C; dissolved oxygen, mg/ℓ; conductivity, μmhos/cm; pH, standard units; turbidity, Nephelometric Turbidity Units (NTU).

Table A3

Summary of Five Water Quality Variables Measured at Lakeport Towhead Secondary Channel (River Mile 528) in July 1984*

	Station				
Variable	C01	C02	C03	C04	$\bar{x}$C
Temperature	27.6	27.7	27.8	27.9	27.7
Dissolved oxygen	6.0	5.9	5.9	6.0	6.0
Conductivity	415	415	416	416	416
pH	7.5	7.5	7.5	7.6	7.5
Turbidity	117	114	117	117	116
	E01	E02	E03	E04	$\bar{x}$E
Temperature	27.9	28.0	28.1	28.5	28.1
Dissolved oxygen	5.5	5.7	5.6	5.2	5.6
Conductivity	416	417	416	418	416
pH	7.4	7.4	7.3	7.4	7.4
Turbidity	124	104	107	77	108
	G01	G02	G03	G04	$\bar{x}$G
Temperature	28.0	28.1	28.0	28.2	28.1
Dissolved oxygen	5.2	5.6	5.7	5.5	5.5
Conductivity	414	416	416	418	416
pH	7.5	7.5	7.4	7.4	7.4
Turbidity	40	39	39	28	37
	$\bar{x}$01	$\bar{x}$02	$\bar{x}$03	$\bar{x}$04	Grand $\bar{x}$
Temperature	27.8	27.9	28.0	28.2	27.9
Dissolved oxygen	5.6	5.7	5.7	5.5	5.7
Conductivity	415	416	416	418	416
pH	7.5	7.5	7.4	7.5	7.4
Turbidity	100	85	88	63	87

* Units of measurement for the five variables are: temperature, °C; dissolved oxygen, mg/ℓ; conductivity, µmhos/cm; pH, standard units; turbidity, Nephelometric Turbidity Units (NTU).

Table A4

Summary of Five Water Quality Variables Measured at Lakeport Towhead Secondary Channel (River Mile 528) in October 1984*

Variable	Station C01	C02	C03	C04	$\bar{x}$C
Temperature	21.7	21.3	2.4	21.0	21.3
Dissolved oxygen	6.6	7.5	7.8	7.3	7.4
Conductivity	481	480	486	490	486
pH	7.4	7.5	7.4	7.5	7.4
Turbidity	19	21	22	26	23
	E01	E02	E03	E04	$\bar{x}$E
Temperature	21.4	20.3	21.8	19.6	21.0
Dissolved oxygen	6.4	5.5	8.2	6.0	6.6
Conductivity	496	540	475	391	492
pH	7.6	7.6	7.5	7.5	7.5
Turbidity	43	18	17	11	25
	G01	G02	G03	G04	$\bar{x}$G
Temperature	22.5	21.7	21.5	22.0	21.9
Dissolved oxygen	7.0	6.8	6.8	6.5	6.8
Conductivity	467	480	484	477	478
pH	7.6	7.6	7.6	7.6	7.6
Turbidity	10	16	12	11	12
	$\bar{x}$01	$\bar{x}$02	$\bar{x}$03	$\bar{x}$04	Grand $\bar{x}$
Temperature	21.8	21.1	21.6	21.3	21.4
Dissolved oxygen	6.6	6.3	7.6	6.8	6.9
Conductivity	484	506	482	470	485
pH	7.6	7.6	7.5	7.5	7.5
Turbidity	28	17	17	17	20

* Units of measurement for the five variables are: temperature, °C; dissolved oxygen, mg/ℓ; conductivity, μmhos/cm; pH, standard units; turbidity, Nephelometric Turbidity Units (NTU).

Table A5

Summary of Five Water Quality Variables Measured at Cottonwood Bar Secondary Channel (River Mile 470) in July 1984*

Variable	Station				
	C01	C02	C03	C04	$\bar{x}$C
Temperature	27.7	27.9	27.8	28.1	27.8
Dissolved oxygen	6.1	5.8	5.8	5.4	5.8
Conductivity	433	435	434	434	434
pH	7.5	7.5	7.5	7.6	7.5
Turbidity	57	55	56	24	53
	E01	E02	E03	E04	$\bar{x}$E
Temperature	27.8	28.0	28.0	28.2	27.9
Dissolved oxygen	6.1	6.1	6.2	5.9	6.1
Conductivity	449	451	451	449	450
pH	8.1	7.6	7.5	7.6	7.6
Turbidity	49	48	48	46	48
	G01	G02	G03	G04	$\bar{x}$G
Temperature	27.9	28.0	27.8	28.2	28.0
Dissolved oxygen	5.8	5.9	5.8	5.6	5.8
Conductivity	450	451	450	452	451
pH	7.7	7.7	7.7	7.8	7.7
Turbidity	51	52	51	48	50
	$\bar{x}$01	$\bar{x}$02	$\bar{x}$03	$\bar{x}$04	Grand $\bar{x}$
Temperature	27.8	27.9	27.9	28.2	27.9
Dissolved oxygen	6.0	5.9	5.9	5.6	5.9
Conductivity	444	446	444	448	445
pH	7.7	7.6	7.6	7.7	7.6
Turbidity	52	52	52	43	51

* Units of measurement for the five variables are: temperature, °C; dissolved oxygen, mg/ℓ; conductivity, μmhos/cm; pH, standard units; turbidity, Nephelometric Turbidity Units (NTU).

Table A6

Summary of Five Water Quality Variables Measured at Cottonwood Bar Secondary Channel (River Mile 470) in October 1984*

Variable	Station C01	C02	C03	C04	$\bar{x}$C
Temperature	20.4	20.5	20.5	20.6	20.5
Dissolved oxygen	7.7	7.6	7.6	7.5	7.6
Conductivity	478	476	476	476	476
pH	7.2	7.2	7.3	7.1	7.2
Turbidity	31	33	32	33	33
	E01	E02	E03	E04	$\bar{x}$E
Temperature	21.2	20.4	20.4	20.7	20.6
Dissolved oxygen	6.6	7.5	7.4	7.2	7.2
Conductivity	477	462	463	463	465
pH	7.2	7.1	7.1	8.4	7.4
Turbidity	40	47	49	45	46
	G01	G02	G03	G04	$\bar{x}$G
Temperature	20.9	20.7	20.6	20.9	20.7
Dissolved oxygen	7.0	7.0	7.1	7.2	7.1
Conductivity	461	462	462	460	461
pH	7.3	7.3	7.4	7.1	7.2
Turbidity	54	57	48	43	51
	$\bar{x}$01	$\bar{x}$02	$\bar{x}$03	$\bar{x}$04	Grand $\bar{x}$
Temperature	20.7	20.5	20.5	20.7	20.6
Dissolved oxygen	7.2	7.4	7.4	7.4	7.3
Conductivity	473	466	468	468	469
pH	7.2	7.2	7.2	7.4	7.3
Turbidity	40	46	43	40	42

* Units of measurement for the five variables are: temperature, °C; dissolved oxygen, mg/ℓ; conductivity, µmhos/cm; pH, standard units; turbidity, Nephelometric Turbidity Units (NTU).

Table A7

Summary of Five Water Quality Variables Measured at Profit Island Secondary Channel (River Mile 250) in July 1984*

Variable	Station				
	C01	C02	C03	C04	$\bar{x}$C
Temperature	27.3	27.3	27.3	27.4	27.4
Dissolved oxygen	6.3	6.3	6.1	6.2	6.2
Conductivity	444	444	444	443	444
pH	7.5	7.5	7.4	7.4	7.4
Turbidity	46	53	53	51	51
	E01	E02	E03	E04	$\bar{x}$E
Temperature	27.5	27.5	27.5	27.6	27.5
Dissolved oxygen	6.1	6.0	5.1	5.2	6.0
Conductivity	444	443	443	443	443
pH	6.6	7.8	7.5	7.8	7.5
Turbidity	52	51	50	54	51
	G01	G02	G03	G04	$\bar{x}$G
Temperature	27.6	27.6	27.5	27.5	27.6
Dissolved oxygen	5.9	5.9	6.0	4.9	5.8
Conductivity	443	443	443	444	443
pH	7.6	7.6	7.4	7.6	7.5
Turbidity	51	48	48	51	49
	$\bar{x}$01	$\bar{x}$02	$\bar{x}$03	$\bar{x}$04	Grand $\bar{x}$
Temperature	27.5	27.5	27.4	27.5	27.5
Dissolved oxygen	6.1	6.0	5.1	5.6	6.0
Conductivity	444	443	443	443	443
pH	7.4	7.6	7.4	7.5	7.5
Turbidity	51	50	50	51	51

* Units of measurement for the five variables are: temperature, °C; dissolved oxygen, mg/ℓ; conductivity, μmhos/cm; pH, standard units; turbidity, Nephelometric Turbidity Units (NTU).

Table A8

Current Speeds Measured at Sampling Stations at Wolf Island Secondary Channel in July 1984*

Station				
C01	C02	C03	C04	$\bar{x}$C
(0.5).57	(0.5).87	(0.5)1.18	(0.5).98	.90
(1.0).46	(2.5).87	(3.5)1.29	(1.5).62	.81
(2.0).46	(5.0).87	(7.0) .98	(3.0).72	.76
E01	E02	E03	E04	$\bar{x}$E
(0.5).57	(0.5) .98	(0.5)1.03	(0.5).46	.76
(3.0).57	(4.5)1.03	(3.5)1.03	(2.0).21	.71
(6.0).51	(9.0) .87	(7.0) .82	(4.0).46	.67
G01	G02	G03	G04	Grand $\bar{x}$
(0.5)1.23	(0.5)1.13	(0.5)1.39	(0.5)2.32	1.52
(3.5)1.23	(1.5)1.13	(1.0)1.39	(3.0)2.06	1.45
(7.0)1.13	---	---	(6.0)1.80	1.47
$\bar{x}$01	$\bar{x}$02	$\bar{x}$03	$\bar{x}$04	Grand $\bar{x}$
.75	.97	1.14	1.07	1.01

* Depths, in parentheses, are given in metres below the surface. Currents are given in metres/second.

Table A9

Current Speeds Measured at Sampling Stations at Island 8 Secondary Channel in July 1984*

Station				
C01	C02	C03	C04	$\bar{x}$C
(0.5)1.03	(0.5)1.13	(0.5)1.29	(0.5).51	.89
(4.0) .82	(5.5)1.39	(4.5)1.13	---	1.11
(8.0) .57	(11.0)1.03	(9.0)1.13	---	.91
E01	E02	E03	E04	$\bar{x}$E
(0.5).87	(0.5)1.08	(0.5)1.08	(1.0).36	.85
(3.0).77	(3.9)1.13	(2.5)1.03	---	.98
(5.5).62	(7.8)1.13	(5.0)1.03	---	.93
G01	G02	G03	G04	$\bar{x}$G
(0.5).98	(0.5)1.03	(0.5)1.08	(0.5).67	.94
(2.0).93	(2.3)1.13	(3.0)1.13	(1.8).67	.97
(4.0).87	(4.5)1.03	(6.0) .98	(3.5).62	.88
$\bar{x}$01	$\bar{x}$02	$\bar{x}$03	$\bar{x}$04	Grand $\bar{x}$
.83	1.12	1.10	.57	.94

* Depths, in parentheses, are given in metres below the surface. Currents are given in metres/second.

Table A10

Current Speeds Measured at Sampling Stations at Lakeport Towhead Secondary Channel in July 1984*

Station				
C01	C02	C03	C04	$\bar{x}$C
(0.5).46	(0.5).57	(0.5).62	(0.5).57	.56
(1.5).41	(1.2).51	(2.2).72	---	.55
(2.5).46	(3.0).51	(4.5).67	---	.55
E01	E02	E03	E04	$\bar{x}$E
(0.5).36	(0.5).62	(0.5).46	(0.5).36	.45
(2.0).36	(6.0).57	(2.0).46	---	.46
(4.0).31	(12.0).46	(4.0).46	---	.41
G01	G02	G03	G04	$\bar{x}$G
(0.5).21	(0.5).36	(0.5).51	(0.5).36	.36
(2.0).21	(1.5).31	(3.0).41	(2.0).36	.32
---	(3.0).31	(6.0).36	---	.34
$\bar{x}$01	$\bar{x}$02	$\bar{x}$03	$\bar{x}$04	Grand $\bar{x}$
.35	.47	.52	.41	.44

* Depths, in parentheses, are given in metres below the surface. Currents are given in metres/second.

Table A11

Current Speeds Measured at Sampling Stations at Lakeport Towhead Secondary Channel in October 1984*

Station				
C01	C02	C03	C04	$\bar{x}$C
(0.5).00	(0.5).02	(0.5).02	(0.5).02	.02
---	---	(1.5).05	(1.0).05	.05
---	---	(2.5).02	(2.0).02	.02
E01	E02	E03	E04	$\bar{x}$E
(0.5).10	(0.5).05	(0.5).00	(0.5).00	.04
(4.5).10	(5.0).08	(2.0).00	---	.06
(9.0).00	(10.5).05	(4.0).05	---	.03
G01	G02	G03	G04	$\bar{x}$G
(0.5).00	(0.5).00	(0.5).00	(0.5).00	.00
(2.0).00	(3.0).00	(3.0).02	(2.0).00	.01
---	(6.0).00	(6.0).00	(3.0).00	.00
$\bar{x}$01	$\bar{x}$02	$\bar{x}$03	$\bar{x}$04	Grand $\bar{x}$
.04	.03	.02	.01	.03

* Depths, in parentheses, are given in metres below the surface. Currents are given in metres/second.

Table A12

Current Speeds Measured at Sampling Stations at Cottonwood Bar Secondary Channel in July 1984*

Station				
C01	C02	C03	C04	$\bar{x}$C
(0.5).93	(0.5).62	(0.5) .98	(0.5).10	.66
(4.0).88	(4.0).57	(1.5)1.03	---	.83
(8.5).67	(8.0).67	(3.0) .88	---	.74
E01	E02	E03	E04	$\bar{x}$E
(0.5)1.03	(0.5)1.75	(0.5)1.08	(1.0).62	1.12
(2.0)1.18	(4.5)1.65	(2.0) .93	---	1.25
(4.5) .93	(9.0)1.44	---	---	1.19
G01	G02	G03	G04	$\bar{x}$G
(0.5).98	(0.5)1.49	(0.5)1.29	(0.5).87	1.16
(1.5).87	(1.5)1.29	(2.5)1.29	(2.5).87	1.08
(3.0).77	(3.0)1.39	(5.0)1.03	(5.0).93	1.03
$\bar{x}$01	$\bar{x}$02	$\bar{x}$03	$\bar{x}$04	Grand $\bar{x}$
.92	1.21	1.06	.68	1.01

* Depths, in parentheses, are given in metres below the surface. Currents are given in metres/second.

Table A13

Current Speeds Measured at Sampling Stations at Cottonwood Bar Secondary Channel in October 1984*

Station				
C01	C02	C03	C04	$\bar{x}$C
(0.5) .98	(0.5)1.13	(0.5)1.54	(0.5)1.44	1.27
(5.0) 1.08	(2.0) .93	(2.0)1.49	(2.0)1.44	1.24
(10.0)1.03	---	(3.0)1.08	(3.0) .98	1.03
E01	E02	E03	E04	$\bar{x}$E
(0.5).26	(0.5)1.59	(0.5)1.03	(0.5).10	.75
(2.0).21	(3.0)1.44	(3.5) .82	(2.0).10	.64
---	(6.0)1.13	(7.5) .87	(3.0).10	.70
G01	G02	G03	G04	$\bar{x}$G
(1.0).72	(0.5)1.03	(1.0)1.18	(0.5).77	.93
(2.0).87	(2.0)1.08	(2.0) .93	---	.96
---	---	---	---	---
$\bar{x}$01	$\bar{x}$02	$\bar{x}$03	$\bar{x}$04	Grand $\bar{x}$
.74	1.04	1.31	.70	.90

* Depths, in parentheses, are given in metres below the surface. Currents are given in metres/second.

Table A14

Current Speeds Measured at Sampling Stations at Profit Island Secondary Channel in July 1984*

Station				
C01	C02	C03	C04	$\bar{x}$C
(0.5).93	(0.5)1.08	(0.5) .51	(0.5)1.90	1.00
---	---	(5.5) .93	(3.5)1.85	1.22
---	---	(11.0)1.03	(7.5)1.13	1.08
E01	E02	E03	E04	$\bar{x}$E
(0.5)1.08	(0.5)1.18	(0.5)1.34	(0.5).26	.97
(4.5)1.18	(7.5)1.08	(4.0)1.29	---	1.18
(9.0) .51	(15.0) .87	(8.5) .98	---	.79
G01	G02	G03	G04	$\bar{x}$G
(0.5).51	(0.5).98	(0.5)1.18	(0.5).15	.71
(2.5).67	(3.0)1.08	(3.5)1.03	(1.5).15	.73
(4.5).51	(6.5) .82	(7.0) .93	---	.75
$\bar{x}$01	$\bar{x}$02	$\bar{x}$03	$\bar{x}$04	Grand $\bar{x}$
.77	1.01	1.02	.91	.93

* Depths, in parentheses, are given in metres below the surface. Currents are given in metres/second.

APPENDIX B: FISH POPULATION DATA COLLECTED FROM FIVE LOWER MISSISSIPPI RIVER SECONDARY CHANNELS, JULY AND OCTOBER 1984

Table B1

Numbers and Weights of Fish Collected by Electroshocker at Wolf Island Secondary Channel

July 1984

Species	Natural Bank		Secondary Channel Sandbar		Main Channel Sandbar		Total		Percent of Total	
	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight
Longnose gar	1	1.800	2	3.161	2	3.610	5	8.571	4.5	18.2
Shortnose gar			1	0.457			1	0.457	0.9	1.0
Skipjack herring	2	0.005					2	0.005	1.8	0.0
Gizzard shad	3	0.135	1	0.154			4	0.289	3.6	0.6
Goldeye				0.004	1	0.110	2	0.114	1.8	0.2
Common carp	1	1.204	2	7.760	1	1.089	4	10.053	3.6	21.3
Silver chub						0.021	1	0.021	0.9	0.0
River carpsucker	1	0.362					1	0.362	0.9	0.8
Bigmouth buffalo	1	0.036					1	0.036	0.9	0.1
Blue catfish	1	0.025	2	3.160	2	0.274	5	3.459	4.5	7.3
Channel catfish	24	4.942	12	3.062	7	0.065	43	8.069	38.4	17.1
Flathead catfish	13	3.675	12	1.805	8	8.571	33	14.051	29.5	29.8
White bass	2	0.725					2	0.725	1.8	1.5
Sauger			1	0.560			1	0.560	0.9	1.2
Freshwater drum	5	0.394	1	0.051	1	0.002	7	0.447	6.3	0.9
Total	54	13.303	35	20.174	23	13.742	112	47.219		
Units of Effort	3	3	3	3	3	3	9	9		
Catch per Unit Effort	18.0	4.434	11.7	6.724	7.7	4.581	12.4	5.246		

Table B2

Numbers and Weights of Fish Collected by Seine at Wolf Island Secondary Channel

July 1984

Species	Natural Bank		Secondary Channel Sandbar		Main Channel Sandbar		Total		Percent of Total	
	Number	Weight g	Number	Weight g	Number	Weight g	Number	Weight g	Number	Weight
Shortnose gar			1	280.0			1	280.0	0.2	56.7
Skipjack herring	7	3.2	1	0.3	4	2.3	12	5.8	2.0	1.2
Gizzard shad	4	1.1	2	3.1			6	4.2	1.0	0.9
Threadfin shad			1	0.8	3	1.9	4	2.7	0.7	0.5
Goldeye			4	9.5	1	2.9	5	12.4	0.8	2.5
Mississippi silvery minnow	1	0.3			10	8.1	11	8.4	1.9	1.7
Silver chub	14	4.9	2	1.4	7	4.3	23	10.6	3.9	2.1
Hybopsis sp.	1	0.1					1	0.1	0.2	0.0
Emerald shiner	157	50.6	224	36.1	76	19.8	457	106.5	77.5	21.6
River shiner	2	3.4	10	1.7	2	3.3	14	8.4	2.4	1.7
Silverband shiner	2	4.0	3	6.7			5	10.7	0.8	2.2
Notropis sp.	2	0.2					2	0.2	0.3	0.0
Smallmouth buffalo	1	1.1					1	1.1	0.2	0.2
Ictiobus sp.					1	0.9	1	0.9	0.2	0.2
Channel catfish	8	6.2	6	7.1	4	2.3	18	15.6	3.1	3.2
White bass	6	13.2					6	13.2	1.0	2.7
Bluegill	1	0.4					1	0.4	0.2	0.1

(Continued)

Table B2 (Concluded)

Species	Natural Bank Number	Natural Bank Weight g	Secondary Channel Sandbar Number	Secondary Channel Sandbar Weight g	Main Channel Sandbar Number	Main Channel Sandbar Weight g	Total Number	Total Weight g	Percent of Total Number	Percent of Total Weight
Centrarchidae	1	0.1					1	0.1	0.2	0.0
River darter	1	0.7					1	0.7	0.2	0.1
Freshwater drum	15	10.0	3	1.2	2	0.9	20	12.1	3.4	2.4
Total	223	99.5	257	347.9	110	46.7	590	494.1		
Units of Effort	5	5	5	5	3	3	13	13		
Catch per Unit Effort	44.6	19.90	51.4	69.58	36.7	15.57	45.4	38.01		

Table B3

Numbers and Target Strengths of Fish Detected with Hydroacoustics from Transects and Microhabitats at Wolf Island

Transects	Number of Fish per 100 m^3	Mean Target Strength db
C01	20.4	-50.8
C01-C04	0.6	-53.3
C04	0.6	-55.9
$\bar{x}$ of C	7.2	-53.3
D01	0.4	-50.1
D01-D04	0.7	-54.0
D04	1.6	-48.4
$\bar{x}$ of D	0.9	-50.8
E01	3.1	-43.3
E01-E04	0.5	-52.4
E04	4.8	-45.2
$\bar{x}$ of E	2.8	-47.0
F01	1.3	-47.7
F01-F04	0.1	-52.0
F04	1.1	-43.9
$\bar{x}$ of F	0.8	-47.9
G01	0.8	-51.3
G01-G04	1.0	-51.7
G04	0.8	-46.7
$\bar{x}$ of G	0.9	-49.9
Microhabitat		
Natural bank	5.2	-48.6
Secondary channel sandbar	1.8	-52.7
Channel	0.6	-48.0
Mean	2.5	-50.6

Table B4

Numbers and Weights of Fish Collected by Electroshocker at Island 8 Secondary Channel

July 1984

	Natural Bank		Secondary Channel Sandbar		Main Channel Sandbar		Total		Percent of Total	
Species	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight
Longnose gar					1	0.597	1	0.597	1.0	2.6
Shortnose gar	6	2.794	2	0.485			8	3.279	7.9	14.0
Skipjack herring					1	0.003	1	0.003	1.0	0.0
Gizzard shad	17	1.576	7	0.313	2	0.095	26	1.984	25.7	8.5
Goldeye	4	0.257	5	0.019	2	0.006	11	0.282	10.9	1.2
Common carp	3	6.900			1	1.750	4	8.650	4.0	37.0
River carpsucker					2	1.629	2	1.629	2.0	7.0
Blue catfish	1	0.056					1	0.056	1.0	0.2
Channel catfish	2	0.013	13	2.478	5	0.109	20	2.600	19.8	11.1
Flathead catfish	7	1.087	2	0.501	11	1.904	20	3.492	19.8	14.9
White bass					2	0.433	2	0.433	2.0	1.9
Sauger			1	0.093	1	0.007	2	0.100	2.0	0.4
Freshwater drum	2	0.267			1	0.027	3	0.294	3.0	1.3
Total	42	12.950	30	3.889	29	6.560	101	23.399		
Units of Effort	3	3	3	3	3	3	9	9		
Catch per Unit Effort	14.0	4.317	10.0	1.296	9.7	2.187	11.2	2.600		

Table B5

Numbers and Weights of Fish Collected by Seine at Island 8 Secondary Channel

July 1984

Species	Natural Bank Number	Natural Bank Weight g	Secondary Channel Sandbar Number	Secondary Channel Sandbar Weight g	Main Channel Sandbar Number	Main Channel Sandbar Weight g	Total Number	Total Weight g	Percent of Total Number	Percent of Total Weight
Skipjack herring			7	12.6	4	1.3	11	13.9	3.7	9.4
Gizzard shad			12	27.8			12	27.8	4.0	18.7
Threadfin shad			4	3.4	8	5.9	12	9.3	4.0	6.3
Mississippi silvery minnow			2	1.7	3	2.7	5	4.4	1.7	3.0
Silver chub			4	2.6			4	2.6	1.3	1.7
Emerald shiner			118	23.9	120	45.5	238	69.4	80.1	46.7
River shiner			5	7.8	3	3.4	8	11.2	2.7	7.5
Silverband shiner					1	1.3	1	1.3	0.3	0.9
River carpsucker			1	1.0			1	1.0	0.3	0.7
Brook silverside			1	0.3			1	0.3	0.3	0.2
White bass			2	4.7	1	1.8	3	6.5	1.0	4.4
Freshwater drum					1	0.9	1	0.9	0.3	0.6
Total			156	85.8	141	62.8	297	148.6		
Units of Effort			5	5	3	3	8	8		
Catch per Unit Effort			31.2	17.16	47.0	20.93	37.1	18.58		

Table B6

Numbers and Target Strengths of Fish Detected with Hydroacoustics from Transects and Microhabitats at Island 8

Transects	Number of Fish per 100 m^3	Mean Target Strength db
C01	1.0	-43.3
C01-C04	0.2	-51.4
C04	4.2	*
$\bar{x}$ of C	1.8	47.4
D01	3.0	-45.7
D01-D04	0.4	-54.6
D04	4.5	*
$\bar{x}$ of D	2.6	-50.3
E01	4.3	-47.5
E01-E04	1.2	-54.8
E04	0.7	-43.5
$\bar{x}$ of E	2.1	
F01	1.6	-42.4
F01-F04	0.3	-56.6
F04	1.5	-48.1
$\bar{x}$ of F	1.1	-48.6
G01	2.5	-46.9
G01-G04	1.8	-54.4
G04	1.3	-41.1
$\bar{x}$ of G	1.9	-47.5
Microhabitat		
Natural bank	2.5	-45.4
Secondary channel sandbar	1.7	-42.6
Channel	0.7	-54.5
Mean	1.9	-48.5

* Insufficient data.

Table B7

Numbers and Weights of Fish Collected by Electroshocker at Lakeport Towhead Secondary Channel

July 1984

Species	Natural Bank Number	Natural Bank Weight kg	Secondary Channel Sandbar Number	Secondary Channel Sandbar Weight kg	Main Channel Sandbar Number	Main Channel Sandbar Weight kg	Dike Number	Dike Weight kg	Total Number	Total Weight kg	Percent of Total Number	Percent of Total Weight
Paddlefish					1	2.020			1	2.020	0.9	6.0
Longnose gar	1	0.360	3	2.413					4	2.773	3.4	8.3
Shortnose gar			1	1.485					1	1.485	0.9	4.4
Emerald shiner			1	0.002					1	0.002	0.9	0.0
River carpsucker			3	1.669					3	1.669	2.6	5.0
Blue catfish	30	0.807	5	0.065	3	0.245	10	0.308	48	1.425	41.4	4.2
Channel catfish	1	0.006					2	0.010	3	0.016	2.6	0.0
Flathead catfish	9	3.316	4	2.256	4	1.083	29	13.785	46	20.440	39.7	60.9
White bass							1	1.230	1	1.230	0.9	3.7
Bluegill					1	0.025			1	0.025	0.9	0.1
White crappie	1	0.505							1	0.505	0.9	1.5
Sauger			1	0.070	1	0.690			2	0.760	1.7	2.3
Freshwater drum							4	1.217	4	1.217	3.4	3.6
Total	42	4.994	18	7.960	10	4.063	46	16.550	116	33.567		
Units of Effort	3	3	3	3	3	3	4	4	13	13		
Catch per Unit Effort	14.0	1.665	6.0	2.654	3.3	1.354	11.5	4.138	9.0	2.582		

Table B8

Numbers and Weights of Fish Collected by Electroshocker at Lakeport Towhead Secondary Channel

October 1984

Species	Natural Bank		Secondary Channel Sandbar		Main Channel Sandbar		Dike		Total		Percent of Total	
	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight
Shortnose gar							1	0.390	1	0.390	0.1	0.6
Skipjack herring	4	0.140	1	0.098	1	0.011	92	2.251	98	2.500	8.9	4.1
Gizzard shad	164	4.722	318	9.052	70	3.901	130	6.323	682	23.998	62.2	39.5
Threadfin shad	17	0.098	146	0.601	8	0.148	80	0.836	251	1.683	22.9	2.8
Goldeye	1	0.021			2	0.243			3	0.264	0.3	0.4
Common carp	1	2.370					1	3.250	2	5.620	0.2	9.3
Emerald shiner							2	0.007	2	0.007	0.2	0.0
River carpsucker	1	0.031					3	0.376	4	0.407	0.4	0.7
Blue sucker					1	3.382	1	1.075	2	4.457	0.2	7.3
Smallmouth buffalo					1	1.122	2	3.207	3	4.327	0.3	7.1
Bigmouth buffalo	2	3.038							2	3.038	0.2	5.0
Blue catfish					1	0.549	2	0.118	3	0.667	0.3	1.1
Channel catfish					1	0.177			1	0.177	0.1	0.3
Flathead catfish	1	0.600					5	1.198	6	1.798	0.5	3.0
White bass	4	0.327	7	1.500	2	0.203	11	4.255	24	6.285	2.2	10.3

(Continued)

Table B8 (Concluded)

Species	Natural Bank		Secondary Channel Sandbar		Main Channel Sandbar		Dike		Total		Percent of Total	
	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight
Striped bass			1	0.872					1	0.872	0.1	1.4
Bluegill							1	0.170	1	0.170	0.1	0.3
Largemouth bass							2	1.014	2	1.014	0.2	1.7
Black crappie							1	0.436	1	0.436	0.1	0.7
Sauger	2	0.525	2	0.168					4	0.693	0.4	1.1
Striped mullet			1	0.440			3	1.500	4	1.940	0.4	3.2
Total	196	11.842	477	12.761	87	9.736	337	26.406	1097	60.745		
Units of Effort	3	3	3	3	3	3	3	3	12	12		
Catch per Unit Effort	65.3	3.947	159.0	4.254	29.0	3.245	112.3	8.802	91.4	5.062		

Table B9

Numbers and Weights of Fish Collected by Seine at Lakeport Towhead Secondary Channel

July 1984

Species	Natural Bank		Secondary Channel Sandbar		Main Channel Sandbar		Dike		Total		Percent of Total	
	Number	Weight g	Number	Weight g	Number	Weight g	Number	Weight g	Number	Weight g	Number	Weight
Skipjack herring	2	0.3					2	1.1	4	1.4	0.6	0.3
Gizzard shad	4	5.5	19	37.0			1	2.1	24	44.6	3.7	10.5
Threadfin shad	11	5.7	2	0.6					13	6.3	2.0	1.5
Goldeye	4	10.8							4	10.8	0.6	2.5
Common carp	1	10.2							1	10.2	0.2	2.4
Mississippi silvery minnow	6	4.2	8	5.2	1	0.9	13	10.8	28	21.1	4.3	5.0
Speckled chub	3	0.3					1	0.1	4	0.4	0.6	0.1
Silver chub	56	12.9	7	3.3			6	3.5	69	19.7	10.6	4.6
Emerald shiner	113	21.5	26	6.7	5	1.1	9	4.5	153	38.8	23.4	7.9
River shiner	2	5.2	14	34.4	4	9.2	10	21.6	30	70.4	4.6	16.6
Silverband shiner	8	9.4					2	4.8	10	14.2	1.5	3.3
Weed shiner	28	8.5							28	8.5	4.3	2.0
Blacktail shiner	3	2.5							3	2.5	0.5	0.6
Mimic shiner	109	27.1	1	0.1	2	0.4	39	27.6	151	55.2	23.1	13.0
Bullhead minnow	5	3.5							5	3.5	0.8	0.8

(Continued)

Table B9 (Concluded)

Species	Natural Bank Number	Natural Bank Weight g	Secondary Channel Sandbar Number	Secondary Channel Sandbar Weight g	Main Channel Sandbar Number	Main Channel Sandbar Weight g	Dike Number	Dike Weight g	Total Number	Total Weight g	Percent of Total Number	Percent of Total Weight
River carpsucker					1	34.2	1	10.7	2	44.9	0.3	10.6
Catostomidae	1	0.2							1	0.2	0.2	0.0
Blue catfish	9	14.4							9	14.4	1.4	3.4
Channel catfish	7	4.5	3	3.4			8	10.0	18	17.9	2.8	4.2
Brook silverside					1	0.4			1	0.4	0.2	0.1
Inland silverside	19	5.2	15	6.0	33	15.7	4	1.2	71	28.1	10.9	6.6
White bass	3	8.4							3	8.4	0.5	2.0
Bluegill	2	0.4							2	0.4	0.3	0.1
Lepomis sp.	11	1.3							11	1.3	1.7	0.3
bluntnose darter	1	0.2							1	0.2	0.2	0.0
River darter	1	0.3	1	0.2					2	0.5	0.3	0.1
Freshwater drum	2	1.2	2	4.5			1	0.3	5	6.0	0.8	1.4
Total	411	163.7	98	101.4	47	61.9	97	98.3	653	425.3		
Units of Effort	5	5	5	5	3	3	6	6	19	19		
Catch per Unit Effort	82.2	32.74	19.6	20.28	15.7	20.63	16.2	16.38	34.4	22.38		

Table B10

Numbers and Weights of Fish Collected by Seine at Lakeport Towhead Secondary Channel

October 1984

Species	Natural Bank		Secondary Channel Sandbar		Main Channel Sandbar		Dike		Total		Percent of Total	
	Number	Weight g	Number	Weight g	Number	Weight g	Number	Weight g	Number	Weight g	Number	Weight
Gizzard shad	7	48.2	5	40.9	2	8.3	3	16.5	17	113.9	3.3	14.5
Threadfin shad	84	186.9	39	92.6	2	3.8		12.5	125	283.3	24.0	36.2
Emerald shiner	28	42.1	51	75.7	6	11.3	28	62.5	113	191.6	21.7	24.5
River shiner	4	0.4	6	3.6	4	5.7	3	2.3	17	12.0	3.3	1.5
Silverband shiner	45	7.3	33	4.8			41	11.1	119	23.2	22.9	3.0
Blacktail shiner	38	11.0	2	0.5	1	0.3	4	1.6	45	13.4	8.7	1.7
Mimic shiner	3	0.3	2	0.2	4	0.4			9	0.9	1.7	0.1
Bullhead minnow	1	0.2					1	0.1	2	0.3	0.4	0.0
Blackstripe topminnow	1	1.5	1	0.7					2	2.2	0.4	0.3
Brook silverside	7	17.8	1	2.4					8	20.2	1.5	2.6
Inland silverside	14	22.4	33	65.6	2	3.7	14	30.6	63	122.3	12.1	15.6
Total	232	338.1	173	287.0	21	33.5	94	124.7	520	783.3		
Units of Effort	5	5	5	5	3	3	5	5	18	18		
Catch per Unit Effort	46.4	67.62	34.6	57.4	7.0	11.17	18.8	24.94	28.9	43.52		

Table B11

Numbers and Target Strengths of Fish Detected with Hydroacoustics from Transects and Microhabitats at Lakeport Towhead

Transects	Number of Fish per 100 m^3	Mean Target Strength db
C01	2.1	-44.9
C01-C04	0.8	-44.4
C04	0.6	-38.3
$\bar{x}$ of C	1.2	-42.5
D01	4.9	-48.6
D01-D04	*	*
D04	2.2	-50.8
$\bar{x}$ of D	3.6	-49.7
E01	6.3	-48.8
E01-E04	1.1	-49.2
E04	0.5	-52.0
$\bar{x}$ of E	2.6	-50.0
F01	9.7	-48.5
F01-F04	1.1	-40.2
F04	0.9	-47.4
$\bar{x}$ of F	3.9	-45.7
G01	15.2	-48.8
G01-G04	1.1	-46.2
G04	2.1	-51.4
$\bar{x}$ of G	6.1	-48.8
Microhabitat		
Natural bank	6.3	-48.2
Secondary channel sandbar	1.4	-48.4
Channel	1.0	-43.3
Mean	3.5	-47.1

* Insufficient data.

Table B12

Numbers and Weights of Fish Collected by Electroshocker at Cottonwood Bar Secondary Channel

July 1984

Species	Natural Bank		Secondary Channel Sandbar		Main Channel Sandbar		Dike		Total		Percent of Total	
	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight
Shortnose gar	1	0.780							1	0.780	1.2	4.2
Skipjack herring			1	0.073	1	0.129			2	0.202	2.4	1.1
Goldeye	1	0.004							1	0.004	1.2	0.0
Common carp	1	1.455					2	4.858	3	6.313	3.5	34.3
River carpsucker			1	0.397			2	0.485	3	0.882	3.5	4.8
Smallmouth buffalo			1	0.137			1	0.308	2	0.445	2.4	2.4
Blue catfish	11	0.187	8	0.193	9	0.300	7	0.250	35	0.930	41.2	5.1
Channel catfish	2	0.013	2	0.028	3	0.023	1	0.021	8	0.085	9.4	0.5
Flathead catfish	7	3.639			4	1.644	10	1.272	21	6.555	24.7	35.6
White bass			1	0.222	1	0.122			2	0.344	2.4	1.9
Sauger			2	0.232					2	0.232	2.4	1.3
Freshwater drum			1	0.142			3	1.273	4	1.415	4.7	7.7
Striped mullet							1	0.217	1	0.217	1.2	1.2
Total	23	6.078	17	1.424	18	2.218	27	8.684	85	18.404		
Units of Effort	3	3	3	3	3	3	3	3	12	12		
Catch per Unit Effort	7.7	2.026	5.7	0.475	6.0	0.739	9.0	2.895	7.1	1.534		

Table B13

Numbers and Weights of Fish Collected by Electroshocker at Cottonwood Bar Secondary Channel

October 1984

Species	Natural Bank		Secondary Channel Sandbar		Main Channel Sandbar		Dike		Total		Percent of Total	
	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight
Longnose gar					1	2.387			1	2.387	0.6	5.5
Skipjack herring	1	0.018	1	0.108			15	0.382	17	0.508	9.6	1.2
Gizzard shad	17	1.172	26	2.255	12	1.283	10	0.497	65	5.207	36.5	11.9
Threadfin shad							30	0.508	30	0.508	16.9	1.2
Goldeye	1	0.044							1	0.044	0.6	0.1
Mooneye	1	0.025							1	0.025	0.6	0.1
Common carp					1	1.424	1	1.566	2	2.990	1.1	6.9
Silver chub					2	0.038			2	0.038	1.1	0.1
Silverband shiner					1	0.014			1	0.014	0.6	0.0
Blue sucker	3	5.935	2	7.299					5	13.234	2.8	30.3
Smallmouth buffalo	1	1.856	1	1.786	1	0.667			3	4.309	1.7	9.9
Bigmouth buffalo			1	1.047					1	1.047	0.6	2.4
Blue catfish	3	0.127	1	1.484	1	0.067	6	0.247	11	1.925	6.2	4.4
Channel catfish	1	0.028							1	0.028	0.6	0.1
Flathead catfish	13	2.874	1	0.284	4	2.536	10	0.685	28	6.379	15.7	14.6
White bass	1	0.208					6	4.215	7	4.423	3.9	10.1
Sauger			1	0.302	1	0.275			2	0.577	1.1	1.3

(Continued)

Table B13 (Concluded)

Species	Natural Bank		Secondary Channel Sandbar		Main Channel Sandbar		Dike		Total		Percent of Total	
	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight
Total	42	12.287	34	14.565	24	8.691	78	8.100	178	43.643		
Units of Effort	3	3	3	3	3	3	2	2	11	11		
Catch per Unit Effort	14.0	4.096	11.3	4.855	8.0	2.897	39.0	4.050	16.2	3.968		

Table B14

Numbers and Weights of Fish Collected by Seine at Cottonwood Bar Secondary Channel

July 1984

Species	Natural Bank		Secondary Channel Sandbar		Main Channel Sandbar		Dike		Total		Percent of Total	
	Number	Weight g	Number	Weight g	Number	Weight g	Number	Weight g	Number	Weight g	Number	Weight
Gizzard shad	1	2.2	28	54.4			1	0.8	30	57.4	12.2	17.5
Threadfin shad	2	1.0	6	0.7					8	1.7	3.3	0.5
Silver chub	1	0.2	2	1.0					3	1.2	1.2	0.4
Emerald shiner	4	1.3	97	27.5	12	4.7	20	6.8	133	40.3	54.1	12.3
River shiner			1	0.1	2	5.0			3	5.1	1.2	1.6
Silverband shiner	3	4.8							3	4.8	1.2	1.8
Weed shiner			4	1.5					4	1.5	1.6	0.5
Blacktail shiner	1	2.1					1	3.1	2	5.2	0.8	1.6
Mimic shiner	1	0.8					1	0.1	2	0.9	0.8	0.3
Channel catfish			1	0.9					1	0.9	0.4	0.3
Mosquito fish			1	0.1					1	0.1	0.4	0.0
Brook silverside			1	0.6			2	1.2	3	1.8	1.2	0.5
Inland silverside	3	1.2	40	23.8	3	2.7	4	1.9	50	29.6	20.3	9.0
White bass					2	177.3			2	177.3	0.8	54.1
Lepomis sp.					1	0.1			1	0.1	0.4	0.0
Total	16	13.6	181	110.6	20	189.8	29	13.9	246	327.9		
Units of Effort	2	2	5	5	3	3	2	2	12	12		
Catch per Unit Effort	8.0	6.80	36.2	22.12	6.7	63.27	14.5	6.95	20.5	27.33		

Table B15

Numbers and Weights of Fish Collected by Seine at Cottonwood Bar Secondary Channel

October 1984

Species	Natural Bank		Secondary Channel Sandbar		Main Channel Sandbar		Dike		Total		Percent of Total	
	Number	Weight g	Number	Weight g	Number	Weight g	Number	Weight g	Number	Weight g	Number	Weight
Gizzard shad	5	47.4	7	61.0			6	34.5	18	142.9	13.5	52.7
Mississippi silvery minnow			3	15.8					3	15.8	2.3	5.8
Silver chub	1	3.0							1	3.0	0.8	1.1
Emerald shiner	23	30.4	5	9.5	3	6.0	2	3.0	33	48.9	24.8	18.0
River shiner			6	6.7			8	1.4	14	8.1	10.5	3.0
Silverband shiner	11	2.8	7	1.9	6	1.4	4	0.4	28	6.5	21.1	2.4
Weed shiner							1	0.9	1	0.9	0.8	0.3
Blacktail shiner	2	0.3	5	2.5					7	2.8	5.3	1.0
Mimic shiner			1	0.2					1	0.2	0.8	0.1
Bullhead minnow	1	0.2	1	0.1			5	0.5	7	0.8	5.3	0.3
Brook silverside							2	4.1	2	4.1	1.5	1.5
Inland silverside	6	12.2	10	20.5	2	4.6			18	37.3	13.5	13.7
Total	49	96.3	45	118.2	11	12.0	28	44.8	133	271.3		
Units of Effort	3	3	5	5	3	3	2	2	13	13		
Catch per Unit Effort	16.3	32.10	9.0	23.64	3.7	4.00	14.0	22.40	12.3	20.87		

Table B16

Numbers and Target Strengths of Fish Detected with Hydroacoustics from Transects and Microhabitats at Cottonwood Bar

Transects	Number of Fish per 100 m^3	Mean Target Strength db
C01	5.0	-47.2
C01-C04	1.3	-50.8
C04	2.3	-56.4
$\bar{x}$ of C	2.9	-51.5
D01	3.4	-47.3
D01-D04	1.0	-50.8
D04	2.8	-40.9
$\bar{x}$ of D	2.4	-46.3
E01	4.3	-48.7
E01-E04	1.5	-51.7
E04	3.3	-54.0
$\bar{x}$ of E	3.0	-51.5
F01	6.9	-46.9
F01-F04	0.5	-52.6
F04	3.0	-50.4
$\bar{x}$ of F	3.5	-50.0
G01	14.7	-45.7
G01-G04	0.9	-54.6
G04	0.6	-52.0
$\bar{x}$ of G	5.4	-50.8
Microhabitat		
Natural bank	5.3	-47.0
Secondary channel sandbar	1.7	-51.3
Channel	1.0	-52.6
Mean	3.4	-50.0

Table B17

Numbers and Weights of Fish Collected by Electroshocker at Profit Island Secondary Channel

July 1984

Species	Natural Bank		Secondary Channel Sandbar		Main Channel Sandbar		Total		Percent of Total	
	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight kg	Number	Weight
Skipjack herring	2	0.116	1	0.061	1	0.068	4	0.245	1.3	0.7
Gizzard shad			2	0.071	1	0.011	3	0.082	1.0	0.2
Threadfin shad	2	0.030					2	0.030	0.6	0.1
Silver chub	1	0.013					1	0.013	0.3	0.0
Smallmouth buffalo	1	0.418					1	0.418	0.3	1.1
Blue catfish	92	4.972	44	1.482	91	3.013	227	9.467	72.3	25.4
Channel catfish	1	0.006	2	0.056			3	0.062	1.0	0.2
Flathead catfish	28	15.170	27	7.495	12	3.265	67	25.930	21.3	69.4
White bass	3	0.568			1	0.274	4	0.842	1.3	2.3
Striped mullet	1	0.144	1	0.108			2	0.252	0.6	0.7
Total	131	21.437	77	9.273	106	6.631	314	37.341		
Units of Effort	3	3	3	3	3	3	9	9		
Catch per Unit Effort	43.7	7.145	25.7	3.091	35.3	2.210	34.9	4.149		

Table B18

Numbers and Weights of Fish Collected by Seine at Profit Island Secondary Channel

July 1984

Species	Natural Bank		Secondary Channel Sandbar		Main Channel Sandbar		Total		Percent of Total	
	Number	Weight g	Number	Weight g	Number	Weight g	Number	Weight g	Number	Weight
Gizzard shad	4	12.1					4	12.1	3.5	7.5
Threadfin shad	2	0.6	1	0.1			3	0.7	2.6	0.4
Goldeye	1	5.1	1	5.1			2	10.2	1.7	6.4
Silver chub			4	1.5			4	1.5	3.5	0.9
Emerald shiner			10	3.9			10	3.9	8.7	2.4
River shiner	2	4.0	10	18.8	3	8.0	15	30.8	13.0	19.2
Silverband shiner			2	4.5	2	3.7	4	8.2	3.5	5.1
Blacktail shiner	1	20.6	8	13.7			9	34.3	7.8	21.4
Mimic shiner			10	4.9			10	4.9	8.7	3.1
Bullhead minnow	1	0.2	2	0.4			3	0.6	2.6	0.4
Blue catfish			2	4.9			2	4.9	1.7	3.1
Blackstripe topminnow	1	0.8	1	0.7			2	1.5	1.7	0.9
Mosquitofish	4	1.4					4	1.4	3.5	0.9
Brook silverside			2	1.4			2	1.4	1.7	0.9
Inland silverside	20	7.2	14	9.1	5	2.1	39	18.4	33.9	11.5
Longear sunfish			1	25.0			1	25.0	0.9	15.6
White crappie	1	0.7					1	0.7	0.9	0.4

(Continued)

Table B18 (Concluded)

Species	Natural Bank Number	Natural Bank Weight g	Secondary Channel Sandbar Number	Secondary Channel Sandbar Weight g	Main Channel Sandbar Number	Main Channel Sandbar Weight g	Total Number	Total Weight g	Percent of Total Number	Percent of Total Weight
Total	37	52.7	68	94.0	10	13.8	115	160.5		
Units of Effort	5	5	5	5	3	3	13	13		
Catch per Unit Effort	7.4	10.54	13.6	18.8	3.3	4.60	8.9	12.34		

Table B19

Numbers and Target Strengths of Fish Detected with Hydroacoustics from Transects and Microhabitats at Profit Island

Transects	Number of Fish per 100 m^3	Mean Target Strength db
C01	1.6	-45.8
C01-C04	2.0	-51.9
C04	0.8	-47.7
$\bar{x}$ of C	1.5	-48.5
D01	0.8	-50.8
D01-D04	*	-51.0
D04	0.9	-52.1
$\bar{x}$ of D	0.9	-51.3
E01	8.5	-46.9
E01-E04	1.7	-51.4
E04	2.2	-51.6
$\bar{x}$ of E	4.1	-50.0
F01	3.4	-45.8
F01-F04	0.2	-53.9
F04	1.7	-49.5
$\bar{x}$ of F	1.8	-49.7
G01	3.4	-47.3
G01-G04	1.3	-49.7
G04	1.7	-48.8
$\bar{x}$ of G	2.1	-48.6
Microhabitat		
Natural bank	3.8	-47.1
Secondary channel sandbar	1.6	-50.2
Channel	0.6	-51.4
Mean	2.2	-49.6

* Insufficient data.

APPENDIX C: MACROINVERTEBRATE DATA COLLECTED FROM FIVE LOWER MISSISSIPPI RIVER SECONDARY CHANNELS, JULY AND OCTOBER 1984

Table C1

Macroinvertebrates Collected in Bottom Samples from Wolf Island Secondary Channel, Lower Mississippi River, July 1984*

Taxon	July
Diptera	
Culicidae	
Chaoborus punctipennis	1
Chironomidae	
Chironomidae pupae	4
Chernovskiia orbicus	52
Chironomus sp.	1
Cryptochironomus sp.	6
Dicrotendipes sp.	1
Harnisha curtilamellata	1
Paratendipes nr *connectens*	1
Polypedilum convictum	16
Polypedilum halterale	2
Polypedilum illinoense	2
Robackia claviger	146
Pelecypoda	
Corbicula fluminea	13
Ephemeroptera	
Baetidae	
Baetis sp.	2
Caenidae	
Caenis sp.	3
Heptageniidae	
Heptagenia sp.	1
Stenonema sp.	2
Stenonema integrum	1
Trichoptera	
Trichoptera pupae	5
Hydropsychidae	
Hydropsychidae early instars	30
Hydropsyche orris	46
Potamyia flava	148
Hydroptilidae	
Neotrichia sp.	1
Microturbellaria	21
Turbellaria	
Tricladida	
Dugesia tigrina	1
Nematoda	2
Annelida	
Enchytraeidae	
Barbidrilus paucisetus	11

(Continued)

Table C1 (Concluded)

Taxon	
Tubificidae	
Aulodrilus limnobius	1
Aulodrilus pigueti	5
Branchiura sowerbyi	1
Ilyodrilus templetoni	1
Limnodrilus cervix	20
Limnodrilus claparedeianus	6
Limnodrilus hoffmeisteri	27
Limnodrilus maumeensis	35
Limnodrilus psammophilus	1
Limnodrilus udekemianus	4
Tubificidae (nc)**	262

* numbers are total counts of each taxon taken in all grab samples combined.
** nc refers to immature tubificids of species lacking capilliform chaetae.

Table C2

Macroinvertebrates Collected in Bottom Samples from Island 8

Secondary Channel, Lower Mississippi River, July 1984*

Taxon	July
Diptera	
Ceratapogonidae	
Bezzia sp.	1
Culicidae	
Chaoborus punctipennis	1
Chironomidae	
Chernovskiia orbicus	94
Cryptochironomus sp.	3
Glyptotendipes sp.	1
Polypedilum nr *connectens*	3
Polypedilum convictum	4
Polypedilum halterale	3
Polypedilum illinoense	1
Robackia claviger	64
Pelecypoda	1
Corbicula fluminea	1
Ephemeroptera	
Caenidae	3
Ephemeridae	
Pentagenia sp.	2
Heptageniidae	1
Polymitarcyidae	
Tortopus incertus	30
Trichoptera	
Hydropsychidae	
Hydropsychidae early instars	40
Hydropsyche orris	50
Potamyia flava	121
Microturbellaria	94
Turbellaria	
Tricladida	
Dugesia tigrina	1
Nematoda	26
Annelida	
Enchytraeidae	
Barbidrilus paucisetus	22
Tubificidae	
Aulodrilus pigueti	1
Tubificidae (nc)**	3

* numbers are total counts of each taxon taken in all grab samples combined.
** nc refers to immature tubificids of species lacking capilliform chaetae.

Table C3

Macroinvertebrates Collected in Bottom Samples from Lakeport Towhead Secondary Channel, Lower Mississippi River, July and October 1984*

Taxon	July	October
Diptera		
Ceratapogonidae		
Bezzia sp.		5
Culicidae		
Chaoborus punctipennis	19	3
Chironomidae		
Chironomidae pupae	1	7
Alabesmyia annulata		15
Coelotanypus scapularis		29
Tanypus stellatus		3
Chernovskiia orbicus	52	
Chironomus plumosus gr		211
Glyptotendipes sp.	1	1
Paratendipes nr *connectens*	4	
Polypedilum convictum	1	
Polypedilum nr *scalaenum*	3	2
Procladius sp.		6
Robackia claviger	20	
Amphipoda		
Gammaridae		
Gammarus sp.	1	
Pelecypoda		
Corbicula fluminea	4	145
Ephemeroptera		
Ephemeridae		
Hexagenia sp.	8	112
Pentagenia sp.	4	
Polymitarcyidae		
Tortopus incertus	9	
Odonata	1	
Anisoptera		
Gomphidae	2	
Neurocordulia molesta	1	
Stylurus sp.		1
Trichoptera		
Hydropsychidae		
Hydropsyche orris	9	
Potamyia flava	5	
Microturbellaria	2	
Nematoda		1
Annelida		
Naidiae		
Dero digitata		30
Nais pardalis	1	

(Continued)

Table C3 (Concluded)

Taxon	July	October
Tubificidae		
Aulodrilus limnobius		1
Aulodrilus pigueti		3
Aulodrilus pluriseta	1	
Branchiura sowerbyi		7
Limnodrilus cervix	1	1
Limnodrilus hoffmeisteri	1	
Limnodrilus maumeensis		3
Limnodrilus udekemianus		1
Tubificidae (c)**		1
Tubificidae (nc)**	5	33
Hydracarina		1
Coleoptera		
Stenelmis sp.	1	
Lepidoptera		1

* numbers are total counts of each taxon taken in all grab samples combined.
** c refers to immature tubificids of species possessing capilliform chaetae; nc refers to immature tubificids of species lacking capilliform chaetae.

Table C4

Macroinvertebrates Collected in Bottom Samples from Cottonwood Bar Secondary Channel, Lower Mississippi River, July and October 1984*

Taxon	July	October
Diptera		
Culicidae		
Chaoborus punctipennis	1	
Chironomidae		
Chironomidae pupae	1	3
Axarus sp.		36
Ablabesmyia annulata		1
Chernovskiia orbicus	24	11
Chironomus sp. 2 (with blood gills)		4
Cryptochironomus sp.		9
Harnisha sp.	2	
Polypedilum convictum	1	12
Polypedilum halterale		1
Polypedilum illinoense	1	1
Rheotanytarsus sp.		3
Robackia claviger	14	19
Amphipoda		
Gammaridae		
Gammarus sp.	1	
Pelecypoda	1	16
Corbicula fluminea	4	5
Ephemeroptera		
Ephemeridae		
Hexagenia sp.	1	16
Pentagenia sp.	1	5
Heptageniidae	1	2
Polymitarcyidae		
Tortopus incertus	19	
Trichoptera	1	
Hydropsychidae		
Hydropsychidae early instars		138
Hydropsyche orris	5	3
Potamyia flava	1	299
Microturbellaria	23	442
Nematoda		10
Annelida		
Tubificidae		
Branchiura sowerbyi	1	
Limnodrilus cervix	1	
Limnodrilus maumeensis	8	
Limnodrilus udekemianus	2	

(Continued)

Table C4 (Concluded)

Taxon	July	October
Tubificidae (c)**	1	
Tubificidae (nc)**	28	2
Coleoptera	1	

* numbers are total counts of each taxon taken in all grab samples combined.

** c refers to immature tubificids of species possessing capilliform chaetae; nc refers to immature tubificids of species lacking capilliform chaetae.

Table C5

Macroinvertebrates Collected in Bottom Samples from Profit Island Secondary Channel, Lower Mississippi River, July 1984*

Taxon	July
Diptera	
Culicidae	
Chaoborus punctipennis	3
Chironomidae	
Chernovskiia orbicus	35
Cryptochironomus sp.	1
Paratendipes nr *connectens*	11
Polypedilum convictum	1
Polypedilum halterale	4
Robackia claviger	14
Pelecypoda	1
Corbicula fluminea	7
Ephemeroptera	
Ephemeridae	
Pentagenia sp.	11
Polymitarcyidae	
Tortopus incertus	29
Trichoptera	
Hydropsychidae	
Hydropsychidae early instars	1
Hydropsyche orris	1
Potamyia flava	1
Microturbellaria	2
Nematoda	9
Annelida	
Enchytraeidae	
Barbidrilus paucisetus	2
Tubificidae	
Limnodrilus cervix	1
Limnodrilus maumeensis	1
Tubificidae (nc)**	20

* numbers are total counts of each taxon taken in all grab samples combined.
** nc refers to immature tubificids of species lacking capilliform chaetae.

Table C6

Percent Composition of Macroinvertebrates Collected from Refuge Dike at Lakeport Towhead Secondary Channel in the Lower Mississippi River, July 1984

Taxon	Upstream Face	Downstream Face	Total
Trichoptera			
Hydropsyche orris	73.6	63.9	72.3
Potamyia flava	6.2	13.4	7.1
Hydropsychidae, Instars I & II	11.0	11.0	11.0
Hydropsychidae pupae	2.7	3.7	2.8
Neotrichia sp.	<0.1	0.2	<0.1
Neureclipsis crepuscularis	<0.1		<0.1
Ephemeroptera			
Stenonema integrum	0.5	2.2	0.7
Stenonema, Instars I & II	0.3	0.8	0.4
Isonychia sp.	0.2	0.7	0.3
Caenis sp.	0.2	0.5	0.2
Heptagenia marginalis	0.1	0.2	0.1
Heptagenia sp.	0.1	0.5	0.1
Stenacron interpunctatum	<0.1		<0.1
Baetis sp.	2.5	1.0	2.3
Diptera			
Polypedilum convictum	2.0	1.0	1.9
Rheotanytarsus sp.	0.1	0.2	0.1
Tanytarsini pupae	0.1		0.1
Chaoborus punctipennis		0.2	<0.1
Stenochironomus sp.	<0.1		<0.1
Glyptotendipes sp.			
Dicrotendipes neomodestus			
Ablabesmyia annulata			
Tricladidae			
Dugesia tigrina	0.2		0.1
Others			
Lirceus sp.	0.1		<0.1
Neurocordulia molesta		0.3	<0.1
Macrobrachium ohione	<0.1		<0.1
Gammarus fasciatus	0.2	0.3	0.2
Gomphus sp.			

Table C7

Percent Composition of Macroinvertebrates Collected from Arcadia Dike at Cottonwood Bar Secondary Channel in the Lower Mississippi River, July 1984

Taxon	Upstream Face	Downstream Face	Total
Trichoptera			
Hydropsyche orris	56.4	44.5	54.4
Potamyia flava	22.0	20.3	21.7
Hydropsychidae, Instars I & II	5.8	9.4	6.4
Hydropsychidae pupae	0.8	3.1	1.2
Neotrichia sp.			
Neureclipsis crepuscularis			
Ephemeroptera			
Stenonema integrum	0.8	1.6	0.9
Stenonema, Instars I & II	1.1	1.6	1.2
Isonychia sp.		0.8	0.1
Caenis sp.		0.8	0.1
Heptagenia marginalis	0.6	0.8	0.7
Heptagenia sp.			
Stenacron interpunctatum			
Baetis sp.	1.7		1.5
Diptera			
Polypedilum convictum	4.6	3.9	4.5
Rheotanytarsus sp.	0.2		0.1
Tanytarsini pupae			
Chaoborus punctipennis		0.8	0.1
Stenochironomus sp.			
Glyptotendipes sp.	0.2		0.1
Dicrotendipes neomodestus	0.2		0.1
Ablabesmyia annulata	0.2		0.1
Tricladidae			
Dugesia tigrina	5.2	11.7	6.3
Others			
Lirceus sp.			
Neurocordulia molesta		0.8	0.1
Macrobrachium ohione			
Gammarus fasciatus			
Gomphus sp.	0.2		0.1

APPENDIX D: GRAIN-SIZE DATA FOR SEDIMENT SAMPLES FROM FIVE LOWER MISSISSIPPI RIVER SECONDARY CHANNELS, JULY AND OCTOBER 1984

Table D1

Percent of Sediment Retained by Standard Sieve Sizes for Bottom Samples from Five Mississippi River Secondary Channels

	Sieve Size Opening (mm)				Standard Sieve Size Number													
Station	25.4	19.1	12.7	9.5	3	4	6	10	16	20	30	40	50	70	100	140	200	<200
									Wolf Island									
C1								0.1	0.1		0.2		0.1	1.3	7.9	11.6	9.7	69.0
C2												0.5	33.0	56.9	8.5	0.6	0.1	0.4
C3			1.5	1.7	1.3	1.7	2.2	5.8	12.1	17.7	25.8	18.3	4.7	5.3	0.7	0.2	0.1	0.9
C4	57.9	22.9	16.2	0.6	1.2	0.6			0.1		0.1	0.1		0.2				0.1
E1										0.2	0.1		0.4	24.0	48.1	16.3	5.2	5.1
E2	8.5	4.1	9.7	2.4	1.7	2.1	1.3	1.8	2.6	5.1	14.0	19.7	13.6	8.2	2.7	1.3	0.4	0.8
E3			1.5	0.8	0.8	0.9	2.1	5.6	9.5	12.8	19.1	19.4	13.6	8.8	2.8	1.1	0.2	1.0
E4											0.1	0.1	1.3	21.2	47.1	17.5	5.8	6.9
G1			3.0	0.5	1.0	1.2	1.4	4.6	11.6	15.3	19.3	19.3	14.5	7.0	0.7	0.1	0.1	0.4
G2	22.7	9.6	19.5	6.1	6.0	3.5	1.8	3.2	3.7	3.4	5.7	6.7	4.7	2.4	0.7	0.2	0.0	0.1
G3		2.1	0.5	1.8	1.0	1.2	2.2	3.7	7.3	8.7	22.3	32.8	13.8	1.9	0.1	0.1		0.5
G4											0.2	0.1	0.3	2.0	6.6	5.1	2.8	82.9
									Island 8									
C1	29.4	4.5	3.0	1.0	1.6	0.4	0.1	0.2	0.2	0.1	0.2	0.5	3.7	25.6	23.5	4.1	1.3	0.6
C2							0.1	0.4	0.8	0.9	3.0	16.0	45.7	27.9	4.8	0.1	0.1	0.2

(Continued)

Table D1 (Continued)

Station	Sieve Size Opening (mm)				Standard Sieve Size Number													
	25.4	19.1	12.7	9.5	3	4	6	10	16	20	30	40	50	70	100	140	200	<200
Island 8 (cont.)																		
C3								0.1	0.3	0.7	4.7	29.4	40.5	20.9	3.0	0.3		0.1
C4								0.2	0.3	0.2	3.1	20.7	23.2	34.8	10.7	3.1	1.7	2.0
E1									0.1	0.1	0.3	0.4	1.6	6.5	29.8	24.1	8.3	28.8
E2			0.5	0.1	1.2	1.3	2.7	7.8	22.9	25.8	23.2	11.5	1.5	0.3	0.2	0.2	0.1	0.7
E3											0.2	1.0	9.8	60.3	25.9	2.0	0.2	0.6
E4												0.2	6.0	51.8	37.3	3.1	0.5	1.1
G1			3.4	11.3	14.2	6.0	7.6	7.3	8.6	5.9	8.3	7.9	4.8	3.8	4.8	2.5	1.0	2.6
G2				1.0	2.3	2.4	6.1	11.1	19.5	18.7	23.1	12.0	2.5	0.3	0.2	0.1	0.1	0.6
G3		1.3	2.0	2.4	2.3	1.4	0.9	1.2	5.9	11.3	28.5	27.4	9.8	3.2	1.1	0.5	0.2	0.6
G4													0.2	7.6	74.0	16.7	0.8	0.7
Lakeport Towhead, July																		
C1										0.2	0.1	1.7	15.2	44.3	25.7	4.1	1.0	7.7
C2									0.1	0.2	1.9	14.0	37.1	30.7	13.0	2.0	0.4	0.6
C3					0.4	0.2		0.2	0.3	0.9	4.5	26.9	38.7	18.0	8.3	1.2	0.3	0.1
C4											0.8	7.8	26.1	40.1	22.1	2.4	0.3	0.4
E1													0.2	0.2	0.3	1.5	16.3	81.5
E2									0.1	0.2	0.7	4.9	13.4	36.4	38.2	4.3	0.8	1.0

(Continued)

(Sheet 2 of 6)

Table D1 (Continued)

Station	Sieve Size Opening (mm) 25.4	19.1	12.7	9.5	Standard Sieve Size Number 3	4	6	10	16	20	30	40	50	70	100	140	200	<200
Lakeport Towhead, July (cont.)																		
E3					0.8	0.1		0.2	0.4	0.5	1.0	4.9	12.1	47.1	29.3	2.7	0.5	0.4
E4												0.5	6.3	44.0	43.3	4.7	0.5	0.7
G1													0.2	0.2	0.2	1.1	4.9	93.4
G2								0.1	0.2	0.4	1.9	7.6	11.7	8.7	18.0	19.2	9.1	23.1
G3										0.1	1.0	6.5	18.4	28.4	24.2	13.5	2.9	5.0
G4													0.4	8.9	54.1	28.2	5.7	2.7
Lakeport Towhead, October																		
C1											0.1	1.7	11.4	52.6	27.8	3.5	1.2	1.7
C2									0.1	0.2	1.8	15.8	31.2	26.5	7.2	0.7	0.6	17.0
C3									0.1	0.2	2.2	25.0	39.3	21.5	6.1	1.3	0.7	3.5
C4										0.1	0.7	8.5	20.8	43.6	16.3	2.1	0.9	6.9
E1											0.2			1.0	0.2		0.2	98.4
E2							0.1	0.4	0.1	0.1	0.7	4.8	7.3	40.9	32.4	2.8	0.8	9.8
E3							0.4	0.2	0.2	0.5	0.7	3.0	1.2	12.6	7.1	1.2	1.1	71.7
E4								1.2	0.5	0.5	0.9	4.9	5.3	58.6	21.2	1.2	0.4	6.3
G1													0.1	0.1		0.1		99.5
G2										0.1		0.1	0.1	2.4	5.3	1.4	0.5	89.9

(Continued)

(Sheet 3 of 6)

Table D1 (Continued)

Station	Sieve Size Opening (mm) 25.4	19.1	12.7	9.5	Standard Sieve Size Number 3	4	6	10	16	20	30	40	50	70	100	140	200	<200
Lakeport Towhead, October (cont.)																		
G3										1.5	0.8	3.1	1.5	32.7	21.5	5.6	2.5	32.0
G4								0.1	0.1	0.3	0.3	0.3	0.3	9.6	41.7	26.9	11.0	9.3
Cottonwood Bar, July																		
C1													0.2	0.9	8.0	14.3	17.2	59.4
C2											0.4	5.9	53.4	31.8	7.4	0.4	0.1	0.6
C3											0.6	7.0	53.0	30.2	7.7	1.1	0.1	0.3
C4	6.5	6.6	6.1	1.8	1.7	0.9	0.5	0.6	0.1	0.3	0.8	7.0	24.6	11.0	5.2	4.8	3.7	17.8
E1												0.2	1.0	1.7	1.2	0.7	1.0	94.2
E2											0.6	18.9	63.7	13.1	2.7	0.4	0.1	0.5
E3				0.7	0.6	0.6	1.3	0.6	1.7	2.2	6.9	20.8	51.4	12.1	0.6		0.2	0.3
E4									0.3	0.7	3.8	16.7	61.1	15.7	1.1	0.2		0.4
G1			2.5		0.9	1.0	0.5	0.7	2.4	4.6	9.1	14.3	29.4	24.0	8.3	1.6	0.3	0.4
G2		3.5	0.7	0.3	0.3	0.1	2.0	5.9	13.4	13.9	20.0	26.0	11.6	1.8	0.1	0.2		0.2
G3		1.6	0.9	0.2	0.8	0.4	0.6	1.2	1.8	2.2	7.1	29.3	43.7	8.5	1.3	0.1		0.3
G4											0.5	3.3	19.7	50.0	18.8	4.9	0.5	2.3

(Continued)

(Sheet 4 of 6)

Table D1 (Continued)

Station	Sieve Size Opening (mm)				Standard Sieve Size Number													
	25.4	19.1	12.7	9.5	3	4	6	10	16	20	30	40	50	70	100	140	200	<200
Cottonwood Bar, October																		
C1		11.7	12.3	6.2	10.3	5.9	2.8	2.3	1.3	0.7	1.5	4.2	10.2	10.4	4.5	0.7	0.2	14.2
C2									0.1	0.7	4.2	25.0	55.8	12.7	1.2			0.2
C3									0.2	0.9	0.2	46.2	37.0	6.2				
C4				0.2	0.2	0.1	0.2	0.6	0.5	1.2	4.6	25.0	51.3	14.4	0.7	0.7		0.6
E1												0.2	0.8	29.5	37.7	21.0	6.8	3.7
E2											0.1	1.5	49.3	41.4	6.9	0.6		
E3					1.1	0.2	0.3	1.3	2.3	3.2	6.7	25.0	34.6	20.0	4.2	0.5	0.1	0.4
E4								0.1	0.2	0.5	2.5	11.3	36.8	18.6	3.9	1.8	1.3	22.8
G1			12.4	7.3	9.0	5.1	5.6	6.8	5.8	3.6	3.5	2.9	9.1	15.9	8.6	2.9	0.6	0.5
G2	5.5	20.8	12.4	4.8	5.6	2.7	2.1	2.2	1.7	2.3	6.6	13.7	12.5	3.4	2.0	0.8	0.1	0.1
G3			0.5		0.2	0.1	0.2	0.2	0.4	1.5	12.1	42.9	31.4	6.0	3.0	0.5		0.6
G4										0.1	0.5	10.2	71.8	15.4	1.5	0.2		0.2
Profit Island																		
C1					0.3	0.3	0.2	1.0	1.6	2.3	5.1	12.6	32.4	29.8	12.3	1.3	0.1	0.7
C2					0.6	0.3	0.3	0.1	0.3	0.9	6.5	25.8	44.2	17.3	3.0	0.3		0.4
C3										0.1	0.2	2.1	23.1	59.6	13.3	1.2	0.1	0.3

(Continued)

Table D1 (Concluded)

Station	Sieve Size Opening (mm)				Standard Sieve Size Number													
	25.4	19.1	12.7	9.5	3	4	6	10	16	20	30	40	50	70	100	140	200	<200
									Profit Island (cont.)									
C4					4.4	2.3	2.0	1.8	1.1	1.4	3.2	5.6	6.4	3.6	1.4	0.3	0.3	66.2
E1												0.4	0.2	0.2	0.7	6.0	16.5	76.0
E2				0.4	1.5	1.5	0.8	1.3	1.5	2.1	5.0	24.7	49.2	8.1	2.2	0.8	0.4	0.5
E3				0.7	0.3	0.1		0.1	0.2	0.4	1.8	9.9	42.8	30.9	10.0	1.8	0.3	0.7
E4												0.2	0.2	1.7	5.3	10.4	15.7	66.5
G1			2.7	3.9	2.6	1.2	0.9	1.1	0.2	0.4	0.5	0.9	3.7	3.5	5.1	13.8	12.3	46.2
G2			8.6	5.9	9.6	6.0	5.0	4.5	3.5	2.8	5.1	11.5	16.6	11.1	6.9	2.0	0.3	0.6
G3					0.2	0.2	0.5	0.7	2.6	5.7	22.4	41.6	16.5	6.5	2.1	0.6	0.1	0.3
G4												0.2	0.4	0.9	8.7	24.6	25.7	39.5

(Sheet 6 of 6)