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STUDY ON THE EFFECTS OF DIVERTING WATER INTO UPPER BURNT POCKET--ETC(U)
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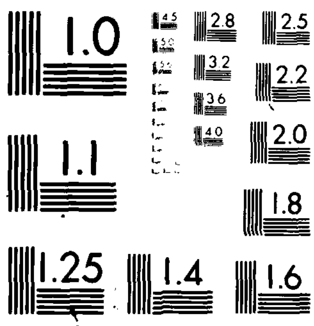

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6 STUDY ON THE EFFECTS OF DIVERTING WATER
INTO UPPER BURNT POCKET,
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A FIELD TEST OF THE REGRESSION SIMULATION MODEL
PREVIOUSLY DEVELOPED ON NAVIGATION POOL ~~NO.~~ 8

Number 8.

9 Final Rep[redacted]t.

Submitted to

The Great River Environmental Action Team (Region II)
for Work Conducted Under Contract 15 DACW25-78-C-0047
Department of the Army, Corps of Engineers,
Rock Island District

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NON-TECHNICAL ABSTRACT

A study was conducted to determine the effects of diverting water from the main channel of the Mississippi River into the upper end of Burnt Pocket (BP) in Navigation Pool No. 18. The study was performed during the pre-opening years of 1978 and 1979 and during the first post-opening year of 1980. During pre-opening years, water flowed through the upper end of BP only in conditions of high water. The experimental cut allows water to enter Upper BP under lower water conditions; however, during late July and August of 1980, water level in Pool No. 18 was so low that even with the cut, BP was largely dry. The high discharge that entered through the experimental cut during earlier high water periods did result in the formation of braided channels in BP. As a result of the braided channels, the composition of the sediments was changed from spatially similar before the experimental opening to dissimilar after the experimental side channel was constructed. Changes in sediment characteristics were also observed in FP where silts and clays (small particles) in the upper reach decreased, and increased amounts of silts and clays were observed in the lower reach. Sediment chemistry data paralleled grain size distribution, e.g. nutrients (TKN and TP) were significantly decreased in both BP and FP. This means that even though lower FP was accumulating silts and clays, the nutrients that support excessive plant production were being flushed from the study area. Water quality remained similar before and after the experimental cut, but there were considerably fewer spatial differences observed during the post-opening period. The water of the study area can be characterized as a nutrient rich, hard water that does not thermally stratify. Turbidity of inflow waters was approximately the same as the outflow.

The benthic (bottom) animals were dominated by Oligochaeta (aquatic worms), mayflies, fingernail clams, and chironomid (midge) larvae. The diversity of benthic organisms remained relatively constant in most areas except lower BP. The lowered diversity was caused by the dominance of <u>Tanypus</u> sp. (midge). In FP, biomass was reduced and species composition was altered; most notable was the decrease in fingernail clams. This may reflect initial scouring after the side-channel opening.

Aquatic plants (macrophytes) were sparsely distributed except in Burnt Pocket where the American Lotus dominated. The only other area where macrophytes were encountered was FP, however, stands were small. The experimental opening did not appear to have an effect on the distribution of the lotus during 1980.

Zooplankton densities were higher in 1979 than in 1980 and taxonomic composition also differed. However, data obtained from within the Burnt Pocket study area were not different than that obtained from the main channel of the Mississippi River. Flushing rates did not appear to affect the density nor the taxonomic composition of zooplankton.

The mathematical model was quite accurate in predicting numbers and biomass for individual taxa, but was not accurate in predicting values for total biomass. Because of varied degrees of accuracy, without modification, the model as a total predictive system for Burnt Pocket will not serve as a management tool. Additional testing of the model during a normal flow year would be required to substantiate or disprove its applicability.

TECHNICAL SUMMARY

Introduction

The objectives of this study were four-fold. First, to determine the ecological effects of opening an experimental side channel between the main channel of the Mississippi River and the upper end of Burnt Pocket (BP). The experimental channel was designed to increase the discharge of water through the entire study area, i.e. from upper Burnt Pocket to the lower end of Fish Pond Slough (FP). A map of the study area is presented in Figure 1 of the final report. The variables investigated with regard to environmental effects of the experimental channel were: hydrological characteristics, sediment grain size distribution and chemistry, water chemistry, benthic macroinvertebrates, and aquatic macrophytes. The second major objective was to assess the effectiveness and accuracy of a regression model that was developed in Navigation Pool No. 8. This objective was to be accomplished by comparing pre- and post-opening standing crops of selected organisms to predicted values generated by the model. The third objective was to develop a users manual for the regression manual. The final objective, although not in the contract, was to compile a vascular plant inventory for the woodland, shore and aquatic habitats of the entire study area. A survey of zooplankton communities of the study area was also conducted as a satellite to the major Burnt Pocket study. This supplementary study was to assess whether the zooplankton would respond to the increased flow in the backwaters. Also, a fishery survey was conducted by the side channel work group and the data are found in the final report submitted to the side channel work group from the Iowa Conservation Commission (Waters and Thelen 1978, Van Vooren 1981).

Pre-opening data were collected during late May and late July 1978 and early June 1979, and post-opening data were collected during late July 1980. The experimental side channel opening was completed in October 1979.

Hydrography and Hydrology

Cross-sectional areas, current velocities, depth and discharge were measured and calculated at transects throughout the Burnt Pocket study area. Water routing through the study area was subsequently determined from these data. Burnt Pocket is an open slough that is separated from the main channel by low, natural landforms. Prior to the construction of the diversion, water entered BP through two channels leading from Campbell Chute. Burnt Pocket has apparently accumulated sediments since the construction of the Lock and Dam System in the 1930's and is now heavily shoaled and vegetated. Water that leaves the lower end of Burnt Pocket or which bypasses its lower end, flows through the channel section of the study area (CH) and through the area designated as Fishhook Slough (FH). The channel varies in width and depth and discharges water into the upstream portion of Fish Pond Slough. Fishhook Slough, a downstream extension of the channel area discharges water into the middle reach of FP.

Low water levels prevailed during the 1980 post-opening sampling period; consequently, there was no discharge through the experimental opening. Total flow into the study area was 209.5 cfs, which was significantly less than that observed during the pre-opening sampling period. The entire flow into the channel area, Fishhook Slough and Fish Pond Slough at the time of post-opening sampling was essentially routed around Burnt Pocket.

Pre- and post-opening water routes were similar, but they differed significantly in total discharge. It is apparent that, at least during the spring of 1980, the experimental channel carried large quantities of water into upper BP. This is evidenced by the erosional patterns (braided channels) that were observed in the upper portion of this area. Furthermore, the grain sizes of Burnt Pocket sediments were more variable during the post-opening period as compared to 1978 and 1979. In short, spatial heterogeniety was introduced because of the increased flow from the side channel opening.

Sediments

Sediment samples were collected from 25 sites located in BP, FP, and the channels connecting these backwater areas. Grain size distribution, total kjeldahl nitrogen (TKN), NO_2-N+NO_3-N and available-P were determined on each sample.

During 1980, sediments in Burnt Pocket were highly variable especially with regard to the smaller grain sizes. The variability in BP sediments during the post-opening period as compared to the pre-opening period implies that the composition was changed from spatially homogeneous before the experimental opening to heterogeneous after the experimental side channel was constructed. This was expected because of the braided channels resulting in BP from the increased discharge. Grain size distribution of sediments from the channel and Fishhook Slough areas remained relatively unchanged during the entire study. The CH area was, however, already well scoured prior to the construction of the experimental opening. In 1980, after receiving the increased discharge from the cut, the upper portion of Fish Pond Slough had lower proportions of silts and clays as compared to 1978 and 1979. Furthermore, the amounts of silts and clays in the middle through lower portion of FP increased during the post-opening period. These data indicate that materials resuspended as a result of the increased discharge from the experimental side channel and the suspended sediments of the influent waters were being deposited in the middle and lower reaches of Fish Pond Slough.

Sediment chemistry paralleled the changes in grain size distributions in Burnt Pocket, i.e. becoming more variable during 1980. Overall, TKN was significantly reduced in BP after the experimental cut was constructed. As expected, TKN remained similar in CH during the entire study, whereas that of FH decreased during 1980. As in BP and FH, the TKN was significantly reduced in the entire Fish Pond Slough area. This implies that even though FP was accumulating silts and clays in middle and lower reaches, the TKN was being flushed out of the study area. Total-P levels followed the trends observed for TKN.

Water Quality

Water samples were collected from the same 25 sites as sediment samples. Sample analyses included nutrients, ionic constituents and particulare material. The water of the study area was not thermally stratified and can be characterized as a bicarbonate water with calcium as the most abundant cation. In both pre- and post-opening investigations, nitrogen and phosphorus exceeded critical concentrations generally accepted as levels which could lead to excessive primary production. Turbidity levels in BP were similar during July 1978 and August 1980. In CH, FH and FP, however, turbidity during the 1980 sample period was significantly reduced. Reductions probably resulted from the reduced flow at that time. Turbidity levels, which resulted from the suspension of inorganic material, were about the same at the inflow (approximately 23 NTU) as at the outflow (29 NTU). Most other water quality characteristics were also similar, but variability was less during the post-opening period. Observed pre- and post-opening differences were attributed to low water levels in 1980.

Benthic Macroinvertebrates

Samples of benthos were collected from each of the 25 stations where sediment and water samples were obtained. The benthic fauna was dominated by the oligochaeta, mayflies, fingernail clams and chironomid larvae. In both pre- and post-opening samples, the diversity of the benthic community remained relatively stable except in lower BP, where it was reduced by almost 50%. The lowered diversity was caused by the dominance of the midge larvae, *Tanypus*. In FP, biomass was reduced and species composition was altered during the post-opening sample period. The Sphaeridae decreased from a pre-opening high of 14,799 to a post-opening low of 1,389. This may reflect initial scouring and subsequent increased turbidities brought about by opening the side channel. In addition, significant increases in occurrence and total biomass were observed for the midge *Tanypus* sp. There were no recognizable effects of the opening on CH and FH.

Aquatic Macrophytes

Aquatic macrophytes were sampled in BP and the lower portion of FP because their distributions were limited to these areas. Samples collected in BP yielded a single rooted species, *Nelumbo lutea*. Pre-opening distribution and standing crops were similar for 1978 and 1979. Significant increases in macrophyte biomass were observed in 1980. Reasons for this increase are obscure, but the construction of the side channel and subsequent increases in flow appeared to have little affect on the biomass and distribution of *N. lutea*.

Vascular Plant Flora

A flora inventory and habitat survey was conducted in the study area watercourse and was augmented with side trips into all major habitat types (aquatic, shore, and woodland). Habitat types were defined by growth form to eliminate possible subjective assessments of species composition. Representatives from 57 species including 38 families were observed at the study area. The woodland flora was dominated by silver maple and buttonbush. Summer grape and riverbank grape were among the dominant vine growth forms while poison ivy was prevalent among both the vines and herbs. The sandy, shoal-like shore habitat was dominated by rice cut-grass, and the other type of shore habitat, sharply delimited banks, was predominately poison ivy and buttonbush. The aquatic flora was sparsely distributed in all areas except BP, where American Lotus was prevalent. The only other area where an edge macrophyte community existed was a small stand in the lower end of Fish Pond Slough where water from FH enters.

Simulation

Simulations were conducted to determine densities of selected benthic invertebrates, total benthic standing crop and total macrophyte standing crop for seven sampling areas within the study area. Predictions were made on the basis of 1980 data, utilizing a projected flow of 820 cfs (not observed at the time of sampling). Differences in actual and predicted values were noted during all three years of data collection in the study area. Oligochaete populations were considerably higher in most instances than predicted, *Hexagenia* and Sphaeridae predictions were quite accurate. The predicted values for total benthic biomass were inaccurate, especially in lower BP and FP where the sharp decline of biomass was not projected. The model erroneously predicted that macrophytes would be eliminated from BP. Because of varying degrees of accuracy, the model will not serve as a management tool for Burnt Pocket.

Reasons for discrepancies between predicted and actual values may include the low water levels encountered during the post-opening period, increased concentrations of smaller particulate suspended sediments during periods of high flow not encountered in Pool 8 (where the model was developed), latitudinal differences in species composition between Pool 8 and 18, and inherent limitations of the model. The limitations in space, time, range of predictor parameters and most probable value predictions are discussed in the regression model users manual.

Zooplankton

Samples of zooplankton were obtained from five sites within the study area and the main channel of the Mississippi River in 1978 and 1980. A comparison of pre- and post-opening zooplankton communities reveals that average standing crops were notably higher in 1978 compared to 1980. Taxonomic composition also differed. Data obtained from within the Burnt Pocket study area, however, were not different than that obtained from the main channel. The implication is that the reduced densities and different taxonomic composition represented general characteristics of the Mississippi River system and cannot be attributed to the opening of the experimental side channel.

ACKNOWLEDGMENTS

A study such as this could not have been completed without the aid and support of a great number of dedicated people. We wish to thank Gloria Wiener for editing and typing the manuscript. Her patience and persistence have been invaluable to the completion of this report.

We would like to express our thanks to Dr. James Peck for his assistance with the vascular plant inventory. Thanks also to Cathy Elstad, Rick Jacobson, Don Juen, Tom Kammer, John Korger, James Rogala, Kathy Trapp, John Velte and Dwight Will.

Finally, we would like to acknowledge the University of Wisconsin-La Crosse, and in particular the Department of Biology, for the provision of services and use of facilities which enhanced the completion of the study.

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INTRODUCTION

The impoundment of the Upper Mississippi River into a series of navigation pools has profoundly affected the physical features of the river. The concomitant ecological responses are visible in virtually every pool. The vast increase in the surface area of water by the inundation of the floodplain effectively rearranged the ecological habitats that existed prior to the closure of the dams. Areas that were once flooded intermittently are now completely inundated. The braided channels that once carried water during periods of high discharge are now filled with permanent standing water. New backwater channels were created to supply water to standing water areas that are separated from the navigation channel by land masses. In short, the open river system was converted to a series of shallow reservoirs, where reservoir dynamics now predominate.

The trapping of sediments and associated nutrients has been occurring since the formation of the reservoirs 40 years ago. These accumulations are most evident. One such area is the Burnt Pocket area and the associated channels and sloughs located immediately downstream. In an effort to alleviate the problems associated with these processes it was proposed that a water diversion channel be constructed to direct water from the main channel into the upper portion of Burnt Pocket to retain a portion of the pocket as open water by scouring sediment and nutrients from the recipient area.

The study was initiated during the summer of 1978. Samples were collected from all recipient areas to establish baseline data in order to accomplish the following objectives.

1. Assess the effects of the diversion on

   a. sediment nutrients
   b. sediment particle size distribution
   c. dissolved oxygen levels
   d. water chemistry
   e. benthic invertebrates
   f. rooted and floating macrophytes

2. Assess the effects of the diversion on the general ecological characteristics of the area and to determine whether the diversion could serve as a possible management tool.

3. Assess the efficacy and accuracy of a regression model that was devėloped in Navigation Pool No. 8 (Upper Mississippi River) by comparing pre- and post-opening populations of selected organisms and by comparing the actual values to predicted values generated by the model.

4. Develop a users manual for the regression model.

*5. Prepare a preliminary vascular plant inventory. The vascular plant flora of the floodplain of the Upper Mississippi River is not well known nor well documented (Swanson and Sohmer 1978). To broaden knowledge of the floodplain flora, efforts were directed toward a preliminary floristic inventory of the vascular plants in and adjacent to the study watercourse.

*It should be noted that this objective was not mentioned in the contract and was accomplished without using contract funds. It was undertaken and completed, however, because the investigators believed that information would be valuable as baseline data.

METHODS AND MATERIALS

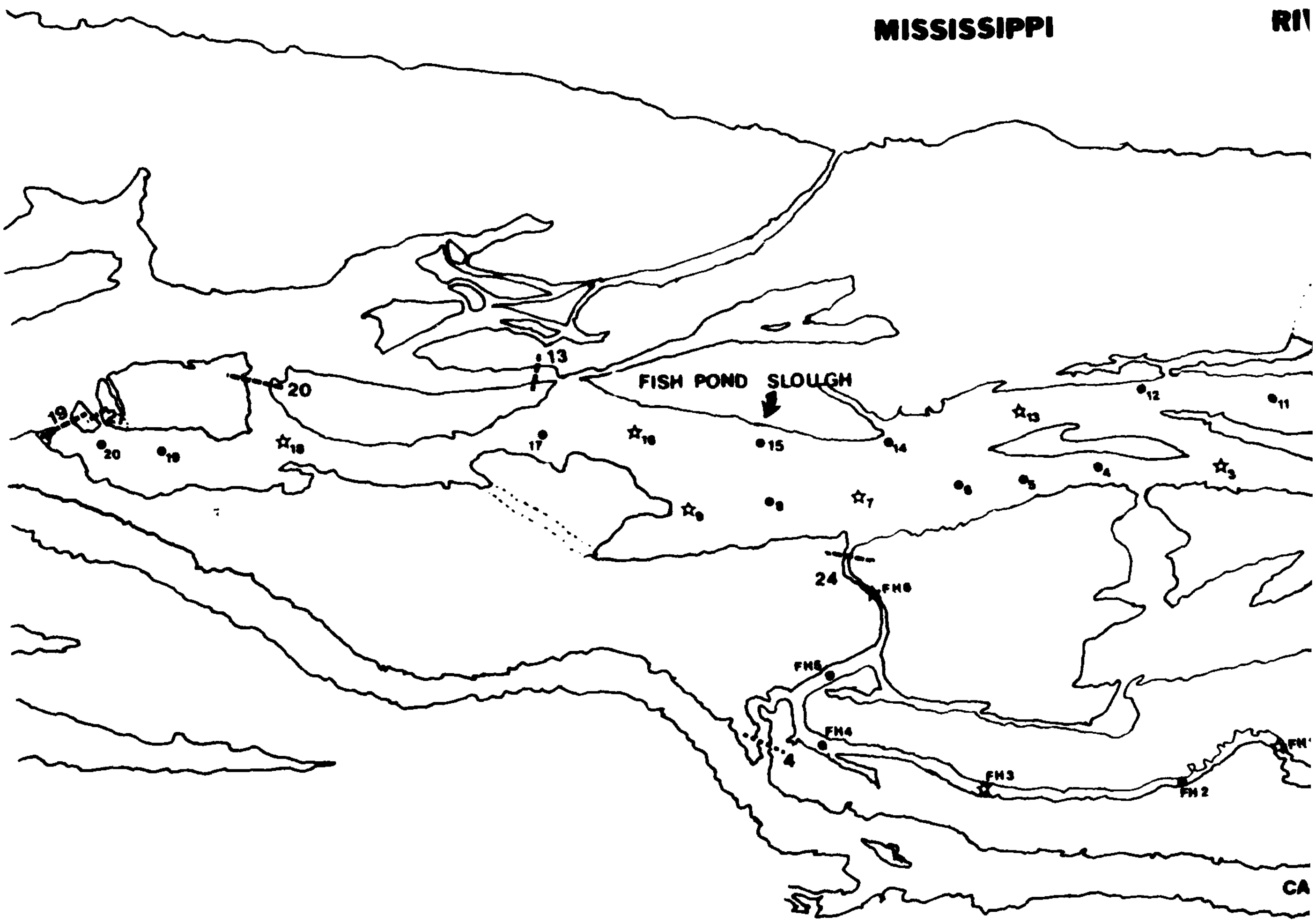
Field

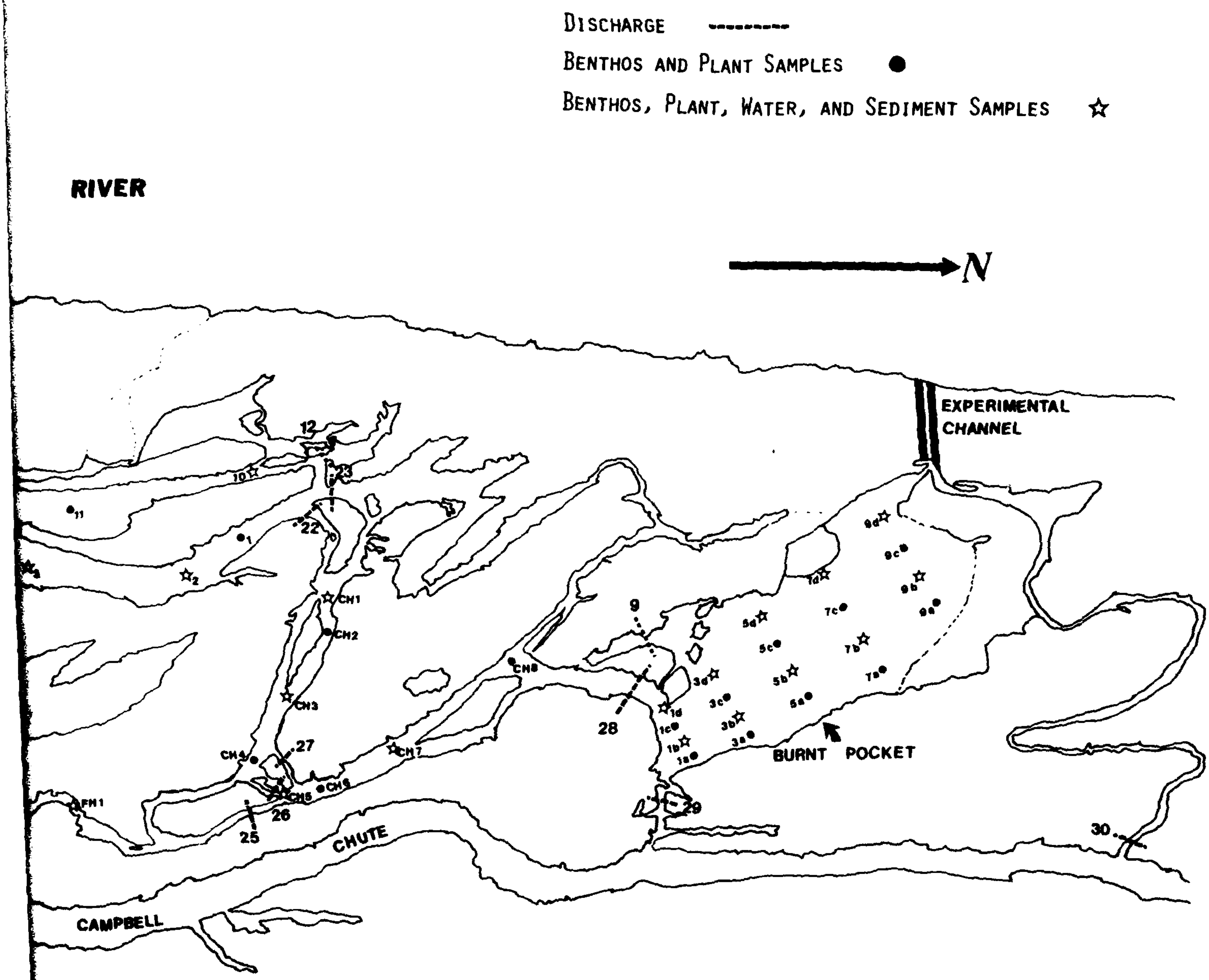
Aquatic macrophytes, benthic macroinvertebrates, sediments, dissolved oxygen, temperature, and hydrological features were investigated at approximately 25 sampling stations on 24-26 May and 26 July 1978, 13 June 1979 and 5 August 1980. Water chemistry samples were also collected at most of the stations. Sample sites and their abbreviations used in this report are: Main Channel of the Mississippi River, MC; Burnt Pocket, BP; Channel area within the study area, CH; Fish-Hook Slough, FH; and Fish Pond Slough, FP (Fig. 1).

Depth and Current Velocity: Cross-sectional areas were determined along transects perpendicular to the flow at each sampling station (Fig. 1). Water depths were measured with sounding poles marked at 1-cm intervals. Current velocity measurements were made at several depths and locations along each transect with a Price Type AA current meter following methodology of USGS (1969a). Since the subsections of the total cross section were divided on the basis of the number of current velocity stations, the current velocities were calculated for each subsection. Interpolation was used to find the velocities at the standard three-point method (0.2, 0.6, 0.8 of the total depth). An appropriate weighted average technique was then used to determine the current velocity of each subsection and of the total cross section. Results are expressed at ft^3/sec.

Discharge through the cross section was determined by summing the calculated discharge of each subsection and is a product of the current velocity and the cross section area, represented by:

FIG. 1. Map showing location of sample sites in the Burnt Pocket study area, Navigation Pool No. 18, Illinois. Abbreviations are: BP, Burnt Pocket; CH, Channel Area; FH, Fish Hook Slough; FP, Fish Pond Slough.


MISSISSIPPI
RI
FISH POND SLOUGH
13
20
19
21
24
4
CA


DISCHARGE
BENTHOS AND PLANT SAMPLES
BENTHOS, PLANT, WATER, AND SEDIMENT SAMPLES
RIVER
N
EXPERIMENTAL CHANNEL
BURNT POCKET
CAMPBELL
CHUTE
12
23
22
9
28
27
26
25
29
30
CH1
CH2
CH3
CH7
CH8

2

$$Q = \text{total discharge} = \sum_{i=1}^{k} Q_i = \sum_{i=1}^{k} A_i V_i$$

where k = number of subsections

Sediments: Sediment samples were collected from each location with a 6-in Ponar dredge. They were then placed in Whirlpacs[R] and kept on ice until arrival at the laboratory. The samples were then frozen until preparation for sediment particle size and sediment chemical analyses.

Water: Samples were collected in acid-washed 1-L polyethylene bottles and then put on ice until arrival at the laboratory. Subsurface water samples were not taken at all of the sampling locations due to their close proximity and mixing which occurred (Fig. 1).

Temperature and Dissolved Oxygen: Dissolved oxygen and temperature at each station was measured with a Yellow Springs Instruments Co. Model 54 dissolved oxygen meter. Determinations were made prior to sunrise to determine lowest dissolved oxygen concentrations during a 24-hr period.

Benthic Macroinvertebrates: Benthos samples were quantitatively collected with a 6-in Ponar dredge which sampled 0.023 m^2 of bottom material. Duplicate Ponar grabs were taken at each station (Fig. 1) and were consolidated into a single sample representing 0.046 m^2 of sediment. The samples were then washed in the field through a U. S. Standard #30 sieve and preserved in a solution of 70% ethanol and 5% glycerol.

Aquatic Macrophytes: A plant sample comprised of duplicate 0.25 m^2 quadrats was taken when vegetation was present. The sampler was an aluminum enclosure 0.5 m on a side and 1.0 m deep. Samples were collected by randomly throwing the sampler into the water and then pushing it deeply into the sediment to cut off any vegetation not contained within the quadrat. All living vegetation, including underground parts, was then harvested from the sampler and placed in a labeled polyethylene bag. The 0.25 m^2 duplicate samples were consolidated and constituted one 0.50 m^2 sample.

Vascular Plant Inventory: Only major aquatic macrophyte beds were sampled quantitatively. Therefore, a flora inventory and habitat survey was conducted to locate and generally characterize edge macrophytes not included in the quantitative study. This part of the study was augmented with side trips into all major habitat types. Habitat types (aquatic, shore, and woodland) were defined by growth form to eliminate possible subjective assessments of species composition (community structure). Plants were sight identified in the field whenever possible, and problematic specimens were collected for determination in the herbarium at the University of Wisconsin-La Crosse.

Zooplankton: Zooplankton samples were obtained by the side-channel work group using a Clarke-Bumpus plankton sampler. A Wildco^R net (#39RNX) of 80μ mesh was employed. Samples were collected from the six sites including Mississippi River (main channel), BP, CH, and three samples from the FP area (Fig. 2). Samples were obtained along transects and preserved in a 70% ethyl alcohol and 5% glycerin solution. During 1978 seven samples were taken between June and October and at monthly intervals in 1980 from June through September.

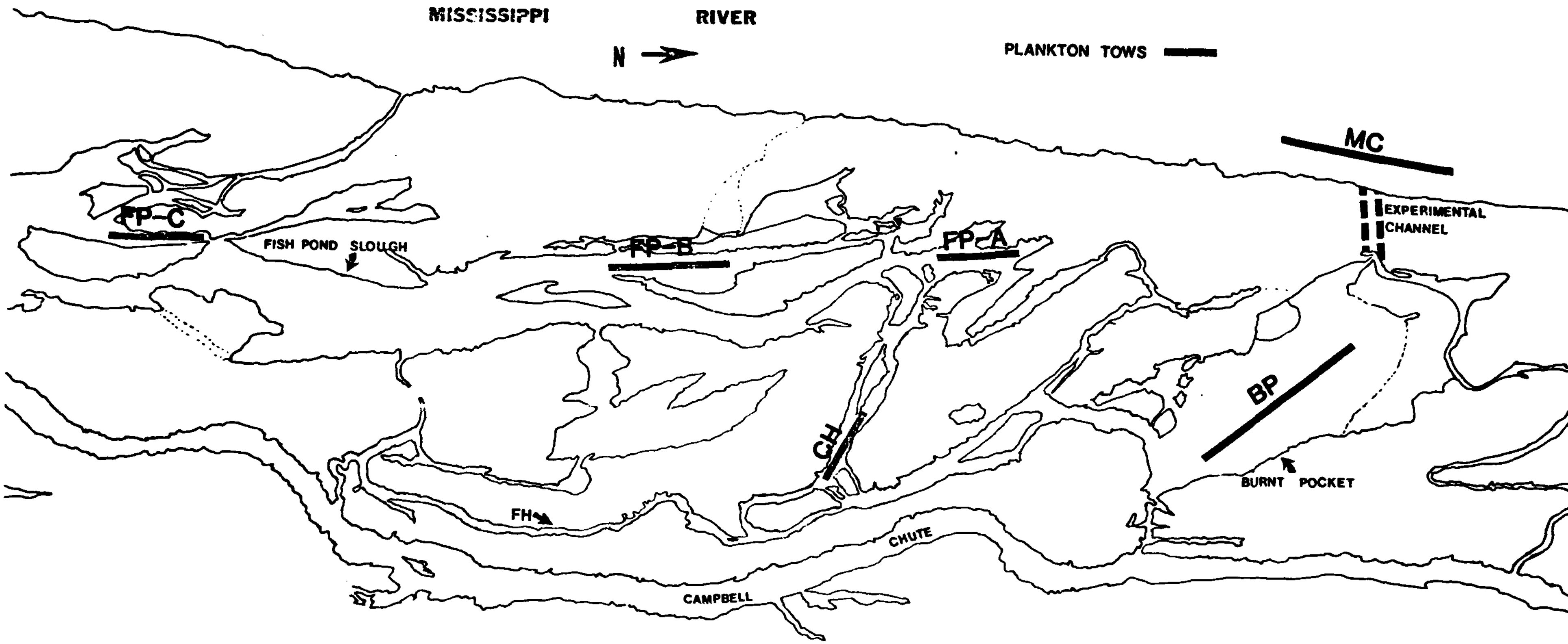
Fish: Fisheries data were collected by the Side Channel Work Group and were analyzed and reported by the Iowa Conservation Commission (VanVooren 1981). Sample locations are shown in Fig. 3.

Laboratory

Sediments: In preparation for sediment particle size and sediment chemical analyses, the frozen samples were thawed, dried at 106°C (APHA 1976), and then triturated with a porcelain mortar and rubber pestle.

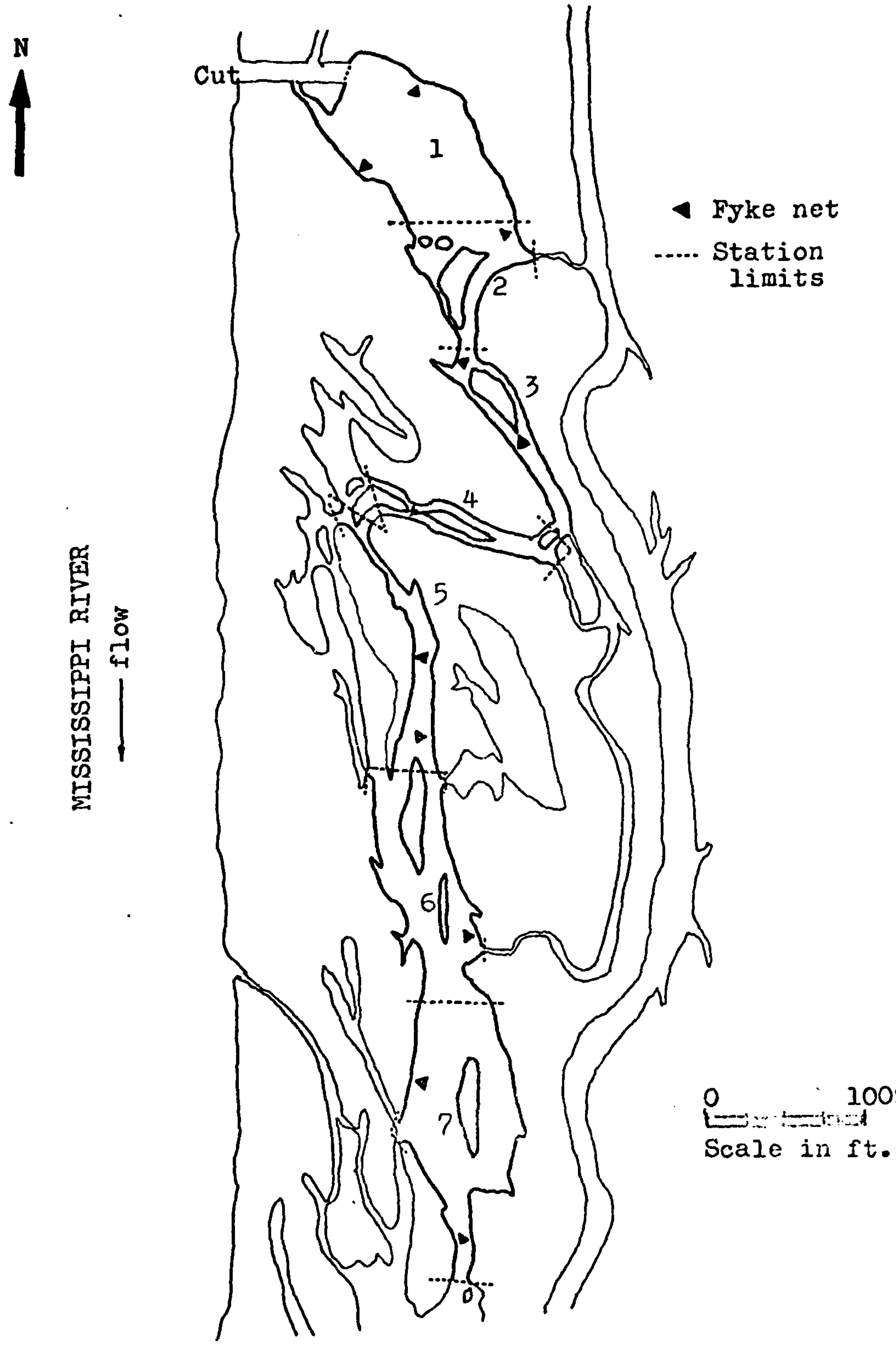
Particle size analyses were performed on a 50.0 g aliquot from each sediment sample according to USGS (1969b). The material was placed in a

FIG. 2. Location of plankton tows in the Burnt Pocket Study Area, Navigation Pool No. 18, Illinois. Transect abbreviations are: MC, Main Channel of the Mississippi River; BP, Burnt Pocket; CH, Channel Area; FP-A, Fish Pond Slough A; FP-B, Fish Pond Slough B; FP-C, Fish Pond Slough-C.



MISSISSIPPI
RIVER
N
PLANKTON TOWS
MC
EXPERIMENTAL
CHANNEL
FP-C
FISH POND SLOUGH
FP-B
FP-A
CH
BP
BURNT POCKET
FH
CHUTE
CAMPBELL

FIG. 3. Location of fisheries sampling stations and specific fyke net sites in the Burnt Pocket Study Area, Navigation Pool No. 18, Illinois (from Van Vooren 1981).


N
Cut
1
2
3
4
5
6
7
8
Fyke net
Station limits
MISSISSIPPI RIVER
flow
0 1000
Scale in ft.

set of U. S. Standard Testing Sieves (63 to 1000 μ mesh opening) and then put on a Soiltest, Inc. shaker for 30 minutes. Data are reported as percent finer than a given grain size class interval.

Total kjeldahl nitrogen was determined on duplicate aliquots (0.5 g) of each sediment sample using the macro-kjeldahl method (EPA 1974). Available sediment nutrients were extracted from 2.0 g of sediment by continual agitation for 30 minutes with 225 ml of deionized water (Olsen and Dean 1975). The extract water was then vacuum filtered through prewashed glass fiber filters (Gelman Type A-E). The filtered extract was analyzed for dissolved ortho-phosphate (EPA 1974), nitrate (Barnes 1959), and nitrite (EPA 1974). Results are expressed as mg N or P/g sediment.

Water: At the laboratory, water samples were analyzed for nitrite, nitrate, total kjeldahl nitrogen, ortho-phosphorus, total phosphorus, total hardness, calcium hardness, total alkalinity, sulfate, chloride, fluoride, specific conductance and turbidity. Additionally, ammonia, sodium, potassium, and iron were determined on most sample dates.

Total phosphorus and soluble ortho-phosphorus were determined using the combined reagent method (EPA 1974). The reduction method of Mullen and Riley (Barnes 1959) was used in the analysis of nitrate, and the single reagent method of the EPA (1974) was used for nitrite analysis. Ammonia was estimated with the phenolhypochlorite method of Liddicoat et al. (1975).

Total hardness and calcium hardness were determined by complexometric methods (APHA 1976). Ferrozine[R] (Hach Chemical Co., Ames, Ia.) was used in the analysis of iron. Total alkalinity, sulfate, chloride, sodium, potassium and fluoride were measured according to APHA (1976). A Markson Electromark[R] conductivity analyzer was used for specific conductance and a Hach Laboratory turbidimeter (Model 1860A) for turbidity.

Benthic Macroinvertebrates: The benthic invertebrates were hand-sorted from residual debris, placed in clear plastic vials, and preserved in a solution of 70% ethanol and 5% glycerin. Identification of the organisms were performed to the generic level whenever possible. Taxonomic keys used for identifications included Johanssen (1934), Burks (1953), Pennak (1953), Usinger (1956), Klemm (1972), Mason (1973), Hilsenhoff (1975), Wiggins (1977), and Cummins (1978). The organisms were retained as voucher specimens. Data for each sample are reported on an areal basis (number/m^2).

Total wet weight of the benthic invertebrates was determined for each sample. The organisms were hand-sorted and blotted dry. They were then placed on tared weighing paper, allowed to air dry for two minutes and weighed to the nearest 10^{-3} g. Wet weight data for each sample are expressed as grams total biomass/m^2. In addition, biomass of important taxa were calculated and are expressed as g/m^2.

Aquatic Macrophytes: Initially the samples were washed to rid the macrophytes of soil, epiphytic algae and aquatic fauna. Plant material was separated by species, wrapped in newspaper, placed in clean polyethylene bags, and then frozen to stop metabolic activities. The samples were then placed in a plant dryer at 60°C for a minimum of 36 hours (Westlake 1963). The macrophytes were weighed to the closest 0.01 g after drying. Plant data are reported as g/m^2.

Vascular Plant Inventory: Specimens collected were compared with other collections from the floodplain of the Mississippi River (Swanson 1977). Useful taxonomic keys included Gleason (1952), Gleason and Cronquist (1963), Fassett (1957), Voss (1972), Mohlenbrock (1975), Mohlenbrock and Ladd (1978), and various family treatments reported in Cochran (1976). The flora was compiled alphabetically by family for convenience to users. The treatment of families employed followed Cronquist (1968) for seed plants, while

Crabbe et al. (1975) was followed for lower vascular plants. The species noted were compared with the preliminary floodplain flora for the Upper Mississippi River from St. Louis north to St. Paul (Swanson 1978).

The flora of each vegetation type was listed alphabetically by genus. Species that were conspicuous in terms of their apparent presence, frequency, biomass, cover, etc. were noted as dominant and marked with an asterisk (*) on the vegetation lists.

Regression Analysis: Multivariate analyses were performed on the data utilizing preselected physical-chemical parameters as independent variables and the biological parameters as dependent variables. The partial regression coefficients that were generated from Navigation Pool No. 8 data for the same parameters were employed as predictors for the present study. Transformations were made for a few of the parameters to obtain the best Multiple-r^2 value. The transformations were restricted to $\log_{10}$, ln and exponential manipulations. Each predicted value is the sum of the products of the input data and their respective partial regression coefficient added to its respective intercept constant. No factor analyses were performed to eliminate independent variables at this time due to the observable inaccuracy of the model at some of the stations in the present study. The computer routines employed are described in Cooley and Lohnes (1971).

Zooplankton: Three 1-ml aliquots were taken from each sample and placed in a Sedgewick-Rafter counting cell. Organisms within the cell were enumuated and identified using Pennak (1953), Ward and Whipple (1959), and Novotny (1974). Biomass, mg/m^3, of the net plankton samples were also determined (EPA 1973), and the relative abundance of algae and detritus were estimated.

DESCRIPTION OF STUDY AREA

Navigation Pool No. 18 of the Mississippi River is formed from water impounded by Lock and Dam No. 18 at river mile 410.5. The upper boundary of Pool No. 18 is delimited by Lock and Dam No. 17 at river mile 437. Bedrock of the Pool 18 area consists of Devonian limestone and kinderhook shale of the Mississippi Age and glacial deposits of the Illinoisan stage. The depth to bedrock ranges from 40-150 ft in the river valley. Riverbed deposits are primarily sand with lesser amounts of clay, silt and gravel. Alluvial floodplain deposits are primarily silt and clay soils (2 to 20 ft deep) that overlie sand deposits (Bade 1978).

The Burnt Pocket study area is located in Campbell's Island along the eastern shore of the Mississippi River from river miles 421.0 to 422.5, Henderson County, Illinois (Fig. 1). For purposes of this research project, the Burnt Pocket study area was divided into four areas that included: 1) Burnt Pocket (BP); 2) Channel area (CH); 3) Fishhook Slough (FH); 4) Fish Pond Slough (FP). The main channel of the Mississippi River is designated by MC and Campbell Chute by CC.

The Burnt Pocket area (Fig. 1) is an open slough separated from the main channel by a low natural levee. The surface area of BP, calculated from a 7½ minute USGS topographic map, is 1,030,312 ft^2 (9.58 ha). Water enters BP through two lateral side channels and drains into the channel area (CH). The Pocket contains rather distinct upper and lower areas. The upper area is dominated by a massive shoal, whereas the lower area is open water. BP has been slowly accumulating sediment since it was inundated in the late 1930's, and approximately one-third of the original water area has become vegetated with grass and tree species (Bade 1978).

The channel area (CH) is designated as that reach within the study area that carries water from the downstream end of BP to the upper end of Fish Pond Slough (FP) (Fig. 1). The channel varies in width and depth and contains four large islands along its course.

Fishhook Slough (FH) is a downstream extension of CH (Fig. 1). This channel, in conjunction with a lateral channel from Campbell Chute, discharges water to the middle reaches of FP.

On an areal basis, the study area is dominated by Fish Pond Slough (FP) (1,404,375 sq ft; 13.05 ha). Water discharges into the slough through inlets at the upstream end and through at least three additional channels at various locations along the periphery of the slough (Fig. 1). Water discharges from FP at several locations at the downstream end (transects 13, 19N, 19S, 20, 21 and 21A). Transects 19S and 21A are extensions of 19 and 21 and are normally land forms at low water that discharge water only during high water periods.

In summary, the study area is dominated by two large, open areas (BP and FP) with two separate channel systems connecting them. The entire study site is isolated from Illinois land masses by Campbell Chute, a continuous channel along the bluffs. Water flows into the study area through at least three channels from Campbell Chute and probably more during high water. Water flows from the study area through channels at the lower end of FP.

The experimental side channel was constructed in October 1979 and directed water from the main channel of the Mississippi River to the Burnt Pocket study area (Fig. 1). The channel was constructed at right angles to the river and has a 50-ft bottom width, a 50% bank slope and discharges 500 cfs at 1 ft above flat pool (Bade 1978). Riprap was placed 75 ft into the channel and around corners at 5 ft above the water line to minimize erosion. During the post-opening sampling period there was no water flowing through the channel.

RESULTS AND DISCUSSION

Hydrography

Pre-opening

Flow into the Burnt Pocket study area from CC ranged from 282.0 to 1163.5 cfs (Table 1). The majority of water, 58.8 to 95.5%, entered the area through lateral channel 29 (Table 2, Fig. 1). Lateral channels 4 and 30 supplied the remaining 4.5 to 41.2% of the inflow. Lateral channel 30 is small and meandering, and supplies significant water only during periods of high flow (Table 3). Outflow from the study area ranged from 263.6 to 1182.3 cfs and occurred through channels 13, 19N, 19S, 20, 21 and 21A. Although absolute differences in outflow were determined, the percent lost through any given channel remained relatively constant (Table 2). The greatest outflow was in channel 20 (range: 34.6 to 57.2%), followed by channel 13 (range: 21.2 to 25.3%) and channel 19N (range: 17.1 to 25.6%). Depending upon sampling date, 93 to 102% of the water flowing into the sample area can be accounted for in the outflow (Table 1). Flow greater than 100% results from either 1) some inflow or outflow waters not being measured; or 2) error in measurements of flow.

The flow of water into and out of BP and FP were also calculated (Table 1). In BP, the inflow through lateral channels 29 and 30 ranged from 274.4 to 886.8 cfs, whereas the outflow from lateral channels 25, 26, and 27 ranged from 258.9 to 813.3 cfs. Depending upon sampling date, 92 to 113% of the water flowing through BP can be accounted for. The majority of water enters BP through channel 29 (average 79%). However, water entering through this channel affects only the lower one-third of BP. The entering water forms a large eddy that extends at least 20-30 m into the pocket before diverting back to the channel area. Consequently, the upper end of BP, in

TABLE 1

Inflow and outflow of water measured as total discharge (cfs) and percent difference between inflow and outflow of the entire study area, Burnt Pocket and Fish Pond Slough in Navigation Pool No. 18, Illinois.

Date	Inflow	Outflow	% Difference
		Entire Study Area	
May 1978	282.0	263.6	7
July 1978	1163.5	1182.3	2
June 1979	509.2	505.6	1
August 1980	209.5	197.9	6
		Burnt Pocket	
May 1978	274.4	258.9	6
July 1978	886.8	813.3	8
June 1979	324.5	368.2	13
August 1980	178.2	159.6	10
		Fish Pond Slough	
May 1978	266.2	263.6	1
July 1978	1191.7	1182.3	1
June 1979	534.4	505.5	5
August 1980	197.9	197.9	0

TABLE 2

Flow of water through the Burnt Pocket Study Area expressed as percent of discharge through specific channels on four dates in Navigation Pool No. 18, Illinois.

	Percent Total Flow			
	May 1978	July 1978	June 1979	August 1980
Discharge into study area				
24(4)	2.7	9.6	36.2	14.9
29	95.5	82.2	58.8	85.1
30	1.7	8.2	4.9	0.0
Discharge from BP area to CH and FH				
25 (FH)	12.7	23.3	27.3	0.0
26, 27 (CH)	87.3	76.7	72.7	100.0
Discharge into FP from CH and FH				
12, 22, 23 (CH)	84.8	76.8	83.8	84.2
24 (FH)	15.2	23.2	16.2	15.8
Discharge from study area				
13	21.2	25.3	24.2	27.0
19N	17.1	25.6	19.8	0.5
19S	--*	5.9	--	--
20	57.2	34.6	49.8	61.1
21	4.5	7.4	6.2	11.4
21A	--	1.2	--	--

*-- denotes no data obtained. These channels carried water only during high periods of flow.

TABLE 3

Total discharge (cfs) through various channels in the Burnt Pocket Study Area, Navigation Pool No. 18, Illinois.

Station	May 1978	July 1978	June 1979	August 1980
4	--*	--	184.7	--
9	--	--	117.7	--
12	--	--	--	13.0
13	55.8	299.7	122.1	50.6
19N	45.1	302.6	100.1	0.9
19S	--	70.3	--	--
20	150.7	408.9	251.9	114.4
21	12.0	88.0	31.4	21.4
21A	--	12.8	--	--
22	97.0	270.4	217.7	22.5
23	129.2	644.6	230.0	131.1
24	40.5	276.7	86.7	31.3
25	32.9	231.8	99.9	0.0
26	185.4	434.5	176.9	142.8
27	40.6	147.0	91.4	16.8
28	226.6	531.6	396.9	166.3
29	269.4	806.7	299.5	178.2
30	5.0	80.1	25.0	0.0
Experimental Side Channel Opening	--	--	--	0.0

*-- denotes no data obtained.

sharp contrast to the lower end, is a massive shoal that is submerged only during periods of high flow and high pool elevation.

The flow regime of FP was also calculated. Inflow, through channels 12, 22, 23 and 24, ranged from 266.2 to 1191.7 cfs (Table 1). Channels 22 and 23 carry the majority of water to FP, averaging 82% of the total inflow (Table 2). Water flows uniformly through the majority of the slough at slow current velocities and is discharged through several downstream openings (channels 13, 19N, 19S, 20, 21, 21A). Outflow from FP is the same as outflow for the total study area and has been discussed above. Ninety-five to 99% of the flow entering FP was accounted for in the outflow.

Within the study area, water flows from BP to a channel area and Fishhook Slough. The channel which initially carries all flow from BP (Fig. 1), forms a side channel, FH Slough from the BP outlet. At the point of divergence 72.7 to 87.3% of channel flow continues within the channel, whereas 12.7 to 27.3% is routed into FH (Table 2).

The channel varies in width and depth and contains four large islands. It is active along its entire length with discharges ranging from 40.6 to 644.6 cfs. Fishhook Slough is differentiated from the channel area because of its relatively low discharge. FH is narrower than CH and maximum velocities were observed at the constricted upstream end (0.30 ft/sec) and at the juncture with FF, 1.23 ft/sec (Table 4). Flow through the remainder of the channel is relatively slower and in general FH is more quiescent than CH.

Post-opening

Low water conditions prevailed and there was no water flowing through the experimental side channel opening at the time of sampling. Flow through the diversion channel at 1 ft above flat pool approximates 500 cfs (Bade 1978). Discharge at Lock and Dam No. 17 and 18, and Pool 18 elevation in

TABLE 4

Current velocity data (ft/sec) for the Burnt Pocket Study Area.

Transect	May 1978	July 1978	June 1979	August 1980
3	--*	--	0.84	--
4	--	--	1.01	--
5	--	--	1.05	--
9	--	--	0.93	--
12	--	--	--	0.31
13	0.32	0.95	0.58	0.03
19N	0.36	0.87	0.33	0.03
19S	--	0.66	--	--
20	0.48	0.67	0.52	0.21
21	0.38	0.60	0.55	0.15
21A	--	0.20	--	--
22	0.75	1.11	0.96	0.02
23	0.93	1.17	0.96	0.22
24	1.23	0.95	1.18	0.50
25	0.30	1.01	1.69	0.00
26	1.04	1.71	1.36	0.29
27	0.99	1.50	1.83	0.17
28	0.87	1.07	0.20	0.55
29	0.80	1.93	1.00	0.31
30	0.86	1.03	0.89	--

*-- denotes no data obtained.

Spring 1980, indicates that significant quantities of water flowed through the experimental side channel (Table 5).

Total flow into the study area was 209.5 cfs, which was significantly less than inflow during the pre-opening studies (Table 1). Outflow was 197.9 cfs and 94% of the incoming flow was accounted for in the outflow.

During the August, 1980 sampling period lateral channel 29 supplied all of the inflow to BP (178.2 cfs) and there was no flow in channel 30. As a result, only the lower reaches of BP contained water and the upper reaches were dry. Outflow through CH was calculated at 159.6 cfs, or 90% of the inflow to BP. The flow of water to FP from BP (2, 22 and 23, Fig. 1) was routed through CH, FH received no flow from BP. Fish Pond Slough also received water directly from CC through lateral channel 24. The total flow into FP was 197.9 cfs and outflow was also 197.9 cfs (Table 1).

In general, the flow through the study area followed the same routes as before opening the experimental side channel. Absolute amounts were, however, significantly less because of the low water.

The volume of water contained in BP was 1,813,350 ft^3 and corresponds to a mean Pool No. 18 elevation of 529.43 ft. The turnover time of this water (calculated by volume/inflow) during May 1978 was 33.9 hr and ranged from 0.6 hr for lower BP and 67.2 hr for upper BP. Distinction between upper and lower BP is based upon the movement of inflow waters. Flow through channel 30 affects all of BP but discharges relatively low quantities of water. Conversely, flow through channel 29 affects only the lower one-third of BP but discharges relatively large quantities of water. The turnover time of 0.6 hr was determined for lower BP and 67.2 hr was determined for upper BP. The volume of FP was 2,893,012 ft^3 and the turnover time was calculated as 7.9 hr. Turnover times for other sampling dates were calculated in the same manner (Table 6). Because of the relatively high and constant inflow through channel 29, lower BP had the shortest turnover times. Upper BP had significantly longer turnover times

TABLE 5

Average monthly discharge (cfs x 10^3) at Lock and Dam No. 17 and 18 and average monthly elevation of Navigation Pool No. 18, Illinois.

Month	1978	1979	1980
	Discharge at Lock and Dam No. 17 cfs x 10^3		
January	52.9	28.2	43.8
February	30.4	30.1	41.8
March	42.9	92.1	59.4
April	110.2	182.0	87.2
May	76.5	152.0	41.7
June	75.2	85.0	74.0
July	109.4	68.8	31.0
August	52.3	70.3	49.8
September	68.2	60.8	81.1
October	47.3	38.2	63.2
November	39.1	59.5	-- *
December	32.8	46.4	--
	Discharge at Lock and Dam No. 18 cfs x 10^3		
January	54.4	28.6	45.7
February	31.2	31.1	41.9
March	52.5	121.6	70.1
April	125.6	221.1	101.0
May	94.6	186.4	47.5
June	87.9	103.8	92.6
July	126.0	84.4	37.1
August	60.3	89.5	63.1
September	79.0	80.0	94.1
October	54.3	44.9	70.9
November	45.8	72.1	--
December	35.6	51.8	--
	Pool 18 Elevation (ft)		
January	9.21	9.10	9.41
February	9.16	9.05	9.26
March	9.14	10.4[illegible]	9.38
April	9.55	13.05	9.47
May	9.43	11.28	9.50
June	9.44	9.40	9.49
July	9.53	9.47	9.47
August	9.37	9.51	9.50
September	9.49	9.45	9.54
October	9.41	9.52	9.52
November	9.54	9.51	--
December	9.45	9.50	--

*As of this writing, data have not been taken.

TABLE 6

Turnover times for Burnt Pocket and Fish Pond Slough in Navigation Pool No. 18, Illinois.

	Turnover (hours)		
	BP		FP
	Lower	Upper*	
May 1978	0.6	67.2	7.9
July 1978	0.4	7.1	1.8
June 1979	0.7	61.9	1.6
August 1980	0.9	--**	5.3

*Lower and Upper BP explained in text.

**--insufficient data for calculations.

because of low and sporadic inflow. Time required for turnover in FP ranged from 1.6 to 7.9 hr.

Construction of the experimental side channel should increase discharge into upper BP by approximately 500 cfs. Assuming this occurred during Spring 1980, turnover time of all of BP would be 1.0 hr and in FP turnover time was reduced to 1.3 hr.

Sediments

Pre-opening

Grain Size: Pre-opening sediment particle size data are presented in Tables 7 and 8. The upper portion of Burnt Pocket is dominated by a large shoal that is exposed to the atmosphere during periods of low flow. This shallow region is dominated by fine sands, silts and clays. Grain sizes less than 250μ diam comprised 46.9 to 60.3% of the sediments along transects BP-5, BP-7 and BP-9 on 25 May 1978, whereas grain sizes less than 250μ comprised 66.6 to 84.4% of the sediments in the same area on 13 June 1979. Stations in upper BP also contained significant amounts of sediments finer than 63μ diam (i.e. ranges of 29.6 to 40.4% in 1978 and 35.2 to 54.5% in 1979). These results were expected because of the restricted discharge and low to undetectable current through this area. As previously discussed, the inlet at the bottom of BP (29) provides the largest volume of water to the study area. Eddy currents resulting from that flowage affect the lower one-third of the pocket (transect BP-1 and BP-3), however, the general sediment grain sizes were similar to the upper reaches of BP. One exception is site BP-1b which consistently had less than 33% silts and clays. Burnt Pocket-1b is, however, more directly affected by the channel.

A high current velocity was maintained in the channel reach of the study area and entrained all except the majority of the sand-size sediments. Consequently, the sediments at the CH sites were well scoured and contained mostly grain sizes >63μ diam. The few exceptions to this general statement are indicative of samples not taken within the thalweg.

TABLE 7

Sediment particle size distribution of bottom samples collected in Navigation Pool No. 18, Upper Mississippi River on May 24-26, 1978. Results expressed in percent finer than a given grain size class interval.*

	% Finer Than				
Station	1000μ	500μ	250μ	125μ	63μ
BP-1b	92.2	72.6	52.7	42.7	32.9
BP-1d	95.0	87.7	79.2	58.2	45.8
BP-3b	95.4	80.3	68.8	62.7	56.8
BP-3d	94.5	80.9	66.8	58.3	51.5
BP-5d	97.0	73.0	52.2	43.5	34.6
BP-7b	97.3	78.0	52.5	40.7	30.9
BP-7d	94.7	60.7	46.9	39.8	29.6
BP-9b	86.2	65.7	52.6	44.2	33.9
BP-9d	94.3	76.8	60.3	51.8	40.4
CH-1	97.2	83.3	57.1	33.5	21.0
CH-3	97.7	93.4	30.6	0.4	0.3
CH-5	96.5	88.6	66.2	20.7	10.9
CH-7	87.4	67.1	13.7	3.2	2.3
FH-3	96.1	86.0	78.4	74.6	69.9
FH-6	80.7	65.9	50.2	40.0	31.4
FP-2	92.8	79.5	69.6	63.8	57.9
FP-3	95.0	85.2	78.0	73.9	67.7
FP-7	94.8	82.2	69.4	62.6	55.8
FP-9	96.4	85.0	72.5	64.3	60.2
FP-10	97.6	90.3	83.7	76.3	61.2
FP-13	92.5	80.6	70.6	64.8	60.1
FP-16	92.3	56.5	46.1	40.4	32.1
FP-18	94.9	80.6	66.7	50.7	40.7

*Stations sampled varied with the year because of dry conditions.

TABLE 8

Sediment particle size distribution of bottom samples collected in Navigation Pool No. 18, Upper Mississippi River on June 13, 1979. Results expressed in percent finer than a given grain size class interval.*

	% Finer Than				
Station	1000μ	500μ	250μ	125μ	63μ
BP-1a	100.0	99.2	75.5	59.9	41.5
BP-1b	99.6	99.0	67.4	42.4	32.3
BP-1c	99.8	99.4	87.8	66.4	44.0
BP-1d	99.2	97.8	87.1	73.6	51.8
BP-3a	99.4	98.8	77.7	63.1	37.9
BP-3b	99.2	98.4	72.8	58.5	45.8
BP-3c	99.2	97.4	80.3	67.6	49.9
BP-3d	99.4	98.6	74.6	63.5	52.2
BP-5a	99.4	99.0	68.1	52.4	40.1
BP-5b	100.0	98.2	69.8	55.5	44.4
BP-5c	99.0	97.6	66.6	51.4	38.4
BP-5d	99.8	99.0	67.5	51.0	39.8
BP-7a	99.2	98.6	68.0	49.8	35.2
BP-7b	99.8	99.4	70.3	53.8	42.7
BP-7c	99.4	98.4	74.7	53.4	39.9
BP-7d	99.4	99.0	74.6	58.2	46.5
BP-9a	99.2	97.6	69.9	54.7	42.8
BP-9b	99.2	93.3	69.1	54.2	43.5
BP-9c	100.0	99.2	84.4	67.4	54.2
BP-9d	99.2	96.0	83.1	66.0	54.4
CH-1	99.4	99.4	97.8	77.6	39.3
CH-3	96.5	86.9	62.6	42.0	24.5
CH-5	99.2	91.2	61.3	29.0	15.5
CH-7	93.3	74.3	23.3	8.3	5.7
FH-1	99.6	98.4	86.0	72.2	55.8
FH-3	99.8	98.0	90.5	84.4	72.8
FH-6	99.8	98.4	72.1	49.1	34.6
FP-2	99.4	98.6	92.4	78.4	58.2
FP-3	99.8	99.4	94.2	82.2	64.4
FP-6	98.2	85.5	58.0	48.2	39.4
FP-7	98.6	97.2	80.9	66.4	52.9
FP-9	99.2	98.4	90.9	73.8	58.9
FP-10	100.0	99.4	94.8	84.5	66.8
FP-13	99.0	95.6	75.9	60.0	47.3
FP-16	99.6	98.8	83.6	73.2	63.3
FP-18	99.4	98.8	79.4	68.0	58.0

*Stations sampled varied with the year because of dry conditions.

Fishhook Slough was dominated by very fine sands, silts and clays. The amounts of grain sizes >63μ in FH sediment samples ranged from 31.4 to 69.9% and 34.6 to 72.8% in 1978 and 1979, respectively. These observations were likely because FH had a low current velocity which allowed a large portion of the suspended sediments to settle out of solution.

The upstream reach of Fish Pond Slough (2, 3 and 10) was composed of sediments ranging from 57.9 to 67.7% and 58.2 to 66.8%, silts and clays during 1978 and 1979, respectively. Similar sediment characteristics were observed in the middle portion of FP (7, 9 and 13). There was, however, a notable difference in sediment composition at the lower end of FP (16 and 18) between 1978 and 1979. At sites FP-16 and FP-18 the average amounts of silts and clays were 36.1% in 1978 and 60.7% in 1979. This may reflect the greater discharge that occurred immediately prior to and during the period of sampling in 1979 as compared to 1978. During that relatively high discharge period in 1979, materials might have been resuspended from upstream portions of the study area. The resuspended sediments and suspended sediments in the influent water from Campbell Chute may have been deposited in the lower reach of Fish Pond Slough.

Sediment Chemistry: Sediment chemistry data are presented in Tables 9, 10, and 11. In Burnt Pocket, total kjeldahl nitrogen (TKN) ranged from a low of 0.52 mg/g at station BP-1b in 1978 to a high of 3.00 mg/g at station BP-5d in 1978. The average TKN concentration in the entire pocket for all three pre-opening sampling periods was 1.74 mg/g, whereas the average in only the lower portion of the pocket (transects BP-1, BP-3 and BP-5) during the same period was 1.59 mg/g. The channel area (CH) was highly variable and contained low amounts of TKN which averaged 0.32 mg/g during 1978 and 1979. Fishhook Slough was intermediate between CH and BP and averaged 0.93 mg/g

TABLE 9

Concentrations of sediment nitrogen and phosphorus (mg/g) in the Burnt Pocket Study Site, Navigation Pool No. 18, Illinois, during May 24-26, 1978.*

Station	TKN	Total-P	Ortho-P	$NO_2 + NO_3$
BP-1b	1.16	0.010	0.010	0.009
BP-1d	0.68	0.009	0.009	0.009
BP-3b	0.92	0.011	0.011	0.006
BP-3d	1.78	0.046	0.019	0.007
BP-5b	2.31	0.030	0.027	0.007
BP-5d	2.06	0.015	0.015	0.006
BP-7b	2.39	0.023	0.022	0.009
BP-7d	2.23	0.022	0.020	0.007
BP-9b	2.12	0.020	0.019	0.006
BP-9d	2.29	0.020	0.019	0.007
CH-1	0.76	0.012	0.011	0.009
CH-3	0.05	0.004	0.003	0.024
CH-5	0.20	0.007	0.006	0.013
CH-7	0.07	0.006	0.004	0.032
FH-1	0.67	0.015	0.012	0.012
FH-3	1.05	0.013	0.012	0.027
FH-6	1.63	0.012	0.011	0.028
FP-2	1.04	0.020	0.019	0.009
FP-3	0.85	0.016	0.014	0.006
FP-7	2.06	0.019	0.019	0.031
FP-9	1.57	0.011	0.011	0.035
FP-10	1.29	0.015	0.015	0.028
FP-13	1.70	0.019	0.015	0.013
FP-16	1.85	0.016	0.015	0.011
FP-18	1.11	0.009	0.006	0.016

*All values are expressed as milligrams N or P per gram of sediment.

TABLE 10

Concentrations of sediment nitrogen and phosphorus (mg/g) in the Burnt Pocket Study Site, Navigation Pool No. 18, Illinois, during July 24-26, 1978.*

Station	TKN	Total-P	Ortho-P	$NO_2 + NO_3$
BP-1b	0.52	0.009	0.005	T**
BP-1d	1.16	0.15	0.008	0.001
BP-3b	1.53	0.020	0.011	0.001
BP-3d	1.55	0.028	0.011	0.001
BP-5b	1.52	0.024	0.011	0.001
BP-5d	3.00	0.047	0.016	0.001
BP-7b	1.30	0.034	0.013	0.001
BP-7d	1.46	0.032	0.018	0.001
BP-9b	1.58	0.034	0.009	0.001
BP-9d	1.74	0.027	0.014	0.001
CH-3	0.27	0.010	0.007	0.002
CH-5	0.62	0.008	0.007	T
CH-7	0.01	0.005	0.003	T
FH-1	1.29	0.038	0.017	0.001
FH-3	0.55	0.015	--***	--
FH-6	0.79	0.021	0.009	T
FP-2	0.92	0.014	0.008	0.003
FP-3	1.13	0.020	0.012	0.001
FP-7	1.67	0.027	0.012	0.008
FP-9	1.31	0.021	0.010	T
FP-10	1.06	0.014	0.007	T
FP-12	1.30	0.016	0.010	0.001
FP-13	0.97	0.030	0.013	0.001
FP-16	1.06	0.014	0.007	T
FP-18	1.30	0.019	0.008	T

*All values are expressed in milligrams N or P per gram of sediment.
**Trace amounts.
***-- denotes no data.

TABLE 11

Concentrations of sediment nitrogen and phosphorus (mg/g) in the Burnt Pocket Study Site, Navigation Pool No. 18, Illinois, on June 13, 1979.*

Station	TKN	Total-P	Ortho-P	$NO_2 + NO_3$
BP-1b	1.07	0.014	0.012	0.001
BP-1d	0.78	0.021	0.017	0.008
BP-3b	2.39	0.018	0.018	0.001
BP-3d	1.37	0.019	0.016	0.002
BP-5b	2.39	0.028	0.027	0.001
BP-5d	2.39	0.030	0.026	0.001
BP-7b	1.43	0.019	0.017	0.001
BP-7d	2.68	0.027	0.018	0.002
BP-9b	1.94	0.024	0.015	0.003
BP-9d	2.45	0.024	0.024	0.001
CH-1	0.38	0.011	0.010	0.016
CH-3	0.25	0.009	0.009	0.006
CH-5	0.76	0.011	0.010	0.007
CH-7	0.15	0.012	0.012	0.003
FH-1	--**	0.021	0.020	0.005
FH-3	0.54	0.023	0.021	0.006
FH-6	--	0.013	0.012	0.004
FP-2	1.07	0.018	0.017	0.006
FP-3	1.26	0.021	0.017	0.007
FP-7	1.28	0.015	0.013	0.005
FP-9	1.58	0.016	0.016	0.007
FP-10	1.15	0.024	0.018	0.002
FP-13	1.29	0.013	0.013	0.008
FP-16	1.53	0.023	0.020	0.007
FP-18	1.31	0.021	0.016	0.002

*All values are expressed as milligrams N or P per gram of sediment.
**-- denotes no data.

TKN. The mean concentration of TKN in Fish Pond Slough was 1.32 mg/g, this level was greater than that for Fishhook Slough but less than that of Burnt Pocket. These results were expected because of the hydrographic and hydrologic characteristics of the various reaches within the study site. In general, TKN is positively correlated with areas that have lower current velocities and larger amounts of silts and clays. More specifically, TKN is usually associated with sediments higher in organic content. Therefore, it was likely that maximal TKN levels were to be found in Burnt Pocket where aquatic macrophytes were most abundant.

Total-P and ortho-P levels followed trends similar to those for TKN. The highest concentrations were found in regions with fine sediments and low current velocities. Nitrite plus nitrate-nitrogen concentrations were highly variable and ranged from trace levels (<0.001 mg/g) in July 1978 to 0.035 mg/g in May 1978. The lowest concentrations of NO_2+NO_3-N occurred during times of high flow. This is indicative of its mobile nature in sediments as compared to phosphorus. In general, the sediment chemistry data in the Burnt Pocket study area follow similar trends as those observed in several upstream navigation pools (Smart 1977, Strodthoff 1978, Claflin and Rada 1979, Rada et al. 1980).

Post-opening

Grain Size: Post-opening sediment particle size data are presented in Table 12. Low water conditions prevailed in Navigation Pool No. 18 during post-opening sampling (Table 1); consequently, most of the sediments in upper Burnt Pocket were exposed to the atmosphere. As a result of exposure, sediment samples were not collected along transects BP-7 and BP-9, and the only submerged sediment samples collected in the upper pocket were BP-5b and BP-5c. During 1980, grain sizes less than 250μ diam comprised 91.6% and 46.4%

TABLE 12

Sediment particle size distribution of bottom samples collected in Navigation Pool No. 18, Upper Mississippi River on August 5, 1980. Results expressed in percent finer than a given grain size class interval.*

Station	1000μ	500μ	% Finer Than 250μ	125μ	63μ
BP-1a	99.9	99.7	87.8	63.0	53.5
BP-1b	99.2	97.1	80.7	45.1	30.5
BP-1c	99.9	99.8	91.0	44.2	30.9
BP-1d	99.6	99.1	96.6	48.3	22.1
BP-3a	99.8	99.5	97.5	96.3	86.8
BP-3b	98.9	88.9	71.7	49.1	20.7
BP-3c	99.7	82.1	67.9	60.3	47.5
BP-3d	99.9	97.6	92.5	63.6	46.6
BP-5b	99.6	99.2	91.6	83.9	73.8
BP-5c	99.9	84.6	46.4	35.6	26.3
CH-1	99.8	97.3	88.8	29.6	13.9
CH-3	99.5	86.1	26.5	9.9	6.7
CH-5	99.6	96.3	86.3	46.6	26.3
CH-7	91.1	73.8	27.5	9.8	5.6
FH-1	99.5	99.0	97.2	93.7	77.4
FH-3	99.9	99.6	88.4	76.3	50.3
FH-6	98.9	90.2	64.7	50.4	35.5
FP-2	98.8	93.2	80.4	59.1	43.9
FP-3	99.4	98.8	98.4	94.8	62.4
FP-7	99.7	99.3	98.3	97.1	92.0
FP-9	100.0	99.5	97.1	94.9	88.7
FP-10	98.3	82.3	54.5	40.1	31.8
FP-13	99.9	99.2	98.2	94.7	73.0
FP-16	99.3	99.0	97.9	97.0	91.2
FP-18	99.9	99.5	97.9	95.7	85.6

*Stations sampled varied with the year because of dry conditions.

of the sediments at BP-5b and BP-5c respectively. In comparison, approximately 70% of the sediments at the same stations in 1979 were comprised of similar grain sizes. The silt-clay component of the sediments during 1980 was also more variable as compared to 1979. During 1979, BP-5b and BP-5c, respectively, contained 44.4% and 38.4% grain sizes less than 63μ, whereas during 1980 the sediments at these stations were comprised of 73.8% and 26.3% silts and clays. During 1980, the sediments in lower Burnt Pocket were also highly variable with regard to the distribution of the smaller particle sizes. In sediment samples from lower BP, the proportion of particles less than 63μ ranged from 20.7% at BP-3b to 86.6% at BP-3a. The variability in BP sediment data during the post-opening period as compared to the pre-opening period implies that the composition of Burnt Pocket sediments was changed from spatially homogenous before the experimental opening to heterogenous after the experimental side channel was constructed. This could have been expected because of the braided channels that resulted in Burnt Pocket from the increased discharge of the experimental opening. Generally, the presence of braided channels indicates that water from the side channel opening was scouring the smallest grain sizes from the pocket. These results are consistent with those discussed by Simons (1979) regarding qualitative responses of river systems to slope, bed material and changes in discharge.

The channel (CH) of the study area remained well scoured after the opening was made. Grain sizes of the sediments were dominated by sands with silts and clays comprising only 5.6 to 26.3% of the sediments.

Overall, Fishhook Slough retained similar sediment grain size characteristics after the side channel opening as compared to 1978 and 1979. The upper to middle reach of FH (1 and 3) was dominated by silts and clays, whereas the lower reach at FH-6 remained at approximately 35% silts and clays. Fishhook

Slough-6 was expected to have less of the small grains due to its constricted channel and higher current velocity.

A comparison of the silt and clay composition of the sediments in the upper, middle and lower regions of Fish Pond Slough during 1978, 1979 and 1980 is presented in Table 13. In 1980, after receiving the increased discharge resulting from the experimental cut, the upper portion of FP appeared to have a lower proportion of silts and clays as compared to 1978 and 1979. This observation was most apparent at FP-2 and FP-10 which are both in narrow regions of FP with relatively high current velocities. Another important observation can be made from Table 13 regarding the middle portion of FP (7, 9 and 13), i.e. the amounts of silts and clays increased from averages of 59.0% in 1978 and 53.0% in 1979 to 84.6% in 1980. Furthermore, the amounts of sediment grain sizes less than 63μ in lower Fish Pond Slough increased from 60.7% in 1979 to 88.4% in 1980. These data indicate that materials resuspended as a result of the increased discharge from the experimental side channel and the suspended sediments of the influent waters were being deposited in the middle and lower reaches of Fish Pond Slough. Future data on sediment grain size will be required to determine if the accumulated sediments will be scoured from Fish Pond Slough when the system again reaches equilibrium.

Sediment Chemistry: Post-opening sediment chemistry data are presented in Table 14. The distribution of TKN reflects the spatial heterogeniety of the Burnt Pocket sediments which resulted from the experimental side channel opening. Post-opening levels of TKN in BP sediments were quite variable with a range of 0.25 to 1.58 mg/g and an average of 0.89 mg/g. This is in sharp contrast to the average sediment TKN, 1.59 mg/g, in the same areas of Burnt Pocket (transects BP-1, BP-3 and BP-5) prior to opening the experimental side channel. A one-tailed t-test, using a pooled estimate of variance, was used to determine that there was a significant reduction ($p = 0.005$)

TABLE 13

Percent of grain sizes finer than 63μ in upper, middle and lower portions of Fish Pond in the Burnt Pocket Study Site, Navigation Pool No. 18, Illinois.

Station	1978	1979	1980
Upper Fish Pond[a]			
FP 2	57.9	58.2	43.9
FP 3	67.7	64.4	62.4
FP 10	61.2	66.8	31.8
Middle Fish Pond[b]			
FP 7	55.7	52.9	92.0
FP 9	61.2	58.9	88.7
FP 13	60.1	47.3	73.0
Lower Fish Pond[c]			
FP 16	32.1	63.3	91.2
FP 18	40.7	58.0	85.6

a = Upper Fish Pond was represented by sites FP 2, FP 3 and FP 10.

b = Middle Fish Pond was represented by sites FP 7, FP 9 and FP 13.

c = Lower Fish Pond was represented by sites FP 16 and FP 18.

TABLE 14

Concentrations of sediment nitrogen and phosphorus (mg/g) in the Burnt Pocket Study Site, Navigation Pool No. 18, Illinois, on August 5, 1980.*

Station	TKN	Total-P	Ortho-P	$NO_2 + NO_3$
BP-1a	0.95	0.014	0.013	0.001
BP-1b	0.25	0.010	0.009	0.001
BP-1c	0.35	0.008	0.008	0.007
BP-1d	0.29	0.006	0.006	0.006
BP-3a	1.02	0.011	0.011	0.001
BP-3b	1.17	0.014	0.014	0.003
BP-3c	1.58	0.019	0.018	0.002
BP-3d	1.41	0.013	0.012	0.001
BP-5c	1.00	0.019	0.017	0.049
CH-1	0.32	0.007	0.008	0.004
CH-3	0.25	0.007	0.007	0.005
CH-5	0.39	0.007	0.006	0.017
CH-7	0.32	0.007	0.007	0.006
FH-1	--**	0.013	0.012	0.001
FH-3	0.37	0.010	0.010	0.006
FH-6	0.35	0.011	0.010	0.002
FP-2	0.74	0.013	0.011	0.002
FP-3	0.59	0.012	0.011	0.002
FP-7	0.74	0.012	0.011	0.005
FP-9	0.83	0.014	0.013	0.001
FP-10	0.50	0.010	0.010	0.001
FP-13	0.41	0.014	0.014	0.001
FP-16	0.48	0.012	0.010	0.003
FP-18	0.71	0.014	0.012	0.001

*All values are expressed as milligrams N or P per gram of sediment.
**-- denotes no data.

in the amount of TKN in Burnt Pocket after the side channel opening was made.

The amount of TKN in the channel area remained similar before and after the opening. This occurrence was likely because it was originally a well scoured channel.

The grain size distribution in Fishhook Slough did not appear to change after the experimental channel was made, however, data indicate that its sediments had less TKN during the post-opening season. This may have been due to the removal of a portion of the surface sediments which may have contained allochthonous organic matter.

The average TKN content of Fish Pond Slough sediments during the pre-opening study period was 1.31 mg/g as compared to 0.62 mg/g during the post-opening period. This observation represents a significant reduction ($p < 0.001$) in the sediment TKN of FP. The TKN data seem to contradict the results obtained on grain size which indicated that FP was accumulating silts and clays as a result of the opening. A probable explanation is that the organic matter and associated TKN of those sediments was lighter and remained suspended. Consequently, a portion was probably lost in the outflow from the study area.

Total-P and ortho-P levels followed the trends observed for TKN. The highest concentration of total-P was 0.019 mg/g at BP-3c and BP-5c and the lowest concentration was 0.006 mg/g at BP-1d. Low levels (0.007 mg/g) were observed throughout the study area. Using a one-tailed, pooled t-test, the average concentrations of total-P were significantly lower in Burnt Pocket ($p = 0.02$), Fishhook Slough ($p = 0.06$) and Fishpond Slough ($p < 0.001$) during the post-opening season as compared to the pre-opening season.

Nitrite plus nitrate-N concentrations were low throughout the study area except for a concentration of 0.049 mg/g at BP-5c. Because of low concentrations and high variability, nitrite plus nitrate-N concentrations were not statistically compared before and after the experimental side channel was constructed.

Water Quality

Pre-opening

The water of the study area could be characterized as a biocarbonate water with calcium as the most abundant cation. The order of abundance of cations was $Ca^{++} > Mg^{++} > Na^{+} > K^{+}$, whereas that of the anions was $HCO_3^{-} > SO_4^{=} > Cl^{-} > F^{-}$. Hutchinson (1957) reports this to be the normal situation for freshwaters of this type. It should be noted that although magnesium was not measured directly, it can be calculated as the difference between total hardness and calcium hardness. This water would also be classified as a "very hard" water typical where waters have been in contact with limestone or dolomite (Hem 1970).

The specific conductance of the water was not highly variable within the study area; however, it did vary considerably among the sampling periods. During May 1978 the Ks was slightly above 400 μmhos/cm, during June 1979 it averaged 446 μmhos/cm and during July it was only about 400 μmhos/cm. This was the result of dilution by the high water during June 1979 and extremely high water during July 1978. This is also readily apparent by observing the hydrological data (Table 1) as well as the data for the individual cations and anions (Tables 15, 16, and 17).

The turbidity of BP averaged approximately 33 NTU in May 1978, 31 NTU in July 1978 and 51 NTU in June 1979, which was significantly lower than all other areas investigated (Tables 15, 16, and 17). This was expected because it was not subjected to the turbulence created by the higher current velocities of the other locations. During the May 1978 sampling, the

TABLE 15

Concentrations of various water chemistry parameters (mg/1), turbidity (NTU) and specific conductance (μmhos/cm) in the Burnt Pocket Study Site, Navigation Pool No. 18, Illinois, on May 26, 1978.

Station	Turbidity NTU	Conductivity μmhos/cm	T. Hdn.* mg/1	Ca^{++} Hdn. mg/1	T. Alk. mg/1	$SO_4^{=}$ mg/1	Cl^- mg/1	F^- mg/1	Fe mg/1	NH_3-N mg/1	NO_2-N mg/1	NO_3-N mg/1	Ortho-P mg/1	Total-P mg/1	TKN mg/1
BP-3b	28	512	272	138	144	48.0	11.0	0.17	0.05	0.084	0.062	1.575	0.065	0.274	1.010
BP-3d	23	511	230	168	148	45.0	8.5	0.18	0.05	0.157	0.069	1.600	0.070	0.274	1.610
BP-5d	27	510	242	132	123	46.5	9.5	0.18	0.05	0.076	0.067	1.700	0.065	0.266	0.984
BP-7d	28	521	240	166	138	44.0	8.3	0.17	0.05	0.102	0.076	1.350	0.067	0.366	1.820
BP-9d	48	506	222	140	140	48.5	8.8	0.25	0.16	0.039	0.032	1.775	0.075	0.572	1.200
BP-Inlet	45	516	274	144	--**	46.5	--	0.15	0.16	0.091	0.051	1.625	0.090	0.424	0.142
CH-3	48	500	270	166	136	48.5	10.0	0.18	0.12	0.013	0.026	1.700	0.099	0.418	0.831
CH-5	45	500	246	164	143	45.5	9.0	0.20	0.07	0.004	0.029	2.150	0.075	0.484	1.190
CH-7	45	507	228	156	143	49.5	9.0	0.20	0.07	0.049	0.037	1.750	0.081	0.424	0.914
CH-8	48	504	272	138	142	48.0	8.8	0.17	0.05	0.003	0.028	1.850	0.073	0.424	1.230
FH-3	50	506	247	126	144	49.5	9.0	0.23	0.12	0.093	0.037	1.775	0.084	0.396	0.744
FH-6	57	501	250	166	143	51.5	8.5	0.23	0.19	0.008	0.033	1.900	0.081	0.496	0.798
FP-7	48	503	238	160	144	46.5	8.5	0.37	0.05	0.002	0.032	1.775	0.075	0.418	0.908
FP-9	58	504	234	168	144	48.0	10.0	0.27	0.06	0.004	0.037	1.775	0.077	0.470	1.220
FP-13	45	504	242	172	135	48.0	8.5	0.20	0.12	0.041	0.034	1.900	0.104	0.440	0.908
FP-18	48	503	241	126	144	48.5	10.0	0.22	0.09	0.020	0.043	1.900	0.077	0.396	0.753
FP-20	37	506	216	168	143	49.5	8.8	0.20	0.07	0.014	0.043	1.950	0.077	0.240	0.762

*Total hardness, calcium hardness, and total alkalinity are expressed as mg/1 $CaCO_3$.

**-- denotes no data.

TABLE 16

Concentrations of various water chemistry parameters (mg/1), turbidity (NTU) and specific conductance (μmhos/cm) in the Burnt Pocket Study Site, Navigation Pool No. 18, Illinois, on July 26, 1978.

Station	Turbidity NTU	Conductivity μmhos/cm	T. Hdn.* mg/1	Ca^{++} Hdn. mg/1	Na^+ mg/1	K^+ mg/1	T. Alk. mg/1	$SO_4^=$ mg/1	Cl^- mg/1	F^- mg/1	Fe mg/1	NH_3-N mg/1	NO_2-N mg/1	NO_3-N mg/1	Ortho-P mg/1	Total-P mg/1	TKN mg/1
BP-3b	21	408	210	145	8.2	1.6	168.8	31.5	12.8	0.20	0.27	0.022	0.034	0.049	0.164	0.270	0.089
BP-3d	32	388	207	140	8.0	1.5	168.0	29.3	13.3	0.20	0.46	0.020	0.025	0.083	0.173	0.348	0.096
BP-5d	28	411	213	134	7.9	1.6	170.5	28.8	12.8	0.22	0.49	0.027	0.036	0.046	0.158	0.328	0.186
BP-7b	56	407	204	154	8.4	2.1	164.0	31.5	13.0	0.22	0.85	0.010	0.024	0.076	0.168	0.448	0.046
BP-7d	23	409	200	138	8.0	1.5	170.5	25.8	13.0	0.18	0.35	0.010	0.029	0.059	0.173	0.288	0.293
BP-9d	26	413	202	134	8.2	1.5	170.5	27.5	13.0	0.18	0.42	0.014	0.030	0.066	0.164	0.342	0.142
BP-Inlet	62	393	198	140	8.4	2.0	164.0	31.0	13.0	0.20	0.92	0.018	0.024	0.076	0.164	0.398	0.047
CH-3	54	397	198	138	8.5	1.8	163.8	31.5	13.5	0.18	0.87	0.014	0.023	0.082	0.173	0.436	0.232
CH-8	58	396	200	124	8.3	3.1	163.5	30.5	13.5	0.18	0.92	0.020	0.026	0.074	0.176	0.416	0.187
FH-1	64	389	198	139	8.4	1.6	162.5	28.0	13.5	0.19	1.07	0.018	0.025	0.075	0.164	0.416	0.590
FH-4	44	407	204	130	8.5	1.5	163.5	25.5	13.3	0.19	0.66	0.020	0.027	0.073	0.185	0.404	0.605
FP-2	48	375	202	134	8.4	1.5	163.5	28.8	13.3	0.20	0.86	0.013	0.026	0.068	0.168	0.410	0.240
FP-7	50	407	192	124	8.2	1.6	164.5	33.0	13.0	0.20	0.78	0.030	0.027	0.072	0.222	0.398	0.482
FP-13	41	407	196	136	8.0	1.8	165.0	30.0	12.8	0.19	0.62	0.024	0.028	0.066	0.178	0.364	0.143
FP-16	37	407	204	138	8.5	1.9	164.8	31.5	13.3	0.18	0.48	0.016	0.029	0.070	0.168	0.364	0.238
FP-18	43	404	192	122	8.3	1.5	165.8	26.0	13.3	0.18	0.30	0.022	0.028	0.071	0.173	0.370	0.289
CC	36	407	200	136	8.4	1.5	167.0	27.5	13.3	0.18	0.59	0.024	0.030	0.053	0.182	0.348	0.389

*Total hardness, calcium hardness and total alkalinity are expressed as mg/1 $CaCO_3$.

TABLE 17

Concentrations of various water chemistry parameters (mg/l), turbidity (NTU) and specific conductance (μmhos/cm) in the Burnt Pocket Study Site, Navigation Pool No. 18, Illinois, on June 13, 1979.

Station	Turbidity NTU	Conductivity μmhos/cm	T. Hdn.* mg/l	Ca^{++} Hdn. mg/l	Na^{+} mg/l	K^{+} mg/l	T. Alk. mg/l	$SO_4^{=}$ mg/l	Cl^{-} mg/l	F^{-} mg/l	NH_3-N mg/l	NO_2-N mg/l	NO_3-N mg/l	Ortho-P mg/l	Total-P mg/l
BP-1b	46	438	243	144	9.5	5.0	166.5	44.3	28.5	0.33	0.20	0.073	1.377	0.085	0.164
BP-1d	55	436	--**	--	9.0	4.0	166.3	40.5	28.0	0.30	0.09	0.061	1.739	0.105	0.273
BP-3b	47	440	229	130	8.6	3.8	165.0	48.8	28.5	0.30	0.09	0.062	1.488	0.098	0.138
BP-3d	48	443	227	131	8.6	4.0	163.8	45.0	27.5	0.37	0.07	0.062	1.613	0.091	0.213
BP-5b	43	435	225	128	8.5	4.0	168.8	44.3	26.5	0.37	0.25	0.078	1.222	0.090	0.202
BP-5d	51	452	232	130	8.4	4.1	178.0	45.8	27.0	0.37	0.19	0.071	1.029	0.115	0.298
BP-7b	54	438	233	130	8.5	4.1	168.0	43.7	26.5	0.33	0.30	0.079	1.096	0.105	0.260
BP-7d	58	452	239	135	8.7	4.2	178.8	46.3	26.5	0.45	0.29	0.078	1.472	0.110	0.204
BP-9b	52	445	225	128	8.5	4.1	169.0	45.7	27.0	0.33	0.26	0.081	1.114	0.075	0.260
BP-9d	56	452	233	130	8.8	4.3	176.0	46.3	26.5	0.33	0.12	0.079	1.471	0.085	0.314
CH-1	47	452	234	130	9.2	4.3	165.0	49.5	28.5	0.15	0.13	0.061	1.739	0.105	0.298
CH-3	60	459	232	129	9.3	4.3	164.0	48.8	28.5	0.33	0.09	0.061	1.614	0.091	0.248
CH-5	54	457	232	128	9.2	4.4	165.0	48.8	28.5	0.24	0.10	0.062	1.563	0.098	0.236
CH-7	58	457	232	129	9.2	4.3	165.0	50.0	28.5	0.30	0.08	0.061	1.614	0.091	0.298
FH-1	56	456	236	132	9.3	4.3	166.3	48.8	28.5	0.24	0.11	0.062	1.738	0.098	0.342
FH-3	61	448	233	129	8.7	4.1	166.3	47.1	28.5	0.33	0.11	0.061	1.664	0.091	0.371
FH-6	--	--	232	129	8.6	3.9	--	49.5	28.5	0.37	0.09	0.062	1.613	0.105	--
FP-1	59	445	--	--	--	--	166.8	50.0	28.5	0.24	--	--	--	--	--
FP-2	59	447	--	--	8.5	--	165.3	50.0	28.5	0.24	0.12	0.065	1.360	0.098	0.342
FP-3	53	445	232	129	8.6	3.8	166.3	47.1	28.5	0.30	0.14	0.067	1.683	0.091	0.300
FP-6	57	443	236	131	8.6	3.9	167.5	46.3	28.5	0.30	0.11	0.069	--	0.098	0.300
FP-7	56	448	238	135	8.5	3.9	167.0	47.8	28.5	0.30	0.13	0.070	1.680	0.091	0.300
FP-10	57	448	237	133	8.6	4.1	166.3	49.5	28.5	0.37	0.13	0.069	1.681	0.098	0.321
FP-13	56	446	237	134	8.6	4.1	166.3	49.5	29.0	0.33	0.13	0.061	1.864	0.091	0.314
FP-16	62	442	235	133	8.5	4.0	166.3	48.8	28.0	0.33	0.16	0.074	1.476	0.085	0.371
FP-18	57	443	235	133	8.4	3.9	166.3	47.1	28.5	0.33	0.10	0.069	1.531	0.091	0.314
CC	54	448	236	132	8.4	3.9	165.8	47.1	28.5	0.33	0.07	0.058	2.067	0.085	0.266

*Total hardness, calcium hardness and total alkalinity are expressed as mg/l $CaCO_3$.

**-- denotes no data.

majority of the water entering the sampling area (Transect 29, Fig. 1) was approximately equal in turbidity to the water of the channel areas and FP. During July 1978, however, the turbidity of the water being discharged from the lower portion of FP was lower than that entering the study area (Table 16). This indicates that some suspended sediment was being deposited in FP during high water.

There were notably higher concentrations of nitrogen and phosphorus during May 1978 and June 1979 as compared with July 1978. As previously mentioned, the lower levels in July were largely due to dilution by the high water in July 1978. Burnt Pocket had the highest concentrations of NH_3 and NO_2-N during May 1978 and June 1979 while in July its levels were essentially the same as the other sampling areas. The most extreme difference between sampling periods was the much higher concentrations of NO_3-N at all areas during May 1978 and June 1979 while the inverse was true of ortho-phosphorus. These features were, however, present in the influent Mississippi River water and were not the result of phenomena occurring within the immediate study area.

Nitrogen and phosphorus concentrations exceeded the critical concentrations generally accepted as levels which, when combined with specific morphological, hydrological and climatic factors, can lead to excessive primary production (Vollenweider 1978, Bachmann and Jones 1974, Dillon 1974, Jones and Bachmann 1976). Critical concentrations in lakes were established at 0.01 to 0.02 mg/l of P and 0.20 to 0.30 mg/l of assimilable inorganic nitrogen (Vollenweider 1978, Bachmann and Jones 1974).

The bottom temperature regime during May 1978 and June 1979 was essentially uniform throughout the entire study site with an average of approximately 20°C (Table 18). Variations occurred in the shallow upstream portions of Burnt Pocket where temperatures up to 23°C were observed. During

TABLE 18

Dissolved oxygen concentrations (mg/l) just prior to sunrise and temperature (^{o}C) observed in the water at Burnt Pocket Study Site, Navigation Pool No. 18, Illinois.*

Station	May 26, 1978 D.O. Bottom	May 26, 1978 ^{o}C Bottom	July 26, 1978 D.O. Surface	July 26, 1978 D.O. Bottom	July 26, 1978 ^{o}C Surface	July 26, 1978 ^{o}C Bottom	June 13, 1979 D.O. Surface	June 13, 1979 D.O. Bottom	June 13, 1979 ^{o}C Surface	June 13, 1979 ^{o}C Bottom	August 5, 1980 D.O. Bottom	August 5, 1980 ^{o}C Bottom
BP-1b	6.5	20.0	3.2	1.9	24.5	24.5	4.2	3.8	20.0	21.0	5.1	27.0
BP-1d	7.7	20.0	5.7	5.0	25.0	25.0	5.4	5.9	20.0	21.0	--**	--
BP-3b	3.3	20.0	3.3	1.1	24.5	24.5	4.1	3.8	20.0	20.0	5.2	27.0
BP-3d	3.5	19.8	4.3	2.0	24.5	23.5	5.4	2.9	20.0	20.9	--	--
BP-5b	3.6	20.0	3.2	0.1	24.5	24.5	4.1	1.9	19.7	20.0	4.9	27.0
BP-5d	3.7	20.0	3.4	0.1	24.5	24.5	3.8	2.2	18.7	20.5	--	--
BP-7b	2.4	22.0	1.6	0.7	24.5	24.5	3.3	1.3	20.0	21.0	--	--
BP-7d	3.1	20.8	4.2	0.1	24.5	24.5	3.8	2.4	20.0	21.0	--	--
BP-9b	1.8	23.0	2.7	1.4	24.2	24.2	2.4	1.7	19.5	21.2	--	--
BP-9d	4.1	23.0	4.9	0.1	25.0	25.0	3.4	3.1	20.0	20.5	--	--
BP-Upper Inlet	7.6	20.0	6.4	6.3	25.0	25.0	--	--	--	--	--	--
BP-Lower Inlet	7.7	20.0	6.3	6.2	25.0	25.0	--	--	--	--	--	--
CH-1	7.7	20.0	6.0	5.8	25.0	25.0	6.2	6.1	20.0	20.1	5.2	26.0
CH-3	7.8	20.0	6.0	5.9	25.0	25.0	6.2	6.1	19.0	20.8	5.3	26.0
CH-5	7.8	20.0	6.1	5.8	25.0	25.0	6.2	6.2	--	21.0	5.3	26.0
CH-7	7.7	20.0	5.9	5.4	25.0	25.0	6.2	6.4	20.0	20.6	5.4	26.0
FH-1	--	--	6.2	5.9	24.8	25.0	6.2	5.8	20.0	20.2	4.6	26.0
FH-3	6.3	20.0	6.1	5.0	24.8	24.8	6.2	5.8	20.0	20.2	4.7	26.0
FH-6	7.6	20.0	--	--	--	--	5.9	6.1	20.0	20.2	4.8	26.0
FP-2	7.3	20.0	5.9	5.6	25.0	25.0	5.9	6.0	20.0	20.2	4.9	26.0
FP-3	6.9	20.0	5.5	2.5	24.6	24.6	5.4	5.7	20.0	20.2	4.8	26.0
FP-6	--	--	--	--	--	--	--	5.3	--	20.2	--	--
FP-7	7.5	20.0	5.8	5.2	25.8	25.8	5.4	5.4	20.0	20.4	4.8	25.0
FP-9	6.4	20.5	5.8	4.0	24.8	24.8	5.4	--	20.0	--	4.4	25.0
FP-10	--	--	5.3	4.9	24.8	24.8	5.2	5.2	20.0	20.2	--	--
FP-13	6.6	20.0	5.6	3.5	24.8	24.8	5.3	5.6	20.0	20.0	4.8	25.0
FP-16	--	--	5.8	2.8	24.8	24.8	5.4	4.7	20.0	20.0	4.0	25.0
FP-18	6.9	20.5	6.0	5.3	24.5	24.8	5.4	5.3	--	20.2	4.7	25.0
FP-20	6.9	20.5	--	--	--	--	--	--	--	--	5.6	25.0

*Stations sampled varied with the year because of dry conditions.
**-- denotes no data.

the high water experienced in July 1978, the top and bottom temperatures throughout the site were uniform ranging from 24.2 to 25.8°C. Because of the uniformity in temperatures, thermal stratification did not occur.

Dissolved oxygen in May 1978 and June 1979 was lower in Burnt Pocket than in all other areas. The average bottom dissolved oxygen concentration in Burnt Pocket during May was 4.0 mg/l. It ranged from a low of 1.8 mg/l at BP-9b, which is shallow, quiet, and has a relatively high organic content, to a high of 7.7 mg/l at BP-1d which is markedly influenced by the main source of water flowing into the study site from Campbell Chute (Fig. 1). In June, a low of 1.3 mg/l was detected at BP-7b, an area similar to BP-9b. Differences in DO between surface and bottom waters in these areas occurred in the absence of any apparent thermal stratification. This phenomenon is indicative of organic sediments which are experiencing high rates of decomposition. The average DO concentrations during May in the CH, FH and FP were 7.8, 7.0, and 6.9 mg/l, respectively and in June they were 6.2, 5.9, and 5.5 mg/l, respectively. This indicates the riverine influence on these areas.

During July 1978 the bottom DO in Burnt Pocket averaged 1.3 mg/l which was significantly lower than in May 1978 and June 1979. Moreover, the concentrations were 0.1 mg/l at several locations in the shallow upstream position. This was expected due to the biological uptake of oxygen associated with the sediments as well as the relatively slow turnover of water in this reach of the study site. Fishhook and CH reflected nearly the same oxygen regime as the inlet waters, whereas FP had somewhat lower levels of dissolved oxygen.

Post-opening

The water quality characteristics after opening the experimental side channel were similar to those observed before the side channel was opened (Tables 15 through 19), although the number of samples, especially in BP, were

TABLE 19

Concentrations of various water chemistry parameters (mg/l), turbidity (NTU) and specific conductance (μmhos/cm) in the Burnt Pocket Study Site, Navigation Pool No. 18, Illinois, on August 5, 1980.

Station	Turbidity NTU	Conductivity μmhos/cm	T. Hdn.* mg/l	T. Alk. mg/l	Ca^{++} mg/l	Mg^{++} mg/l	Na^{+} mg/l	K^{+} mg/l	$SO_4^{=}$ mg/l	Cl^{-} mg/l	F^{-} mg/l	NH_3-N mg/l	NO_2-N mg/l	NO_3-N m/gl	Ortho-P mg/l	Total-P mg/l
BP-1b	28	410	188	149.0	44.1	19.0	11.6	3.4	30.5	17.0	0.3	0.031	0.032	0.449	0.142	0.227
BP-1d	28	410	186	148.0	41.7	19.9	11.6	3.4	26.0	16.0	0.2	0.024	0.031	0.609	0.124	0.185
BP-3b	23	410	190	149.0	43.3	19.9	11.6	3.4	30.0	18.5	0.1	0.024	0.038	0.543	0.133	0.215
BP-3d	22	410	190	150.0	44.9	19.0	11.6	3.3	30.2	20.2	0.3	0.012	0.035	0.606	0.123	0.255
BP-5b	23	410	188	149.0	42.5	19.9	11.6	3.4	29.5	16.2	0.2	0.029	0.034	0.516	0.127	0.215
CH-1	28	405	186	162.0	44.9	18.0	11.6	3.3	30.2	16.5	0.3	0.012	0.029	0.542	0.124	0.247
CH-3	26	410	188	151.0	44.1	19.0	11.6	3.3	30.8	16.1	0.3	0.006	0.030	0.550	0.144	0.215
CH-5	22	405	188	153.0	44.1	19.0	11.7	3.3	32.2	16.5	0.2	0.010	0.030	0.611	0.130	0.208
CH-7	23	405	190	148.5	42.5	20.4	11.6	3.3	32.2	18.0	0.2	0.069	0.031	0.611	0.130	0.223
FH-1	34	400	188	150.0	46.5	17.5	11.7	3.4	28.2	16.0	0.2	0.012	0.028	0.422	0.127	0.239
FH-3	31	405	186	146.0	46.5	17.0	11.6	3.5	33.7	18.5	0.1	0.010	0.027	0.483	0.130	0.290
FH-6	37	405	188	148.5	45.7	18.0	11.5	3.4	33.0	22.3	0.1	0.059	0.030	0.481	0.118	0.239
FP-2	20	400	190	146.0	44.9	19.0	11.6	3.3	30.2	15.5	0.1	0.006	0.030	0.491	0.014	0.219
FP-3	21	400	190	149.0	43.3	19.9	11.6	3.3	28.2	16.1	0.3	0.008	0.028	0.482	0.017	0.200
FP-7	42	400	188	149.0	42.5	19.9	11.5	3.4	27.7	16.5	0.3	0.008	0.027	0.313	0.166	0.268
FP-9	29	400	168	147.0	42.5	19.9	11.6	3.4	27.0	15.9	0.2	0.014	0.033	0.412	0.124	0.223
FP-10	29	400	188	144.5	44.9	18.5	11.6	3.7	28.2	17.0	0.3	0.010	0.029	0.471	0.145	0.231
FP-13	33	395	188	146.0	44.9	18.5	11.4	3.5	30.2	16.8	0.2	0.008	0.026	0.389	0.130	0.247
FP-16	25	405	190	151.5	42.5	20.4	11.5	3.3	28.9	16.2	0.3	0.006	0.028	0.372	0.144	0.219
FP-18	29	400	190	152.0	43.3	19.9	11.5	3.6	27.0	15.5	0.2	0.010	0.028	0.242	0.130	0.552
CC	23	410	188	151.0	43.3	19.5	11.5	3.4	28.2	19.0	0.3	0.016	0.036	0.668	0.124	0.208
MC	28	410	188	148.5	44.9	18.5	11.5	3.5	28.9	17.5	0.3	0.052	0.035	0.749	0.133	0.219

*Total hardness, total alkalinity and bicarbonate are expressed as mg/l $CaCO_3$.

reduced. There was also less variation within the study area. Conductivity, for example, ranged from 395 to 410 μmhos/cm and turbidity averaged 24.8 NTU in BP and 25.8 NTU in FP. Conductivity was similar to that observed during the high flow period in July 1978. Levels of turbidity in BP were also similar during July 1978 and August 1980. Turbidities in CH, FH and FP were, however, significantly less during the 1980 sampling period (Table 19). The reduced turbidities probably resulted from the reduced flow at that time. Turbidity levels were about the same at the inflow (approximately 28 NTU) as at the outflow (29 NTU).

Nitrite and NH_3-N concentrations were greatest in BP as was the case in May 1978 and June 1979 (Table 19). Nitrate, ortho-P, and total-P were relatively constant throughout the study area. In general, during this sample period NH_3-N and total-P concentrations were less than the pre-opening values, NO_2-N and ortho-P concentrations were similar to July 1978, and NO_3-N was about one-half the concentrations observed in May 1978 and June 1979. Similar to pre-opening conditions, nitrogen and phosphorus concentrations in the post-opening period exceeded the levels which could lead to excessive primary production.

Bottom temperatures were relatively uniform (Table 18) and ranged from 25.0 to 27.0°C. These values were warmer than the pre-opening temperatures and were probably attributable to the shallow water conditions existing during August 1980.

Dissolved oxygen concentrations in CH, FH, and FP were lower than those observed during pre-opening investigations. Burnt Pocket, which consistently maintained the lowest pre-opening concentrations, could not be compared with those concentrations because only three samples were obtained due to the dry conditions.

Benthic Macroinvertebrates

A total of 68 taxa representing nematodes, annelids, arthropods and molluscs were observed during the survey of the Burnt Pocket study area (Appendix I). The number per station, standing crop and biomass values are summarized in Appendix II, III, IV and V. The fauna is best characterized in the study area by the frequency of occurrence, total numbers of organisms and their respective rank for each sampling period (Tables 20 through 23).

Pre-opening

Members of the Class Oligochaeta were the dominant macroinvertebrates in the study area (Tables 20, 21 and 22). They occurred in 85 to 91% of all samples collected and represented from 38 to 56% of the total standing crop during the pre-opening period. In general, the oligochaeta are adapted to burrowing in soft sediments, deriving most of their nutritional requirements from the ingestion of bacteria within the sediments (Brinkhurst and Cook 1974).

Hexagenia sp. occurred in 56 to 87% of all samples in the pre-opening period. They comprised 11 to 17% of the total standing crop, and were generally more abundant in the BP and FP areas. They exhibit a distinct preference for muddy substrates, and are found along the entire length of the Mississippi River (Fremling 1964, Elstad 1978, Trapp 1979).

Several macroinvertebrates exhibited an increase in the frequency of occurrence during the pre-opening period. The Sphaeridae increased from 32 to 80% of all samples during this time. Members of this family were generally more abundant in the lower reaches of the study area (i.e. FP) than in the upper BP area. Their proportion of the total standing crop consequently increased from 2.4% to about 18%. This increase is probably accounted for by natural population fluctuations.

TABLE 20

Total number, percent of total number, rank* and frequency of occurrence** of macroinvertebrates at Burnt Pocket Study Site, Navigation Pool No. 18, Upper Mississippi River, during May, 1978.

Taxon	Total Number	Percent of Total	Rank	Frequency of Occurrence
Oligochaeta	55,911	55.6	2	85.2
Hexagenia sp.	17,153	17.0	1	87.0
Chironomus sp.	3,819	3.8	3	44.4
Procladius sp.	2,537	2.5	4	42.6
Sphaeridae	2,366	2.4	7	31.5
Palpomyia sp.	1,462	1.5	5	37.0
Coelotanypus sp.	1,419	1.4	6	33.3
Chironominae pupae	387	0.4	9	11.1
Ablabesmyia sp.	1,147	1.1	8	27.8
Tanypus sp.	323	0.3	10	11.1

*Rank: organisms ranked by frequency of occurrence; only 10 most abundant organisms were ranked.

**Frequency of occurrence: percent of sites at which taxa were collected.

TABLE 21

Total number, percent of total number, rank* and frequency of occurrence** of macroinvertebrates at Burnt Pocket Study Site, Navigation Pool No. 18, Upper Mississippi River, during July, 1978.

Taxon	Total Number	Percent of Total	Rank	Frequency of Occurrence
Oligochaeta	22,319	40.1	1	90.7
Sphaeridae	8,504	15.3	2	59.3
Hexagenia sp.	6,320	11.4	3	55.6
Hirudinea	2,025	3.6	7	25.9
Ablabesmyia sp.	2,053	3.7	5	40.7
Chironomus sp.	1,725	3.1	8	24.1
Cryptochironomus sp.	955	1.7	4	42.6
Clinotanypus sp.	714	1.3	6	27.8
Procladius sp.	626	1.1	10	16.7
Tanypus sp.	458	0.8	9	20.4

*Rank: organisms ranked by frequency of occurrence; only 10 most abundant organisms were ranked.

**Frequency of occurrence: percent of sites at which taxa were collected.

TABLE 22

Total number, percent of total number, rank* and frequency of occurrence** of macroinvertebrates at Burnt Pocket Study Site, Navigation Pool No. 18, Upper Mississippi River, during June, 1979.

Taxon	Total Number	Percent of Total	Rank	Frequency of Occurrence
Oligochaeta	30,485	37.7	1	88.9
Hexagenia sp.	19,508	24.1	3	75.9
Sphaeridae	14,799	18.3	2	79.6
Ablabesmyia sp.	6,256	7.7	4	68.5
Chironomus sp.	2,533	3.1	5	46.3
Palpomyia sp.	1,587	2.0	6	46.3
Polypedilum sp.	671	0.8	8	16.7
Tanypus sp.	603	0.7	9	14.8
Cryptochironomus sp.	492	0.6	7	20.4
Cryptocladopelma sp.	306	0.4	10	13.0

*Rank: organisms ranked by frequency of occurrence; only 10 most abundant organisms were ranked.

**Frequency of occurrence: percent of sites at which taxa were collected.

TABLE 23

Total number, percent of total number, rank* and frequency of occurrence** of macroinvertebrates at Burnt Pocket Study Site, Navigation Pool No. 18, Upper Mississippi River, during August, 1980.

Taxon	Total Number	Percent of Total	Rank	Frequency of Occurrence
Oligochaeta	32,666	57.1	1	93.0
Tanypus sp.	15,167	26.5	2	81.4
Hexagenia sp.	3,577	6.3	3	72.1
Sphaeridae	1,383	2.4	4	46.5
Coelotanypus sp.	756	1.3	5	37.2
Ablabesmyia sp.	477	0.8	6	30.2
Buenoa sp.	413	0.7	8	20.9
Cryptochironomus sp.	391	0.7	7	27.9
Chironomus sp.	368	0.6	9	16.3
Procladius sp.	197	0.3	10	16.3

*Rank: organisms ranked by frequency of occurrence; only 10 most abundant organisms were ranked.

**Frequency of occurrence: percent of sites at which taxa were collected.

Ablabesmyia sp. exhibited an increase in frequency of occurrence from 28 to 69% during the pre-opening period. It also increased in abundance from 1.1% of the total standing crop in 1978 to 7.7% in 1979. This increase is related to significant increases in the standing crops in the BP and FP areas. This midge is generally found in erosional and depositional lotic habitats where it engulfs and preys on microcrustacea and other Chironomidae (Merritt and Cummins 1978).

The remainder of the most abundant and frequently occurring macro-invertebrates during the pre-opening period was comprised of Chironomidae larvae.

Biomass determinations of the major taxa (Fig. 4 to 6) followed the same pattern as was observed for abundance and frequency of occurrence. The Oligochaeta, Ephemeroptera, Pelecypoda, and Diptera comprised the majority of the biomass at each station; similarly, they were the most abundant and frequently occurring taxa.

The Burnt Pocket region of the study area was divided into the upper and lower reaches for purposes of benthic invertebrate discussions. The upper reach was heavily vegetated and shallow (transects BP-7, BP-9), whereas the lower reach was deeper and appeared to be more influenced by the channel (29) entering the study area from Campbell Chute (transects BP-1, BP-3, BP-5).

The average total number of organisms ($\#/m^2$) during the 1978 and 1979 sampling periods was 986 organisms/m^2 with an average total biomass for all organisms of 4.51 g/m^2 (average biomass = total number organisms/total biomass; Appendix II through V). The community was dominated by oligochaetes, Hexagenia sp., and the midges Ablabesmyia sp., Procladius sp. and Chironomus sp. (Diptera:Chironomidae) and Palpomyia sp. (Diptera:Ceratopogonidae).

FIG. 4. Biomass (g/m^2) of the major benthic macroinvertebrate taxa at each station in the Burnt Pocket Study Area, Navigation Pool No. 18, Illinois, on May 26, 1978. A = Oligochaeta, B = Hirudinea, C = Ephemeroptera, D = Odonata, E = Trichoptera, F = Coleoptera, G = Diptera, H = Gastropoda, I = Pelecypoda.

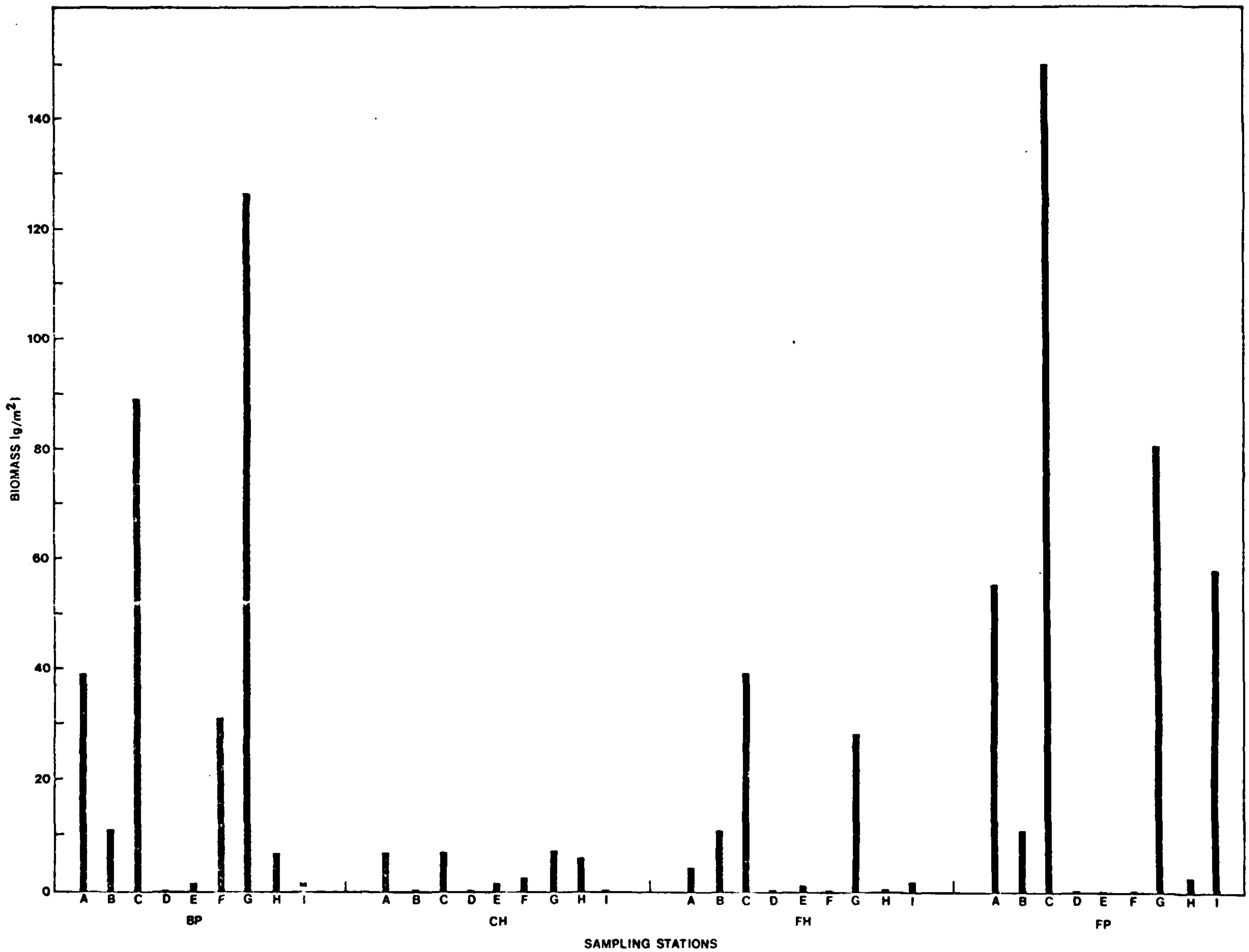
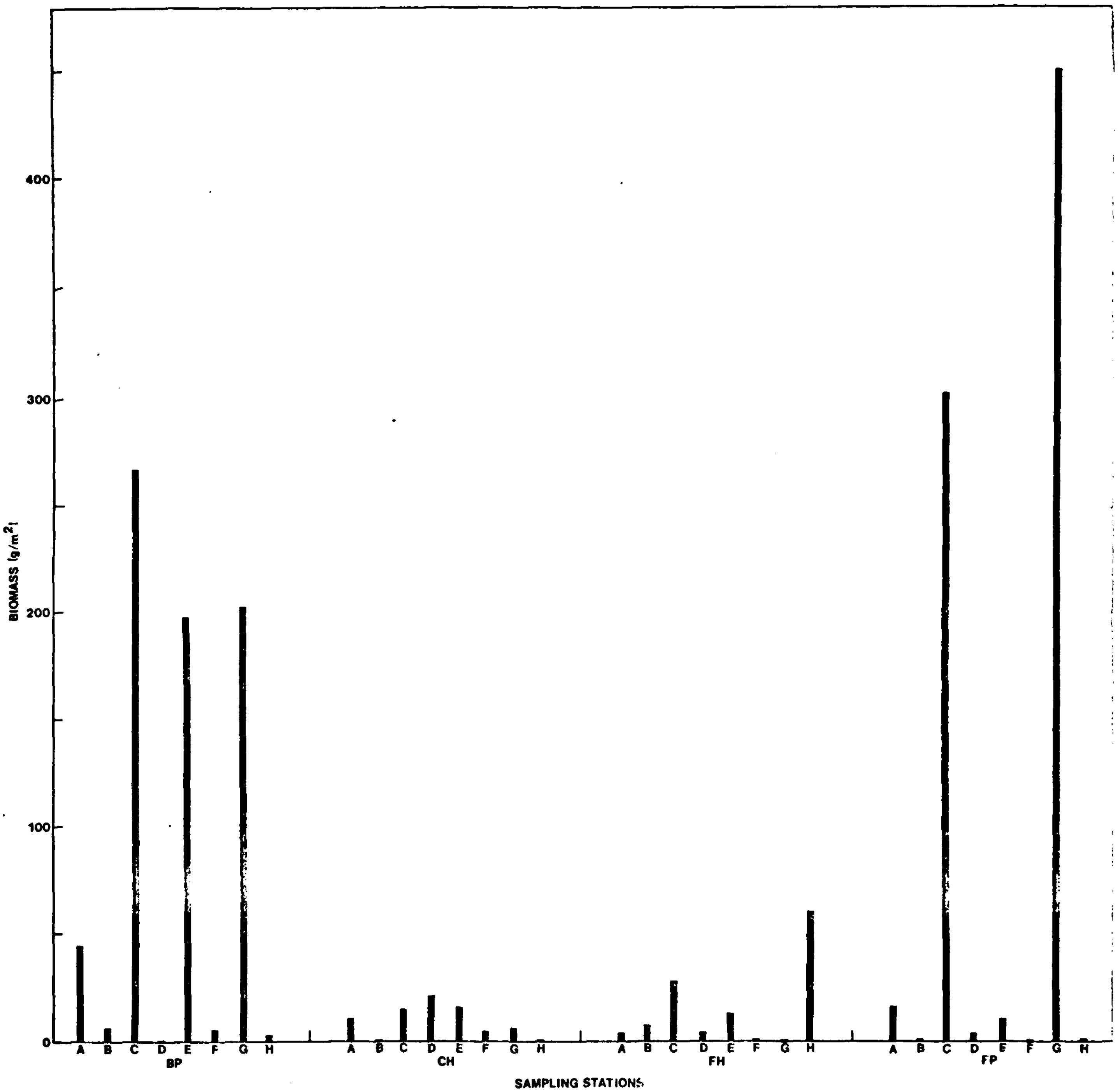
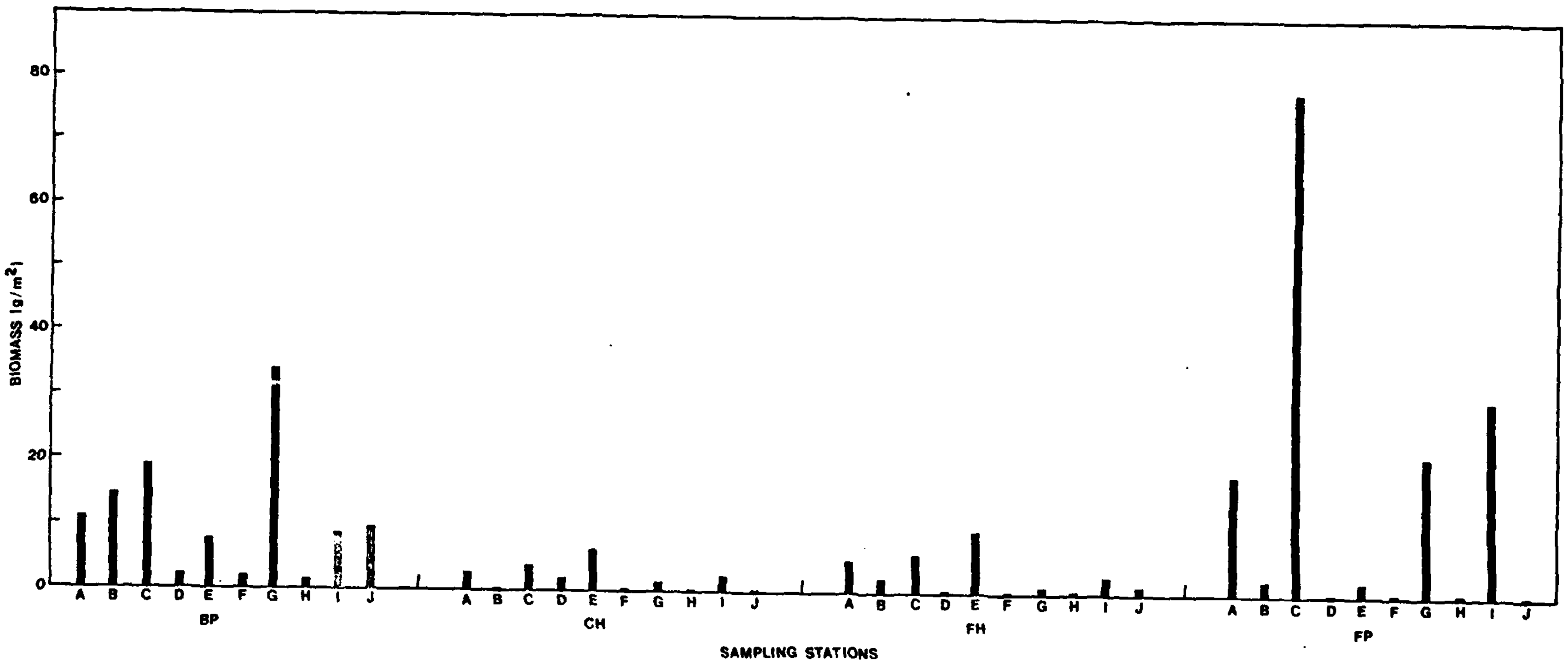

BIOMASS (g/m²)
0
20
40
60
80
100
120
140
A B C D E F G H I
BP
A B C D E F G H I
CH
A B C D E F G H I
FH
A B C D E F G H I
FP
SAMPLING STATIONS

FIG. 5. Biomass (g/m^2) of the major benthic macroinvertebrate taxa at each station in the Burnt Pocket Study Area, Navigation Pool No. 18, Illinois, on July 26, 1978. A = Oligochaeta, B = Hirudinea, C = Ephemeroptera, D = Trichoptera, E = Diptera, F = Gastropoda, G = Pelecypoda, H = Isopoda.



BIOMASS (g/m²)
400
300
200
100
0
A B C D E F G H
BP
A B C D E F G H
CH
A B C D E F G H
FH
A B C D E F G H
FP
SAMPLING STATIONS

FIG. 6. Biomass (g/m^2) of the major benthic macroinvertebrate taxa at each station in the Burnt Pocket Study Area, Navigation Pool No. 18, Illinois, on June 13, 1979. A = Oligochaeta, B = Hirudinea, C = Ephemeroptera, D = Odonata, E = Trichoptera, F = Coeleoptera, G = Diptera, H = Gastropoda, I = Pelecypoda, J = Isopoda.


BIOMASS (g/m²)
0
20
40
60
80
A B C D E F G H I J
BP
A B C D E F G H I J
CH
A B C D E F G H I J
FH
A B C D E F G H I J
FP
SAMPLING STATIONS

The benthic community in lower Burnt Pocket was dominated by the same species. However, the number of organisms was considerably higher ($1696/m^2$) and the average biomasses were greater ($7.8\ g/m^2$).

In summary, the total pre-opening benthic fauna in all of Burnt Pocket was characteristic of highly eutrophic lentic environments. Organismal diversity as expressed by the Shannon-Weaver index (EPA 1973), averaged 2.28 for 1978 and 1979 (Table 24). This index is based on the generally observed phenomenon that relatively undisturbed environments support communities having large numbers of species with no individual species present in overwhelming abundance. As environmental stress increases, diversity is reduced and hence the index value decreases.

The standing crops in the channel areas were considerably less than in Burnt Pocket (Appendix II, III and IV) with an average of 489 organisms/m^2 and an average biomass of $1.37\ g/m^2$. The species composition, however, was somewhat similar in spite of the differences in habitat type. Oligochaetes were present, but in smaller numbers ($346/m^2$ average). Sphaeridae were also represented in approximately one-half of the samples, but at considerably lower densities ($48/m^2$ average). Hydropsyche sp. was also found at moderately low densities ($194/m^2$) in the channel area during the pre-opening period. The average Shannon-Weaver value for CH was 2.04.

The pre-opening benthic standing crop of FH was higher than the channel area, and was probably due to the low current velocities. Oligochaetes were common throughout the area ($181/m^2$). Similarly, mayflies, caddisflies, and fingernail clams were also prevalent (Appendix II, III and IV). The average density and biomass for 1978 and 1979 was 873 organisms/m^2 and $4.64\ g/m^2$, respectively. The diversity index for FH was 2.25 (Table 24).

Fish Pond Slough was divided into three reaches (upper, middle, lower) on the basis of physical features, e.g. width, depth and flow patterns (Fig. 1).

TABLE 24

Shannon-Weaver indices for all sampling areas, pooled samples by year and combined (1978-79) Navigation Pool No. 18, Illinois.

Area	Pre-opening 1978 (May)	1978 (July)	1979	Average	Post-opening 1980	Change in index values*
BP (Upper)	2.47	3.84	2.40	2.90	--**	--
BP (Lower)	1.42	2.65	1.68	1.92	0.88	-0.85
CH	1.76	1.97	2.39	2.04	1.83	-0.21
FH	1.93	2.58	2.25	2.25	2.23	-0.02
FP (Upper)	1.67	2.04	2.56	2.09	2.05	-0.04
FP (Middle)	1.86	2.39	2.00	2.08	1.92	-0.16
FP (Lower)	1.95	2.05	2.06	2.02	1.93	-0.09

*Difference between pre-opening and post-opening.

**-- denotes no sample obtained because of low water.

Even though the pre-opening standing crops were greater in 1979 than in 1978, the species composition throughout the entire area was similar. As in other reaches of the study area, members of the Class Oligochaeta dominated the community. Mayflies and fingernail clams were also found in almost all areas of Fish Pond Slough. The remainder of the community was composed largely of midges (Diptera:Chironomidae). The pre-opening standing crops of total macroinvertebrates were similar throughout Fish Pond Slough ranging from 22.20 g/m^2 in the upper reach, to 2.78 g/m^2 in the lower portion. Organismal densities ranged from 1,224 organisms/m^2 in the lower FP to 2,083/m^2 in the middle reach (Appendix II, III, IV, and V).

Post-opening

The water level in the study area was extremely low during the 1980 sampling period. Total biomass at each station closely resembled the values found on 13 June 1979 (Figs. 6 and 7). The dominant taxa were also the same and included the Oligochaeta, Ephemeroptera, Diptera, and Pelecypoda. Consequently, all of the transect BP-9 was exposed to the atmosphere and could not be sampled. Lower Burnt Pocket, however, had high standing crops of oligochaetes (Appendix V) in addition to smaller numbers of the mayfly Hexagenia sp. and the chironomid Tanypus sp. (Diptera:Chironomidae). The diversity index was not calculated for the upper Burnt Pocket 1980 samples because there were too few samples.

The benthic fauna of lower Burnt Pocket was qualitatively similar to the upper reach, and was dominated by Oligochaeta, mayflies and midges. However, the overall diversity of the community was much lower in the post-opening period as the midge fauna was dominated by a single taxon (Appendix V).

There were no recognizable effects of the opening on CH and FH. Standing crops were similar in the pre- and post-opening phases of the study (Appendix II, III, IV, and V). The diversity indices were also quite similar (Table 24).

FIG. 7. Biomass (g/m^2) of the major benthic macroinvertebrate taxa at each station in the Burnt Pocket Study Area, Navigation Pool No. 18, Illinois, on August 5, 1980. A = Oligochaeta, B = Hirudinea, C = Ephemeroptera, D = Odonata, E = Trichoptera, F = Coleoptera, G = Diptera, H = Pelecypoda.

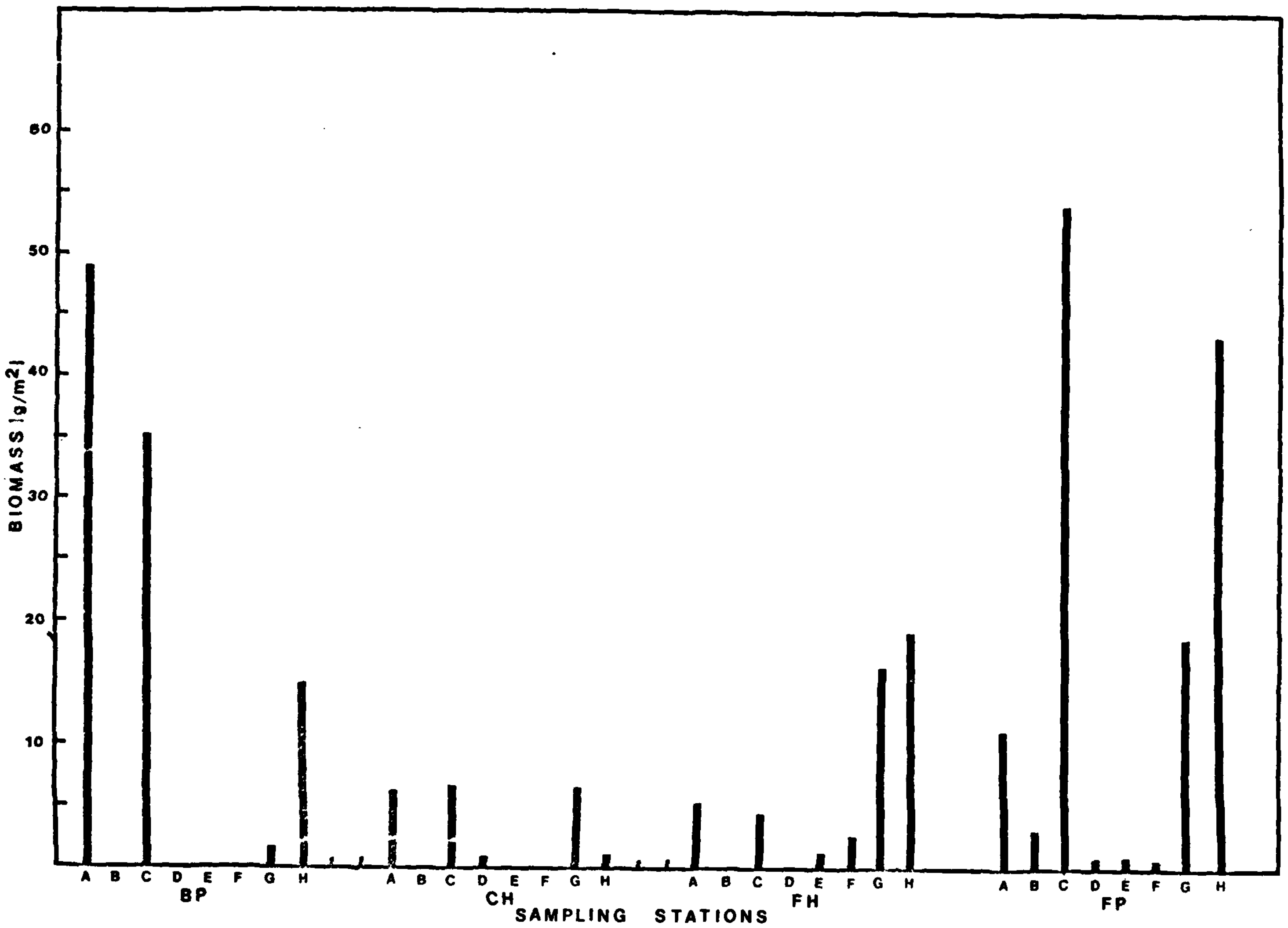
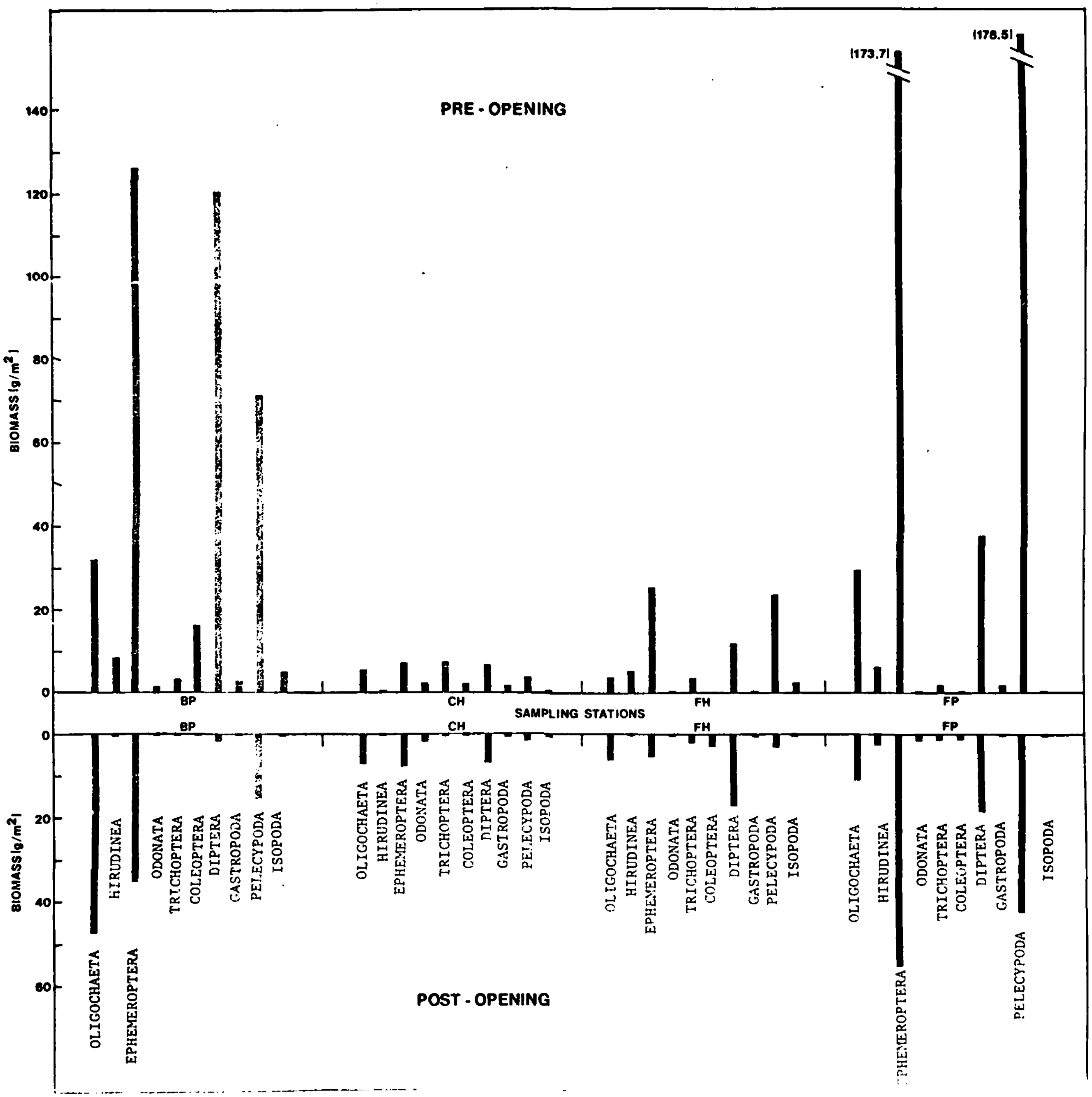

BIOMASS [g/m²]
60
50
40
30
20
10
A B C D E F G H
BP
A B C D E F G H
CH
A B C D E F G H
FH
A B C D E F G H
FP
SAMPLING STATIONS

FIG. 8. Comparison of the mean biomass (g/m^2) of the major benthic macroinvertebrate taxa between pre- and post-opening of the experimental side channel, Navigation Pool No. 18, Illinois. A = Oligochaeta, B = Hirudinea, C = Ephemeroptera, D = Odonata, E = Trichoptera, F = Coeloptera, G = Diptera, H = Gastropoda, I = Pelecypoda, J = Isopoda.


PRE - OPENING
POST - OPENING
BIOMASS (g/m²)
SAMPLING STATIONS
BP
CH
FH
FP
(173.7)
(178.5)
OLIGOCHAETA
HIRUDINEA
EPHEMEROPTERA
ODONATA
TRICHOPTERA
COLEOPTERA
DIPTERA
GASTROPODA
PELECYPODA
ISOPODA

The benthic fauna in FP changed considerably in 1980 after the water diversion was completed. The standing crops were reduced by 59% in the middle reach to 81% in the lower portion. The diversity, however, was not severely affected (Table 24). Qualitative changes (taxonomic composition) were also evident (Appendix V). Fingernail clam standing crops were significantly reduced in all three reaches of Fish Pond Slough. Conversely, the densities of Tanypus sp. (midge) increased significantly as it did in other study reaches. The remainder of the community was composed of various midges, which probably accounted for the diversity index remaining relatively unchanged.

A comparison of mean pre-opening and post-opening biomass at each station is given in Fig. 8. In BP after the side channel was completed, the Oligochaeta comprised the greatest biomass, and substantial reductions in the Ephemeroptera, Diptera, and Pelecypoda were observed. This was probably due to the extreme low water in upper BP. Little change was noted between pre- and post-opening in CH and FH. In FP, however, biomass was greatly reduced but the dominant taxa remained unchanged.

A comparison of the benthic invertebrate and the sediment data seem to indicate that during the period of high discharge through the diversion canal (Spring 1980) fine particulate sediments were transported through the study area to Fish Pond Slough. One can conclude that these sedimentation rates were apparently great enough to preclude adaptation and survival of fingernail clams. This raises the question as to whether this will be a continuous process or whether a state of dynamic equilibrium will be reached whereby the sediment discharge from Fish Pond Slough will equal the upstream sediment input.

Aquatic Macrophytes

Pre-opening

The distribution of rooted aquatic macrophytes in the study area was restricted to Burnt Pocket (BP), and to a small area in the lower end of Fish Pond Slough (Fig. 9). The macrophytes in the Central Pond Area east of Fish Pond Slough were disregarded, because CPA was not considered a part of the study area due to its isolation.

Samples collected in Burnt Pocket yielded a single rooted species, *Nelumbo lutea*. The 1978 and 1979 distribution patterns were similar (Fig. 10). Standing crops were also similar during the pre-opening study period (Table 25). The increase noted in the 1979 sampling period was due either to sample variability or to variable rates of maturation, which is a function of annual differences in weather and climate.

Lemna sp. was also collected during 1979 at three stations, but it was not considered further because it was absent in 1978 and 1980 and was probably wind-distributed.

Post-opening

A significant increase in macrophyte biomass was observed in 1980 in Burnt Pocket (Table 25). The specific cause(s) of this increase are obscure, but the construction of the side channel appeared to have little affect on the biomass and distribution of *N. lutea*. On the contrary, low water levels experienced during the majority of the 1980 growing season probably had a greater effect. The apparent high discharges during the Spring of 1980 resulted in the excavation of braided channels in the upper pocket. This limited the development of *N. lutea* in these localized areas. Because the majority of the plant growth occurred after the river discharge subsided, the

FIG. 9. A vegetation map showing major habitat types (woodland, shore, aquatic) within the Burnt Pocket Study Site, Mississippi River, Navigation Pool No. 18, Illinois, during 1978. The extent of the Leersia-type shore habitat in the Burnt Pocket Area (BP) reflects low water conditions. The high waters during July resulted in the inundation and degradation of the southern portion in the shore habitat of the Upper Burnt Pocket shoal. The outline of the persisting section is marked with a solid line within that habitat.

WOODLAND

SHORE

AQUATIC

NON-VEGETATED WATER

AD-A098 628 WISCONSIN UNIV-LA CROSSE RIVER STUDIES CENTER F/G 8/8
STUDY ON THE EFFECTS OF DIVERTING WATER INTO UPPER BURNT POCKET--ETC(U)
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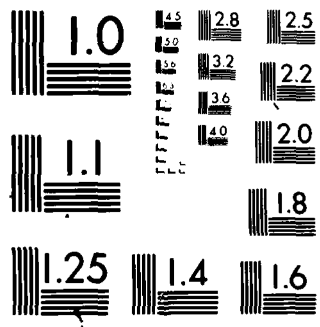
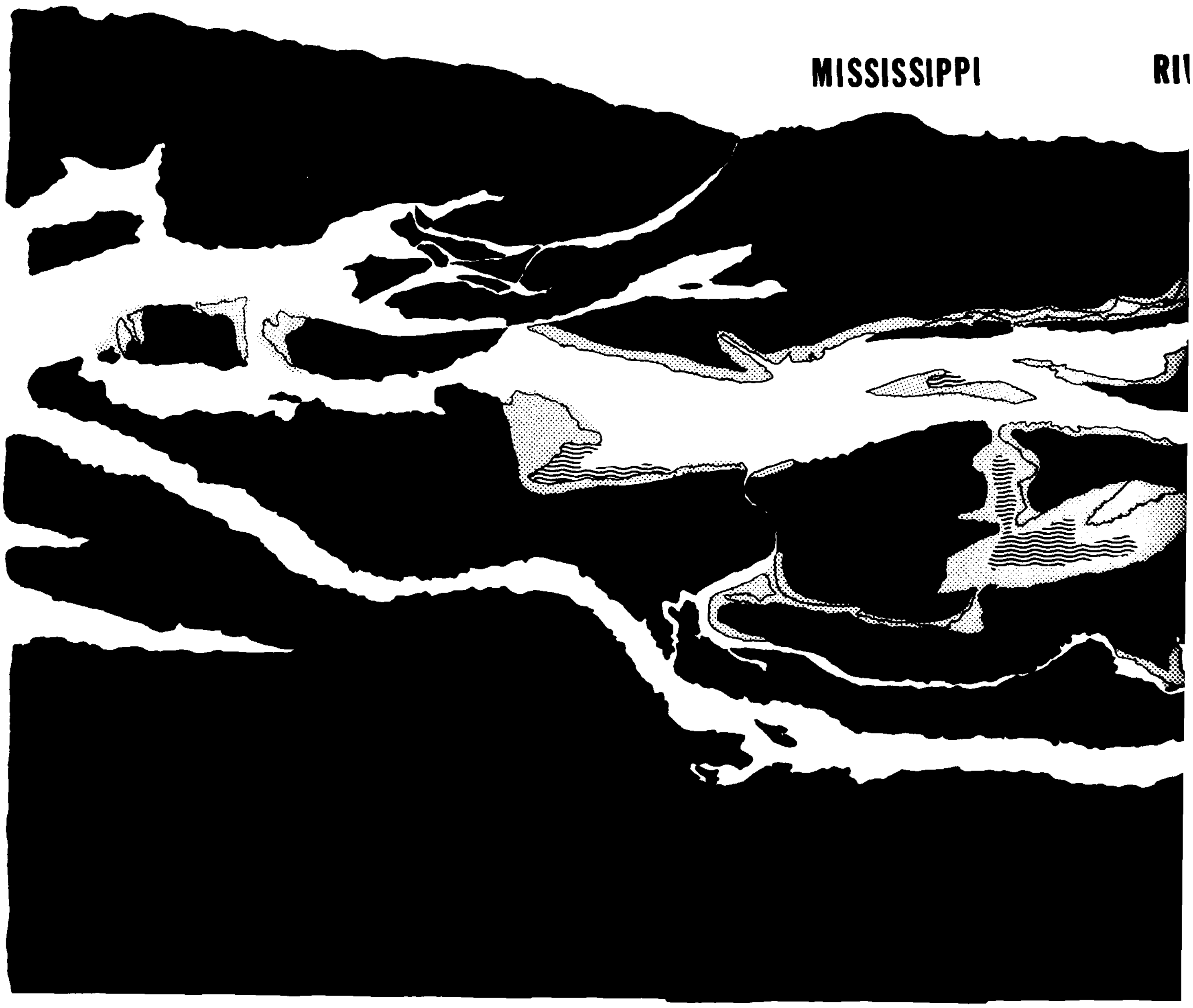


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A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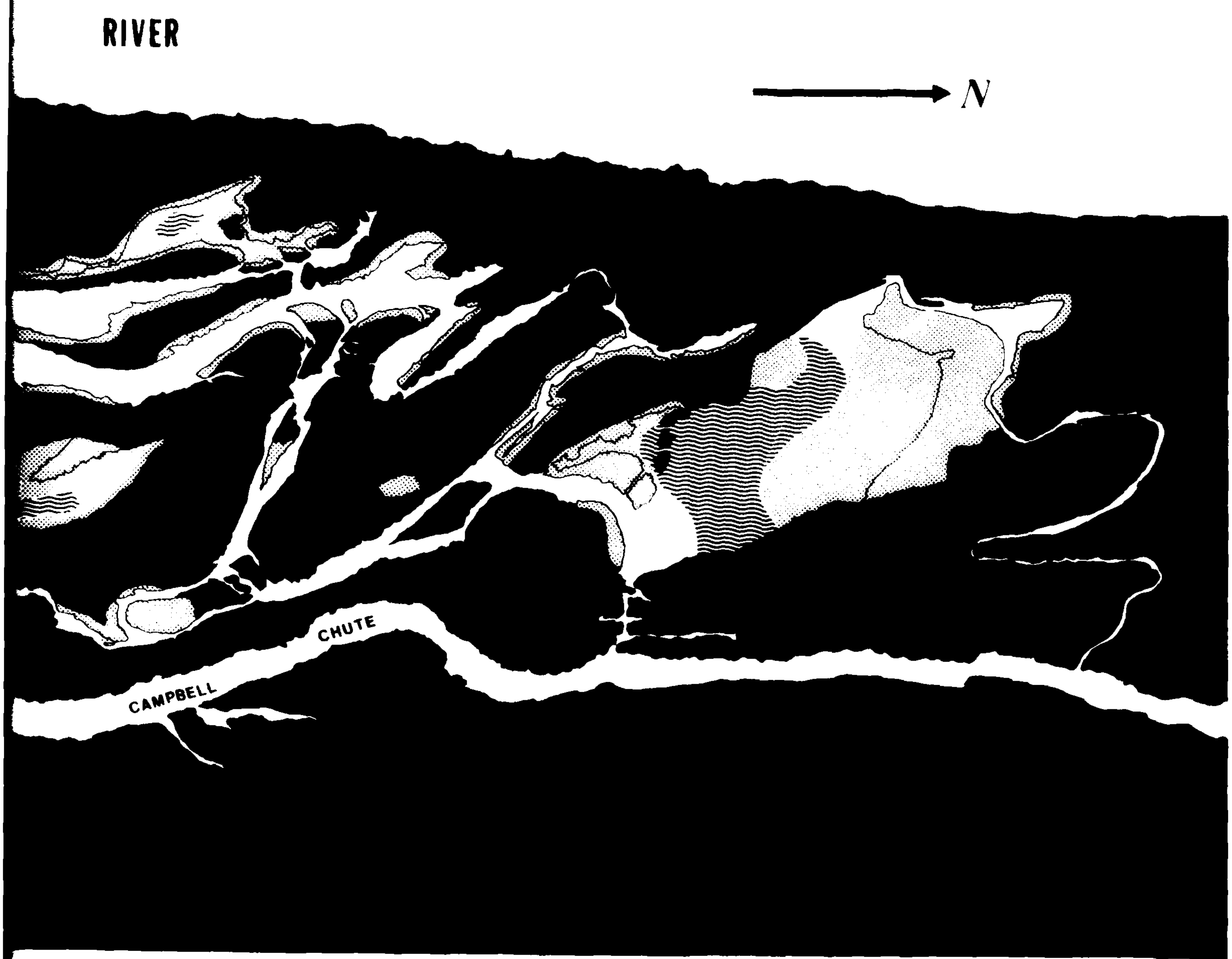

RIVER
N
CHUTE
CAMPBELL

FIG. 10. Distribution patterns of vegetation in Burnt Pocket, 1978, 1979 and 1980, Navigation Pool No. 18, Illinois.

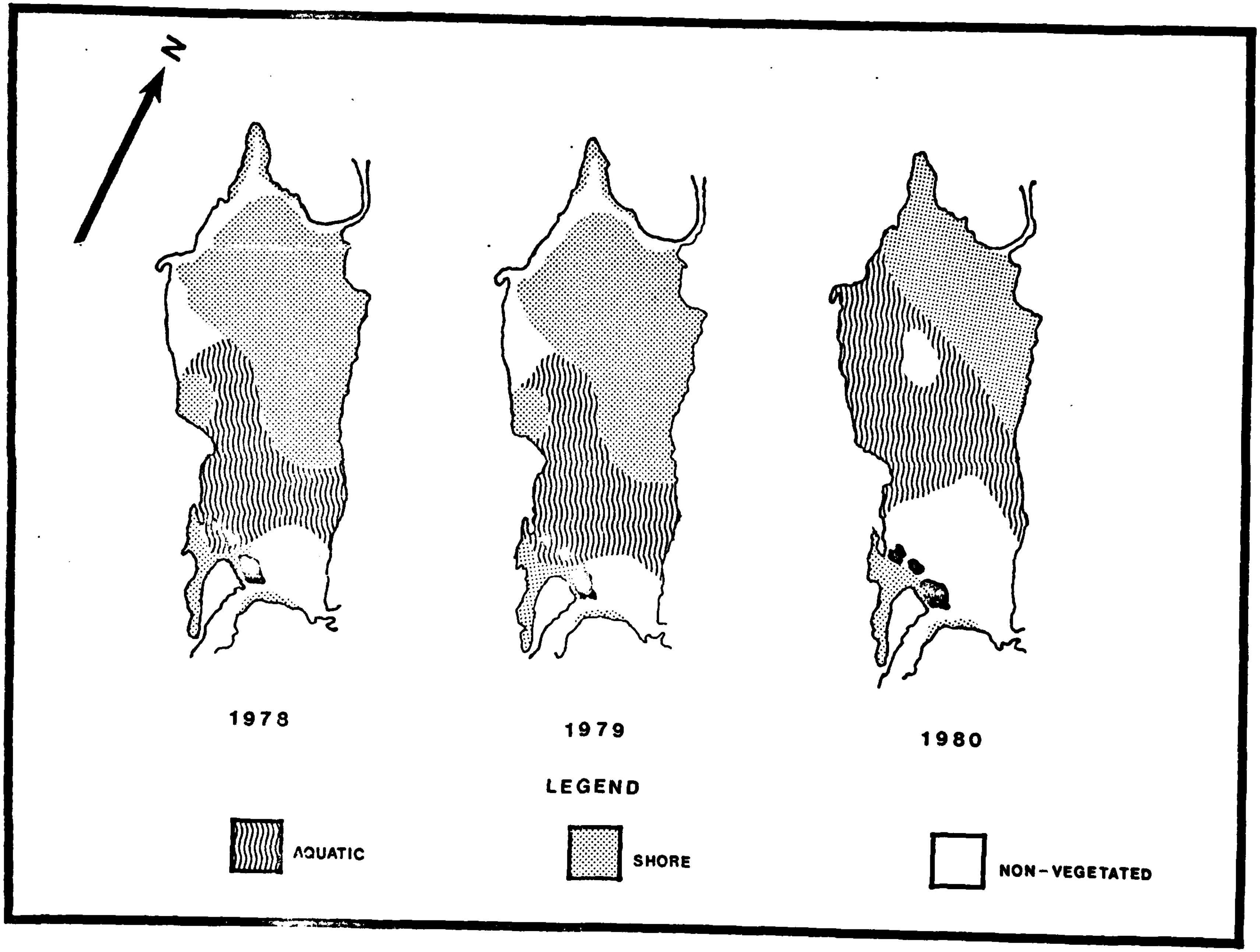

N
1978
1979
1980
LEGEND
AQUATIC
SHORE
NON-VEGETATED

TABLE 25

Total standing crop of macrophytes (*Nelumbo lutea*) (g/m^2 dry wt) in Burnt Pocket, 1978, 1979 and 1980, Navigation Pool No. 18, Illinois.

Station (Burnt Pocket)	1978	1979	1980
BP-3a	0	0	57.4
BP-3b	0	0	61.7
BP-3c	0	0	71.3
BP-3d	10.7	13.4	60.0
BP-5a	41.5	51.0	68.0
BP-5b*	41.5	51.0	81.4
BP-7a	0	0	0
BP-7b	0	0	0
BP-7c	21.1	23.4	80.4
BP-7d*	21.1	23.4	79.8

*Samples combined in 1978 and 1979.

lotus was more greatly affected by the sustained low levels during the summer. This is supported by the general distribution patterns in 1980 (Fig. 10).

Vascular Plant Flora

Representatives from 57 species including 38 families were observed at the Burnt Pocket Study Site (Appendix VI). These organisms were separated according to habitat type (Woodland, Shore and Aquatic) and further by growth form within each habitat type e.g. trees, vines, shrubs, herbs, emergent aquatic, floating aquatic, and submerged aquatic (Appendix VII). Common names are also provided for each species. The vegetation map (Fig. 9) shows the habitat types which were populated by the species of the various growth forms indicated in Appendix VII.

The woodland flora observed was comprised of 23 species of trees which were dominated by silver maple (*Acer saccharinum*) and buttonbush (*Cephalanthus occidentalis*). Summer grape (*Vitis aestivalis*) and river-bank grape (*Vitis riparia*) were among the dominant vine growth forms while poison ivy *Toxicodendron radicans*) was prevalent among both the vines and herbs.

The shore habitat was basically of two types: 1) rather large peripheral, sandy, shoal-like areas resulting from sediment deposited by inflowing waters e.g. the Upper Burnt Pocket shoal and other similar resultant areas; and 2) shore habitats with sharply delimited banks. The sandy shoal-like habitats were essentially dominated by large monotypic stands of rice cut grass (*Leersia oryzoides*). The other type of shore habitat was comprised predominately by poison ivy and buttonbush.

Figure 9 illustrates that the aquatic flora was sparsely distributed in all areas except Burnt Pocket which had substantial stands of the American lotus (*Nelumbo lutea*) and smaller amounts of the common arrowleaf (*Sagittaria latifolia*). It is important to observe that BP was the only area with a substantial edge community of aquatic macrophytes. Fish Pond Slough was the only other reach of water sampled that had any notable amount of aquatic plants. The area had some small isolated stands containing substantial amounts of fennel-leaved pondweed (Potomogeton pectinatus), common arrowleaf, and American lotus. These stands were located primarily along the edge of the island in FP. Another small stand was observed at the lower reach of FP just below the inflow from FH.

Simulations

Simulations were conducted to determine densities of selected benthic invertebrates, total benthic invertebrate standing crops and total macrophyte standing crops for seven sampling areas within the study area. Simulations were run separately for each of three years where complete input data were available. Actual and predicted values are given in Tables 26, 27 and 28. Taxonomic selections were based on their common distribution in Pools 18 and 8. In the case of Chironomidae, the sum of all predicted and actual values of those taxa common to both study areas were utilized. The total taxa that were utilized however, were those that composed the majority of the benthic invertebrate community. A detailed explanation of the regression simulation model is given in Appendix X.

Pre-opening

Standing crops of benthos in 1978 and 1979 were comparable, but species differences were observed in a few sampling sites. The total standing crop in Burnt Pocket decreased in 1979 and changes in numbers of individual taxa were also noticeable. Oligochaeta concentrations for example were reduced in Fish Pond Slough during 1979. Simulations were made for the selected organisms utilizing the actual physical-chemical data for those years. Large discrepancies were noted between actual and predicted values, particularly for 1979.

TABLE 26

Actual and predicted values of selected benthic invertebrates, total benthic biomass and total macrophyte biomass, Navigation Pool No. 18, Illinois, (1978 physical/chemical data used as input).

	Oligochaeta	Hexagenia	Chironomidae	Sphaeridae	Benthic Total Biomass	Macrophyte Total Biomass
BP (Upper)						
Actual	1353	302	217	11	14.1	0
Predicted	1760	481	43	0	17.8	93.1
BP (Lower)						
Actual	1425	207	171	12	18.2	0
Predicted	2360	370	216	1	13.0	91.6
CH						
Actual	215	3	38	19	4.7	0
Predicted	173	0	13	1	1.0	0
FH						
Actual	316	75	91	5	14.6	0
Predicted	74	7	11	1	4.9	0
FP (Upper)						
Actual	1310	359	67	33	21.8	0
Predicted	790	371	217	3	25.3	21.6
FP (Middle)						
Actual	1751	83	41	145	17.1	0
Predicted	610	311	291	270	24.7	22.5
FP (Lower)						
Actual	826	101	73	21	14.4	0
Predicted	684	343	308	281	13.1	24.7

TABLE 27

Actual and predicted values of selected benthic invertebrates, total benthic biomass and total macrophyte biomass, Navigation Pool No. 18, Illinois, (1979 physical/chemical data used as input).

	Oligochaeta	*Hexagenia*	Chironomidae	Sphaeridae	Benthic Total Biomass	Macrophyte Total Biomass
BP (Upper)						
Actual	1417	460	296	144	4.01	0
Predicted	1813	371	47	0	13.8	87.3
BP (Lower)						
Actual	1955	361	161	110	7.8	0
Predicted	2410	373	211	43	8.1	81.2
CH						
Actual	478	38	61	60	1.0	0
Predicted	186	0	16	11	1.2	0
FH						
Actual	46	259	19	140	5.0	0
Predicted	67	1	19	13	3.7	0
FP (Upper)						
Actual	300	544	121	321	8.3	0
Predicted	684	371	209	37	21.6	18.3
FP (Middle)						
Actual	609	457	109	287	1.3	0
Predicted	612	393	261	280	22.2	17.9
FP (Lower)						
Actual	122	359	93	539	1.2	0
Predicted	673	301	233	497	16.7	19.6

TABLE 28

Actual and predicted values of selected benthic invertebrates, total benthic biomass and total macrophyte biomass, Navigation Pool No. 18, Illinois, (1980 physical/chemical data used as input).*

	Oligochaeta	*Hexagenia*	Chironomidae	Sphaeridae	Benthic Total Biomass	Macrophyte Total Biomass
BP (Upper)						
Actual	4321	0	202	0	22.3	80.5
Predicted	2070	31	49	0	26.1	0
BP (Lower)						
Actual	1820	352	202	43	6.4	45.1
Predicted	3128	483	49	27	35.7	0
CH						
Actual	215	3	97	3	2.9	0
Predicted	136	16	46	1	0	0
FH						
Actual	409	51	621	47	5.5	0
Predicted	77	14	1012	0	3.2	0
FP (Upper)						
Actual	339	129	535	35	7.1	0
Predicted	258	126	558	0	26.0	0
FP (Middle)						
Actual	126	136	814	25	9.6	0
Predicted	154	128	506	8.4	20.1	0
FP (Lower)						
Actual	366	127	349	65	5.2	0
Predicted	152	127	430	8.4	17.4	0

*Current velocity values were calculated for modeling purposes assuming 285 cfs flow from Campbell Chute + 500 cfs through experimental opening.

Differences between actual and predicted values are evident during all three years of data collection in the study areas. Whereas it is difficult to assign specific reasons for these differences, it is apparent that the low water levels encountered during the post-opening period affected the actual standing crop values. The redistribution of sediments and nutrients, however, indicates that during the spring of 1980, the experimental side channel opening carried appreciable quantities of water into Burnt Pocket. The large fluctuations in total benthic biomass during the study period were not reflected by the predictions. On the contrary, fluctuations in the predictions appear to be small; furthermore, better accuracy was observed in predicting the densities of specific taxa. For example, the decline of Sphaeridae in Fish Pond Slough was predicted. The decline was judged to be a function of the instability of sediments created by the opening (sediment characteristics are included as an independent variable in the model).

The model also predicted that macrophytes would be totally eliminated from Burnt Pocket. This probably would have occurred if 1980 would have been a normal water level year. The applicability of the model to the Burnt Pocket study area is highly questionable. In its present form, the regression model is undependable in predicting most of the changes that were observed in the study area. Probable reasons for the model not working include:

1. extremely low water in 1980.
2. differences in sediment characteristics and latitude between Pool 18 and Pool 8 (reach of Mississippi River where the model was developed).
3. inherent problems in the model include spatial limitations, temporal limitations and the limited range of the independent variables.

4. limited data base.

The model at this time can not serve as a management tool because as a total predictive system it is unreliable.

A "physical model" as requested by Great II does not exist but the relationships between the physical and chemical features of the study area can be calculated. These relationships are described in Table 29 as a function of current velocity, (values for the dependent variables can thus be calculated if the current velocity is known). The equations individually describe the relationships between current velocity and the other characteristics of the study area. The model predicted similar values for the two years and did not account for the decreases observed in 1979, particularly in Fish Pond Slough.

Post-opening

The actual densities and standing crops within the BP study area varied by study site. Increases in total oligochaetes were particularly noticeable in Burnt Pocket, and their numbers declined in Middle Fish Pond Slough. Hexagenia sp. standing crops declined in Burnt Pocket and throughout Fish Pond Slough but remained relatively unchanged in the flowing water regimes (CH, FH) where their numbers were low during the pre-opening period. The densities of midges increased in Fish Pond Slough, but this was due to a large increase of a single taxon (Tanypus sp.). Fingernail clam densities decreased throughout the entire study area but total benthic standing crops were reduced only in Fish Pond Slough. Macrophyte standing crops increased in the Burnt Pocket area, and the increase was probably due to low water levels during the 1980 growing season. Predictions were made on the basis of 1980 data, utilizing a projected flow of 820 cfs (not observed at the time of sampling). Oligochaete populations were considerably higher in most instances than predicted (Table 28). The predictions of Hexagenia sp., on the other hand,

TABLE 29

Regression equations relating selected physical and chemical variables (y) to current velocity (x), Burnt Pocket data, 1978, 1979 and 1980 (n = 53).

Turbidity		= 9.77 + 29.67(x)
Dissolved Oxygen		= 4.13 + 3.81(x)
TKN		= -2.40 + 1.44(x)
Sediment NO_3-N		= -0.02 + 0.02(x)
Sediment NO_2-N		= -0.01 + 0.01(x)
Sediment PO_4-P		= -0.01 + 0.01(x)
Sediment grain size:	> 1000μ	= 2.29 + 0.92(x)
	500 to 1000μ	= 8.19 + 6.64(x)
	250 to 500μ	= 13.27 + 11.57(x)
	125 to 250μ	= 13.52 + 22.51(x)
	63 to 125μ	= 17.19 + 29.57(x)
	<63μ	= 23.33 + 37.66(x)

were quite accurate, particularly in Fish Pond Slough where even with increased discharge, current velocities were negligible. The reduction in Sphaeridae was also predicted, although predicted values were lower than actual in most cases. The predicted values for total benthic biomass were inaccurate, particularly in lower Burnt Pocket and in Fish Pond Slough where the sharp decline of biomass was not projected. Finally, the model predicted that the macrophytes would be eliminated from Burnt Pocket, and obviously they were not. This may have been due again, to the lack of flow through the system throughout most of the 1980 growing season.

Zooplankton

Pre-opening

Differences were not observed among total zooplankton densities nor among densities of various zooplankton taxa at the six different stations (Table 30, Fig. 11). Conversely, there were differences in biomass among stations (Table 31, Appendix Fig. VIII-1) and between the main channel of the Mississippi River and the mean for all stations in the Burnt Pocket area (Appendix Fig. VIII-2). A comparison of zooplankton biomass and density data indicates that biomass data are highly variable and less meaningful than density data. The reason for this situation is that the entire contents of the zooplankton samples were weighed and reported as zooplankton biomass. This means that the weight reported as zooplankton biomass also includes algae, detritus, plant material, and suspended sediments. The amounts of these types of extraneous materials in the water at the time of collection significantly affected the amount of particulate mass retained by the plankton net. This problem can be illustrated by comparing biomass (Table 31) and density (Table 30) on 9-6-78. Biomass at the six stations varied considerably (47.5 - 268 mg/m^3), whereas densities remained relatively constant (8.4 - 9.0 organisms/liter). Furthermore, no

TABLE 30

Densities (number/l) of zooplankton taxa (Calanoida, Cyclopoida, Cladocera, Rotifera and total Copepoda nauplii) at each station in the Burnt Pocket Study Area, Navigation Pool No. 18, Illinois, during 1978.

Taxon Date	Station MC	BP	CH	FP-A	FP-B	FP-C
Calanoida						
6-28-78	2.7	1.7	2.1	2.3	2.1	1.8
7-12-78	--*	6.3	6.4	5.7	6.4	6.8
7-28-78	9.2	8.6	8.6	9.1	8.7	9.1
8-17-78	3.5	3.1	3.3	2.8	3.7	3.2
9-6-78	3.6	3.2	3.5	3.8	3.5	3.3
9-19-78	2.3	2.2	1.9	1.6	2.3	2.2
10-2-78	3.3	3.4	3.2	2.9	3.7	3.1
Cyclopoida						
6-28-78	0.4	0.3	0.4	0.5	0.4	0.3
7-12-78	--	2.4	2.6	2.6	2.5	2.8
7-28-78	3.9	3.7	3.7	3.6	3.5	3.4
8-17-78	1.6	1.4	2.0	1.7	1.4	1.6
9-6-78	1.5	1.7	1.6	1.5	1.1	1.2
9-19-78	1.5	1.7	1.4	1.6	1.4	1.4
10-2-78	1.5	1.2	1.3	1.6	1.5	1.7
Cladocera						
6-28-78	0.2	0.2	0.2	0.3	0.3	0.3
7-12-78	--	0.2	0.2	0.2	0.2	0.2
7-28-78	0.2	0.1	0.2	0.2	0.2	0.2
8-17-78	0.1	0.1	0.1	0.1	0.1	0.1
9-6-78	0.1	0.1	0.1	0.1	0.1	0.1
9-19-78	0.1	0.1	0.1	0.2	0.1	0.2
10-2-78	0.1	0.1	0.1	0.1	0.2	0.2
Rotifera						
6-28-78	3.9	3.6	4.7	4.7	4.3	4.3
7-12-78	--	4.5	4.4	4.8	4.5	4.5
7-28-78	6.9	7.2	6.7	6.9	6.7	5.8
8-17-78	5.0	4.2	4.7	4.8	5.2	4.7
9-6-78	3.3	3.5	3.7	3.6	3.8	3.8
9-19-78	3.5	3.4	3.4	3.6	3.6	3.5
10-2-78	3.1	3.1	3.4	3.6	3.7	3.3
Nauplii						
6-28-78	T**	T	T	T	T	0.0
7-12-78	--	0.5	0.5	0.6	0.5	0.3
7-28-78	0.4	0.4	0.5	0.4	0.3	0.5
8-17-78	T	T	0.0	T	0.0	T
9-6-78	T	T	0.0	0.0	T	0.0
9-19-78	0.0	T	0.0	0.0	T	0.0
10-2-78	0.0	T	T	T	T	T
Total						
6-28-78	7.2	5.8	7.4	7.8	7.1	6.7
7-12-78	--	12.9	14.1	13.9	14.1	14.6
7-28-78	20.6	20.0	19.7	20.2	19.4	19.0
8-17-78	10.2	8.8	10.1	9.4	10.4	9.6
9-6-78	8.5	8.5	8.9	9.0	8.5	8.4
9-19-78	7.4	7.4	6.8	7.1	7.4	7.3
10-2-78	8.0	7.8	8.0	8.2	9.1	8.3

*-- denotes no sample obtained.
**T denotes standing crops less than 0.05 org/l.

TABLE 31

Biomass (mg/m^3) of the net plankton in the Burnt Pocket Study Area, Navigation Pool No. 18, Illinois, during 1978.

Station	6-28	7-12	7-28	8-17	9-6	9-19	10-2	Mean
MC	77.4	--*	210.6	761.4	268.0	133.0	185.0	272.6
BP	12.4	26.3	30.2	955.4	96.9	36.7	504.2	237.4
CH	86.2	77.9	258.6	392.3	244.3	139.6	162.9	194.5
FP-A	17.5	23.9	66.9	--	168.2	50.9	--	65.5
FP-B	25.9	85.6	181.8	58.2	47.5	39.4	262.8	100.9
FP-C	20.8	133.1	73.5	65.1	130.5	47.7	92.8	80.5

*--denotes no data obtained.

apparent size differences were noted for specific zooplankton taxa among the stations. There were, however, observable differences in the quantities of algae and detritus, thus accounting for much of the variability in biomass data. For these reasons, only density (number/liter) will be used to discuss zooplankton data. In addition, because of the uniformity among stations, zooplankton will be discussed on a seasonal basis by using combined data from all stations, thereby obtaining mean densities for the entire area on each date.

Although the Burnt Pocket study area was spatially homogeneous with regard to zooplankton, there were notable seasonal differences both in total densities and densities of various taxa (Fig. 12). The lowest mean total density was observed on 28 June and was dominated by rotifers (4.3/1) and calanoid copepods (2.1/1). Zooplankton densities increased on 12 July and reached the seasonal maxima (20.0/1) on 28 July. At that time, the zooplankton community was comprised mostly of calanoid copepods (8.9/1) and rotifers (6.7/1) with lesser amounts of cyclopoid copepods (3.6/1) and nauplii (1.0/1). On 17 August, total zooplankton densities were significantly lower (10/1) and continued to decline through 19 September when 7.5 organisms/1 were observed. Zooplankton were slightly more abundant on 2 October. Algae were predominately Mycrocystis aueriginosa. Mycrocystis aueriginosa was most abundant on 7-28-78 and 8-14-78. Lesser amounts of Aphanizominon flos-aquae were also observed at MC and FP-B on 10-2-78, and FP-A and FP-C on 9-6-78. Two chironomidae larvae were found in samples from BP on 7-12-78 and 8-17-78. In summary, calanoid copepods and rotifers were the dominant organisms in the entire study area and collectively accounted for 76.6 to 90.1% of the total number of zooplankton during the pre-opening period (1978). Cyclopoid copepods were the only other organisms comprising a major proportion of the community. Cladoceran densities never exceeded 0.3 organisms per liter.

FIG. 11. Densities of zooplankton taxa (number/l) and total standing crop at each station in the Burnt Pocket study area, Navigation Pool No. 18, Illinois, during 1978. A = Calanoida, B = Cyclopoida, C = Cladocera, D = Rotifera, E = Copepoda nauplii and F = Total number.

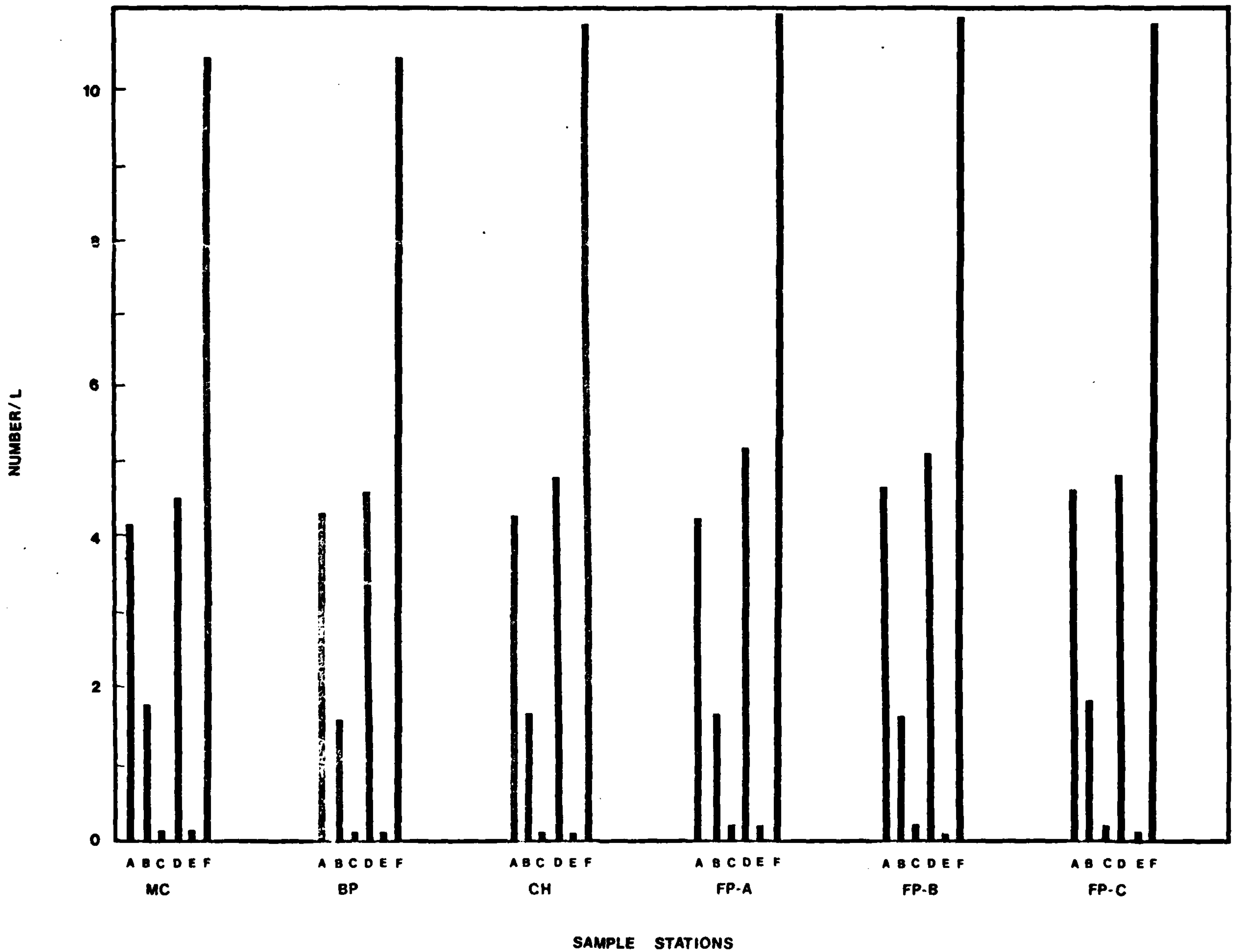
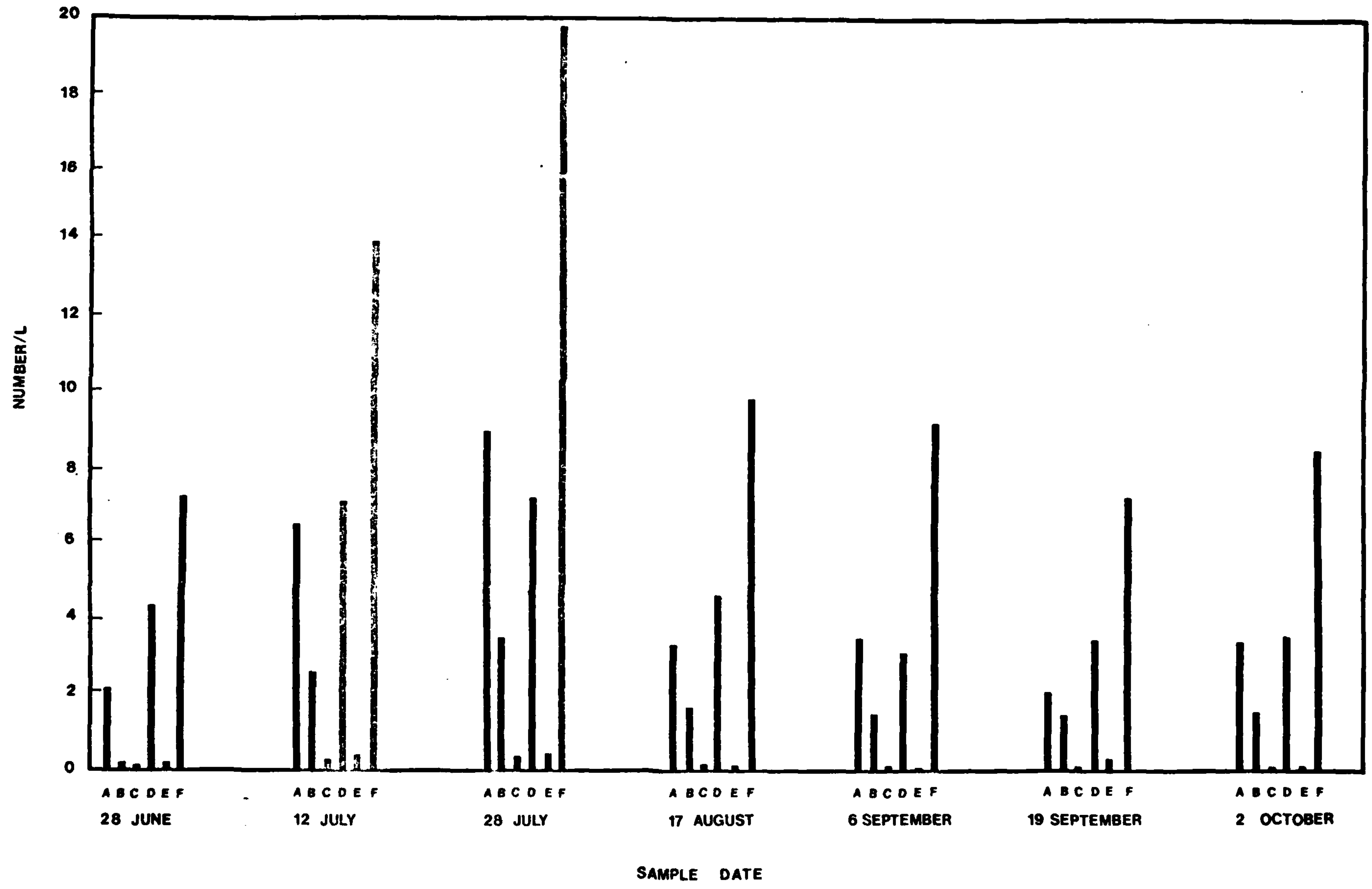

NUMBER/L
10
8
6
4
2
0
A B C D E F
MC
A B C D E F
BP
A B C D E F
CH
A B C D E F
FP-A
A B C D E F
FP-B
A B C D E F
FP-C
SAMPLE STATIONS

FIG. 12. Densities of zooplankton taxa (number/l) and total standing crop on the sample dates in 1978 in the Burnt Pocket study area, Navigation Pool No. 18, Illinois. A = Calanoida, B = Cyclopoida, C = Cladocera, D = Rotifera, E = Copepoda nauplii and F = total number.



NUMBER/L
20
18
16
14
12
10
8
6
4
2
0
A B C D E F
28 JUNE
12 JULY
28 JULY
17 AUGUST
6 SEPTEMBER
19 SEPTEMBER
2 OCTOBER
SAMPLE DATE

Post-opening

Zooplankton data for total densities and densities of each taxon at the various stations are presented in Table 32. Biomass data are also given (Table 34; Appendix Fig. VIII-3), but for reasons previously stated, densities of zooplankton will be used in the ensuing discussion. In contrast to the uniformity observed in 1978, there was considerably more variation observed in the zooplankton communities among stations and dates during 1980. On a seasonal average basis (19 June 1980 through 26 September 1980), however, stations MC, BP, CH, FP-A and FP-B were similar (Fig. 13). Their mean densities ranged from a low of 5.0/1 in the main channel to 5.8/1 in the channel area within the study site. The highest average density was 7.2/1 at FP-C. Calanoid copepods followed by cyclopoid copepods were the dominant zooplankters at all stations during the post-opening period. A notable difference between pre-opening and post-opening communities is that rotifers were scarce in 1980, whereas they were the dominant taxon in 1978. Cladocera were also more abundant in 1980 as compared to 1978. Algae, predominately Mycrocystis aueriginosa, was less abundant in 1980 while detritus exhibited similar fluctuations (Appendix IX). Lemna sp. was observed in the CH area on 8-22-80.

Similar to 1978, seasonal differences were also apparent during 1980 (Fig. 14). The average density for the entire area was 5.8/1 on 19 June and the maximum standing crop was 7.3/1 on 1 July. The lowest concentration of zooplankton observed was 3.9/1 on 26 September. As expected from the previous comparison of stations, the calanoid and cyclopoid copepods were respectively, the most abundant taxa, comprising from 43.1 to 56.1% and 22.0 and 28.2% of the total standing crops. Rotifers were the least numerous zooplankters in 1980 ranging in proportion from 5.2 to 8.5% of the total zooplankton community.

Relationships between zooplankton and juvenile fish were examined. The standing crops and species composition of fishes varied considerably (Table 34). Juvenile fish were not collected at station 1 during the fall of 1978 and in spring and summer of 1980. However, because there were no differences in densities or species composition of the zooplankton within the study area during each year sampled, the relationship between fishes and plankton is not apparent. The same reasoning can be applied to the relationships between turnover times (Table 6) and zooplankton. Even though turnover times varied, the zooplankton remained relatively unchanged. Because of the uniformity of the zooplankton populations relationships with juvenile fish and turnover times can not be elucidated.

In summary, a comparison of pre- and post-opening zooplankton communities reveals that average standing crops were notably higher in 1978 as compared to 1980. The taxonomic composition was also different in the post-opening period. Data obtained from within the Burnt Pocket study area, however, were not different than that obtained from the main channel. The implication is that the reduced densities and different taxonomic composition represented general characteristics of the Mississippi River system and cannot be attributed to the opening of the experimental side channel.

TABLE 32

Densities (number/l) of zooplankton taxa (Calanoida, Cyclopoida, Cladocera, Rotifera and total Copepoda nauplii) at each station in the Burnt Pocket Study Area, Navigation Pool No. 18, Illinois, during 1980.

Taxon Date	Station MC	BP	CH	FP-A	FP-B	FP-C
Calanoida						
6-19-80	3.0	3.3	1.1	3.1	3.6	2.1
7-1-80	2.9	--*	4.8	4.1	--	4.5
8-22-80	1.8	4.5	4.1	3.0	2.9	--
9-26-80	1.0	2.7	1.3	1.8	2.2	2.2
Cyclopoida						
6-19-80	2.0	0.8	0.4	2.2	1.3	1.4
7-1-80	2.6	--	1.8	1.6	--	1.4
8-22-80	1.4	1.7	2.1	0.6	1.7	--
9-26-80	0.4	1.1	1.9	1.6	0.8	1.8
Cladocera						
6-19-80	1.4	0.4	0.3	1.2	0.5	0.8
7-1-80	0.8	--	0.7	0.5	--	0.5
8-22-80	0.1	0.3	0.4	0.3	0.0	--
9-26-80	0.2	0.2	0.3	0.6	0.3	1.1
Rotifera						
6-19-80	0.2	0.2	0.3	0.5	0.2	0.1
7-1-80	0.6	--	0.3	0.5	--	0.1
8-22-80	0.7	0.4	1.1	0.2	0.3	--
9-26-80	0.2	0.2	0.4	0.2	0.1	0.4
Nauplii						
6-19-80	0.4	1.0	0.5	1.2	1.3	0.8
7-1-80	0.2	--	0.3	0.2	--	0.3
8-22-80	0.1	0.0	1.2	0.2	0.5	--
9-26-80	0.1	0.1	0.0	0.1	0.3	0.1
Total						
6-19-80	7.0	5.7	2.6	8.2	7.9	5.2
7-1-80	7.1	--	7.9	6.8	--	6.8
8-22-80	4.1	6.9	8.9	4.3	5.4	--
9-26-80	1.9	4.3	3.9	4.3	3.7	5.6

*-- denotes no sample obtained.

TABLE 33

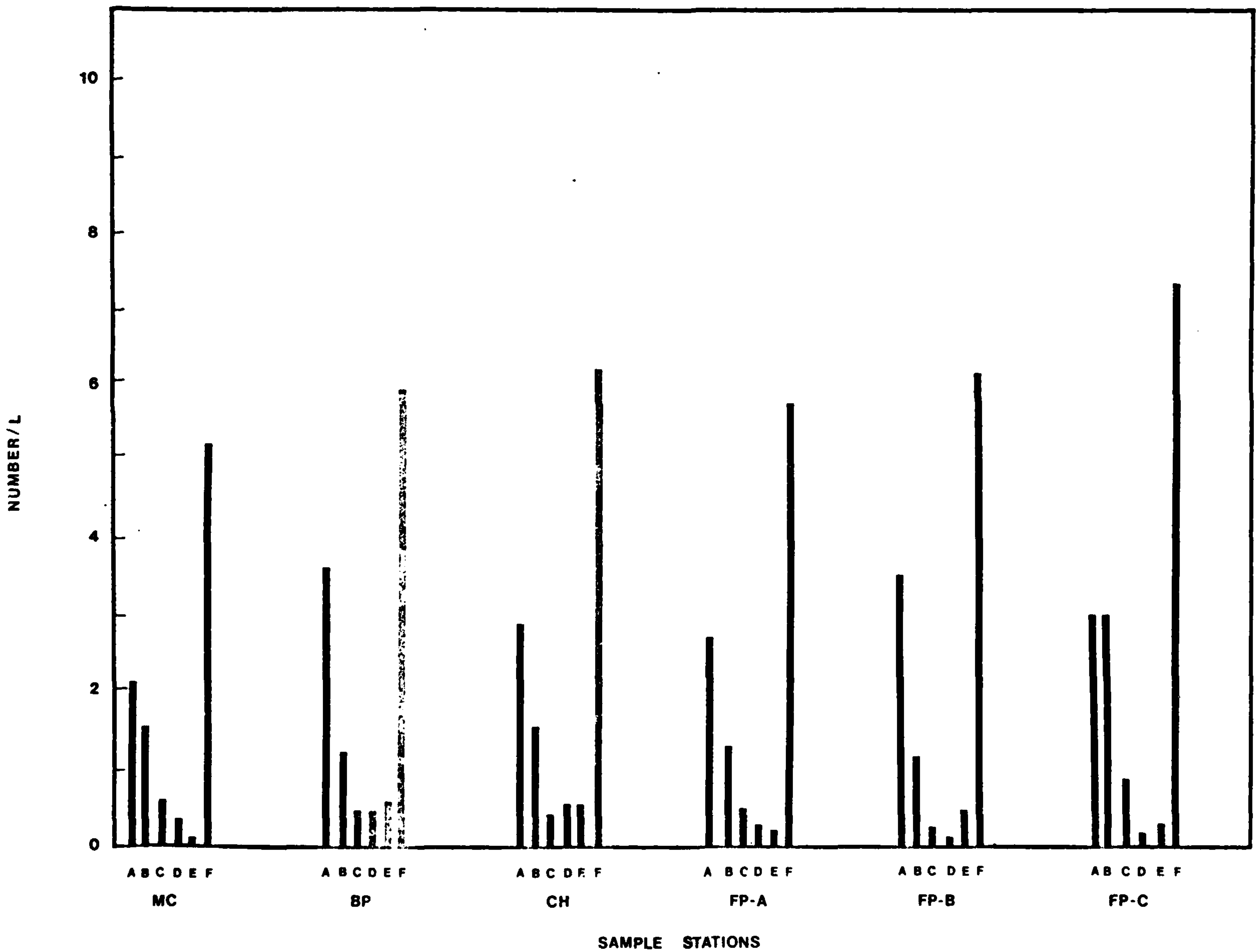
Biomass (mg/m^3) of the net plankton in the Burnt Pocket Study Area, Navigation Pool No. 18, Illinois, during 1980.

Station	DATE 6-19-80	7-1-80	8-22-80	9-26-80	Mean
MC	171.2	138.4	445.3	178.6	300.0
BP	114.3	--*	14,755.4**	59.4	86.9
CH	81.8	44.9	178.2	124.7	107.4
FP-A	38.3	--	285.4	40.1	121.3
FP-B	29.2	23.0	64.6	51.1	42.0
FP-C	40.1	27.9	--	53.3	40.4

*-- no sample.

**weight primarily due to sediment, not included in the mean.

FIG. 13. Densities of zooplankton taxa (number/l) and total standing crop at each station in the Burnt Pocket study area, Navigation Pool No. 18, Illinois, during 1980. A = Calanoida, B = Cyclopoida, C = Cladocera, D = Rotifera, E = *Copepoda nauplii* and F = Total number.



NUMBER/L
10
8
6
4
2
0
A B C D E F
MC
A B C D E F
BP
A B C D E F
CH
A B C D E F
FP-A
A B C D E F
FP-B
A B C D E F
FP-C
SAMPLE STATIONS

FIG. 14. Densities of zooplankton taxa (number/l) and total standing crop on the sample dates in 1980 in the Burnt Pocket Study Area, Navigation Pool No. 18, Illinois. A = Calanoida, B = Cyclopoida, C = Cladocera, D = Rotifera, E = Copepoda nauplii and F = total number.

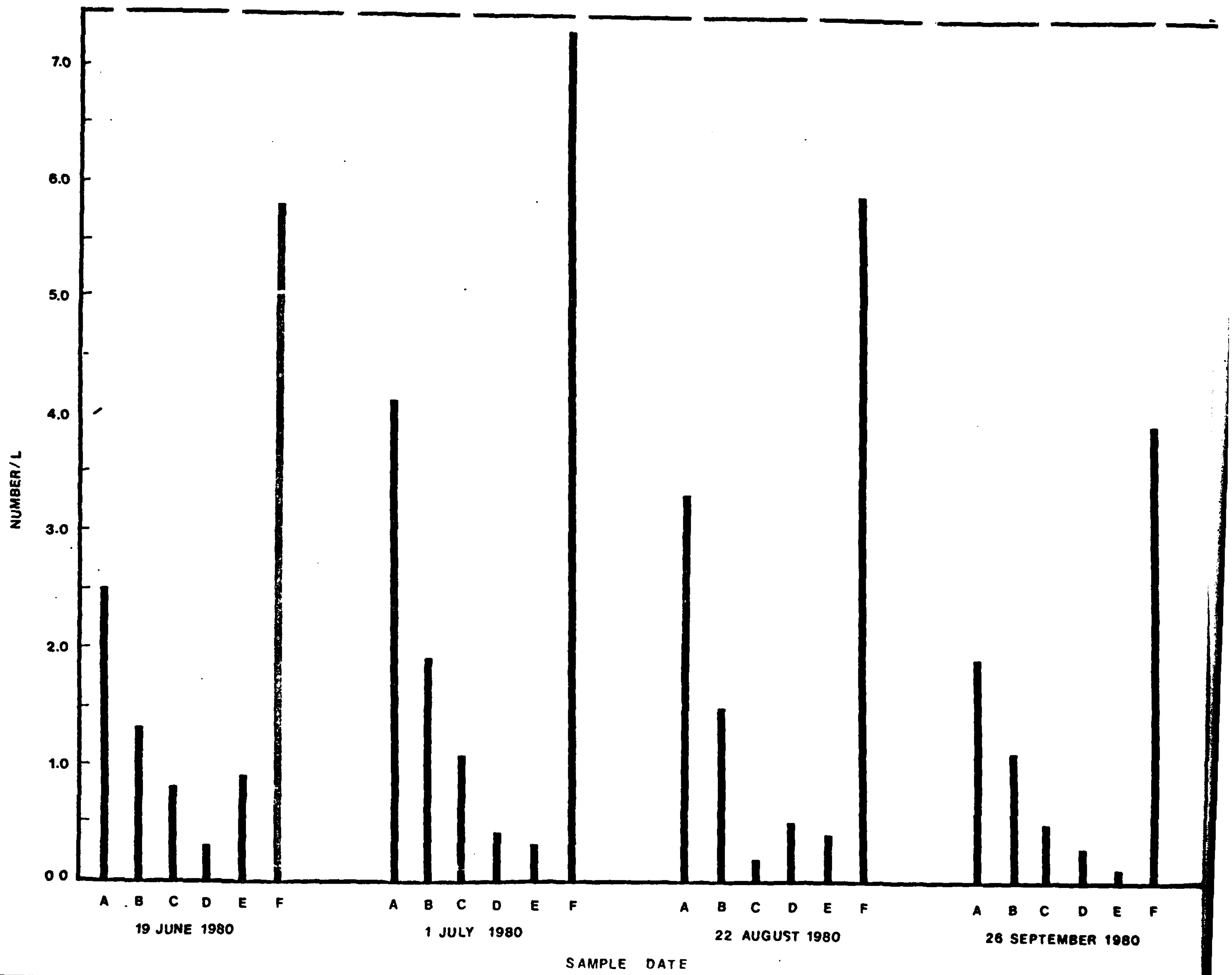

NUMBER/L
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
A B C D E F
19 JUNE 1980
A B C D E F
1 JULY 1980
A B C D E F
22 AUGUST 1980
A B C D E F
26 SEPTEMBER 1980
SAMPLE DATE

TABLE 34

Numbers of juvenile fish collected by electrofishing in Burnt Pocket in 1978 and 1980. Young-of-the-year and yearlings in parenthesis are included. Stations are shown in Fig. 3. (From Van Vooren 1981).

	Station 1						Station 2					
	1978			1980			1978			1980		
Fish	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall*	Spring	Summer	Fall
Gizzard Shad	(13)	20				124	(4)	90	17	(4)	71	87
Carp	(20)					1	(19)				1	
Notropis and Pimephales												
River Carpsucker	(13)	1(12)				4(1)	(14)	(4)		(11)	1(1)	1(3)
Quillback Carpsucker						3(1)	(5)	2(12)	(1)	(1)		
Smallmouth Buffalo	(10)	(1)				1	(8)	(4)		(4)	1	
Bigmouth Buffalo										(1)		
Golden Redhorse										(1)		
Shorthead Redhorse										(1)	(2)	
Channel Catfish		(1)	No Survey	No Survey	No Survey	1		(16)				7
White Bass						4					5	6
Bluegill	(15)	3(6)				3(10)	(1)	2	x(x)	(43)	4(31)	(2)
Largemouth Bass		2(2)					(20)	2(8)	x	(18)	1(9)	
White Crappie		1							(1)	(4)		
Black Crappie	(7)						(3)	(1)		(4)	(1)	
Yellow Perch							(3)	(1)			1	
Sauger		(1)				3	(4)	(5)	5			2
Walleye		(2)				1	(1)	(3)	x		1	1
Freshwater Drum	(1)	1(3)				32(1)	(5)	7(16)	x	(4)	23(4)	41(2)
Smallmouth Bass									1			
Shocking Time (Min)	39	64				80	38	59	34	72	73	67

*For some species length range only was recorded - occurrence is noted by an x.

SUMMARY

The study on the effects of diverting water into Burnt Pocket in Navigation Pool No. 18 was conducted during pre-opening years of 1978 and 1979 and the first post-opening year of 1980. Some of the results can be attributed to the opening of the experimental side channel, however, other results do not appear to be related to the opening. The most notable observations of the study are listed below.

1. Grain size distribution of sediments in BP were changed from spatially homogeneous to heterogeneous. The amounts of silts and clays increased in the middle and lower areas of FP as deposition of suspended sediments from its influent waters occurred. The CH, a well scoured channel before opening, and FH reaches remained relatively unchanged.
2. Concentrations of sediment TKN and phosphorus were reduced in BP, FP and FH. Values in CH remained unchanged.
3. Water quality characteristics were similar during pre- and post-opening. Differences were attributed to low water during sampling in 1980.
4. The diversity of the benthic community remained stable except in lower BP, where it was reduced by almost 50%. Reductions in the numbers of Sphaeridae and Hexagenia sp. and increases in Tanypus sp. were the most notable taxonomic alterations.
5. Aquatic macrophyte biomass increased, but the increases cannot be attributed to opening the channel.

6. Zooplankton reflected the general characteristics of the Mississippi River system and their community composition cannot be attributed to the side channel opening.

The other aspect of the study was to assess the applicability of the Navigation Pool No. 8 regression model to Navigation Pool No. 18. Simulations were quite accurate for individual taxa, but the model predicted values for total benthic and macrophyte biomass with less accuracy. Probable reasons for discrepencies include:

1. extremely low water in 1980.
2. differences in sediment characteristics and latitude between Pool 18 and Pool 8 (reach of Mississippi River where the model was developed).
3. inherent problems in the model include spatial limitations, temporal limitations and the limited range of the independent variables.
4. limited data base.

The model at this time can not serve as a management tool because as a total predictive system it is unreliable.

Finally, there is the question of whether the cut was appropriate for Burnt Pocket. Trends are difficult to recognize with only one year of post-opening data. Furthermore, the post-opening season was an abnormally low water year. In spite of the increase in macrophyte standing crops in Burnt Pocket, a net loss of nutrients from the system occurred and sediments were at least rearranged. It can be expected that these processes will continue during normal and high flow periods, and that in time the entire area will contain lower concentrations of nitrogen and phosphorus. Existing data do not permit conclusions concerning sediment accumulation. The sediment movement during the first post-opening year, however, indicate that the area may discharge the sediments that it receives in the future. If this occurs, then the opening would certainly have a net beneficial effect.

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APPENDICES

APPENDIX I

Taxonomic list of benthic macroinvertebrate fauna collected from Burnt Pocket Study Site, Navigation Pool No. 18, Upper Mississippi River, between 1978 and 1980.

NEMATODA	round worms
ANNELIDA	
Oligochaeta	earth worms
Hirudinea	leeches
RHYNCHOBDELLIDA	
Glossiphoniidae	
<u>Helobdella</u> sp. (Castle)	
ARTHROPODA	
Crustacea	
Malacostraca	
Pericarida	
ISOPODA	aquatic sow bugs
Asellota	
Asellidae	
<u>Asellus</u> sp. Geoffrey St. Hillare	
AMPHIPODA	
Talitridae	
<u>Hyallela</u> sp. (Saussure)	
Insecta	
EPHEMEROPTERA	mayflies
Siphlonuridae	
Heptageniidae	
<u>Stenonema</u> sp. Traver	

APPENDIX I (Cont.)

Caenidae	
Brachycercus sp. Curtis	
Caenis sp. Stephans	
Potamanthidae	
Potamanthus sp. Pictet	
Ephemeridae	
Hexagenia sp. Walsh	
ODONATA	dragonflies, damselflies
Zygoptera	damselflies
Coenagrionidae	
Enallagma sp. Charpentier	
Ischnura sp. Charpentier	
Anisoptera	dragonflies
Gomphidae	
Arigomphus sp. Needham	
Dromogomphus sp. Selys	
Hagenius sp. Selys	
HEMIPTERA	true bugs
Notonectidae	back swimmers
Buenoa sp. Kirkaldy	
Corixidae	water boatmen
TRICHOPTERA	caddisflies
Hydropsychoidea	net spinners
Polycentropodidae	
Polycentropodinae	
Cyrnellus sp. Banks	
Neureclipsis sp. McLachlan	
Hydropsychidae	
Hydropsychinae	
Cheumatopsyche sp. Wallengren	

APPENDIX I (Cont.)

Hydropsyche sp. Pictet	
Rhyacophiloidea	
Hydroptilidae	purse-case makers
Hydroptilinae	
Stactobiella sp. Martynow	
Limnephiloidea	
Leptoceridae	tube-case makers
Leptocerinae	
Oecetini	
Oecetis sp. McLachlan	
MEGALOPTERA	fishflies, alderflies, dobsonflies, hellgrammites
Corydalidae	fishflies, dobsonflies
Chauloides sp. Latreille	
LEPIDOPTERA	moths
Heterocera	
Pyralidae	
Nymphula sp. Schrank	
COLEOPTERA	beetles
Adephaga	
Haliplidae	crawling water beetles
Peltodytes sp. Regimbart	
Gyrinidae	
Gyrinus sp.	whirligig beetles
Polyphaga	
Elmidae	riffle beetles
Stenelmis sp. Dufour	

APPENDIX I (Cont.)

DIPTERA	flies and midges
Nematocera	
Tipulidae	crane flies
Chaoboridae	phantom midges
Chaoborus sp. Lichtenstein	
Ceratopogonidae	biting midges, punkies, no-see-ums, sand flies
Heleinae	
Palpomyia sp. Meigen	
Chironomidae	lake flies, midges
Tanypodinae	
Tanypodini	
Clinotanypus sp. Kieffer	
Coelotanypus sp. Kieffer	
Tanypus sp. Meigen	
Macropelopiini	
Procladius sp. Skuse	
Psectrotanypus sp. Kieffer	
Pentaneurini	
Ablabesmyia sp. Johannsen	
Arctopelopia sp. Fittkau	
Conchapelopia sp. Fittkau	
Larsia sp. Wiedemann	
Rheopelopia sp. Bause	
Chironominae	
Chironomini	
Chironomus sp. Meigen	
Cryptochironomus sp. Kieffer	
Cryptocladopelma sp.	
Dicrotendipes sp. Kieffer	
Einfeldia sp. Kieffer	
Endochironomus sp. Kieffer	
Glyptotendipes sp. Kieffer	
Parachironomus sp. Kieffer	
Phaenopsectra sp. Kieffer	
Polypedilum sp. Kieffer	

APPENDIX I (Cont.)

Pseudochironomini

Pseudochironomus sp. Malloch

Tanytarsini

Paratanytarsus sp. Bause
Tanytarsus sp. Wulp

Orthocladiinae

Cricotopus sp. Wulp
Epoicocladius sp.
Smittia sp. Holmgren

Simuliidae — buffalo gnats, black flies, turkey gnats

Eusimulium sp. Roubaud
Simulium sp. Latreille

Cyclorrapha

Muscidae

MOLLUSCA

Gastropoda — snails, limpets

Pulmonata

BASOMMATOPHORA

Physidae — pouch snails

Physa sp. Draparnaud

Planorbidae — orb snails

Gyraulus sp. Charpentier

Ancylidae — limpets

Ferrissia sp. Walker

Bivalvia

Paleoheterodonta

UNIONOIDA

Unionidae

Lampsilinae

APPENDIX I (Cont.)

Lampsilini

<u>Proptera</u> sp.
<u>Lampsilis</u> sp.
<u>Lasmigona</u> sp.
<u>Anadonta</u> sp.

Sphaeridae

APPENDIX II

Number of benthic macroinvertebrates/m^2 of each taxon at each station in Navigation Pool No. 18, Illinois on May 26, 1978.

Station	Olig	Hiru	Caen	Hexa	Drom	Cheu	Oece	Palp	Tanp	Coel	Tany	Proc	Abla
BP-1a	43			345		43				86			
BP-1b	258			172								43	43
BP-1c	86			129									
BP-1d										43			
BP-3a	1076			258				43					
BP-3b	5942			258				86		43		129	
BP-3c	1938			388						43		172	43
BP-3d	3230			689				43	43	86		258	
BP-5a	129			86				172			86		
BP-5b	43			301				172			43	86	
BP-5c				388						43			
BP-5d	215			86							43		
BP-7a	129			86				86			43	301	43
BP-7b				258				344				43	43
BP-7c	215			603				129					
BP-7d	732			258				86					
BP-9a	2067	43		215				43			65		258
BP-9b	2067			129									86
BP-9c	43			344				86					43
BP-9d		43		344				43					43
CH-1	43							86		43			
CH-2	301							43					
CH-3													
CH-4	517												
CH-5	1033			43									
CH-6	732			86						86			
CH-7													
CH-8	431			344	43		43						
FH-1	172	86		431								43	
FH-2	43			621				43				43	43
FH-3	86			775								43	
FH-4	1206			474								258	
FH-5	344												
FH-6				43		86							
FP-1	43			86						129			
FP-2	904			344				43		43		129	
FP-3	775			431						86			
FP-4	2282			517				172	43	172		172	
FP-5	431		43	215							43		86
FP-6	646			431						43			129
FP-7	1722			388						172		86	86
FP-8	344			775				43		43		43	
FP-9	904			431				43				43	
FP-10	2497			818								43	43
FP-11	2713			258								43	
FP-12	1507			388						86			
FP-13	2368			603						86		43	
FP-14	4521			258									
FP-15	818			1076						86			
FP-16	603			129								86	86
FP-17	344			344								344	172
FP-18				344				43					
FP-19	732			732								43	
FP-20	1636	86		431								43	

Olig = Oligochaeta
Hiru = Hirudinea
Caen = *Caenis* sp.
Hexa = *Hexagenia* sp.
Drom = *Dromogomphus* sp.
Cheu = *Cheumatopsyche* sp.
Oece = *Oecetis* sp.
Palp = *Palpomyia* sp.
Tanp = Tanypodinae pupae
Coel = *Coelotanypus* sp.
Tany = *Tanypus* sp.
Proc = *Procladius* sp.
Abla = *Ablabesmyia* sp.

Blank spaces indicate no organisms present in the sample.

APPENDIX II (Cont.)

Station	Chip	Chir	Crch	Einf	Endo	Poly	Phys	Ambl	Spha	Standing crop #/m²	biomass (g/m²)
BP-1a			43							560	14.032
BP-1b					43					516	25.736
BP-1c			43						43	301	13.208
BP-1d										43	0.027
BP-3a		732								2152	13.331
BP-3b									43	6458	22.958
BP-3c										2584	22.001
BP-3d									43	4392	45.920
BP-5a		172								645	10.354
BP-5b	86	43						43		946	21.792
BP-5c										474	10.048
BP-5d		431								775	2.978
BP-7a	43	215								946	13.945
BP-7b		86		43						817	16.159
BP-7c		431					43			1421	11.139
BP-7d		216								1292	15.641
BP-9a		86								2927	14.453
BP-9b	86	301		43					43	2755	14.001
BP-9c		258								774	14.263
BP-9d										473	11.154
CH-1		43							86	301	1.091
CH-2				86		43			43	473	0.966
CH-3											
CH-4										517	1.117
CH-5			43						43	1162	7.679
CH-6		86	43							947	5.564
CH-7											
CH-8										861	11.477
FH-1		43	43							732	20.611
FH-2									43	836	17.251
FH-3										904	36.843
FH-4										1938	10.549
FH-5					43					387	1.674
FH-6						43				172	0.637
FP-1										129	0.808
FP-2		129							43	1582	9.597
FP-3		43							43	1292	19.950
FP-4		86							302	3574	44.949
FP-5		172							172	1162	28.054
FP-6									129	1335	30.243
FP-7		43								2325	10.229
FP-8		172			43	43			397	1850	28.268
FP-9		43							86	1550	12.438
FP-10									86	3487	28.360
FP-11										3014	33.713
FP-12		86							86	1981	15.936
FP-13		86							129	3272	30.153
FP-14									43	4865	34.032
FP-15		86							172	2238	13.354
FP-16									43	947	16.509
FP-17										1204	18.287
FP-18	43								43	473	18.819
FP-19	86								43	1722	39.320
FP-20	43									2282	10.211

Chip = Chironominae pupae
Chir = *Chironomus* sp.
Crch = *Cryptochironomus* sp.
Einf = *Einfeldia* sp.
Endo = *Endochironomus* sp.
Poly = *Polypedilum* sp.
Phys = *Physa* sp.
Ambl = *Amblema* sp.
Spha = Sphaeridae

Blank spaces indicate no organisms present in the sample.

APPENDIX III

Number of benthic macroinvertebrates/m^2 of each taxon at each station in Navigation Pool No. 18, Illinois, on July 26, 1978.

Station	Nema	Olig	Hiru	Asel	Hyal	Siph	Hept	Caen	Pota	Hexa	Haeg	Trip
BP-1a		884								625		
BP-1b		3470								539		
BP-1c		1552								388		
BP-1d		388								43		
BP-3a		1767								45		
BP-3b		1530								151		
BP-3c		4331								409		
BP-3d		1724			22					690		
BP-5a		582		22						410		
BP-5b		129								302		
BP-5c					22					453		
BP-5d		302								733		
BP-7a		45								45		
BP-7b		45								453		
BP-7c		1358	22							711		
BP-7d		1142								754		
BP-9a		22								45		
BP-9b		431								208		
BP-9c		797								754		
BP-9d		151								647		
CH-1		1099						129		129		
CH-2		1056										
CH-3		604										
CH-4		668										
CH-5		45				45	22		108	172		
CH-6		45										
CH-7		65										
CH-8												
FH-1		108						22		65		
FH-2										216		
FH-3		86								237		
FH-4				22						884		
FH-5		43	22									
FH-6		129								151		
FP-1		302						22		862		
FP-2		65								496		
FP-3		308								366	22	
FP-4		108						22		259		
FP-5		129								797		
FP-6		86								237		
FP-7		2069								560		
FP-8		86								539		
FP-9		1197								453		
FP-10		280						45		345		
FP-11		1142								754		
FP-12		65						22		474		
FP-13		45						45		907		
FP-14		172								45		
FP-15												
FP-16		345								517		
FP-17	22	108								582		
FP-18		129								388		
FP-19		151								237		
FP-20										431		22

Nema = Nematoda
Olig = Oligochaeta
Hiru = Hirudinea
Asel = *Asellus* sp.
Hyal = *Hyallela* sp.
Siph = Siphlonuridae
Hept = Heptageniidae
Caen = *Caenis* sp.
Pota = *Potamanthus* sp.
Hexa = *Hexagenia* sp.
Haeg = *Haegenius* sp.
Trip = Trichoptera pupae

Blank spaces indicate no organisms present in the sample.

APPENDIX III (Cont.)

Station	Hydp	Cheu	Hydr	Lepp	Nymp	Palp	Tanp	Clin	Coel	Tany	Abla	Chir
BP-1a										65	280	151
BP-1b						22				86	194	45
BP-1c						172				22		194
BP-1d						22					43	65
BP-3a												22
BP-3b						45				108	86	22
BP-3c						86					302	151
BP-3d						108				22	496	194
BP-5a						108				216	108	259
BP-5b						129			22			22
BP-5c						151					108	86
BP-5d						65		26			216	65
BP-7a						45					108	22
BP-7b											582	
BP-7c						45					323	22
BP-7d						129				62	345	215
BP-9a						22					65	194
BP-9b						22					86	65
BP-9c						172					108	45
BP-9d											172	496
CH-1												45
CH-2						22						
CH-3												
CH-4												
CH-5	237	1379	194					22				
CH-6												
CH-7												
CH-8												
FH-1		22	22								22	
FH-2									22			
FH-3						22						
FH-4											259	22
FH-5												
FH-6				22								
FP-1												
FP-2							43				129	
FP-3						45					86	65
FP-4						22					86	
FP-5											259	
FP-6							22				45	22
FP-7									22		280	
FP-8					22						86	
FP-9						22					129	
FP-10						22					194	
FP-11						22					431	22
FP-12											172	
FP-13						22			22		22	
FP-14											22	
FP-15												
FP-16						45					129	22
FP-17										22	108	
FP-18									129		45	
FP-19											22	
FP-20									409		108	

Hydp = Hydropsychidae pupae
Cheu = *Cheumatopsyche* sp.
Hydr = *Hydropsyche* sp.
Lepp = Leptoceridae pupae
Nymp = *Nymphula* sp.
Palp = *Palpomyia* sp.
Tanp = Tanypodinae pupae
Clin = *Clinotanypus* sp.
Coel = *Coelotanypus* sp.
Tany = *Tanypus* sp.
Abla = *Ablabesmyia* sp.
Chir = *Chironomus* sp.

Blank spaces indicate no organisms present in the sample.

APPENDIX III (Cont.)

Station	Crch	Crcl	Einf	Poly	Tnta	Epoi	Eusi	Phys	Trun	Spha	Standing crop (#/m^2)	biomass (g/m^2)
BP-1a				43						194	2285	46.092
BP-1b										129	4483	51.269
BP-1c										129	2522	14.856
BP-1d				22		22					604	6.593
BP-3a	22							22		108	1983	35.151
BP-3b	22									108	2177	26.924
BP-3c	45	65								172	6164	74.077
BP-3d		65								43	3707	55.960
BP-5a		45		22		22				65	1940	40.972
BP-5b											646	30.089
BP-5c										970	1810	58.597
BP-5d								22		43	1487	47.407
BP-7a											259	8.819
BP-7b										151	1315	43.456
BP-7c										474	3082	70.846
BP-7d	26										2780	62.404
BP-9a											560	21.579
BP-9b											991	30.226
BP-9c	22					22				22	2026	56.005
BP-9d											1465	70.644
CH-1								22		366	1789	18.191
CH-2										22	1121	4.837
CH-3				22						22	647	1.259
CH-4	22										690	3.889
CH-5				410	45		22			45	2759	12.930
CH-6	22										65	0.194
CH-7										22	108	0.148
CH-8	22			86						45	151	1.766
FH-1			22							151	453	7.306
FH-2										237	453	24.884
FH-3										345	690	17.387
FH-4	22									45	1250	61.743
FH-5										65	108	3.447
FH-6				22							345	0.540
FP-1										388	1595	4.683
FP-2										129	841	51.764
FP-3	22			22						207	1250	31.159
FP-4		22								388	905	22.503
FP-5										991	2198	79.510
FP-6		22								302	733	24.048
FP-7										108	3039	52.071
FP-8		22								108	884	42.046
FP-9										323	2842	66.149
FP-10		65								129	1164	22.172
FP-11	45					22				86	2521	50.255
FP-12				22						249	1056	28.672
FP-13									22	474	1616	25.957
FP-14										410	690	18.587
FP-15												
FP-16										410	1509	52.463
FP-17										797	1681	84.076
FP-18						22				604	1271	50.894
FP-19										733	1229	42.315
FP-20										690	1660	73.102

Crch = *Cryptochironomus* sp.
Crcl = *Cryptocladopelma* sp.
Einf = *Einfeldia* sp.
Poly = *Polypedilum* sp.
Tnta = *Tanytarsus* sp.
Epio = *Epoicocladius* sp.
Eusi = *Eusimulium* sp.
Phys = *Physa* sp.
Trun = *Truncilla* sp.
Spha = Sphaeridae

Blank spaces indicate no organisms present in the sample.

APPENDIX IV

Number of benthic macroinvertebrates/m^2 of each taxon at each station in Navigation Pool No. 18, Illinois on June 13, 1979.

Station	Nema	Olig	Hiru	Asel	Hyal	Brac	Caen	Hexa	Odon	Enal	Isch	Arig	Corn
BP-1a		65	43					108					
BP-1b		1184						926					
BP-1c		1399						474					
BP-1d		581		22			108	22		22			
BP-3a		818						129					22
BP-3b		1162											
BP-3c		1765											
BP-3d		43											
BP-5a													
BP-5b		646					22	43		22			
BP-5c		818						22					
BP-5d		323	86					43					
BP-7a			301		22		43						
BP-7b		344											
BP-7c		65	108										
BP-7d		108	151		65								
BP-9a		22	301	237	215		22			43	65		
BP-9b		452	301						22				
BP-9c		732	323										
BP-9d		22	237		22								
CH-1		495											
CH-2		237											
CH-3													
CH-4		172											
CH-5	22	495											
CH-6		280											
CH-7		43										22	22
CH-8						43		22					
FH-1		86											
FH-2		43						194					
FH-3		366						129					
FH-4		1206			22			172					
FH-5		86					22	108					
FH-6		108	86										
FP-1		65					22	43					
FP-2		861											
FP-3		108				22		609					
FP-4		1098						452					
FP-5		732						495					
FP-6	151	43											
FP-7		215	22					22					
FP-8		495	22			86		151					
FP-9		603	22					65					
FP-10								926					
FP-11		517						258					
FP-12		904						86					
FP-13		388						172					
FP-14		366						86					
FP-15		301						151					
FP-16		65						108					
FP-17		560						258					
FP-18		22	22					43					
FP-19		926						43					
FP-20		194											

Nema = Nematoda
Olig = Oligochaeta
Hiru = Hirudinea
Asel = *Asellus* sp.
Hyal = *Hyallela* sp.
Brac = *Brachycercus* sp.
Caen = *Caenis* sp.
Hexa = *Hexagenia* sp.
Odon = Odonata nymph
Enal = *Enallagma* sp.
Isch = *Ischnura* sp.
Arig = *Arigonphus* sp.
Corn = Corixidae nymph

Blank spaces indicate no organisms present in the sample.

APPENDIX IV (Cont.)

Station	Cori	Cyrn	Neur	Hydp	Cheu	Hydr	Stac	Oece	Lepp	Pelt	Gyri	Sten	Palp
BP-1a					431								
BP-1b													
BP-1c													
BP-1d		22	86									43	
BP-3a													
BP-3b													
BP-3c													
BP-3d					538								
BP-5a													
BP-5b	22	22											
BP-5c													43
BP-5d													
BP-7a											22		
BP-7b													22
BP-7c													
BP-7d							43	22					
BP-9a					22		22		22		43		
BP-9b	22				22					22			22
BP-9c													
BP-9d													
CH-1													
CH-2													
CH-3													
CH-4						948							
CH-5				22									
CH-6													
CH-7													
CH-8						581							
FH-1													
FH-2													
FH-3						22							
FH-4													
FH-5						151							22
FH-6				22		1421							22
FP-1													
FP-2													
FP-3						43							
FP-4						22							
FP-5													
FP-6													
FP-7													
FP-8													
FP-9													
FP-10													43
FP-11													
FP-12													
FP-13		22											
FP-14													
FP-15													
FP-16													
FP-17													
FP-18													
FP-19													
FP-20													

Cori = Corixidae
Cyrn = *Cyrnellus* sp.
Neur = *Neureclipsis* sp.
Hydp = Hydropsychidae pupae
Cheu = *Cheumatopsyche* sp.
Hydr = *Hydropsyche* sp.
Stac = *Stactobiella* sp.
Oece = *Oecetis* sp.
Lepp = Lepidoptera pupae
Pelt = *Peltodytes* sp.
Gyri = *Gyrinus* sp.
Sten = *Stenelmis* sp.
Palp = *Palpomyia* sp.

Blank spaces indicate no organisms present in the sample.

APPENDIX IV (Cont.)

Station	Tanp	Clin	Coel	Tany	Proc	Abla	Arct	Conc	Lars	Rheo	Chip	Chir	Crch
BP-1a				43	65							43	
BP-1b						65							
BP-1c		22				151							
BP-1d							22	22		22		22	43
BP-3a		22		22	43	151						108	22
BP-3b		43		86	86								
BP-3c		65		65	151								22
BP-3d													
BP-5a			22	43	22	22			43			237	65
BP-5b		22		22	129	22						151	
BP-5c				65		22			22				
BP-5d				86	65	43						65	
BP-7a													
BP-7b	22	43		22		172						194	
BP-7c				22	22	43						151	22
BP-7d		65			43								22
BP-9a											86	409	
BP-9b												86	22
BP-9c												215	65
BP-9d				22								22	
CH-1													43
CH-2													
CH-3													
CH-4													43
CH-5													108
CH-6													
CH-7													
CH-8													
FH-1			43										
FH-2						65							22
FH-3			129			22							43
FH-4			22			108						22	
FH-5									22				43
FH-6			22										22
FP-1													22
FP-2													65
FP-3						43							22
FP-4		22				65							43
FP-5		43				65							22
FP-6			22			22							
FP-7													22
FP-8		108				22							22
FP-9		86							22				
FP-10	22					129							
FP-11	22					65							65
FP-12													
FP-13		22							86		22		
FP-14													
FP-15						86							
FP-16			22			22							
FP-17		43							22				
FP-18													
FP-19		65											22
FP-20		43				22							43

Tanp = Tanypodinae pupae
Clin = *Clinotanypus* sp.
Coel = *Coelotanypus* sp.
Tany = *Tanypus* sp.
Proc = *Procladius* sp.
Alab = *Ablabesmyia* sp.
Arct = *Arctopelopia* sp.
Conc = *Conchapelopia* sp.
Lars = *Larsia* sp.
Rheo = *Rheopelopia* sp.
Chip = Chironominae pupae
Chir = *Chironomus* sp.
Crch = *Cryptochironomus* sp.

Blank spaces indicate no organisms present in the sample.

APPENDIX IV (Cont.)

Station	Crcl	Dicr	Einf	Endo	Glyp	Prch	Phae	Poly	Pseu	Prtn	Cric	Simu	Pulm
BP-1a													
BP-1b													
BP-1c													
BP-1d								517				22	
BP-3a		22											
BP-3b													
BP-3c													
BP-3d													
BP-5a													
BP-5b							22						
BP-5c													
BP-5d													
BP-7a	22	22			22		22						
BP-7b													
BP-7c				22									
BP-7d								22			22		
BP-9a		366	215	215		43		22	65	151	22		65
BP-9b		43						22					
BP-9c		65									22		
BP-9d													
CH-1													
CH-2													
CH-3													
CH-4								22					
CH-5													
CH-6													
CH-7													
CH-8													
FH-1													
FH-2													
FH-3													
FH-4													
FH-5								22					
FH-6													
FP-1													
FP-2													
FP-3													
FP-4													
FP-5													
FP-6													
FP-7													
FP-8													
FP-9													
FP-10								22					
FP-11													
FP-12													
FP-13													
FP-14													
FP-15													
FP-16													
FP-17													
FP-18													
FP-19								22					
FP-20													

Crcl = *Cryptocladopelma* sp.
Dicr = *Dicrotendipes* sp.
Einf = *Einfeldia* sp.
Endo = *Endochironomus* sp.
Glyp = *Glyptotendipes* sp.
Prch = *Parachironomus*
Phae = *Phaenopsectra* sp.
Poly = *Polypedilum* sp.
Pseu = *Pseudochironomus* sp.
Prtn = *Paratanytarsus* sp.
Cric = *Cricotopus* sp.
Simu = *Simulium* sp.
Pulm = Pulmonata

Blank spaces indicate no organisms present in the sample.

APPENDIX IV (Cont.)

Station	Phys	Gyra	Ferr	Unio	Prop	Lamp	Lasm	Anad	Spha	Standing crop #/m^2	biomass g/m^2
BP-1a									108	475	3.226
BP-1b				43					237	2455	8.758
BP-1c								22	301	2369	10.982
BP-1d	129									2242	2.274
BP-3a									366	1725	14.652
BP-3b									1400	2777	7.100
BP-3c										2090	14.460
BP-3d									22	65	1.601
BP-5a										734	4.103
BP-5b									43	1188	8.736
BP-5c										1057	8.210
BP-5d									151	862	4.707
BP-7a										476	2.285
BP-7b										754	2.622
BP-7c										498	2.487
BP-7d										563	2.340
BP-9a	323	43	43							3039	6.357
BP-9b										1036	2.820
BP-9c										1422	8.776
BP-9d										325	0.562
CH-1										538	1.154
CH-2										237	0.322
CH-3						22				22	2.321
CH-4									22	1250	1.538
CH-5										625	0.745
CH-6										280	0.426
CH-7									22	130	0.845
CH-8					43				237	970	6.240
FH-1									22	151	0.748
FH-2										324	1.885
FH-3									22	733	3.028
FH-4										1530	10.740
FH-5									431	929	6.369
FH-6									215	1918	3.144
FP-1									1141	1724	9.003
FP-2									22	1077	4.046
FP-3									237	1084	9.237
FP-4									387	2089	11.056
FP-5									237	1594	9.787
FP-6									22	281	1.047
FP-7										281	0.584
FP-8				43					732	1660	13.257
FP-9					22					820	12.178
FP-10									65	1229	10.860
FP-11									43	905	9.231
FP-12									172	1162	10.420
FP-13									188	943	5.390
FP-14									259	733	7.888
FP-15					22				947	1529	13.400
FP-16									151	368	2.723
FP-17									130	1013	6.474
FP-18									129	216	1.986
FP-19										1078	4.519
FP-20							22		43	390	10.038

Phys = *Physa* sp.
Gyra = *Gyraulus* sp.
Ferr = *Ferrissia* sp.
Unio = Unionidae
Prop = *Proptera* sp.
Lamp = *Lampsilis* sp.
Lasm = *Lasmigona* sp.
Anad = *Anadonta* sp.
Spha = Sphaeridae

Blank spaces indicate no organisms present in the sample.

APPENDIX V

Number of benthic macroinvertebrates/m^2 of each taxon at each station in Navigation Pool No. 18, Illinois on August 5, 1980.

Station	Nema	Olig	Helo	Hexa	Drom	Buen	Cheu	Chau	Sten	Tipu	Chao	Palp	Chrd	Coel	Tany
BP-1a		388		43										22	237
BP-1b		452		538											151
BP-1c		1399		474											
BP-1d		1399													43
BP-3a		1163		22											323
BP-3b		474		43											194
BP-3c		7169				22									
BP-3d															
BP-5a															
BP-5b		2949				22									
BP-5c		6695													
BP-5d															
BP-7a															
BP-7b															
BP-7c															
BP-7d															
BP-9a															
BP-9b															
BP-9c															
BP-9d															
CH-1		710			22										
CH-2		43		22											
CH-3		86		366				22						86	301
CH-4		215		22							22				43
CH-5		194		22										22	22
CH-6		1077		22						22					151
CH-7		22		22											43
CH-8		581													22
FH-1		452									22				947
FH-2		667		194										43	1485
FH-3		689		43		65									753
FH-4		603		65										43	474
FH-5									172			22			65
FH-6		43					65		194			22			
FP-1		215		107										43	280
FP-2		387		280			22				22			43	1442
FP-3				22											108
FP-4	22	172		129	22				22					43	624
FP-5		129		129											86
FP-6		108		215											86
FP-7		65		129							22			86	1012
FP-8		108		129											280
FP-9		215		22	22							43		22	840
FP-10		65	22								43			22	258
FP-11		1055				194						22			86
FP-12		689		22		22								22	1399
FP-13		108		215		22									1270
FP-14		151		108							22			65	1399
FP-15															
FP-16		172		43									22		301
FP-17	22	538		22		22						22		43	215
FP-18		258		43										108	409
FP-19		495		43		22								43	495
FP-20		366		43		22					22				323

Nema = Nematoda
Olig = Oligochaeta
Helo = *Helobdella* sp.
Hexa = *Hexagenia* sp.
Drom = *Dromogomphus* sp.
Buen = *Buenoa* sp. adult
Cheu = *Cheumatopsyche* sp.
Chau = *Chauloides* sp.
Sten = *Stenelmis* sp.
Tipu = Tipulidae larvae
Chao = *Chaoborus* sp.
Palp = *Palpomyia* sp.
Chrd = Chironomidae pupae
Coel = *Coelotanypus* sp.
Tany = *Tanypus* sp.

Blank spaces indicate no organisms present in the sample.

APPENDIX V (Cont.)

Station	Proc	Abla	Chir	Chrp	Crch	Glyp	Poly	Plyp	Smit	Mscd	Quad	Spha	Standing crop #/m^2	biomass (g/m^2)
BP-1a		22											712	5.311
BP-1b		43										65	1249	9.792
BP-1c		22											1895	7.653
BP-1d													1442	2.848
BP-3a												43	1551	11.537
BP-3b												22	733	7.760
BP-3c													7191	44.633
BP-3d														
BP-5a														
BP-5b													2971	22.875
BP-5c										22			6717	21.643
BP-5d														
BP-7a														
BP-7b														
BP-7c														
BP-7d														
BP-9a														
BP-9b														
BP-9c														
BP-9d														
CH-1			22	22	86								862	10.859
CH-2			43		22		22						152	0.120
CH-3			22										883	7.301
CH-4					22								324	0.689
CH-5							43	22					325	0.399
CH-6					22							22	1316	2.836
CH-7					22								109	0.099
CH-8													603	0.672
FH-1	22												1443	2.354
FH-2	22		22									65	2498	15.190
FH-3	65											22	1637	4.844
FH-4	22				43							194	1444	8.863
FH-5	22		65			22							368	0.799
FH-6			172				43						539	1.148
FP-1					43		65						753	1.406
FP-2		107			22							22	2347	9.792
FP-3												22	152	0.882
FP-4											22		1056	4.385
FP-5												43	387	8.885
FP-6		22										129	560	13.315
FP-7		22							22			65	1423	11.390
FP-8		43							22				582	7.395
FP-9		65							22			22	1273	6.447
FP-10		22			22								454	0.479
FP-11													1357	15.545
FP-12													2154	15.108
FP-13	22				43		22		22			194	2308	22.593
FP-14	22				22							65	1854	11.343
FP-15														
FP-16		22										22	582	4.952
FP-17		22			22							22	972	5.546
FP-18												86	904	3.629
FP-19		43										86	1227	4.544
FP-20		22	22								22	172	1014	7.530

Proc = *Procladius* sp.
Abla = *Ablabesmyia* sp.
Chir = *Chironomus* sp.
Chrp = *Chironomus* sp. pupae
Crch = *Cryptochironomus* sp.
Glyp = *Glyptotendipes*
Poly = *Polypedilum* sp.
Plyp = *Polypedilum* sp. pupae
Smit = *Smittia* sp.
Mscd = Muscidae larvae
Quad = *Quadrula* sp.
Spha = Sphaeridae

Blank spaces indicate no organisms present in the sample.

APPENDIX VI

Vascular plant flora within and adjacent to the Burnt Pocket Study Site, Navigation Pool No. 18, Illinois, during 1978.

ACERACEAE	
Acer saccharinum L.	Silver Maple
ALISMATCEAE	
Sagittaria latifolia Willd.	Common Arrowleaf
ANACARDIACEAE	
Toxicodendron radicans (L.) Kuntze	Poison Ivy
ASCLEPIADACEAE	
Asclepias incarnata L.	Swamp Milkweed
ASTERACEAE	
Solidago gigantea Ait.	Late Goldenrod
BETULACEAE	
Betula nigra L.	River Birch
BIGNONIACEAE	
Catalpa speciosa Warder	Catalpa
CAMPANULACEAE	
Campanula uliginosa Rydb.	Marsh Bellflower
CAPRIFOLIACEAE	
Sambucus canadensis L.	Elderberry
CERATOPHYLLACEAE	
Ceratophyllum demersum L.	Coontail
CHENOPODIACEAE	
Salsola kali L. var. *tenuifolia* Tausch.	Russian Thistle
CONVOLVULACEAE	
Convolvulus sepium L.	American Bindweed

APPENDIX VI (Cont.)

CORNACEAE	
Cornus obliqua Raf.	Pale Dogwood
FABACEAE	
Amorpha fruticosa L.	False Indigo
Gleditsia triacanthos L.	Honey Locust
Gymnocladus dioica (L.) K. Koch	Kentucky Coffee-Tree
Robinia pseudoacacia L.	Black Locust
FAGACEAE	
Quercus macrocarpa Michx.	Bur Oak
Quercus palustris Muenchh.	Pin Oak
JUGLANDACEAE	
Carya laciniosa (Michx.) Loud.	Kingnut Hickory
Carya tomentosa (Poir.) Nutt.	Mockernut Hickory
LAMIACEAE	
Lycopus americanus Muhl.	Water Horehound
Scutellaria lateriflora L.	Skullcap
Stachys hispida Pursh	Hedge Nettle
LEMNACEAE	
Lemna minor L.	Duckweed
MALVACEAE	
Hisbiscus militaris Cav.	Halberd-Leaved Rose Mallow
MENISPERMACEAE	
Menispermum canadense L.	Moonseed
MORACEAE	
Morus alba L.	White Mulberry
Morus rubra L.	Red Mulberry

APPENDIX VI (Cont.)

NELUMBONACEAE	
Nelumbo lutea (Willd.) Pers.	American Lotus
NYMPHACEAE	
Nymphaea tuberosa Paine	White Water Lily
OLEACEAE	
Fraxinus pennsylvanica Marsh. var. *subintegerrima* (Vahl) Fern.	Green Ash
PHYTOLACCACEAE	
Phytolacca americana L.	Pokeweed
PLATANACEAE	
Platanus occidentalis L.	Sycamore
POACEAE	
Leersia oryzoides (L.) Sw.	Rice Cutgrass
POLYGONACEAE	
Polygonum amphibium L.	Water Smartweed
POTAMOGETONACEAE	
Potamogeton crispus L.	Curly Pondweed
Potamogeton nodosus Poir.	Pondweed
Potamogeton pectinatus L.	Fennel-Leaved Pondweed
RHAMNACEAE	
Rhamnus catharticus L.	Buckthorn
RUBIACEAE	
Ceplalanthus occidentalis L.	Buttonbush
SALICACEAE	
Salix interior Rowlee	Sandbar Willow
Salix nigra Marsh.	Black Willow
Populus deltoides Marsh.	Cottonwood

APPENDIX VI (Cont.)

SCROPHULARIACEAE	
Veronicastrum virginicum (L.) Farw.	Culver's Root
SMILACACEAE	
Smilax glauca Walt.	Catbrier
Smilax hispida Muhl.	Bristly Catbrier
TYPHACEAE	
Typha latifolia L.	Common Cattail
ULMACEAE	
Celtis occidentalis L.	Hackberry
Ulmus rubra Muhl.	Slippery Elm
Ulmus americana L.	American Elm
URTICACEAE	
Boehmeria cylindrica (L.) Sw.	False Nettle
Laportea canadensis (L.) Wedd.	Wood Nettle
Uritca dioica L.	Stinging Nettle
VITACEAE	
Vitis aestivalis Michx.	Summer Grape
Vitis palmata Vahl.	Catbird Grape
Vitis riparia Michx.	Riverbank Grape

APPENDIX VII

Vascular plant flora of major habitat types (woodland, shore, aquatic) within the Burnt Pocket Study Site, Navigation Pool No. 18, Illinois, during 1978. The flora are arranged according to growth forms within each habitat type.

WOODLAND FLORA

Trees

*Acer saccharinum L.	Silver Maple
Betula nigra L.	River Birch
Catalpa speciosa Warder	Catalpa
Gledtsia triacanthos L.	Honey Locust
Gymnocladus dioica (L.) K. Koch.	Kentucky Coffee-Tree
Quercus macrocarpa Mich.	Bur Oak
Quercus palustris Muenchh.	Pin Oak
Robinia pseudoacacia L.	Black Locust
Carya laciniosa (Michx.) Loud.	Kingnut Hickory
Carya tomentosa (Poir.) Nutt.	Mockernut Hickory
Morus rubra L.	Red Mulberry
Fraxinus pennsylvanica Marsh. var. subintegerrima (Vahl) Fern.	Green Ash
Platanus occidentalis L.	Sycamore
Salix nigra Marsh.	Black Willow
Populus deltoides Marsh.	Cottonwood
Celtis occidentalis L.	Hackberry
Ulmus rubra Muhl.	Slippery Elm
Ulmus americana L.	American Elm

*Dominant or most abundant species in each habitat/growth form

APPENDIX VII (Cont.)

Shrubs

*Cephalanthus occidentalis L.	Buttonbush
Cornus obliqua Raf.	Pale Dogwood
Morus alba L.	White Mulberry
Rhamnus cathartica L.	Buckthorn
Sambucus canadensis L.	Elderberry

Vines

Menispermum canadense L.	Moonseed
Smilax glauca Walt.	Catbrier
Smilax hispida Muhl.	Bristly Catbrier
*Vitis aestivalis Michx.	Summer Grape
Vitis palmata Vahl.	Catbird Grape
*Vitis riparia Michx.	Riverbank Grape
*Toxicodendron radicans (L.) Kuntze	Poison Ivy

Herbs

Campanula uliginosa Rydb.	Marsh Bellflower
Phytolacca americana L.	Pokeweed
*Toxicodendron radicans (L.) Kuntze	Poison Ivy
Veronicastrum virginicum (L.) Farw.	Culver's Root
Boehmeria cylindrica (L.) Sw.	False Nettle
Laportea canadensis (L.) Wedd.	Wood Nettle
Urtica dioica L.	Stinging Nettle

SHORE FLORA

Trees

Salix nigra Marsh.	Black Willow

APPENDIX VII (Cont.)

Shrubs

Salix interior Rowlee	Sandbar Willow
Amorpha fruticosa L.	False Indigo
**Cephalanthus occidentalis* L.	Buttonbush

Vines

**Toxicodendron radicans* (L.) Kuntze	Poison Ivy
Convolvulus sepium L.	American Bindweed

Herbs

Asclepias incarnata L.	Swamp Milkweed
**Toxicodendron radicans* (L.) Kuntze	Poison Ivy
Boehmeria cylindrica (L.) Sw.	False Nettle
Solidago gigantea Ait.	Late Goldenrod
Salsola kali L. var. *tenufolia* Tausch.	Russian Thistle
Lycopus americanus Muhl.	Water Horehound
Scutellaria lateriflora L.	Skullcap
Stachys hispida Pursh	Hedge Nettle
Hibiscus militaris Cav.	Halberd-Leaved Rose Mallow
**Leersia oryzoides* (L.) Sw.	Rice Cutgrass
Polygonum amphibium L.	Water Smartweed

AQUATIC FLORA

Emmergent

**Nelumbo lutea* (Willd.) Pers.	American Lotus
**Sagittaria latifolia* Willd.	Common Arrowleaf
Nymphaea tuberosa Paine	White Water Lily

APPENDIX VII (Cont.)

Typha latifolia L.	Common Cattail

Floating

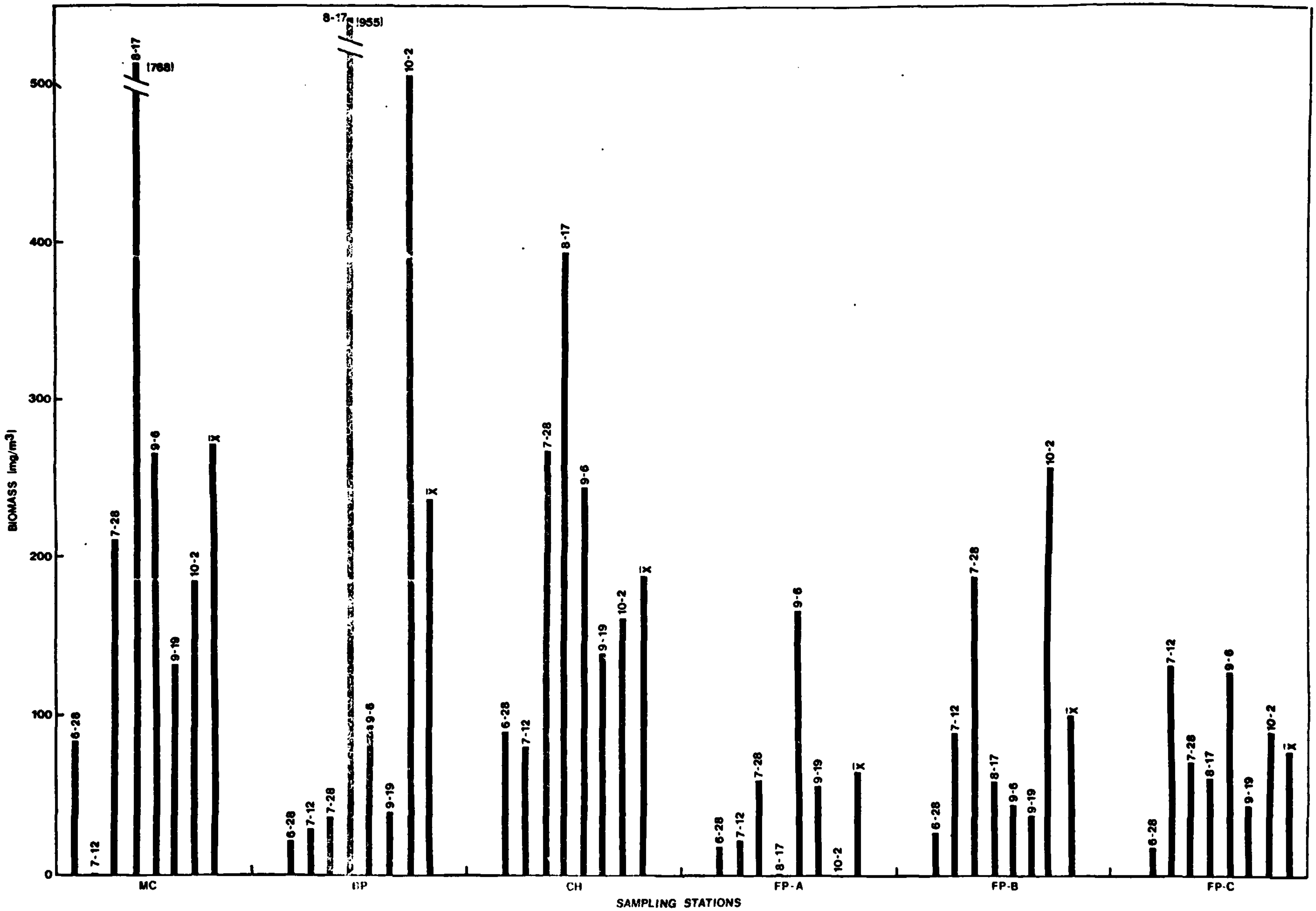
**Lemna minor* L.	Duckweed

Submerged

Ceratophyllum demersum L.	Coontail
Potamogeton crispus L.	Curly Pondweed
Potamogeton nodosus Poir.	Pondweed
**Potamogeton pectinatus* L.	Fennel-Leaved Pondweed

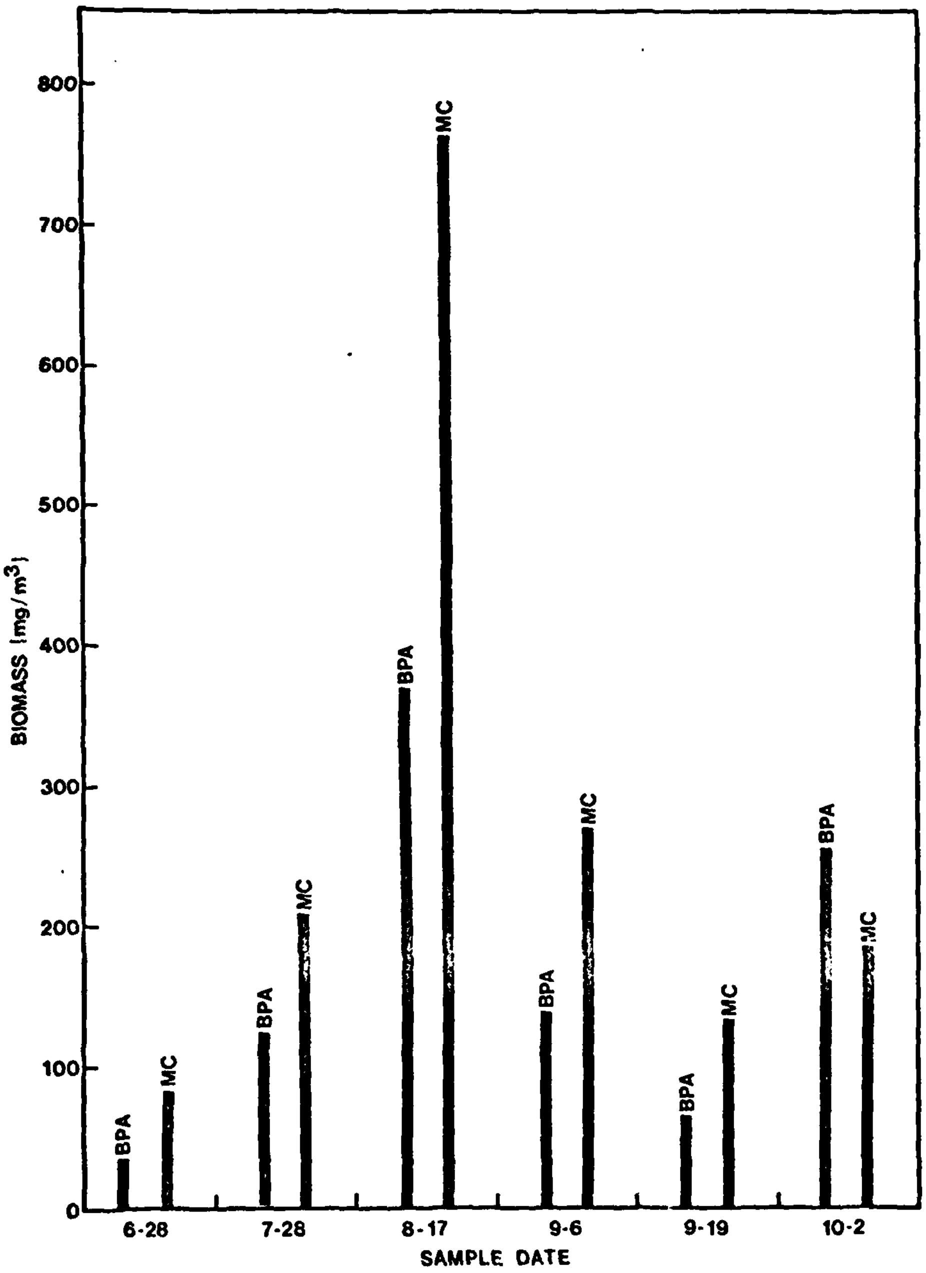
APPENDIX VIII. Zooplankton biomass in the Burnt Pocket Study Area during 1978 and 1980, Navigation Pool No. 18, Illinois. Comparisons between the study area and the main channel of the Mississippi are also given.

APPENDIX VIII - FIG. 1. Biomass (mg/m^3) of zooplankton at the sample stations on each sampling date and the mean biomass for each station in the Burnt Pocket Study Area, Navigation Pool No. 18, Illinois, during 1978.

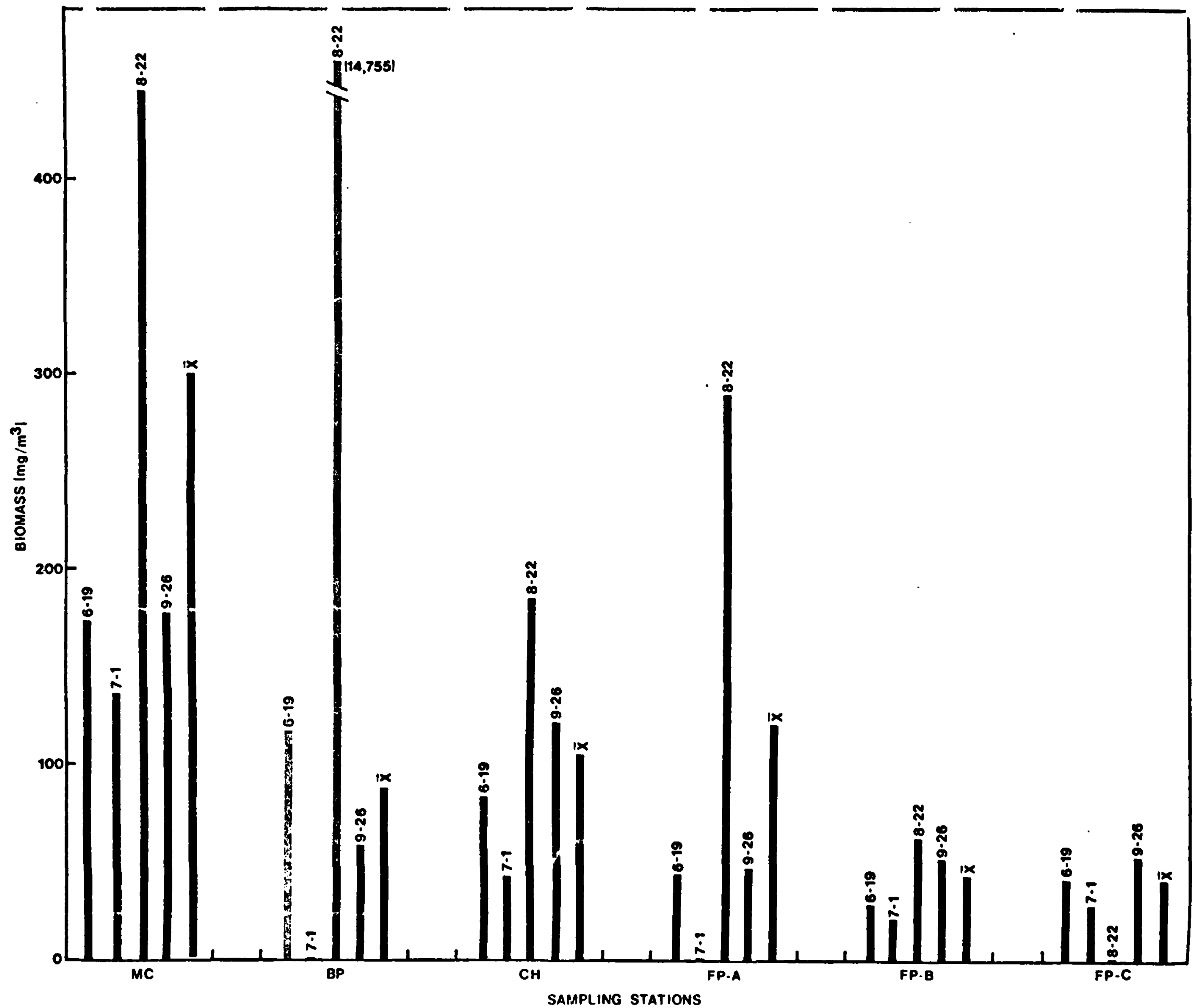


BIOMASS (mg/m3)
0
100
200
300
400
500
8-17 (768)
8-17 (955)
MC
BP
CH
FP-A
FP-B
FP-C
SAMPLING STATIONS

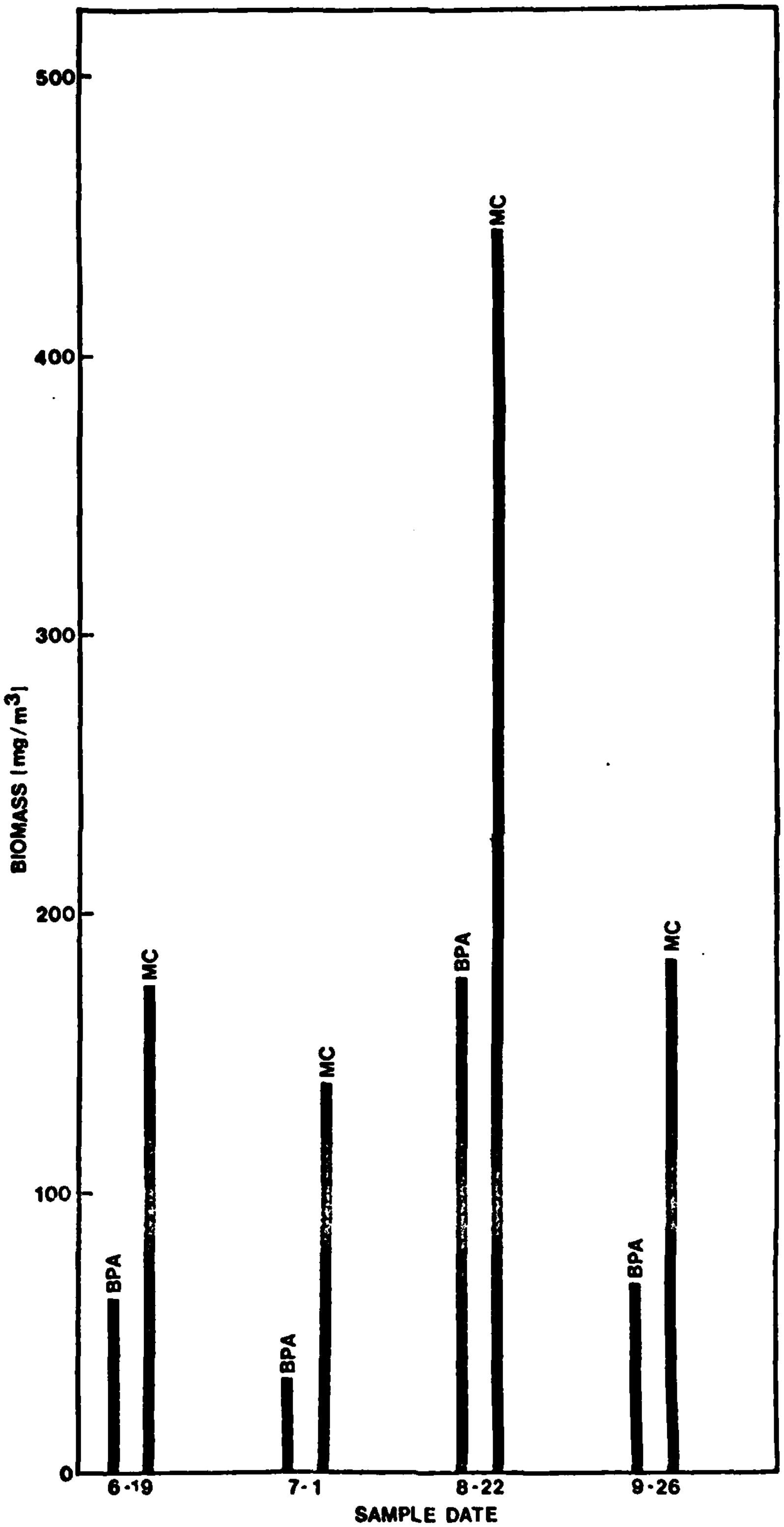
APPENDIX VIII - FIG. 2. Comparison of zooplankton biomass between the main channel of the Mississippi River and the Burnt Pocket Study Area, Navigation Pool No. 18, Illinois, during 1978.


BIOMASS (mg/m3)
800
700
600
500
400
300
200
100
0
BPA
MC
6-28
7-28
8-17
9-6
9-19
10-2
SAMPLE DATE

APPENDIX VIII - FIG. 3. Biomass (mg/m^3) of zooplankton at the sample stations on each sampling date and the mean biomass for each station in the Burnt Pocket Study Area, Navigation Pool No. 18, Illinois, during 1980.


BIOMASS (mg/m3)
0
100
200
300
400
SAMPLING STATIONS
MC
BP
CH
FP-A
FP-B
FP-C
6-19
7-1
8-22
9-26
X̄
(14,755)

APPENDIX VIII - FIG. 4. Comparison of zooplankton biomass between the main channel of the Mississippi River and the Burnt Pocket Study Area, Navigation Pool No. 18, Illinois, during 1980.



500
400
300
200
100
0
BIOMASS (mg/m3)
BPA
MC
6-19
7-1
8-22
9-26
SAMPLE DATE

APPENDIX IX

Relative abundance of Detritus and Algae in the Burnt Pocket Study Area, Navigation Pool 18, Illinois, 1978 and 1980. A = abundant; C = common; and R = rare.

Date	Detritus			Algae		
Station	A	C	R	A	C	R
6-26-78						
MC		x				x
BP			x			x
CH		x				x
FP-A			x			x
FP-B		x				x
FP-C		x				x
7-12-78						
MC (no sample)						
BP		x				x
CH		x				x
FP-A			x			x
FP-B			x			x
FP-C		x				x
7-28-78						
MC	x			x		
BP			x			x
CH		x			x	
FP-A			x		x	
FP-B		x			x	
FP-C		x			x	
8-14-78						
MC			x	x		
BP			x	x		
CH			x		x	
FP-A			x		x	
FP-B			x		x	
FP-C		x			x	

APPENDIX IX (Cont.)

Date Station	Detritus A	 C	 R	Algae A	 C	 R
9-6-78						
MC		x			x	
BP			x		x	
CH			x		x	
FP-A		x			x	
FP-B			x		x	
FP-C			x		x	
9-19-78						
MC	x				x	
BP			x		x	
CH		x			x	
FP-A			x		x	
FP-B			x		x	
FP-C			x		x	
10-2-78						
MC		x			x	
BP		x			x	
CH		x			x	
FP-A		x			x	
FP-B		x			x	
FP-C		x			x	
6-19-80						
MC		x				x
BP		x				x
CH		x				x
FP-A		x				x
FP-B		x				x
FP-C		x				x
7-1-80						
MC		x				x
BP (no sample)						
CH		x				x
FP-A		x				x
FP-B (no sample)						
FP-C		x				x

APPENDIX IX (Cont.)

Date	Detritus			Algae		
Station	A	C	R	A	C	R
8-22-80						
MC	x					x
BP	x					x
CH	x					x
FP-A		x				x
FP-B		x				x
FP-C (no sample)						
9-26-80						
MC	x					x
BP		x				x
CH		x				x
FP-A		x				x
FP-B		x				x
FP-C		x				x