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To provide data for design of field studies to determine the impacts and ecological value of the man-made habitats formed by dike and revetment structures in the Lower Mississippi River, the aquatic habitat of a 50-mile reach of the river (mile 480 to 530 Above Head of Passes, AHP) was quantitatively mapped to determine spatial relationships among and within habitat types as a function of river stage and discharge.

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20. ABSTRACT (Continued).

Twelve aquatic habitat types were defined within the study reach based on hydraulic, geomorphological, and ecological criteria: main channel, natural banks, revetted banks, sandbars, dike fields, permanent and temporary secondary channels, abandoned river channels (Types I and II), oxbow lakes, borrow pits, and inundated floodplain. By use of controlled aerial photography and hydrographic survey data, aquatic habitat surface acreages were computed for three river stages (low flow = +13.2 ft, medium flow = +24.6, and high flow = +38.4 ft on the Greenville, Mississippi, gage).

Results of the habitat mapping revealed a significant change in total aquatic habitat acreage with changes in river stage and discharge. At the low flow stage 18,581 acres of habitat were present. Habitat area increased to 29,020 acres at medium flow and rose to 56,902 acres for high flow--a total increase of 222 percent in area over low flow conditions. The main channel was the predominant habitat type during the low flow period, composing 45 percent of total habitat. Dike fields and the main channel were the most abundant habitat types at medium flow, making up 28 and 29 percent of total habitat, respectively. For the high flow period, inundated floodplain habitats were the most common habitats, comprising 27 percent of the total aquatic habitat. Variation in river stage and discharge caused a significant change in the spatial relationships among and within habitat types. The habitat mapping technique used in the studies was found to be a convenient and efficient technique to stratify large river systems for designing field sampling efforts for evaluating impacts of Corps flood control and navigation projects.

This is Report 2 of the series "Aquatic Habitat Studies on the Lower Mississippi River, River Mile 480 to 530." A complete listing of the reports is as follows:

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

PREFACE

The study reported herein was conducted as part of the Environmental and Water Quality Operational Studies (EWQOS), Project VIIB, Waterway Field Studies conducted by the Environmental Systems Division, Environmental Laboratory (EL), U. S. Army Engineer Waterways Experiment Station (WES). The EWQOS Program is sponsored by the Office, Chief of Engineers, and is assigned to WES under the purview of EL. This is Report 2 of the series "Aquatic Habitat Studies on the Lower Mississippi River, River Mile 480 to 530." The study was undertaken from April to October 1978.

The aquatic habitat mapping studies presented in this report were conducted by Messrs. Stephen P. Cobb and Jonathan R. Clark. Numerous other members of the Waterways Field Study Team at WES contributed to the conceptualization and conduct of the study. Principal among these were Messrs. David Mathis and Eugene Buglewicz and Drs. Harold Schramm, James Pennington, Michael Farrell, and A. Dale Magoun.

The study was directly supervised by Mr. Stephen Cobb and generally supervised by Dr. Walter B. Gallaher, former Chief, Waterway Habitat Monitoring Group (WHMG); Dr. Thomas D. Wright, Chief, WHMG; Mr. Bob Benn, Chief, Environmental Systems Division; Dr. Jerry Mahloch, Program Manager, EWQOS; and Dr. John Harrison, Chief, EL.

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

CONTENTS

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

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

Multiply	By	To Obtain
acres	4046.873	square metres
cubic feet per second	0.02831685	cubic metres per second
feet	0.3048	metres
miles (U. S. statute)	1.609347	kilometres
square feet	0.09290304	square metres

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

AQUATIC HABITAT MAPPING

PART I: INTRODUCTION

Background

1. From an ecological viewpoint, large alluvial rivers such as the Lower Mississippi River may be considered a mosaic of aquatic habitat types or geomorphological units. These habitats are formed and maintained in a dynamic equilibrium by fluvial processes--i.e., the interaction of water flow, sediment transport, and the geological features of the river valley. Although individual habitats are constantly being modified by the river's action, the various habitat types remain present in the system through long time periods. For instance, a particular middle bar (sandbar) may be formed and increase in size for a few years at one location and ther due to a change in hydraulic regime be eroded away with a new bar being formed elsewhere in the channel.

2. A more or less characteristic array of physical, chemical, and geological features is associated with each habitat type. Wide annual fluctuations in river stage and discharge generally cause pronounced seasonal variation in habitat characteristics. But the distinctiveness of a given habitat type is maintained temporally and is especially evident during low flow conditions.

3. The spatial distribution and abundance of many riverine species and assemblages are closely related to the distribution of habitat types. Thus, the fluvial processes that mold habitat types and characteristics can be considered the ultimate determinants of biological distribution patterns in the river ecosystem.

4. In the design of a field sampling program for a large alluvial river system, division of the ecosystem into habitat types is a useful initial step. This technique may be referred to as the "habitat

approach" and has been used in the Upper, Middle, and Lower Mississippi River.*

5. A sampling effort, for whatever purposes, can be stratified according to habitat. In high-order rivers, the large-scale and complex geomorphology adds emphasis and distinction to the many habitat types present. In the Lower Mississippi River, for instance, a sandbar can be several hundred acres** in surface area, while in a small, medium-order stream an analogous bar may be only a few hundred square feet in size.

Purpose and Scope

6. As part of the Environmental and Water Quality Operational Studies (EWQOS) being conducted by the U. S. Army Engineer Waterways Experiment Station (WES), the environmental effects of dike and revetment structures in the Lower Mississippi River are being investigated. The general objectives of the study are to determine the impacts of dikes and revetments and to obtain data on the ecological value of the riverine habitats formed by these structures. Dike and revetment structures and associated riverine areas were classified as man-made habitats for this study.

7. Maps of major aquatic habitat types in the study reach were prepared. The objective of habitat mapping was to determine the area

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* Sternberg, R. B. 1971. "Upper Mississippi River Habitat Classification Survey, Hastings, Minnesota to Alton, Illinois." Upper Mississippi River Conservation Committee, Fish Technical Section, St. Louis, Mo.

U. S. Army Engineer District, Vicksburg. 1976. "Final Environmental Impact Statement, Mississippi River and Tributaries, Mississippi River Levees and Channel Improvement," Vicksburg, Miss.

U. S. Army Engineer District, St. Louis. 1980. "Quantitative Report, Upper Mississippi River and Lower Illinois Rivers, Pools 24, 25, and 26, Terrestrial and Aquatic Land Use and Habitat Change as a Result of the Nine-Foot Channel Project," St. Louis, Mo.

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

and relative abundance of each habitat type and to document spatial relationships among and within habitat types as a function of river stage and discharge. Habitat mapping results and pilot survey data were used to select sampling locations and to design the field study proper. This report presents the results of the habitat mapping effort.

PART II: METHODS

Study Area

8. Aquatic habitats were mapped in a 50-mile reach of the Lower Mississippi River (Figure 1) between Lake Providence, Louisiana, and Greenville, Mississippi (river mile 480 to 530 Above Head of Passes, AHP). This reach encompasses two major bendway systems, Kentucky Bend and Opossum Chute. The river in the study area vicinity (Vicksburg, Mississippi, river mile 437) has an average discharge of about 561,000 cfs and may fluctuate as much as 40 ft in stage annually.* A 50-mile study reach was selected to obtain a realistic estimate of the average relative abundance of aquatic habitat types. Mapping a reach that was too short could result in a bias of spatial relationships among habitats if one large, but relatively uncommon habitat type (such as a large oxbow lake) occurred in the reach.

Habitat Definitions

9. The first step in habitat mapping was defining aquatic habitat types in a specific manner that could provide quantitative acreage measurements and that had ecological meaning. The classification system developed was based on a synthesis of ecological and basic river hydraulic considerations. For example, the distinction between a shallow water sandbar habitat and the adjacent main channel is clear from an ecological standpoint; however, the boundary between the two habitats was defined in terms of the hydraulic concepts of the main channel. Continuing studies will serve to establish the ecological integrity of the habitat definitions. Only general, qualitative habitat characteristics are presented herein. Data from the ongoing Waterway Field Studies will be used to refine and further quantify the habitat descriptions.

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* Mississippi River Commission. 1977. "Channel Improvement Feature, Flood Control, Mississippi River and Tributaries Project." Office of the President, Mississippi River Commission, Vicksburg, Miss.

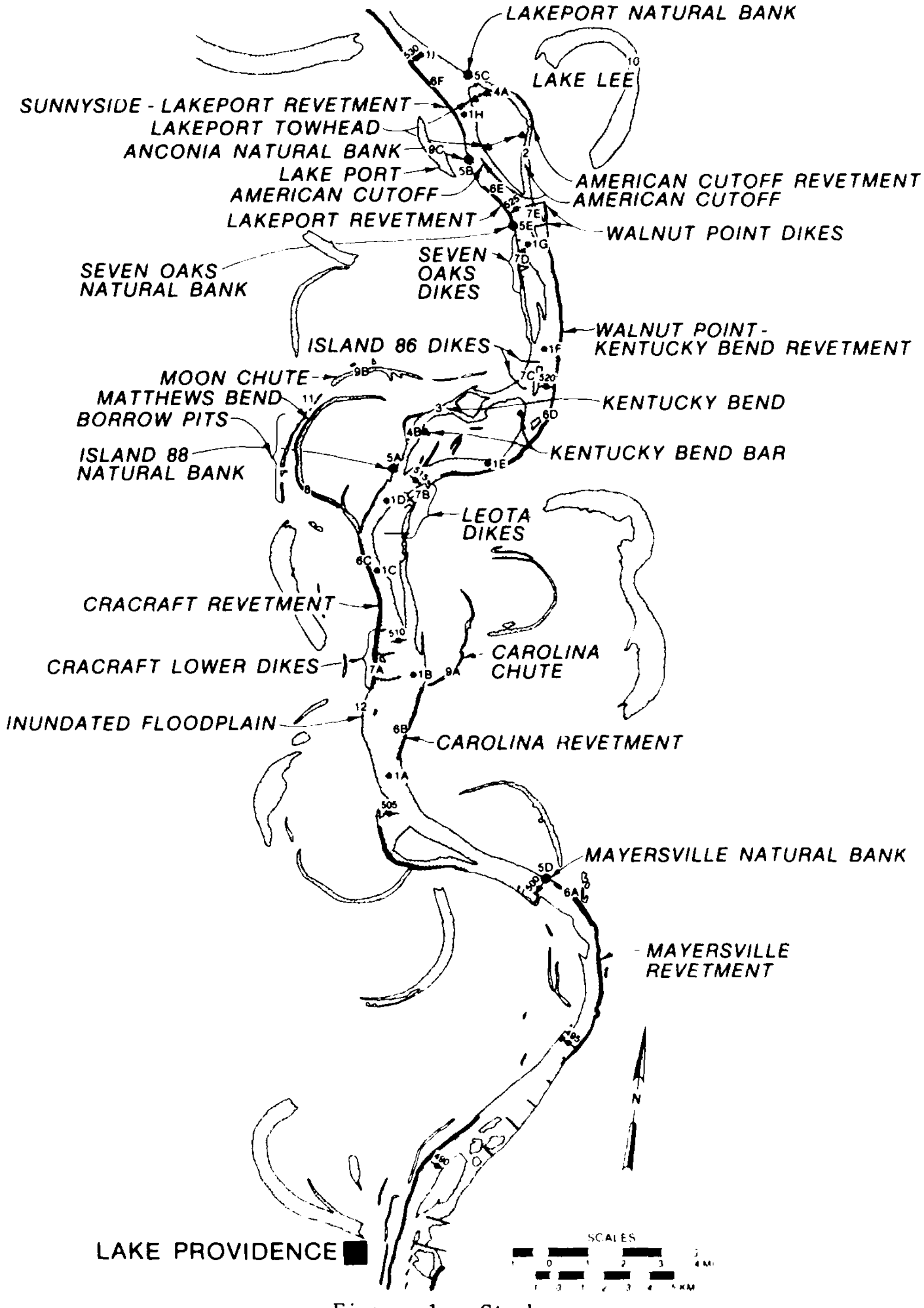

Figure 1. Study area

The descriptions provided, however, are based on pilot study observations of the biota and physical and chemical variables. All depth contours are in terms of the Low Water Reference Plane (LWRP). The LWRP is defined as the plane of the river stage elevation for the discharge that occurs 97 percent of the time based on a long period of record. The LWRP is arbitarily assigned an elevation value of 0 ft, and contours are referenced to this standard.

10. All aquatic habitats within the leveed floodplain were included in the mapping effort. Although floodplain habitats are isolated from the main channel during low flow conditions, they become confluent with the channel in periods of overbank flow and are an integral part of the river system. The 12 aquatic habitat types found in the study area (Figure 2) are defined as follows:

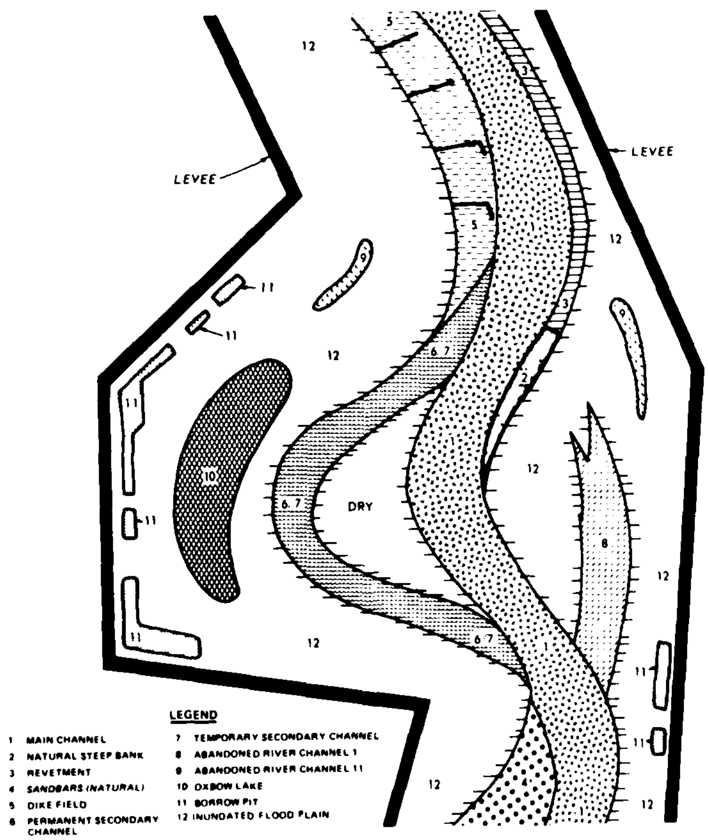

Figure 2. Schematic drawing of habitats sampled in Lower Mississippi River, 1978

a. Main channel. That portion of the river encompassing the thalweg and navigation channel and lying riverward of the minus 10-ft LWRP contour on the convex bank and the toe (typically the minus 30-ft contour) of the natural or revetted bank on the concave bank. Environmental conditions in the main channel are rigorous with strong current velocities and turbulence, deep water, shifting coarse sand and gravel sediments, and high turbidity.

b. Natural banks. This habitat consists of the inundated natural or unprotected banks of the main and secondary channels, except where sandbars occur. Natural banks are located on the concave side of bendways and in straight reaches. Banks are steep (slope usually >30 percent) and are comprised of consolidated clays and silts (clay plug and backswamp deposits) of low plasticity often interspersed with sand layers or point bar deposits. Natural banks extend from the edge of the water to the floor of the channel, typically the minus 30-ft contour. Most natural banks continually cave and erode, but rates vary widely depending on hydraulic and geological conditions. Fallen trees and snags are generally present. Currents are strong, approaching adjacent main channel velocities, but turbulence caused by bank friction and bank line irregularities is high; upstream flow and eddies are common. The water is highly turbid as in the thalweg.

c. Revetted banks. This habitat consists of riverbanks that have been stabilized with articulated concrete mattress (ACM) and riprap. Revetments serve in conjunction with dikes to maintain a desired channel alignment. Revetted banks are most common on the concave side of bendways, but are also used to stabilize banks in other locations as needed. Some revetments may be 8 miles or more in length, while other structures are less than 1 mile long. Current velocities are similar to those of the main channel, but flows are usually more streamlined than flows occurring along the more irregular natural banks. The concrete substrate and the interstices between the ACM and slabs constitute a unique environment for organisms in the river system. Coarse sand bed-load sediments from the main channel are often deposited on the lower part of the revetment, and finer suspended sediments may be found on the upper portions of a revetment, particularly in sheltered locations. Older revetments may be densely vegetated with willow and cottonwood stands and numerous species of herbs and forbs.

d. Sandbars and sandbar pools.

(1) Sandbars. Sandbars are relatively shallow habitats that gently slope toward the main channel and occur

as point bars on the convex side of bendways, on the borders of large islands, and in channel crossings. Current velocities are moderate to swift and sediments are composed of coarse sand occasionally mixed with gravel. The minus 10-ft contour (LWRP) is the offshore boundary of the sandbar habitat. Turbid main channel waters occur in the sandbar habitat. Accretion stands of sandbar willows and cottonwoods are often found along the shoreline of bars.

(2) Sandbar pools. Slack-water pools are found in swales on large sandbars and middle islands. This habitat is formed as waters are ponded in depressions on a sandbar, following the receding of high waters. These pools assume lentic conditions and rapidly clear up as suspended materials settle.

e. Dike fields. This habitat consists of the area influenced directly by the presence of impermeable stone dikes (Figure 2) of various designs. Dikes generally extend perpendicularly from the bank line toward the main channel and are placed on point bars and across secondary channels. These structures are used to constrict and scour the navigation channel and to stabilize banks. Within the study reach, large limestone rocks are the material from which dikes are constructed. The dike field habitat is complex, consisting of a mixture of several riverine habitat types on a comparatively small scale; conditions change markedly with river stage. Typically, a dike field consists of a shallow to deep channel or pool area adjacent to the bank, the natural bank, and a large sandbar on the channel side. The dike field pool may carry considerable flow when the river rises above the elevation of the dikes, but slackwater conditions are formed in the pool at low river stages (below the controlling elevation of the dikes). Current velocity may approach that of the adjacent main channel at peak flows. Sediments in the pool areas vary from coarse sands and gravel to fine unconsolidated silt-clay deposits in more sheltered areas. Sediment type may change with river stage due to the scouring action of the currents. Deep pools (plunge pools) are typically found on the immediate downstream side of dikes in the pool areas; water depths of a minus 40-ft LWRP or more may occur. Turbidity varies from that of main channel waters at high flows to low levels during pooled, lentic conditions. The sandbar associated with a dike field extends from the shoreline of the offshore bar to the border of the main channel (minus 10-ft LWRP contour). Environmental conditions are generally the same as for natural sandbars. The stone dikes themselves are a unique habitat within the river system for aquatic macroinvertebrates and other organisms. At high river stages, the entire dike field, including the sandbar and the pool area, is inundated and approximates main channel conditions.

f. Permanent secondary channels. This aquatic habitat is found where flow in the main channel is divided by a middle island or bar. The secondary channel is the smaller channel and is subordinate in flow-carrying capacity to the main channel. Flow is maintained year long. Environmental conditions are very similar to those of the main channel.

g. Temporary secondary channels. This habitat is similar to a permanent secondary channel, except that no flow occurs during low river stages and depths are generally shallower. Flow is blocked at the upstream opening of the channel by sand deposits. Dikes are sometimes placed across the upstream end of secondary channels to restrict flow.

h. Abandoned river channel (Type I). This habitat consists of relatively small old river channels located on the floodplain, which are formed by natural or man-made bendway cutoffs or other meandering actions of the river. Abandoned channels are distinguished from oxbow lakes primarily by their much smaller size. However, it is recognized that both habitat types are formed by similar river action and are old river courses. This habitat remains confluent with the main channel via an outlet channel throughout most, if not all, of the year. The shoreward boundary of these areas was defined as 0-ft contour (LWRP). Lentic conditions exist in abandoned channels except when they are inundated during periods of overbank flow. Sediments are a flocculent silt-clay that may contain large amounts of detritus in the form of leaves and twigs. Water clarity is high compared to the turbid condition of the main channel and associated habitats. Average water depths are on the order of 15 to 20 ft.

i. Abandoned channel (Type II). This habitat is very similar physically to abandoned channel (Type I), except that the water body is not confluent with the main channel other than during periods of overbank flow and water depths are much shallower (<10 ft).

j. Oxbow lakes. Oxbow lakes are much larger than abandoned channel habitats (generally more than 1000 acres) and have much greater depths. The lakes are formed by the natural cutoff of large bendways or meander loops. Lentic conditions are characteristic and sediments are loosely consolidated silt-clays. Although oxbow lakes and abandoned channels have similar origins and are both old river courses, they are considered distinct habitats in an ecological sense.

k. Borrow pits. These man-made floodplain water bodies are formed by excavation of fill material for construction of levees. Borrow pits lie adjacent to the levee, primarily on the riverside, and vary greatly in size and depth. A typical borrow pit might be 175-ft wide and 1000-ft long and have an average depth of 6 ft. Lentic conditions prevail throughout the year, except when floodwaters inundate this habitat. Sediments are flocculent silt-clays.

l. Inundated floodplain. The terrestrial portion of the floodplain consists of various types of bottomland hardwood forests, old fields, and agricultural lands that are inundated during high flow periods.

Habitat Mapping Techniques

11. Habitat maps of the study reach were prepared for three river stages: low flow (18 June 1976), medium flow (5 December 1978), and overbank flow (18 December 1978). Stages and discharge readings on the Greenville, Mississippi, gage for these times were:

Flow	Stage, ft	Discharge, cfs
Low	+ 13.2	140,000
Medium	+ 24.6	400,000
Overbank	+ 38.4	870,000

Flood stage on the Greenville gage is +48.0 ft and late summer-early fall low stages are typically less than +10.0 ft on the gage. The Greenville gage is located at approximately river mile 537, about 7.0 miles upstream from the northern boundary of the study area. The fact that there was a 2-yr interval between the photography used in the preparation of the low flow map and that used for the two other stages was not desirable but was unavoidable due to the unavailability of more concurrent photography. However, the quality of the maps was not seriously degraded since no major changes in river geometry were observed in this time period. The U. S. Army Engineer Comprehensive River Survey

(1975) served as the base map for the study reach. The hydrographic survey maps provide elevation contours for all main-stem areas of the river in 5-ft intervals as well as the location of dike and revetment structures and elevation ranges from levee to levee across the flood-plain. A mylar overlay of the aquatic habitats was prepared for each selected river stage using the base maps. To further delineate the boundary of aquatic water bodies, controlled aerial photography was used. Panchromatic aerial photography, scale 1:20,000, was obtained for the study area for all three river stages. Shoreline boundaries and extents of inundation were marked on the photographs and optically transferred to the base maps using a Bausch and Lomb Zoom Transfer Scope. A horizontal control network was established on the base maps and the photographs to ensure that this transfer produced geometrically correct habitat overlays. The surface acreage of each habitat was measured using a polar-compensating planimeter. The boundaries of each habitat were delineated for planimetering using elevation contours and visual features of habitat boundaries obtained from the photographs and overlays. Maximum error of the surface acreage measurements ranged from 4 to 12 percent. The surface acreage of the revetment and natural bank habitats were computed as the horizontal plane surface area, not the area of the actual bank slope. Thus, the acreages for bank habitats are underestimated in terms of river bottom area. Similar distortions occur in other habitats with highly irregular bottom topography, such as some dike fields.

PART III: EFFECTS OF CHANGES IN STAGE AND DISCHARGE

Results of Mapping

Study reach

12. The 50-mile study reach contained 18,581 surface acres of aquatic habitat during the low flow condition. The quantity of aquatic habitat increased 56 percent at medium flow conditions to 29,020 acres. During the high flow period, approximately 10 ft below flood stage, 56,902 acres of habitat were present, a 222 percent increase over the amount of habitat present during the low flow period (Table 1, Figure 3). The large increase in the amount of aquatic habitat was directly related to increased river stage and discharge (Figure 4, Plates 1-3).

13. In the 50-mile study reach, aquatic habitat per river mile during the low flow period averaged 372 acres. The number of acres of aquatic habitat per river mile was 580 for the medium flow period and increased to 1,138 acres for the high flow period. The doubling of available aquatic habitat at high flow relative to medium flow mainly reflects the formation of 15,122 acres of inundated floodplain habitat by overbank flooding resulting from increased river stage and discharge.

Aquatic habitats

14. Main channel. The main channel was by definition held at a constant acreage (8435 acres) over different river stages. However, the relative abundance of this habitat changed markedly with river stage as the total aquatic area fluctuated. At low flow conditions the main channel comprised 45 percent of total habitat, but made up only 15 percent of total habitat at high flow conditions (Table 1, Figure 3, Plates 1-3).

15. Natural banks. At all three river stages, the natural bank habitat made up 1 percent of the aquatic habitat acreage, but had an approximate threefold increase in acreage from the low flow to the high flow condition (Table 1, Figure 3, Plates 1-3). The natural bank habitat increased in size as the river water level rose and inundated previously exposed banks. The maximum amount of natural bank habitat

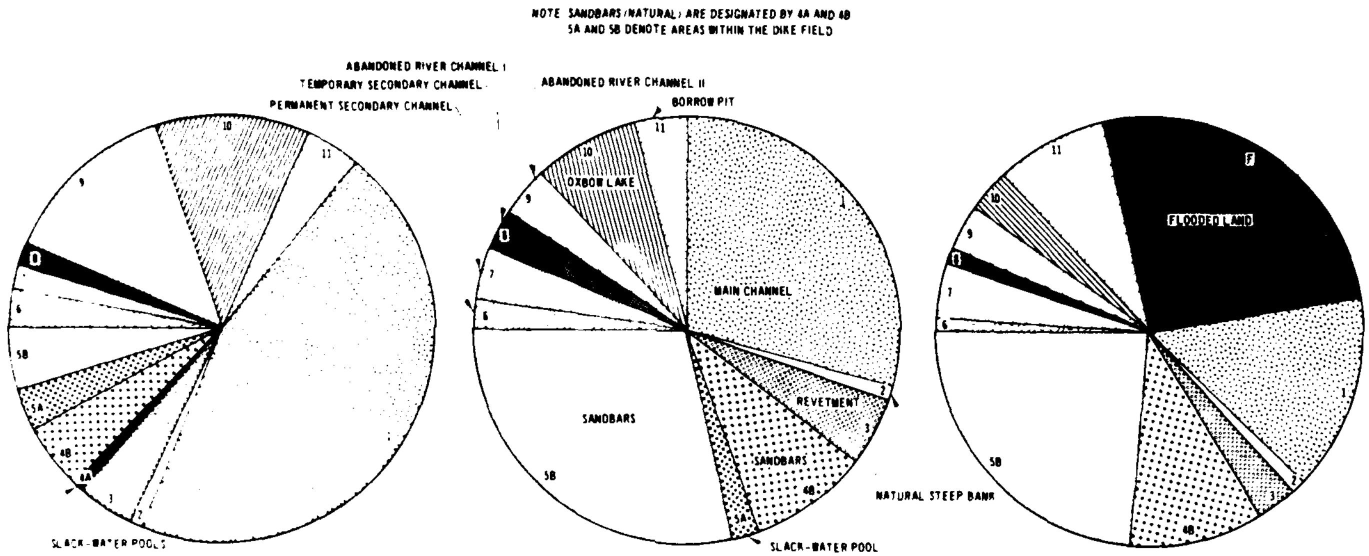

Figure 3. Relative abundance of habitat types for three flow conditions (left to right: low, medium, and high flow)

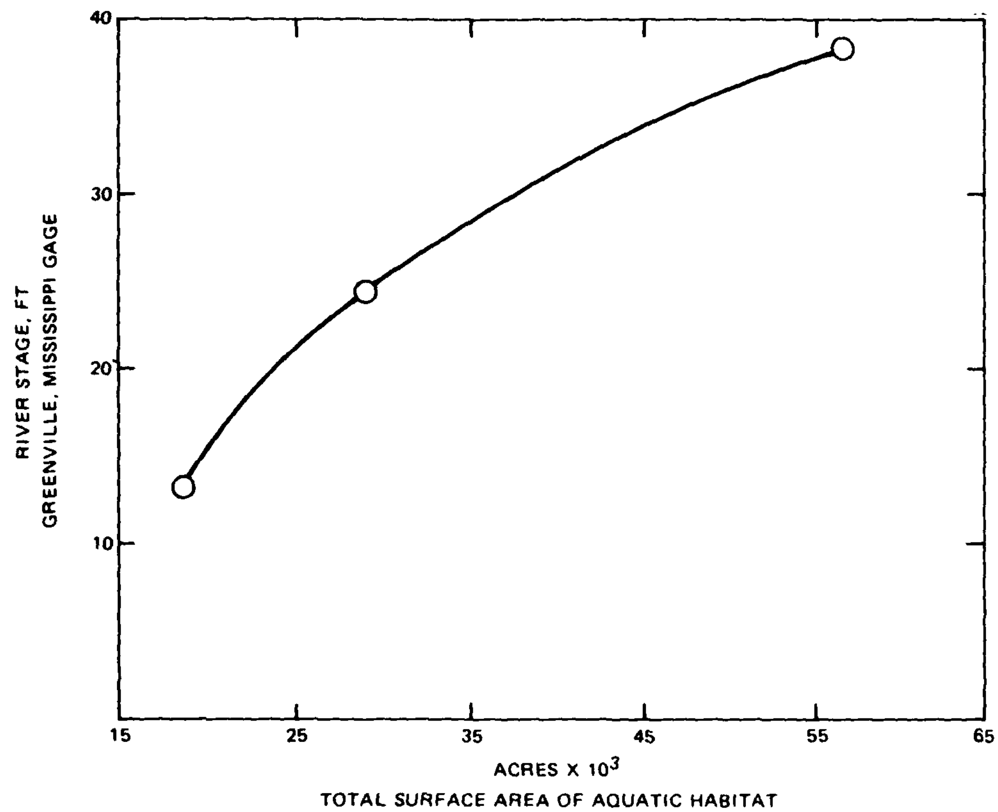

Figure 4. Graph of river stage versus habitat of surface area (acreage)

available is controlled by the elevation of the top bank.

16. Revetted banks. The surface acreage of revetted banks was approximately four to five times as large as the surface area of natural banks during low and medium flow periods and was three times larger than natural banks at high flow. Revetment habitat composed 5 percent of total habitat at low and medium river stages, but decreased in relative abundance to 3 percent at high flow conditions due to the greatly expanded inundated floodplain and sandbar habitats (Table 1, Figure 3, Plates 1-3).

17. Sandbars. Sandbar habitats, including sandbar slack-water pools and natural sandbars, made up about 6 percent of all aquatic habitat area at low river flow and 8 and 11 percent of total habitat at

medium and high flow (Table 1, Figure 3, Plates 1-3). However, the acreage of this habitat was over five times greater at high flow than at low flow conditions. The main stem of the river contains large expanses of sandbars that are exposed at low river stages and are inundated at high river stages.

18. Dike fields. The total dike field habitat--pool areas and sandbars--comprised only 8 percent of the available aquatic habitat during the low flow period. The relative abundance of this habitat, however, increased significantly in the medium flow period when dike fields constituted 28 percent of total aquatic habitat (Table 1, Figure 3, Plates 1-3). The percentage composition of dike fields declined to 18 percent during high flow conditions, although dike field acreage rose from 7,993 to 10,441 acres. The dramatic enlargement of the dike field habitat at medium and high flow conditions resulted from inundation of the extensive dike field sandbars. Dike field pool areas nearly doubled in size between the low flow and medium flow periods; during high flows pool areas were combined with the sandbar area because of the uniform conditions present during high river stages. This approach may not be strictly valid in dike fields with very deep pools containing fine sediments all year, but it is applicable to dike fields with generally shallow pools and sand and gravel substrates. About 2 to 3 percent of the river's aquatic environment consisted of pool areas during low to medium flow conditions.

19. Secondary channels. Permanent secondary channels were relatively insignificant in terms of habitat area, comprising only 2 percent or less of the total aquatic habitat. The acreage of this habitat was small and increased only about 19 percent from low flow to high flow conditions; the relative size of this habitat type decreased with an increase in river flow as the main channel did (Table 1, Figure 3, Plates 1-3).

20. Temporary secondary channel habitats were about 25 percent larger in total size than permanent secondary channels. Total acreage of this habitat increased about threefold with rising river stages (Table 1, Figure 3, Plates 1-3). At low river stages, flow ceases in

temporary channels and portions of the channel may become dry. As the channels are refilled at higher river stages, these areas are inundated and the habitat area enlarges. This habitat type made up 5 percent or less of total aquatic habitat during high flow.

21. Abandoned channels. Abandoned channel (Type I) habitats had a comparatively small surface acreage, comprising 4 to 5 percent of total aquatic habitat. The area of this habitat type increased 56 percent from low to medium flow and expanded an additional 64 percent in area from medium to high flow. The abandoned channel (Type I) fluctuated in size with river stage because these habitats are confluent with the river and are subjected to main channel water level changes. The surface area of abandoned channels (Type I) was about one-half that of abandoned channels (Type II) at low flow; the two types were approximately equal in size at the medium flow, and the Type I areas were 17 percent larger than Type II areas at high flows.

22. Abandoned channels (Type II) were larger in size than the similar Type I habitat. Surface area remained constant for abandoned channels (Type II) at 1860 acres, since these habitats are not confluent with the river except during overbank flow periods, and the shoreline boundary is fixed at the 0-ft LWRP contour. The relative spatial abundance of abandoned channels (Type II) decreased with increased river stage from 9 to 3 percent (Table 1, Figure 3, Plates 1-3).

23. Oxbow lakes. The two large oxbow lakes in the study area (Lake Lee and Gassoway Lake) and the smaller Lake Port have a combined surface area of 2191 acres at low flow. The size of these lakes increased only slightly to 2309 acres at high flow due to the introduction of main channel water. The relative percentage of total aquatic habitat made up of oxbow lakes decreased from 12 to 4 percent with increased river stage (Table 1, Figure 3, Plates 1-3). Oxbow lake acreage was similar to that of the combined abandoned channels (Types I and II) at low flow, but at medium and high flow the abandoned channels were 30 percent and 44 percent larger than the oxbow lake habitat type.

24. Borrow pits. Borrow pits accounted from 4 to 8 percent of the riverine aquatic environment (Table 1, Figure 3, Plates 1-3). It is

probable that precipitation collected in borrow pits during winter and fall caused the increase in acreage of this habitat type from 826 acres during low flow to 1165 acres at medium flow. At high flow, these water bodies were inundated by main channel waters and assumed a greater importance as a habitat due to the increase in area (4798 acres).

25. Inundated floodplain. At high flow, river waters inundated much of the floodplain between the main-line levees. These flooded terrestrial areas or inundated floodplain habitat are mainly bottomland hardwood forest and agricultural lands. The inundated floodplain consisted of 15,122 acres or 27 percent of the total aquatic habitat during high flow (Table 1, Figure 3, Plates 1-3). The large size of this habitat type during high flow significantly affected the relative abundance of the other habitat types.

Discussion

Total acreage fluctuations

26. Fluctuations in river stage, recorded at the Greenville, Mississippi, gage, resulted in significant changes in both the total acreage of aquatic habitat and in the spatial relationships among habitat types (Figure 3, Plates 1-3). The main channel was the largest aquatic habitat (45 percent of total habitat) during low flow with the combined lentic floodplain habitats (abandoned channels, oxbow lakes, and borrow pits) being second in size (29 percent of the total habitat). Medium flow resulted in a shift in habitat spatial relationships such that the main channel and the dike fields were about equally abundant in terms of surface acreage, 29 and 28 percent, respectively; combined lentic floodplain habitats accounted for 24 percent of total aquatic habitat. Inundated floodplain habitats (27 percent of total habitat) and dike field sandbars (18 percent of total habitat) were the most abundant habitat types at overbank (high) flow.

Spatial relationships

27. Spatial relationships between the combined acreage of habitats associated with the main stem of the river (main channel, secondary

channels, dike fields, sandbars, and bank habitats) and the floodplain habitats (abandoned channels, oxbow lakes, borrow pits, and inundated floodplains) varied noticeably with river stage. The ratio of total main-stem habitat acreage to total floodplain habitat acreage was 2.3 for low flow, 3.3 for medium flow, and 1.2 for high flow. The large increase in dike field habitat area was the primary cause of the ratio increase at medium flow, since floodplain, channel, and bank habitats remained relatively stable in size. The drop in the ratio for high flow reflects the effect of the large amount of inundated floodplain habitat.

Other habitat mapping studies

28. Upper Mississippi River. The U. S. Army Engineer District, St. Louis had an aquatic habitat map prepared for Pools 24, 25, and 26 of the Upper Mississippi River and Lower Illinois River for 1935, 1950, and 1977.* The maps were based on normal pool elevations, and eight habitat types were identified. The river in the upper reaches is a series of navigation pools formed by locks and dams and is much less riverine in character than the Lower Mississippi River. The study used a classification of aquatic habitats that was coarser, but somewhat similar to the classification system used in this study. The main channel border habitats (including sandbars, dike fields, riverbanks, and associated areas) and side channels (dike pools) were the predominant habitat types. A total of 45,723 acres of aquatic habitat occurred in the 1975-77 period in the 98-mile study area of the Mississippi River main stem, or an average of 467 acres of aquatic habitat per river mile. This value compares closely to the medium flow value of 580 acres of aquatic habitat per river mile at the Lower Mississippi River study site.

29. Lower Mississippi River. The Final Environmental Impact Statement for the Mississippi River and Tributaries Project contains results of aquatic habitat mapping studies for the entire Lower Mississippi River between the main-line levees.** Aquatic habitats were

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* U. S. Army Engineer District, St. Louis, op. cit.
** U. S. Army Engineer District, Vicksburg, op. cit.

classified into the following five categories based on average LWRP (very low flow) conditions:

a. Main channel > 5 ft in depth.

b. Main channel < 5 ft in depth (includes many sandbars and bank areas).

c. River slack water (includes dike fields).

d. River chutes (includes secondary channels).

e. Lakes and borrow pits.

30. Results of the study showed a total of 444,800 acres of aquatic habitat present in the Lower Mississippi River leveed floodplain. In the reach from Memphis, Tennessee, to Baton Rouge, Louisiana, which encompasses the study area reported on herein, 251,200 acres of habitat occurred. In the 465-mile reach from Memphis to Baton Rouge, 53 percent of the aquatic habitat was main channel >5 ft in depth; 31 percent of the habitat was floodplain lakes and borrow pits; and 5 percent of the habitat was river slack waters (including dike field pools). These results, although based on different classification schemes and done at different river stages, were very similar to those of the present study, which showed that aquatic habitat during the low flow condition was 45 percent main channel, 29 percent floodplain lakes and borrow pits, and 8 percent dike fields. The Memphis to Baton Rouge reach reportedly had 540 acres of aquatic habitat per river mile, while the 50-mile study reach mapped for this report contained 372 acres per river mile at low stages and 580 acres per river mile at medium flow. Based on comparison with the mapping results from the middle section of the lower river, it appears that the methods used on the 50-mile reach mapped for this study yielded satisfactorily representative results.

PART IV: CONCLUSIONS

31. Riverine aquatic habitats of the Lower Mississippi River change extensively in surface area through time as a result of fluctuating river stage and discharge. The relative abundance of the various types of aquatic habitat also shifts significantly through time with varying hydrographic conditions in the river. Spatial and temporal relationships in riverine aquatic habitat distributions should be a major consideration in designing ecological studies in large river systems.

32. The habitat mapping results proved useful in designing the 1979 EWQOS field studies on the Lower Mississippi River, and the habitat mapping technique described herein appears to be a viable technique for stratifying the ecosystem of any large alluvial river to design ecological field sampling programs. Data on habitat acreages and changes in habitat sizes with river stage and discharge are beneficial in quantifying study results, especially studies of benthic communities. The acreage data combined with benthic standing crop data can be readily used to distinguish the key habitats of the river in terms of potential benthic production. In general, the habitat maps provide a valuable framework for the portrayal and interpretation of data from aquatic habitat surveys and investigations in large river systems.

33. The aquatic habitat mapping approach appears directly applicable to evaluating projectrelated impacts using habitat evaluation methods. Aquatic habitat maps of waterways could be used to establish existing and future with- and without-project conditions for various planning activities. The data could be applied to riverine systems as land-use data are applied to evaluate terrestrial impacts of a water resources development project.

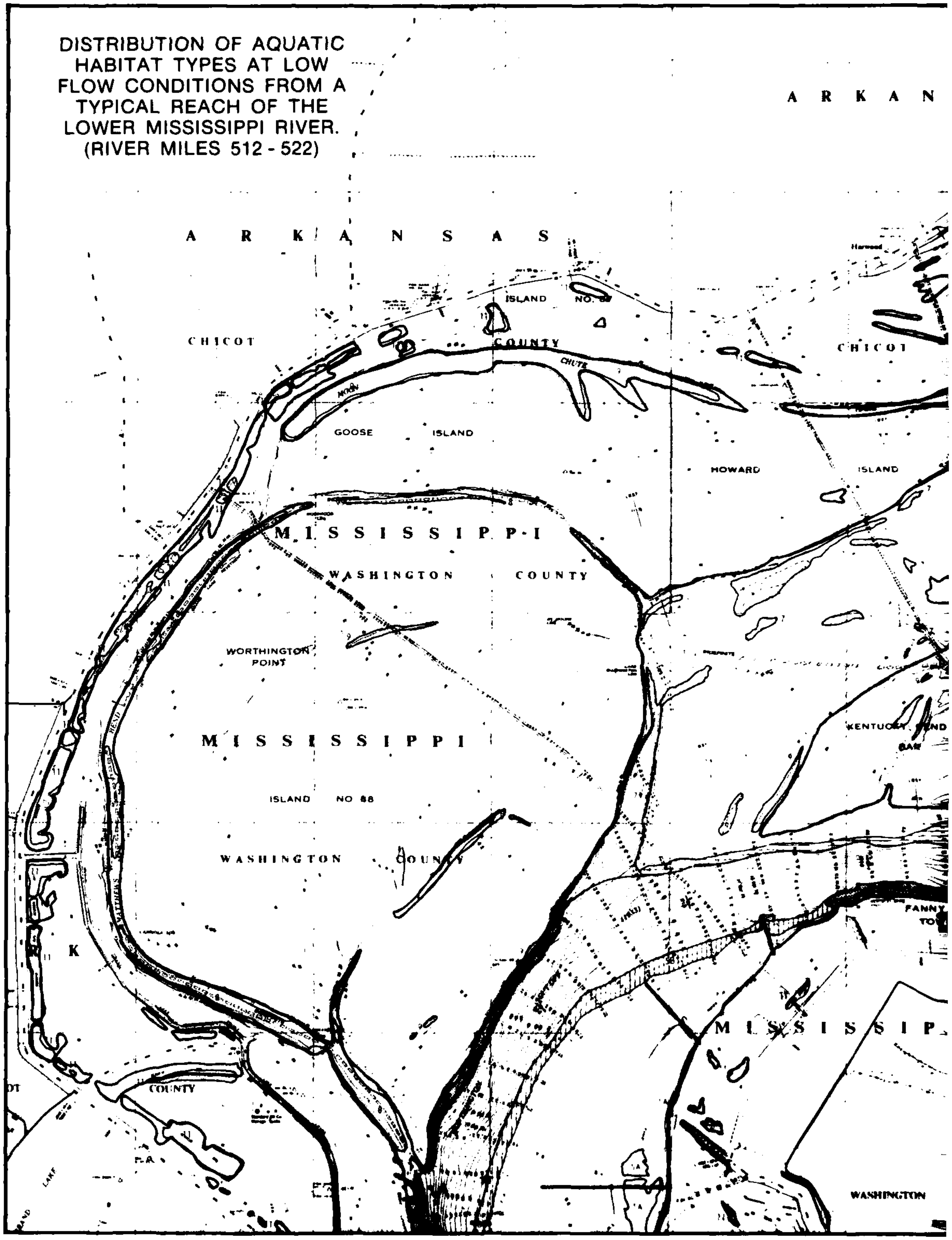
34. Further study is needed to establish the ecological integrity of the delineated habitats, especially during high river stages when main-stem habitats become physically obscured.

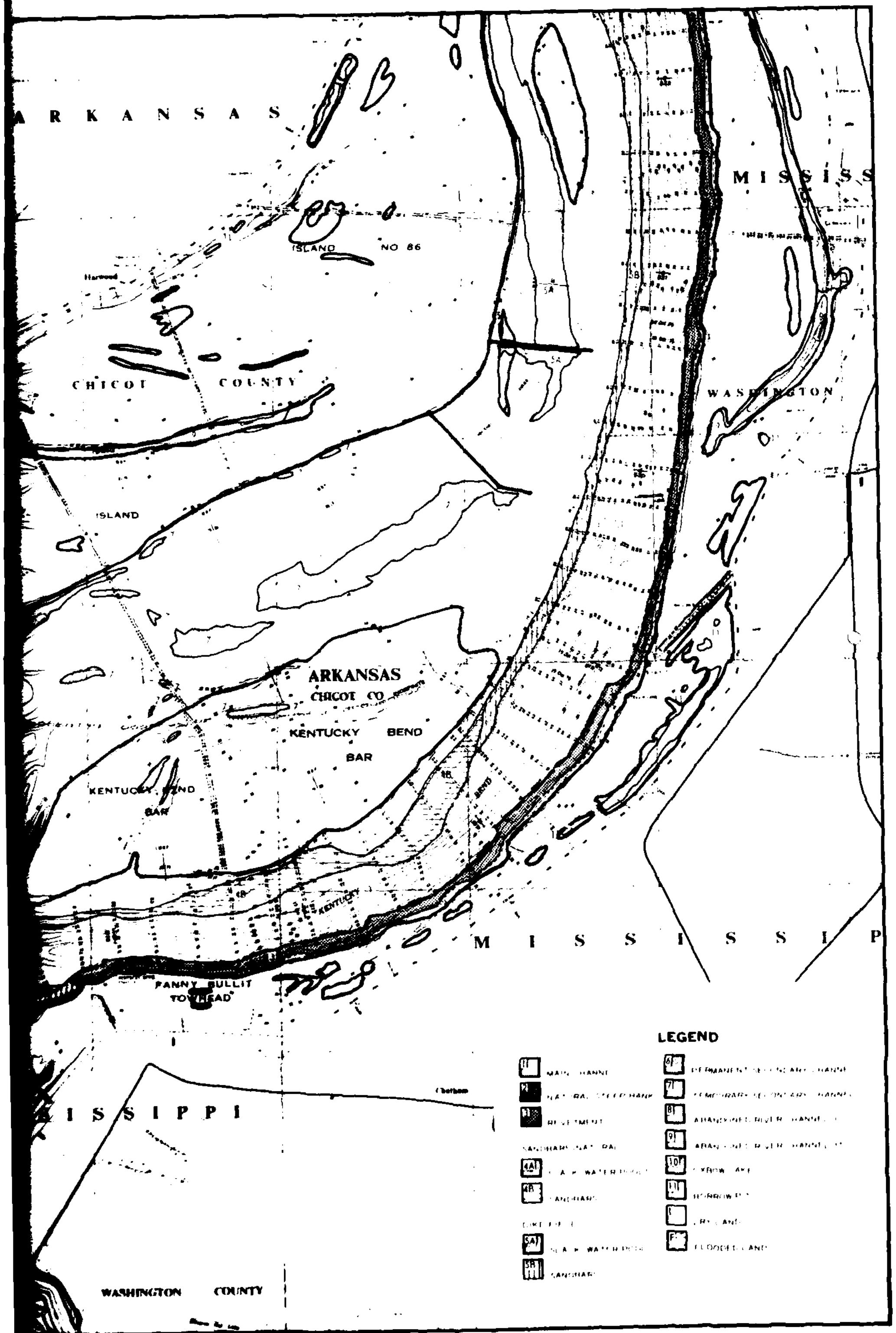
Table 1

Surface Acreage of Aquatic Habitats at Three River Stages from a Reach of the Lower Mississippi River, River Mile 480 to 530 AHP

No.*	Habitat Type	Low Flow (18 Jun 76) Acres	Low Flow (18 Jun 76) %	Medium Flow (5 Dec 78) Acres	Medium Flow (5 Dec 78) %	High Flow (18 Dec 78) Acres	High Flow (18 Dec 78) %
1	Main channel	8,435	45	8,435	29	8,435	15
2	Natural banks	166	1	281	1	448	1
3	Revetted banks	842	5	1,536	5	1,791	3
4a	Sandbar slack-water pools	101	1	0	0	0	0
4b	Natural sandbars	962	5	2,397	8	6,285	11
5a	Dike field pool areas	311	3	600	2	0	0
5b	Dike field sandbars	848	5	7,393	26	10,441	18
6	Permanent secondary channels	530	2	630	2	630	1
7	Temporary secondary channels	708	4	990	3	2,553	5
8	Abandoned channel (Type I)	801	4	1,424	5	2,230	4
9	Abandoned channel (Type II)	1,860	9	1,860	7	1,860	3
10	Oxbow lakes	2,191	12	2,309	8	2,309	4
11	Borrow pits	826	4	1,165	4	4,798	8
F	Inundated floodplain	0	0	0	0	15,122	27
	Totals	18,581	100	29,020	100	56,902	100
Average acres of habitat per river mile		372		580		1,138	

* These numbers correspond to the numbers shown in Figure 3.


DISTRIBUTION OF AQUATIC
HABITAT TYPES AT LOW
FLOW CONDITIONS FROM A
TYPICAL REACH OF THE
LOWER MISSISSIPPI RIVER.
(RIVER MILES 512 - 522)
A R K A N S A S
A R K A N
CHICOT
COUNTY
CHICOT
ISLAND NO. 87
CHUTE
GOOSE ISLAND
HOWARD
ISLAND
MISSISSIPPI
WASHINGTON COUNTY
WORTHINGTON POINT
MISSISSIPPI
ISLAND NO 88
WASHINGTON COUNTY
KENTUCKY BEND BAR
COUNTY
WASHINGTON


ARKANSAS
ISLAND NO 86
CHICOT COUNTY
MISSISS
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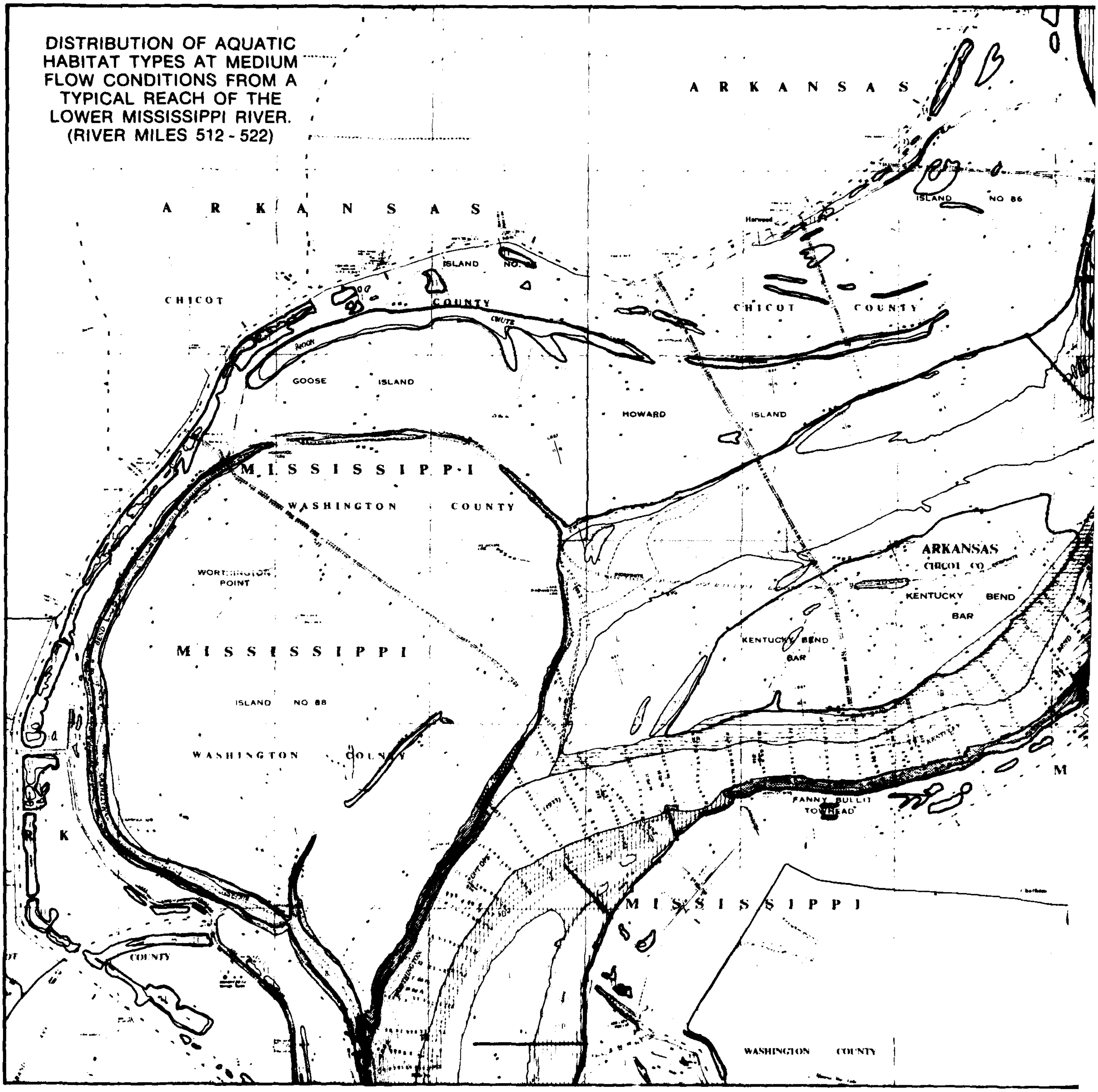
ISLAND
ARKANSAS
CHICOT CO
KENTUCKY BEND BAR
KENTUCKY BEND BAR
MISSISSIP
FANNY BULLIT TOWHEAD
ISSIPPI
WASHINGTON COUNTY
LEGEND
REVETMENT
FLOODED LAND

PLATE 1



DISTRIBUTION OF AQUATIC HABITAT TYPES AT MEDIUM FLOW CONDITIONS FROM A TYPICAL REACH OF THE LOWER MISSISSIPPI RIVER. (RIVER MILES 512 - 522)
A R K A N S A S
A R K A N S A S
ISLAND NO. 86
CHICOT
CHICOT COUNTY
ISLAND NO.
COUNTY
GOOSE ISLAND
HOWARD ISLAND
M I S S I S S I P P I
WASHINGTON COUNTY
WORTHINGTON POINT
M I S S I S S I P P I
ISLAND NO 88
WASHINGTON COUNTY
ARKANSAS
CHICOT CO
KENTUCKY BEND BAR
KENTUCKY BEND BAR
FANNY BULLIT TOWHEAD
M I S S I S S I P P I
COUNTY
WASHINGTON COUNTY

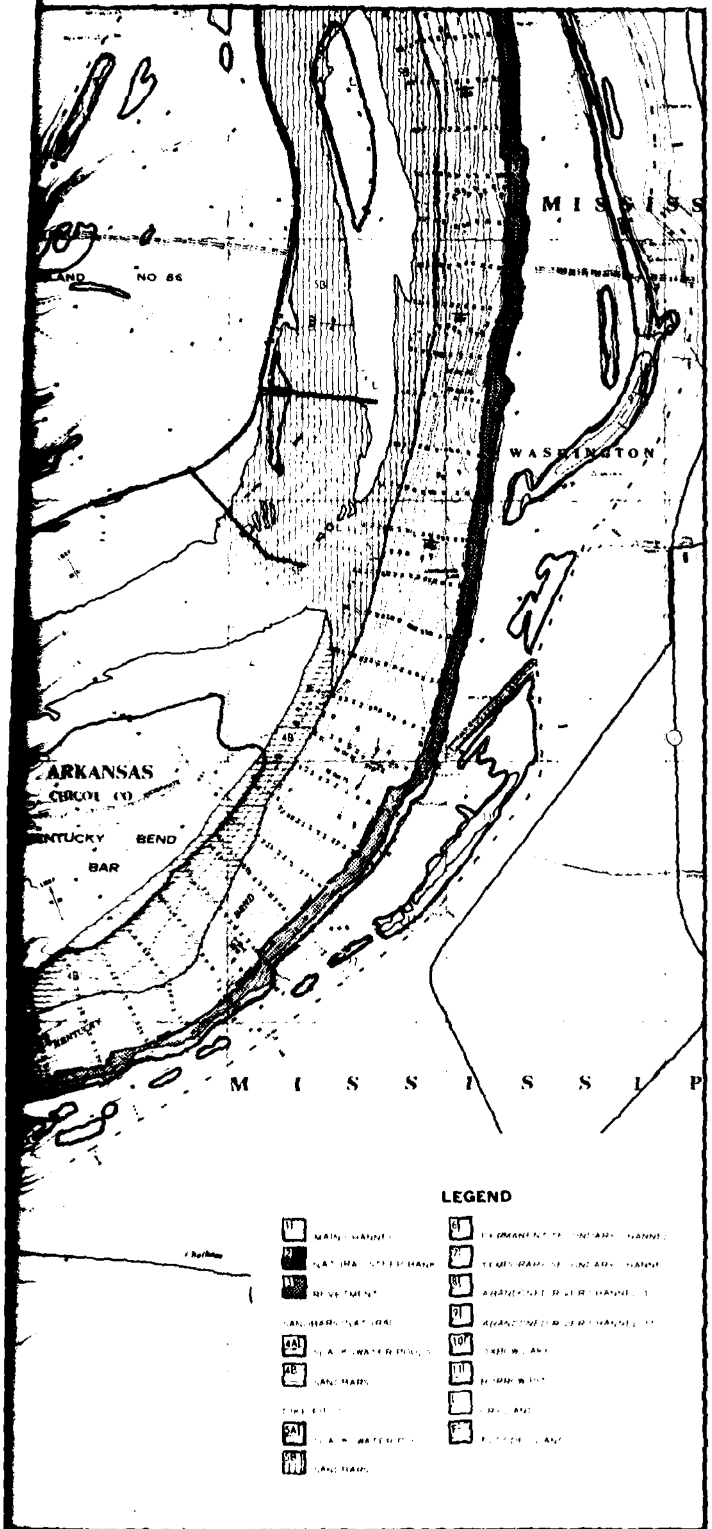
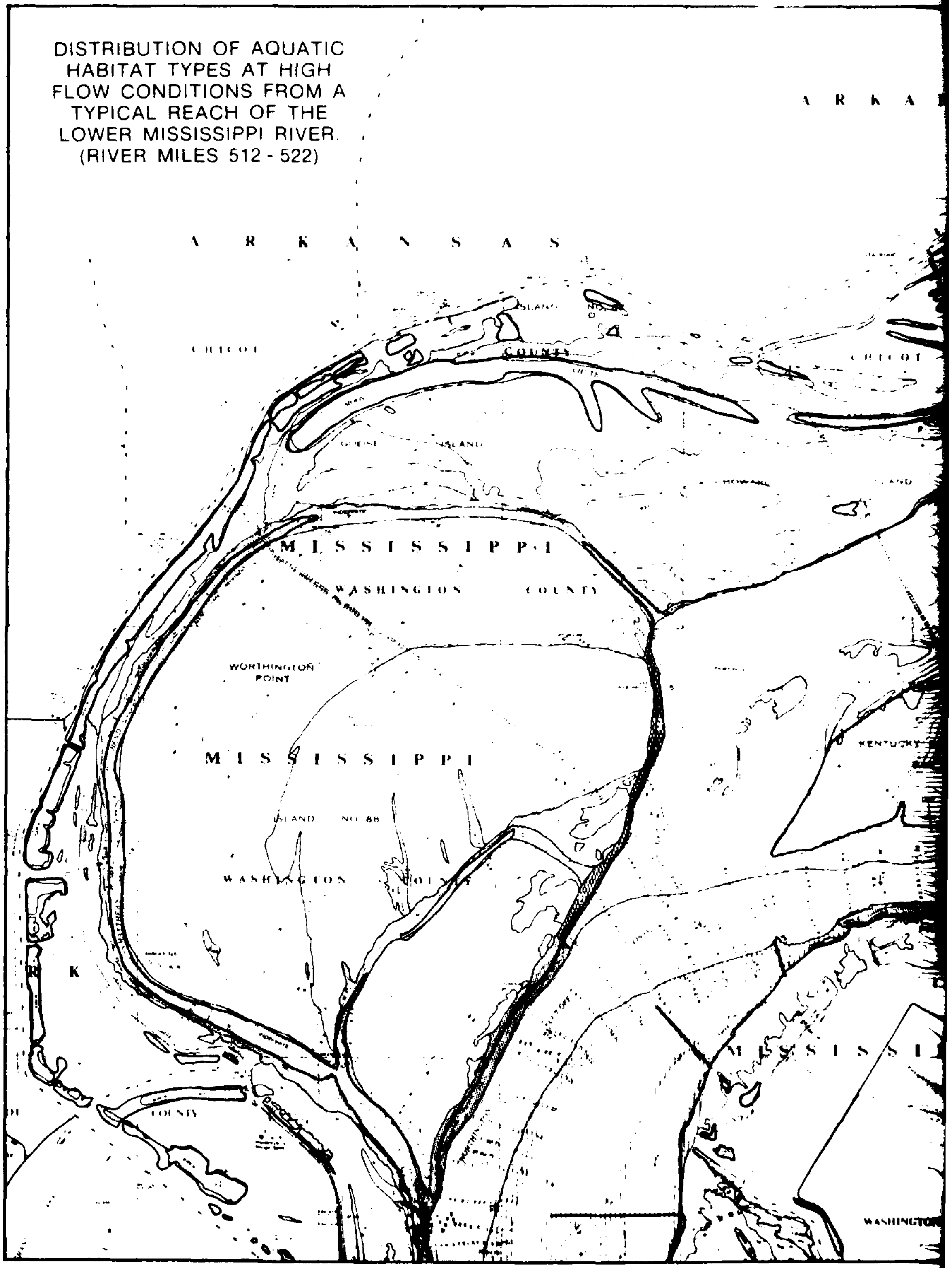
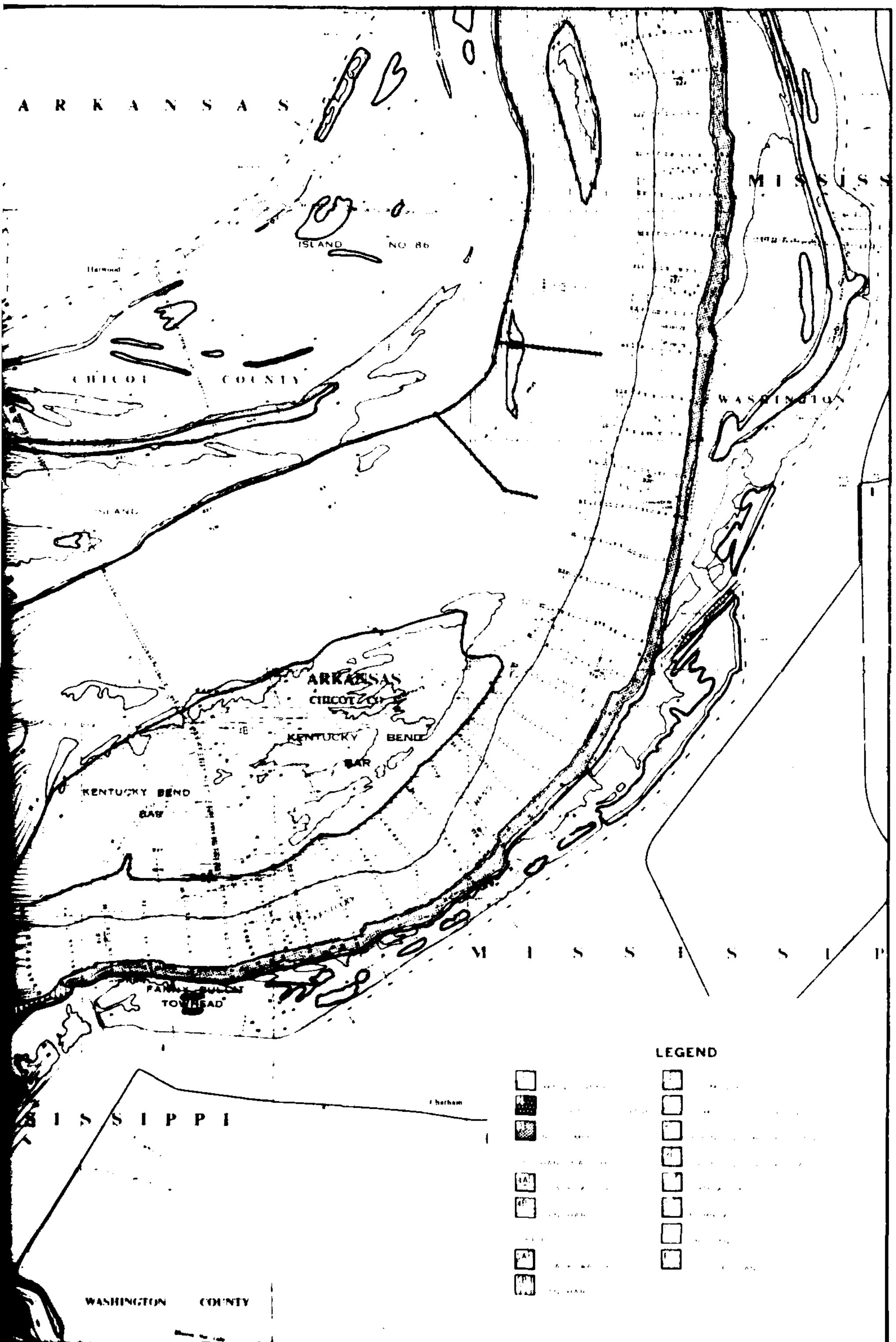

MISSISS
NO 86
WASHINGTON
ARKANSAS
KENTUCKY BEND
BAR
M I S S I S S I P
LEGEND

PLATE 2


DISTRIBUTION OF AQUATIC
HABITAT TYPES AT HIGH
FLOW CONDITIONS FROM A
TYPICAL REACH OF THE
LOWER MISSISSIPPI RIVER
(RIVER MILES 512 - 522)
A R K A N S A S
CHICOT
COUNTY
CHICOT
GOOSE ISLAND
HOWARD
MISSISSIPPI
WASHINGTON COUNTY
WORTHINGTON POINT
M I S S I S S I P P I
ISLAND NO. 88
WASHINGTON COUNTY
KENTUCKY
COUNTY
WASHINGTON

1


A R K A N S A S
ISLAND NO 86
CHICOT COUNTY
MISSIS
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ARKANSAS
CHICOT CO
KENTUCKY BEND BAR
KENTUCKY BEND BAR
TOWHEAD
M I S S I S S I P
S I S S I P P I
LEGEND
WASHINGTON COUNTY

PLATE 3

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

Cobb, Stephen P.
Aquatic habitat studies on the Lower Mississippi River, river mile 480 to 530 : Report 2 : Aquatic habitat mapping / by Stephen P. Cobb, Jonathan R. Clark (Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station) ; prepared for Office, Chief of Engineers, U.S. Army. -- Vicksburg, Miss. : U.S. Army Engineer Waterways Experiment Station ; Springfield, Va. : available from NTIS, 1981.
24 p., [3] leaves of plates : ill. ; 27 cm. -- (Miscellaneous paper / U.S. Army Engineer Waterways Experiment Station ; E-80-1, Report 2)
Cover title.
"March 1981."
"Under EWQOS Work Unit VIIB."

1. Maps. 2. Marine biology. 3. Mississippi River. I. Clark, Jonathan R. II. United States. Army. Corps of Engineers. Office of the Chief of Engineers. III. United States. Army Engineer Waterways

Cobb, Stephen P.
Aquatic habitat studies on the Lower Mississippi : ... 1981.
(Card 2)

Experiment Station. Environmental Laboratory. IV. Title V. Series: Miscellaneous paper (United States. Army Engineer Waterways Experiment Station) ; E-80-1, Report 2.
TA7.W34m no.E-80-1, Report 2