# ENVIRONMENTAL OBSERVATIONS OF A RIPARIAN ECOSYSTEM DURING FLOOD SEASON

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# Preface

This report describes a project that is an excellent example of how a water resources research center can provide new knowledge rapidly. The principal investigator approached the director concerning the the significance of collecting data before a flood started on the Kankakee River. Within one month funds were allocated to him, and a major study was undertaken and completed within a six-month period. In addition to our support, the Illinois Institute of Technology, IIT, donated their indirect costs, and the students and principal investigators devoted many hours of hard work without remuneration in order to complete the study expediently.

This study was a part of a series of investigations conducted during the past year to evaluate the impact of various management strategies on the Kankakee River. Much of the major support for the total program was provided by the Institute of Natural Resources (IINR). IINR's current studies are listed below:

1. Geological Characteristics of Bottom Sediments in the Momence Area of the Kankakee River (20.121); Illinois State Geological Survey
2. Monitoring Sediment Movements in the Kankakee Basin in Illinois (20.120); Illinois State Water Survey
3. Suspended Sediment and Hydraulic Flow Data for the Kankakee River Basin in Illinois (20.119); United States Geological Survey
4. The Effects of Sedimentation on Aquatic Life in the Kankakee River in Illinois (20.118); Illinois State Natural History Survey
5. Preservation of the Momence Wetlands Area on the Kankakee: Wildlife Data (20.115); Illinois State Natural History Survey
6. Biological Verification of Hydrologic and Sediment Data in the Kankakee River Basin (20.124); William Mitsch, IIT.
7. Economic Value of Wetlands -- Case Study: The Kankakee River (20.114); William Mitsch, IIT.
8. Preservation of the Momence Wetlands Area on the Kankakee River: Project Coordination and Report to the U.S. Fish and Wildlife Service (20.116); Natural Lands Institute
9. Kankakee River Interstate Coordinating Committee Support Service (20.117); Illinois-Indiana Bi-State Commission

Further details of any of these projects may be obtained by contacting David J. Jones, Environmental Scientist, Illinois Institute of Natural Resources, 309 West Washington Street, Chicago, Illinois 60606.

Glenn E. Stout, Director

## ABSTRACT


ENVIRONMENTAL OBSERVATIONS OF A RIPARIAN ECOSYSTEM DURING FLOOD SEASON

Dynamics of floodplain wetlands along the Kankakee River in Northeastern Illinois were studied during the Spring flood season of 1979. The study involved hydrology, water chemistry and sedimentation measurements. The wetlands study areas were dominated by silver maple (*Acer saccharinum*) with river birch (*Betula nigra*), pin oak (*Quercus palustris*), America elm (*Ulmus americana* and swamp white oak (*Q. bicolor*) as subdominants. The floodplain forest study site was inundated for 62 to 80 days, depending on location, during March - May 1979. Flooding was determined to occur at a river discharge of 4000 to 4500 cfs and the floodplain forest was determined to be under water 66 percent of the years for at least 10 days since 1917. Flooding has not occurred at all in only five years during that period. Approximately 6.2 million cubic meters of water was stored in the entire wetland area, this representing 2.3 percent of the floodwater above bankfull discharge at a downstream location. Water quality during flooding indicated that few spatial patterns existed on different floodplain sites and no differences were seen in the floodplain and main channel water quality of the river. Groundwater showed increasing orthophosphates and decreasing nitrates after floodwater receded. Sedimentation plates placed on the floodplain prior to flooding collected an average of 590 $g/m^2$ of sediments, representing a gross deposition of 4500 metric tons of sediments on the entire wetland area. No consistent spatial pattern of sediment deposition was noted.



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KEYWORDS: wetlands/ flooding/ sedimentation/ riparian ecosystems/ water quality/ floodplain

## ACKNOWLEDGEMENT

The authors would like to thank the Institute of Natural Resources, particularly George Benda, for supplemental funding for this project (INR Project 20.124). Ben Baer of the Illinois Institute of Technology assisted in field and laboratory measurements. Surburban Laboratories, Inc. of Hillside, Illinois analyzed the water samples.

# TABLE OF CONTENTS

# INTRODUCTION

Natural ecosystems growing along river banks are influenced by that proximity to water and are called riparian ecosystems. As described by Odum (1979) "riparian ecosystems are well-defined landscape features that have many of the same values and land-use problems as wetlands in general, but are nevertheless distinct enough to warrant special consideration. ... As functional ecosystems, they are very open with large energy, nutrient and biotic interchanges with aquatic systems on the inner margin and upland terrestrial ecosystems on the other margin."

The riparian ecosystem is dependent on the hydrology, water quality, and sediment characteristics of the flooding river. The inputs of water and sediments to the floodplain represent major forcing functions of this system; the floodplain ecosystem, in turn, channels these forcing functions together with solar energy, to further support the river ecosystem (Figure 1). Floodplain wetlands may have additional benefits of wildlife conservation, water conservation and water quality enhancement. Johnson _et al_. (1979) present several papers discussing these values.

Few data exist, however, on the hydrology, water quality, and sediment retention of the riparian ecosystem during the flood season. It is ironic that few studies

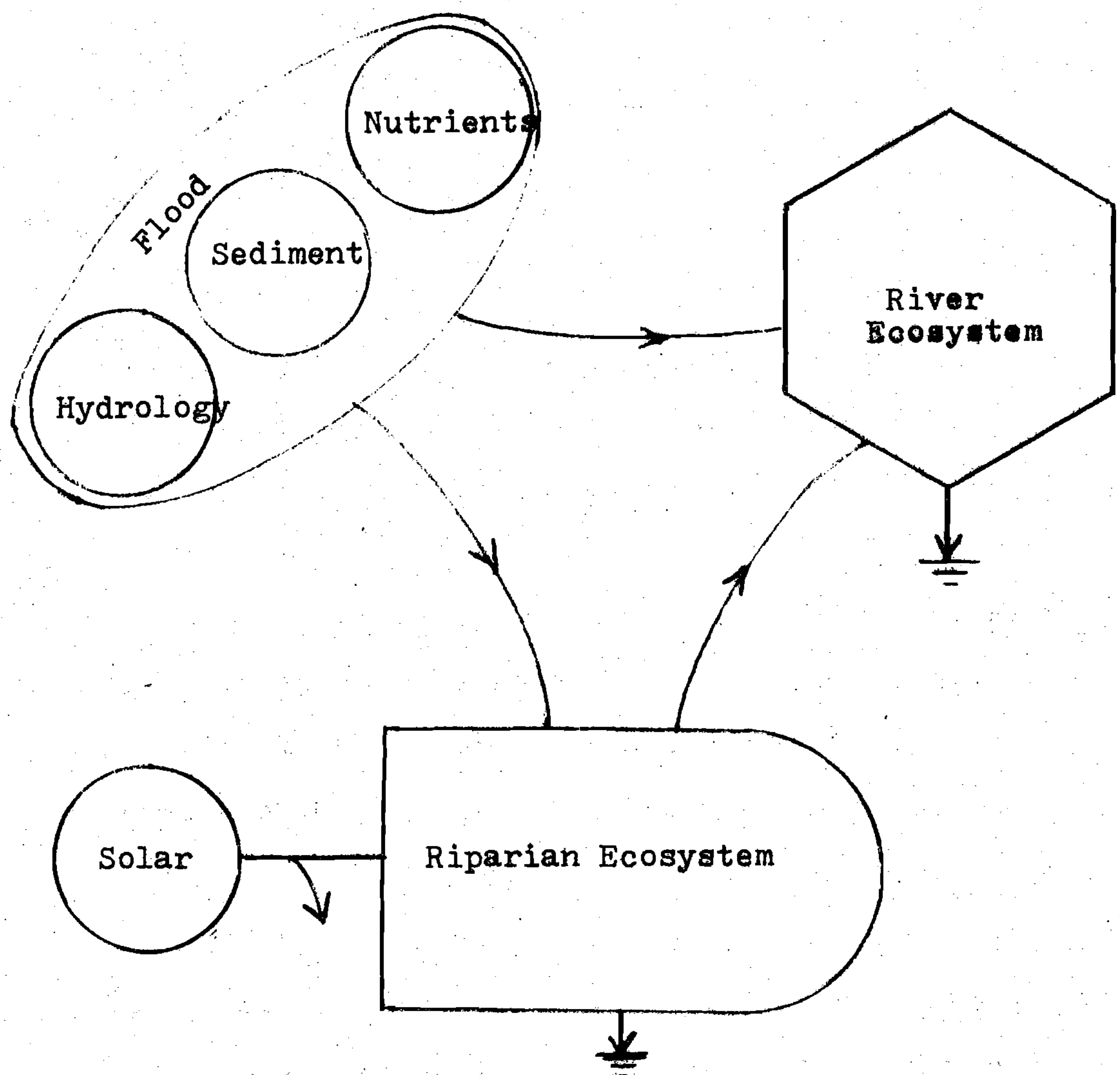


Figure 1. Interactions between Riparian Ecosystems and Flooding River.

have been made of riparian ecosystems during their flooding cycle, a situation that owes itself as much to site inacessibility during flooding as to any other cause. This study sought to quantify some of the characteristics of a flooding river as it exceeds its banks and spills into a riparian ecosystem. The study looks at the hydrology, water chemistry, and sediment deposition of selected study sites in forested floodplain wetland during flooding by the Kankakee River in northeastern Illinois.

# SITE DESCRIPTION

The study site is located in a frequently flooded riparian forest along the Kankakee River in northeastern Illinois. (Figure 2). The Kankakee River rises in the swamplands near South Bend, Indiana, and flows in a southwesterly direction through Indiana. It crosses the Illinois-Indiana state line just east of Momence, and continues west and southwest to the vicinity of the city of Kankakee, where it is joined by the Iroquois River. It turns to the northeast and joins the Des Plaines River to form the Illinois River.

## The Momence Wetlands

From the Indiana border west to Momence, Illinois, the Kankakee River meanders through a 10-kilometer-long area dominated by floodplain forest. This represents the study area of this report, called the Momence Wetlands (See Figure 3). The Momence wetlands are a portion of what was once known as the Great Kankakee Swamp, an area that extended upstream from Momence through much of the Indiana portion of the basin (Meyer, 1935). Most of the Indiana portion of the river has since been channelized and the once great expanse of wetlands is now in cropland.

A bedrock outcrop near Momence serves as a natural dam on the river, helping to maintain a very low gradient and

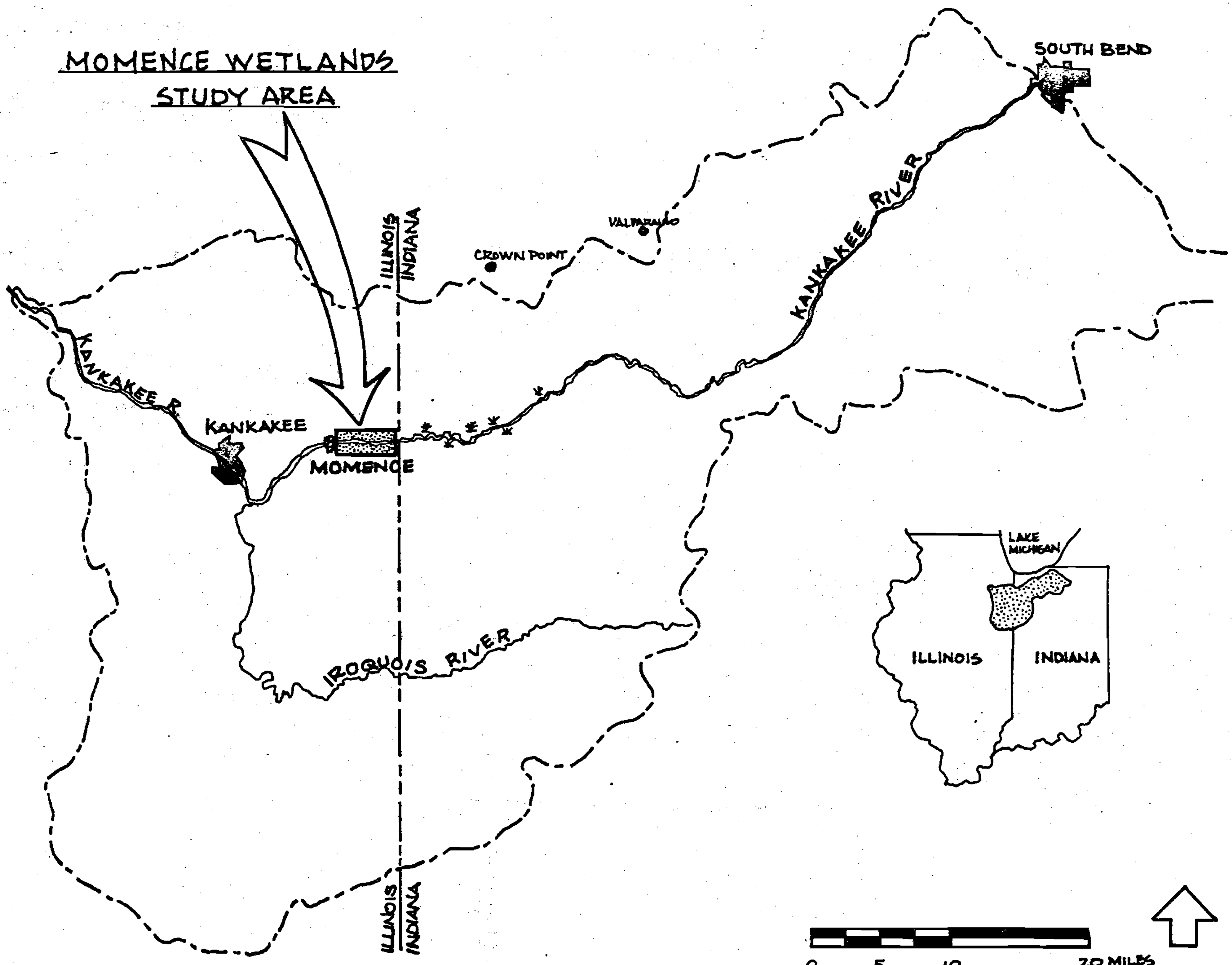


Figure 2. Location of Momence Wetlands in the Kankakee River Basin.

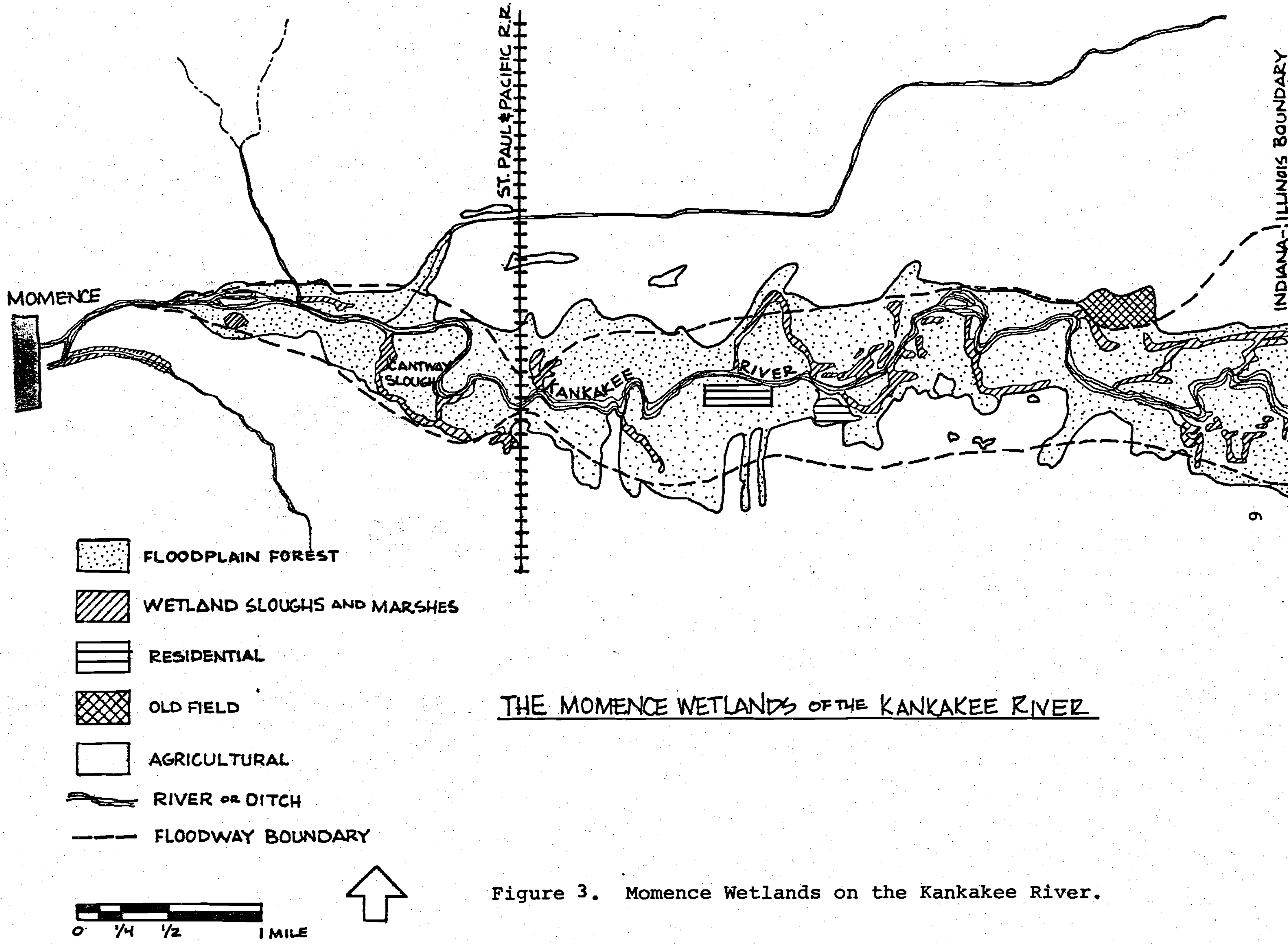


Figure 3. Momence Wetlands on the Kankakee River.

hence the wetland character upstream of Momence (Barker et al., 1957). Most of the 670 hectares of floodplain forest in the Momence Wetlands are temporarily flooded for several weeks each year (Figure 4). More than 50 hectares of the area are more permanently flooded sloughs and marshes (Figure 5). The remainder is in drier upland forest (50 hectares). The present land use of the Momence Wetlands area is shown in Figure 3. The reader is referred to Mitsch _et al._, (1979) for a more detailed description of the history of the Kankakee and Momence Wetlands.

Floodplain forest that makes up the largest area (670 ha) in the Momence wetlands is dominated by silver maple (_Acer saccharinum_ L). These trees rarely attain large size and are constantly being stressed by flooding and saturated soils. Many logs and branches from silver maple are strewn across the forest floor and are constantly shifted by the flooding river (Figure 6). Other major tree species in the forest include pin oak (_Quercus palustris_, river birch (_Betula nigra_ L.), American elm (_Ulmus americana_ L.), and swamp white oak (_Q. bicolor_ Willd.). The understory is generally sparce due to flooding and is dominated by buttonbush (_Cephalanthus occidentalis_). The vegetation is further described by Kurz (1978). The approximately 50 hectares of abandoned sloughs and meadows may eventually fill with sediment but now provide sites that are wet most of the year. Buttonbush dominates the

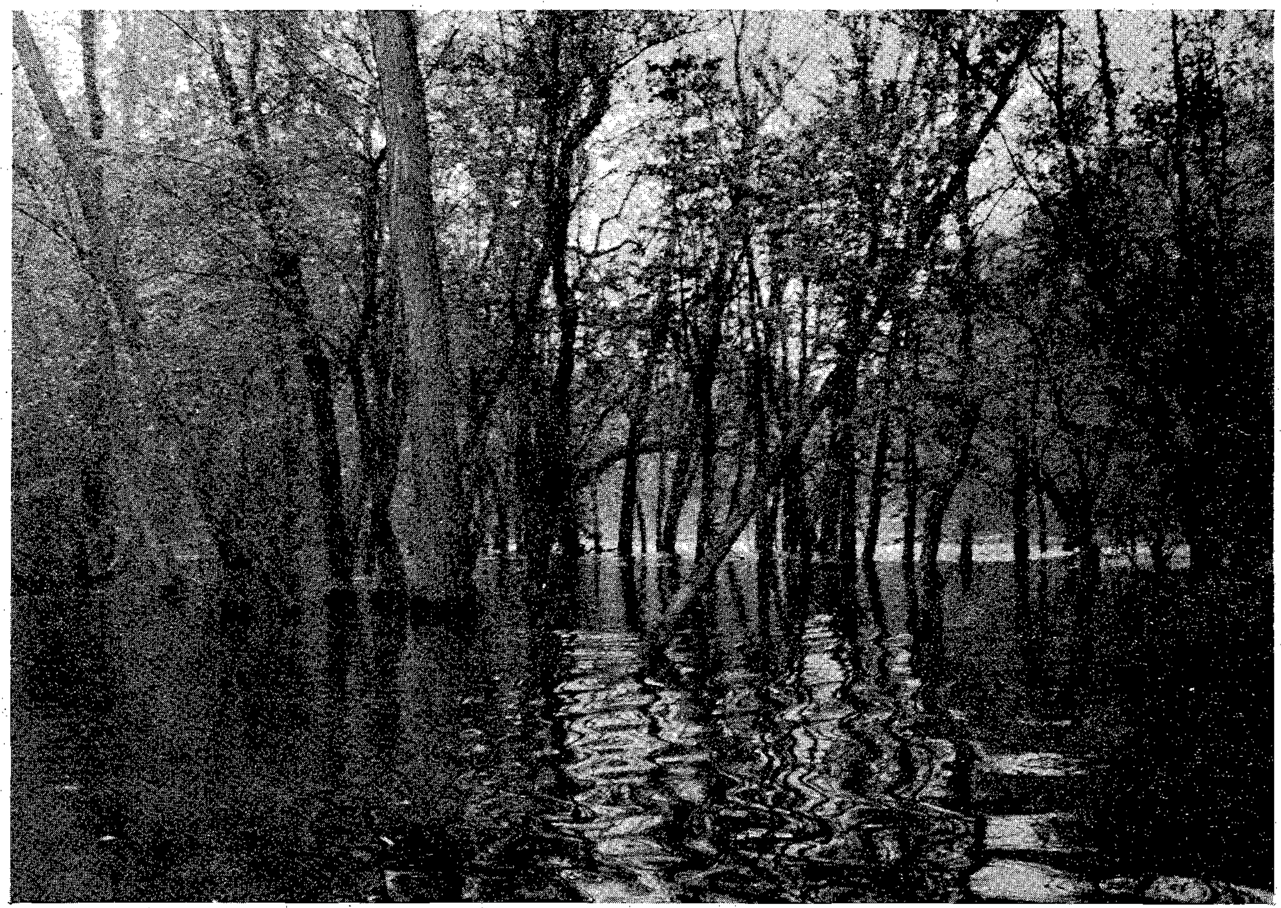

Figure 4. Momence Wetlands Floodplain Forest During Flood Season.

Figure 5. Permanently Flooded Wetland in the Momence Wetlands Study Area.

Figure 6. Floodplain Forest in the Momence Wetlands During Dry Season. Note Dead Trees Strewn on Forest Floor.

shallow areas while the deeper areas are covered by duckweed and other aquatic plants in the growing season. Another 50 hectares of the study area are in dry upland forest on sandy terraces slightly higher than the floodplain forest. These areas are dominated by black oak (*Q. velutina* Lam.) red oak (*Q rubra* L.) and white oak (*Q. alba* L.) and are less frequently flooded.

## Management Issues

The Momence Wetlands area is of particular interest to the State of Illinois. Parts of the study area have been described in the Illinois Natural Area Inventory recently completed at the University of Illinois as the "best of its kind" in Illinois. The area also may be of significant value to the region in other ways (Mitsch *et al.*, 1979). The Kankakee River is one of the best fishing streams in Illinois and some of the good quality of the river may be due to the presence of riparian vegetation. The flooding river may offer opportunities for fish to extend their spawning and feeding habitat at a critical time in their life cycle. The wetlands may also contribute organics to river food chains in the dry season.

The Momence Wetlands are also important to the maintenance of sediment balances in the watershed. Presently, a controversy about increased sediments in the river has many Illinoisians blaming upstream Indiana, due to the extensive channelization and drainage of the Kankakee in that state. The wetlands may be acting as a sediment trap for some of these sediments, a question addressed in this study.

Few springs have been ushered into northeastern Illinois recently without local concern and subsequent media coverage about the flooding Kankakee River. The river floods lands that have been converted from wetlands to farm land and residential sites that have been recently developed on the floodplain. The Momence Wetlands also receive the annual flooding but they offer a place for the river to go without any impact on human affairs. They also may give some of this water that is stored in the soils back to the river during the dry season. Damping of both high and low river flow may be the most important value of large expanses of riparian wetlands along the Kankakee.

## Sampling Site Locations

The sampling sites used in this study are shown in Figure 7. These include water sampling sites (indicated by circles) and sedimentation transects set up on the north floodplain site. Shallow wells were also installed at sampling sites 1 through 4 and water level was continuously monitored at Station 2.

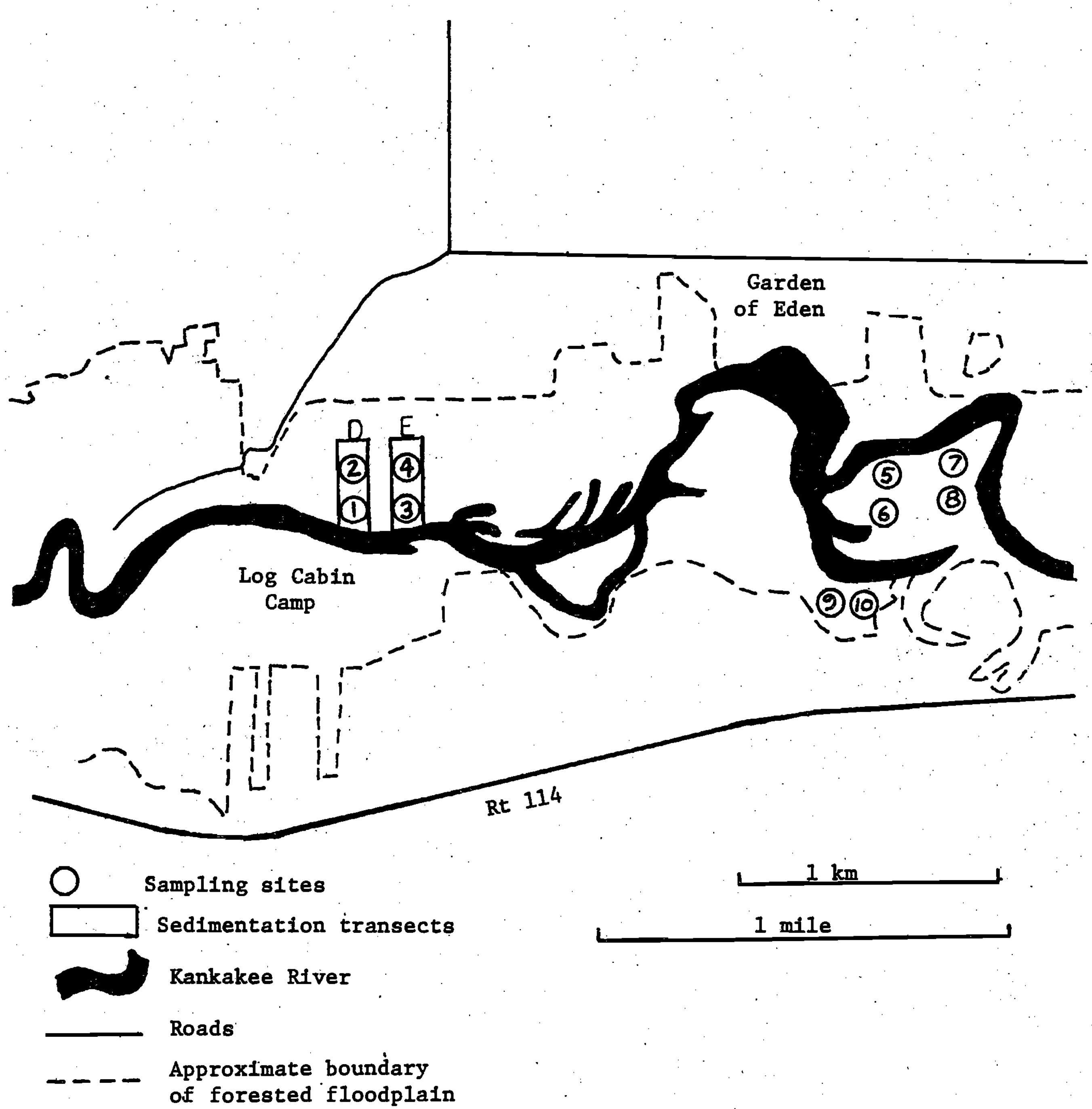


Figure 7. Location of Sampling Sites in Momence Wetlands.

# METHODS

## Hydrology

Groundwater and surface water levels were measured at Stations 1 through 4 (see Figure 7) from December 19, 1978, through June 2, 1979. During this period, river discharge data were obtained from the U.S. Geological Survey for their station at Momence, 8.5 km downstream from the study area.

Groundwater levels were measured using 5.1 cm diameter polyvinyl chloride (PVC) observation wells that were installed at Stations 1 through 4 to a depth of 1.25 to 2.0 meters. Slots approximately 2mm in width and at 1.0 cm intervals were cut into the sidewalls of the pipes to allow for hydrostatic balance with the groundwater. A Stevens water level recorder was installed on the well at Station 2 to continuously record groundwater and surface level. Water levels at the remaining wells were measured every 2 to 3 weeks before and after flooding and every 3 to 4 days during flooding. A fishing float on a line was lowered into each well to determine the level. The water levels during flooding were measured with a staff gauge attached to a tree. The wells were checked during flooding and were found to be at the same level as the surface water.

## Water Quality Sampling and Analysis

Water quality samples were taken in polyethylene bottles from the surface waters of the floodplain on both the north and south sides of the river. Sampling locations are shown in Figure 7. River channel samples were taken from the Kankakee River at the Momence bridge with a van Dorn sampler. Two samples were taken here and composited. Surface samples on the floodplain were taken from a canoe while well samples were extracted with a plastic hand pump from 4 shallow PVC wells on the north floodplain. All samples were immediately transported to the lab for refrigeration at about 4°C until they were transported again for analysis. No preservatives were used.

Samples were analyzed by Suburban Laboratories, Inc. in Hillside, Illinois, according to standard procedures (APHA, 1975). Total phosphorus and ortho-phosphate were determined by the stannous chloride method and nitrates were determined by the brucine method. Total solids were measured as the total residual after drying a sample at 103-105°C. Total suspended solids were determined as the nonfilterable residue (filter size = 0.45μ) dried at 103-105°C. Total organic solids represented the residue volatized at 550°C from unfiltered samples. Total inorganic solids were determined as the difference between total and organic solids.

Sedimentation

Two transects, each consisting of fifteen 10 x 10 meter cells were laid out on the floodplain study area, each perpendicular to the river channel (Figure 7). Sixty 23 x 23 cm plexiglass plates, with rough surfaces for better sediment retention, were placed along the transects, two per cell, in February 1979. Duplicate plates were placed in the center of each cell, about 1.5 to 2.0 meters apart. Flooding began in early March and floodwaters covered the plates until they were collected in mid-May. The plates were collected, along with the sediments that had accumulated, in marked plastic bags after the floodwaters had receded.

During the brief period between sample collection and analysis, samples were kept in the dark at 4°C. Sediment samples from each plate were suspended in 1 liter of distilled, deionized water, to obtain a uniform slurry. Large pieces of litter were removed at this time. Aliquots of the remaining suspension were analyzed for total and volatile suspended solids at 103°C and 550°C respectively (A.P.H.A., 1975). Phosphorus samples were digested using dilute HCl and autoclaving at 121°C for 45 minutes. The ascorbic acid method was used for phosphorus determination of the extract. Deposition was calculated by the following equation:

$$\text{Deposition } (g/m^2) = \frac{\dfrac{\text{grams measured (g)}}{\text{Aliquot volume (ml)}} \times \dfrac{1000 \text{ ml}}{1}}{0.053 \text{ m}^2}$$

# RESULTS AND DISCUSSION

## Floodplain Hydrology

Groundwater and surface water levels were measured on the Momence Wetlands study site during floodplain inundation to determine the duration of flooding and to identify possible relationships between floodplain hydrology and the main channel discharge as measured at Momence. The results include the Kankakee flood discharge during the study period, groundwater and surface water level fluctuations on the floodplain, and reconstruction of previous floodplain inundation from historical river flow.

Kankakee River Flood - The discharge for the Kankakee River during this study period is shown in Figure 8. Flooding began around March 3, 1979, and continued until early May. Peak discharge in the Kankakee River occurred on March 5 and was estimated to be at least 11,000 cfs; this rapid peak in early March was due to a combination of rainfall and a rapid thaw of snow in the basin. An ice blockage near Momence during peak flooding caused difficulty in estimating the peak discharge accurately. Rainfall occurring in the Kankakee River drainage basin during March through May caused several smaller peaks to occur. The estimated peak discharge measured at Momence has a recurrence interval of 50 years, based on frequence curves in Barker *et al.*, (1967).

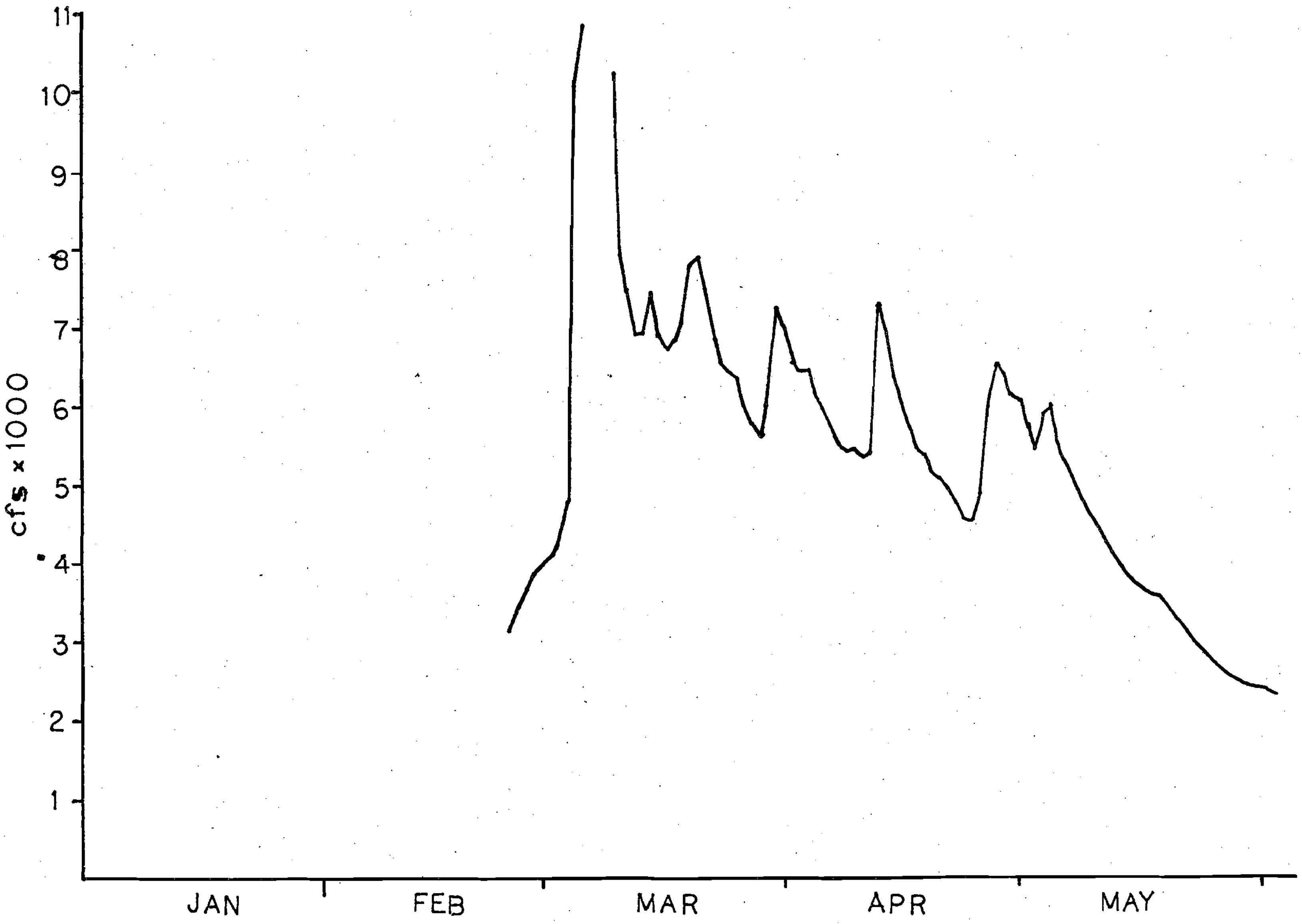


Figure 8. Kankakee River Discharge at Momence During Study Period. Data Were Not Available for January 1 - Feb. 23 When River Was Partially Frozen.

Water Level Fluctuations - The water level as measured continuously at Station 2 in the floodplain study site is shown in Figure 9. The water levels at Stations 1, 3, and 4 are shown in Figure 10. As expected, water levels in the wells and surface water levels were identical during flooding. Table 1 summarizes maximum floodwater depth that occurred at each station and the total number of days each station was inundated. Depth of floodwater above the soil surface at

Table 1

Maximum Depth of Floodwater and Days of Floodplain Inundation at Four Stations on Momence Wetlands Study Area

| Station | Maximum Depth of Inundation, meters | Days of Floodplain Inundation |
|---|---|---|
| 1 | 0.91 | 80 |
| 2 | 0.48 | 62 |
| 3 | 0.60 | 74 |
| 4 | 0.78 | 69 |

the stations ranged from 0.91 meters at Station 1 to 0.48 meters at Station 2. These depths showed that the soil surface elevation was 0.43 meters higher at Station 2 than Station 1. There is a decrease in elevation from Station 3 to 4, showing that there is no consistent gradient in the floodplain away from the river.

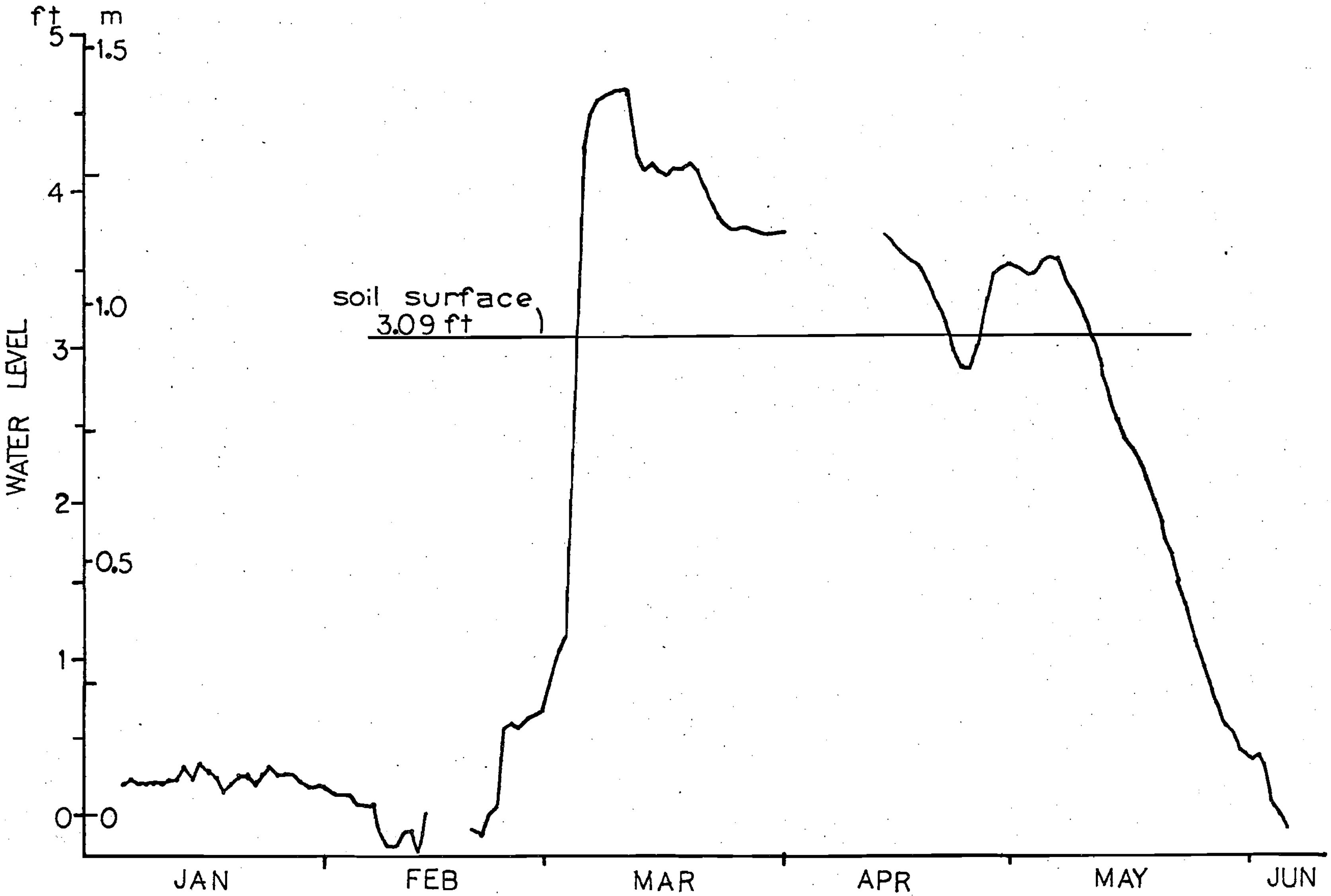


Figure 9. Daily Groundwater Level at Station 2 of Momence Wetland Study Area. Water Level Readings are Based on Staff Gage at Study Site.

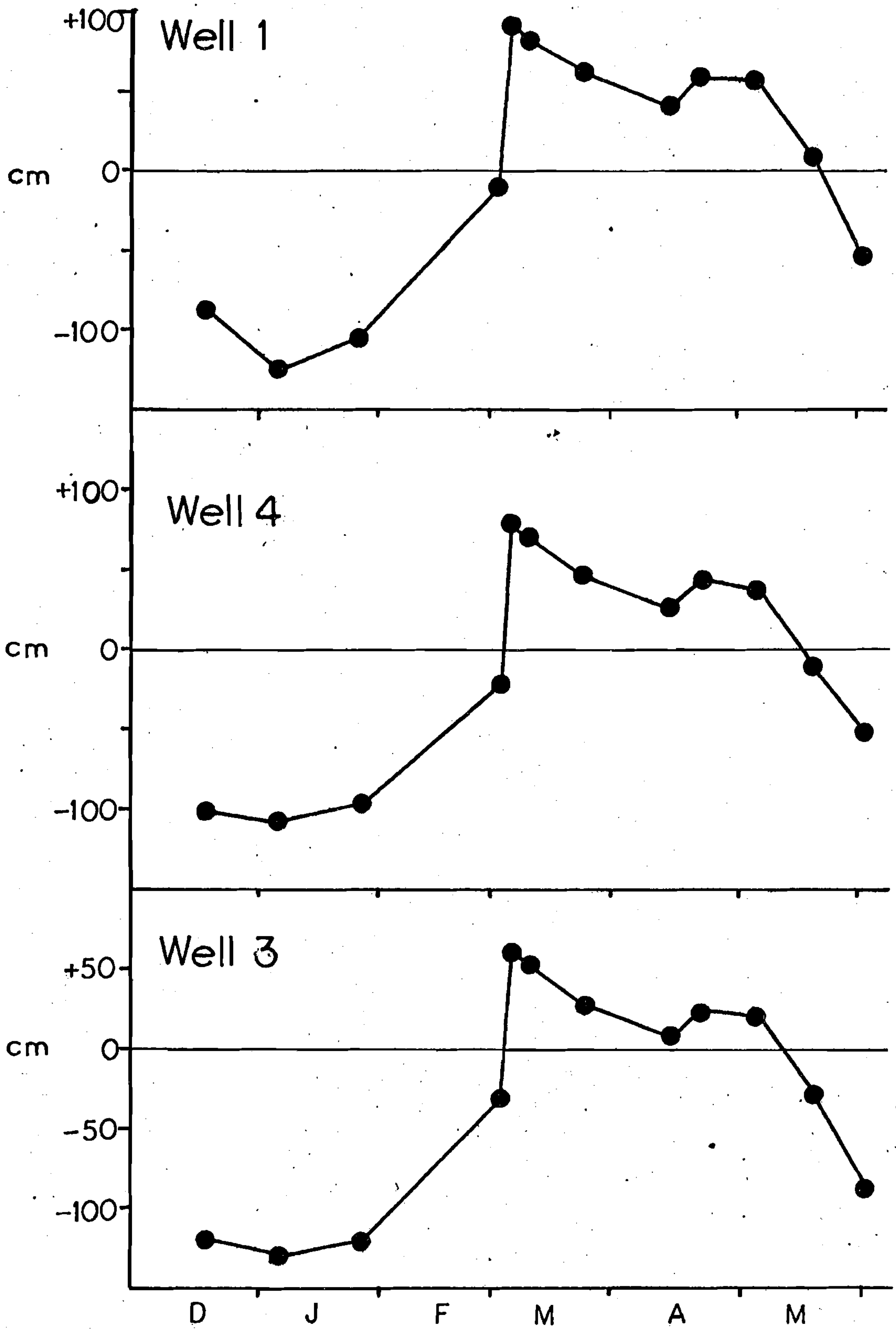


Figure 10. Water Elevations in Well 1, 3 and 4 on Momence Wetland Study Area. Levels are Indicated For Above (+) and Below (-) Soil Surface.

The length of time that the soil surface remained under water ranged from 62 days at Station 2 to 80 days at Station 1. Floodwater levels decreased below the soil surface at Station 2 for approximately 5 days while the floodwaters were receding. Subsequent rainfall caused the floodwaters to rise again, inundating the soil surface for another 14 days.

In this study, the floodplain stations were flooded when the Kankakee River discharged at Momence was between 4000 and 4500 cfs. These data agree with observations reported by Barker _et al._, (1967).

The Momence floodplain water level showed less fluctuations in daily water level than did the water level at Momence. This is shown in Figure 11. The floodplain is narrow at Momence and is located at the beginning of the rock outcrop. The water levels on the floodplain changed very little as a result of peak discharges, suggesting that the vast area of the floodplain may mitigate peak flow fluctuations downstream by storing floodwaters. The floodwater storage is partially caused by the very slight slope of the river through the Momence Wetlands area. The hydraulic gradient of the river in this area is 0.15 m/km (0.8 ft/mi) compared to a gradient of 0.85 m/km (4.5 ft/mk) downstream of the wetlands area.

A rough estimation of the significance of the floodwater storage on the floodplain ecosystems can be made by comparing the storage to the total "excess" of water discharged at Momence above bankfull discharge. From Figure 8 it was

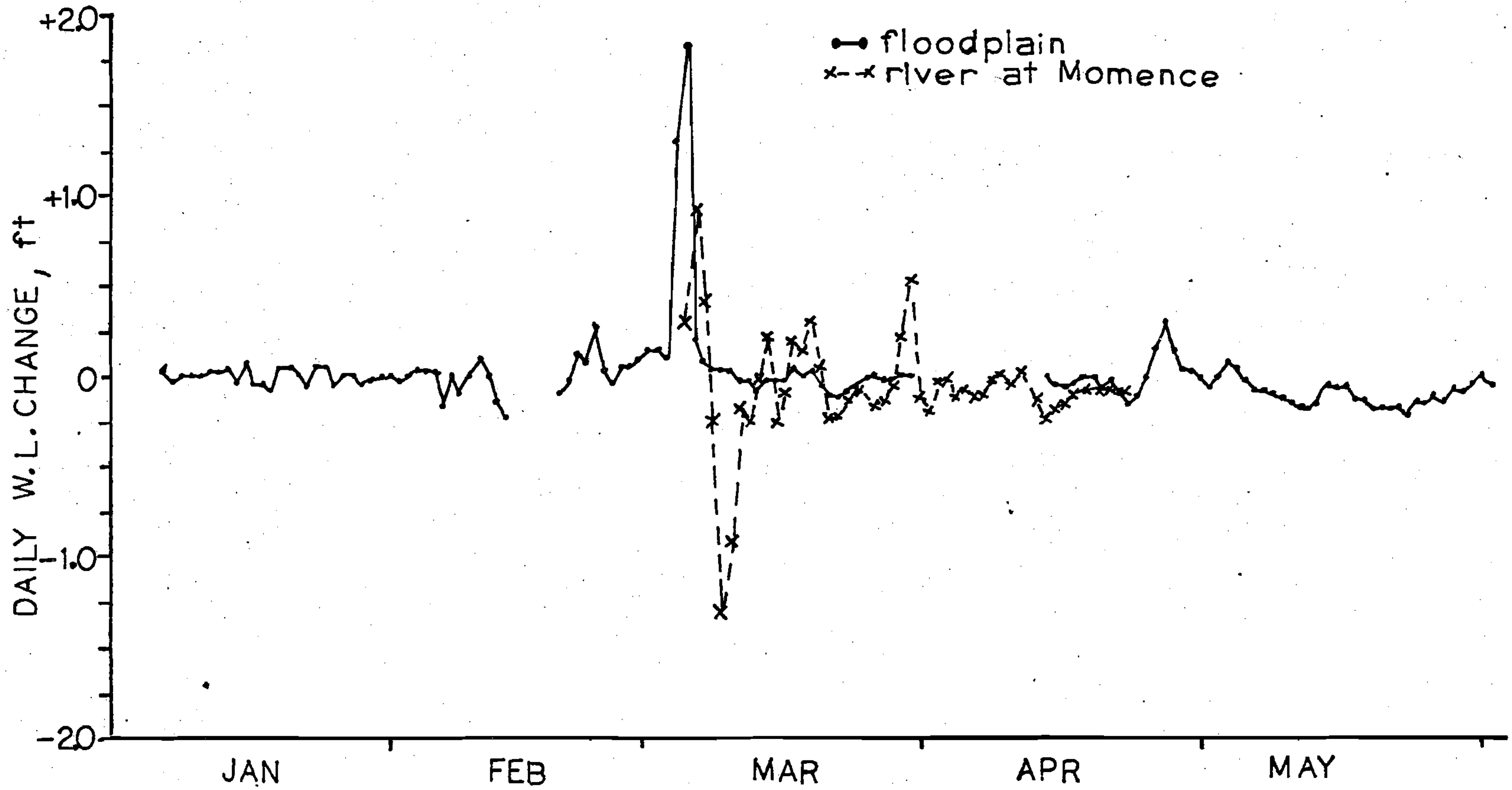


Figure 11. Daily Water Level Changes at Floodplain Study Area and at Stream Gaging Station at Momence.

estimated that 270 million cubic meters of water above 4500 cfs passed Momence as "floodwaters" between March 3 and April 23. During this time, the floodplain was storing an average of about 0.5 m as standing water and the equivalent of about 0.3 m as groundwater, giving the 770 ha of floodplain wetlands a storage of 6.2 million cubic meters of floodwater. The Momence Wetlands were thus "storing" about 2.3% of the total amount of floodwater that flowed pass Momence. Stated another way, the floodplain wetlands between the Indiana state line and Momence decreased downstream flooding by 2.3%. While this may not appear significant, the preservation of similar wetland areas along the entire Kankakee River would have a dramatic effect on decreasing downstream flooding.

Floodplain Flooding History - The peak annual discharges of the Kankakee River since 1917 are shown in Figure 12. Over the 62-year record there have been five years in which our floodplain study site, and presumably the entire Momence Wetlands area, have not been inundated. Over the remaining 57 years the floodplain has been inundated for periods that range from 2 to 110 days per year. Figure 13 shows the length of time the floodplain has been flooded each year and Table 2 presents a summary of flooding frequency and the days of inundation. Only once has the floodplain at the

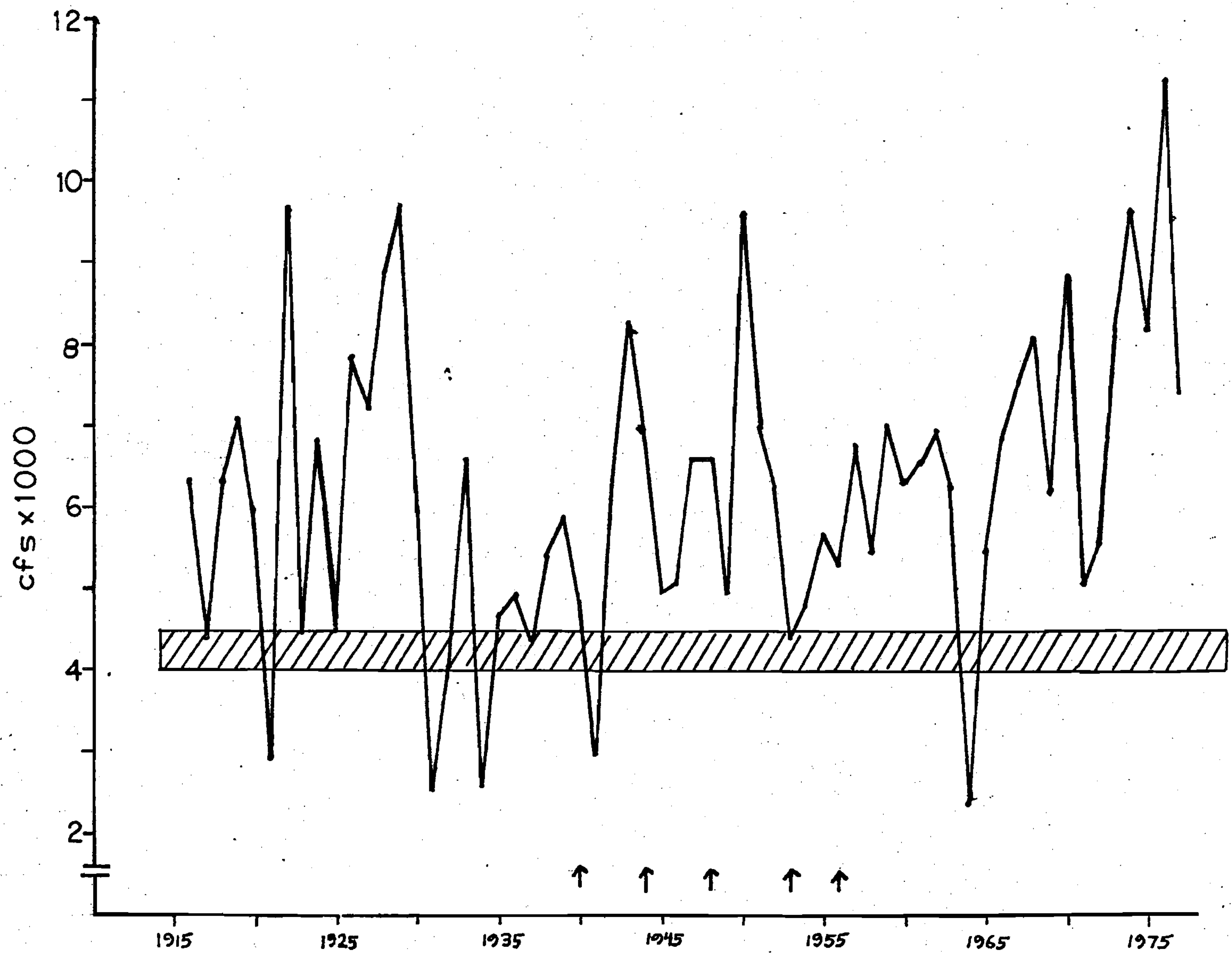


Figure 12. Peak Discharges of Kankakee River for Water Years 1916-1977. Arrows Indicate Drought Years and Hatched Area Indicates Range Above Which Inundation of Floodplain Takes Place.

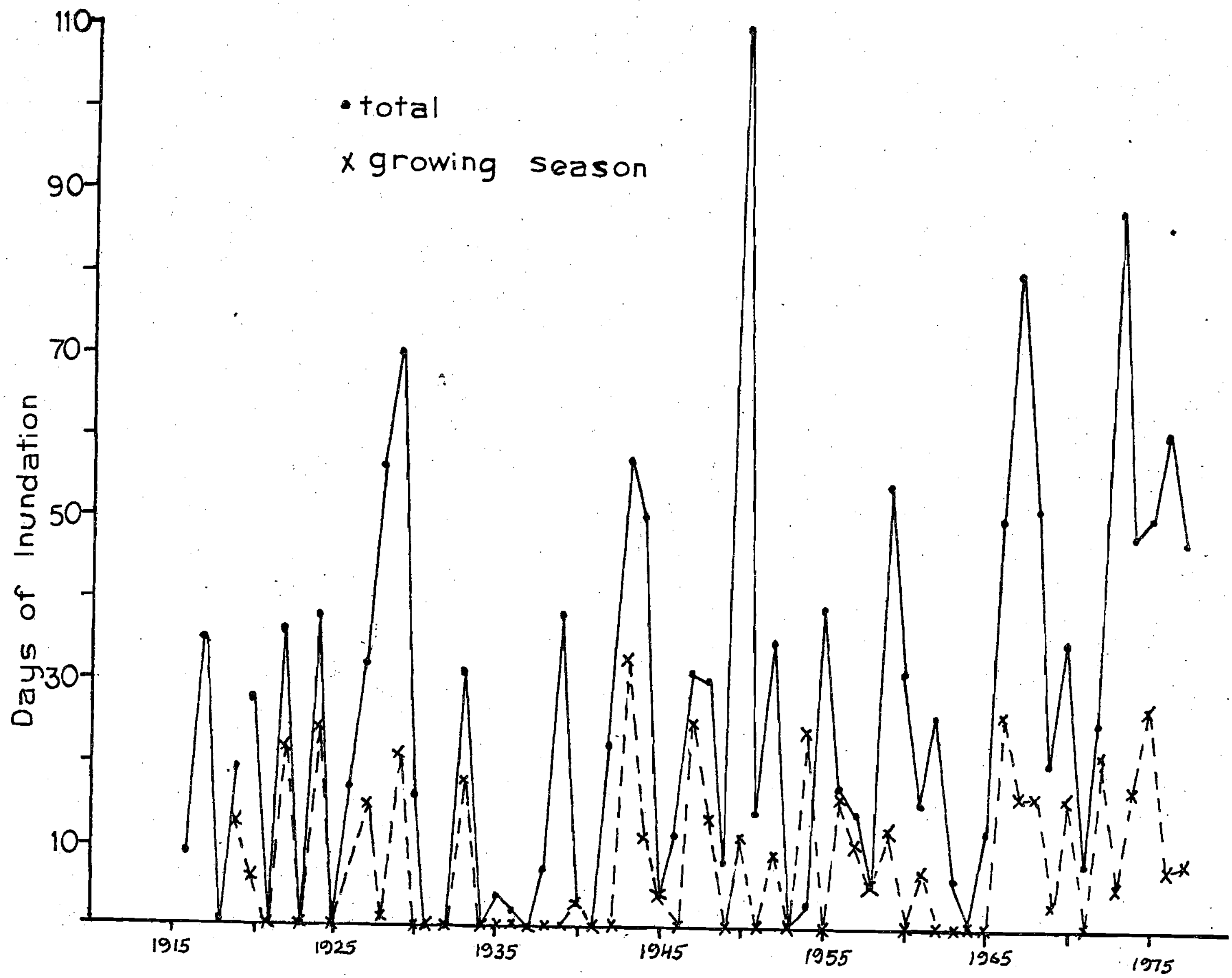


Figure 13. Days Per Year of Floodplain Inundation in Study Area. Total Days are for Water Year While Growing Season Days (May 1 - Oct 10) are for Calander Year.

Table 2

Flooding Duration for the Momence Wetlands on the Kankakee River for 1917 to 1978. Data Are Given for Annual Floods and for Flooding During Growing Season.[1]

| Annual Floods | | Floods During Growing Season[2] | |
|---|---|---|---|
| Days of Flooding | Frequency of Occurrence | Days of Flooding | Frequency of Occurrence |
| 10 | 41 | 5 | 31 |
| 25 | 30 | 10 | 23 |
| 50 | 13 | 20 | 7 |
| 75 | 4 | 25 | 3 |
| 100 | 1 | 30 | 1 |

[1]Floodplain inundation occurs between 4000 and 4500 cfs.

[2]The average growing season is May 1 through October 10.

study area been inundated for more than 100 days and in 66 percent of the years the floodplain is under water for 10 days or more. The flood in the spring of 1979, which inundated the floodplain for 62 to 80 days, depending on location, has only been exceeded in length of flooding on four occasions for the period of record since 1916.

During the average growing season for floodplain vegetation, from May 1 through October 10, the floodplain has been inundated for 30 days or more only once, and every other year it can be expected to flood for 5 days or less. The flooding during the growing season may have effects on the ecosystem vegetation that are different than the effects of flooding during the non-growing season. This is a potential area for more study in the Momence Wetlands.

Apparently, enough water enters the Kankakee River drainage basin to cause floodplain flooding even during drought years. Droughts have occurred in 1940, 1944, 1948, 1953 and 1956 in the Kankakee area (State of Indiana *et al.*, 1976). Figure 12 shows that the occurrence of peak discharges during these drought years all inundated the Momence floodplain.

## Floodplain Water Quality

Water quality data were collected on the Momence floodplain and from the Kankakee River during flooding to determine if significant changes occurred with time as the waters spilled over the river's banks and flowed imperceptibly across the floodplain for several weeks. It was also of interest to compare floodplain water quality with that in the main channel of the Kankakee River to determine if noticeable differences in water quality were occurring on the floodplain. If differences existed, they would suggest active physical, chemical or biological processes occurring as the water remains with long detention time on the floodplain. The analyses were chosen to represent those that may indicate significant changes in nutrient and sediment concentrations. The original data for water quality are given in Appendix A. The data will be discussed separately as surface water and well water.

Surface Water - Table 3 gives the averages and standard errors for standing water on the floodplain during the flooding. All data represent the period when stations were 0.5-0.9 meters under water. The change in water level was only 36 cm during this period and no correlations of water quality with depth were noted. Samples were averaged where it was felt that the water was well mixed, e.g. sta-

Table 3

Water Quality for Floodplain Sites and Kankakee River During Flooding (Average ± standard error)

| | South Floodplain Stations 5-8 | South Floodplain Backwater Stations 9-10 | North Floodplain Stations 1-4 | Kankakee River at Momence[1] |
|---|---|---|---|---|
| Number of samples | 12 | 6 | 16 | 8 |
| Date of Sampling | March 6 - April 14 | March 6 - April 14 | March 10 - April 21 | March 6 - May 5 |
| Total Phosphorus, mg - P/1 | 0.46 ± 0.12 | 0.77 ± 0.35 | 0.54 ± 0.13 | 0.42 ± .07 |
| Ortho-P, mg - P/1 | 0.26 ± 0.13 | 0.20 ± 0.09 | 0.24 ± 0.13 | 0.21 ± .07 |
| Total suspended solids, mg/1 | 18 ± 2 | 14 ± 3 | 27 ± 5 | 33 ± 8 |
| Total solids, mg/1 | 418 ± 31 | 489 ± 31 | 458 ± 39 | 483 ± 33 |
| Total organic solids, mg/1 | 139 ± 10 | 174 ± 7 | 165 ± 6 | 172 ± 8 |
| Total inorganic solids, mg/1 | 280 ± 20 | 315 ± 26 | 295 ± 30 | 315 ± 16 |
| Nitrates, mg-N/1 | 2.1 ± 0.3 | 1.6 ± 0.2 | 2.1 ± 0.1 | 2.2 ± 0.2 |

1 Two samples composited in field for each sample.

tions 1-4, 5-8 and 9-10. The Kankakee River water quality is also given in Table 3 for comparison. There is no consistent spatial variation among the floodplain sites for the water quality parameters measured. Total phosphorus in the floodplain waters averaged 0.5 - 0.8 mg-P/l while ortho-phosphate was around 0.2 - 0.3 mg-P/l. Much of the phosphorus is thus tied up in organic and inorganic sediments. A plot of the phosphorus that is not in the form of ortho-phosphate vs. the total suspended sediments gives a trend of higher P with higher suspended sediments but there is much scatter of data in the low ranges most frequently seen (Fig. 14). Obviously, sediments are important for transport and deposition of phosphorus to the floodplain forest.

There are few differences among the sites for organic and inorganic residue. The samples averaged from 28 to 33 percent organic residue at each of the three sites. Suspended sediments were higher on the north floodplain site, suggesting that the north site may have fewer sediments depositing than the south sites. It was observed that there was more macro litter (large branches, fallen trees, etc.) on the north site so that currents may be greater through this site, thus depositing fewer sediments. On the north floodplain, suspended sediments averaged 21 mg/l at 30 meters from the river channel and 33 mg/l at 70 meters from the channel. This spatial pattern is consistent with what is known about deposi-

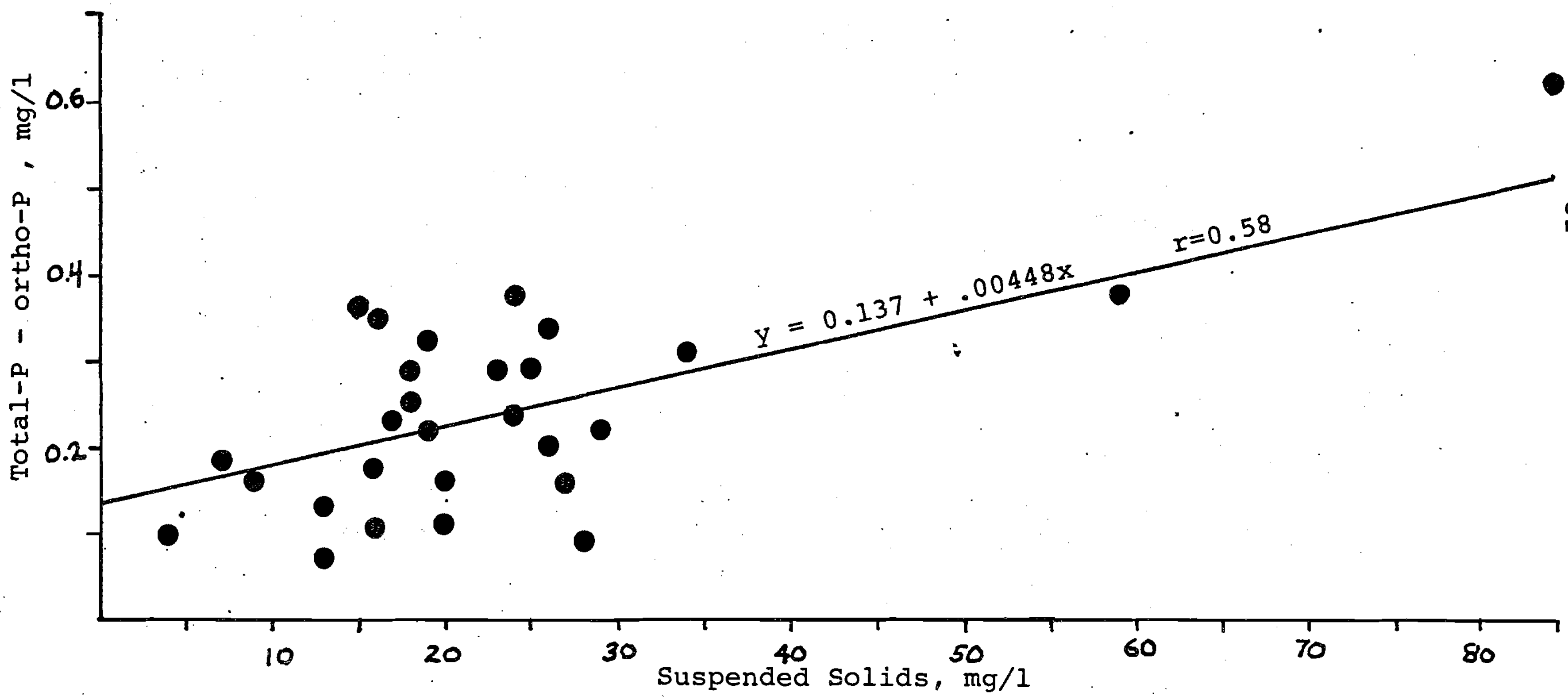


Figure 14. Relation of Total Phosphorus minus ortho-Phosphorus to Suspended Solids for Surface Waters on Momence Wetlands.

tion of sediments on floodplains - it is often greatest near the original channel and thus forms a natural levee along the channel over the years. This theory can be compared with the actual sedimentation results in the next section.

Leopold et al., (1964) suggest that the fine materials that make up the silt load of a river are not deposited uniformly but that irregular flows over the floodplain may cause scour rather than deposition in different locations. Suspended sediments, therefore, may be an indirect measure of velocities across the floodplain that are otherwise too low to measure. In our study, lowest velocities are thus represented at Stations 6, 9 and 10 (see Figure 7) which are all apparently more representative of backwater areas that may be accumulating sediments more rapidly.

When the floodplain water quality is compared with that of the Kankakee main channel as measured at Momence (Table 3), surprisingly little difference is seen. Average suspended sediment concentrations are slightly higher in the river, due primarily to high sediment loads measured on March 6 and 31, but other parameters show no differences. Paired-t tests revealed that there were no significant differences ($\alpha$=0.05) in water quality on the north floodplain and in the river. Plots of temporal variation of selected measures of solids are given in Figures 15 and 16.
No consistent patterns were observed in these graphs although

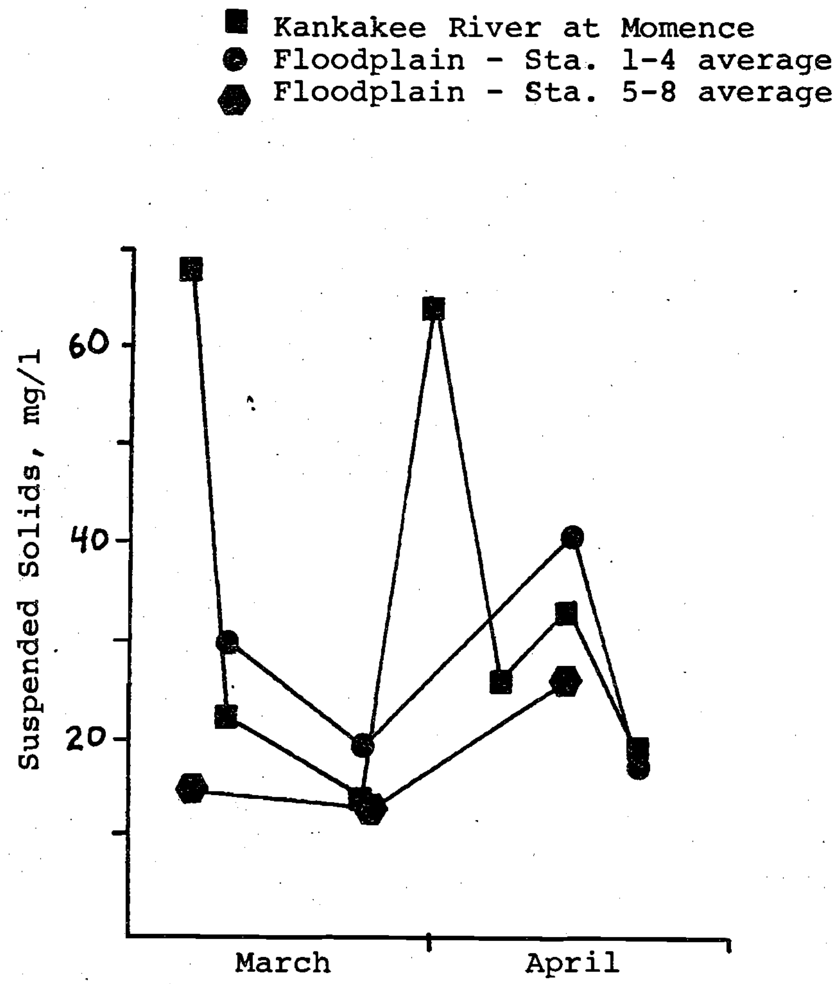


Figure 15. Comparison of Suspended Sediments in Floodplain Standing Water and in Kankakee River.

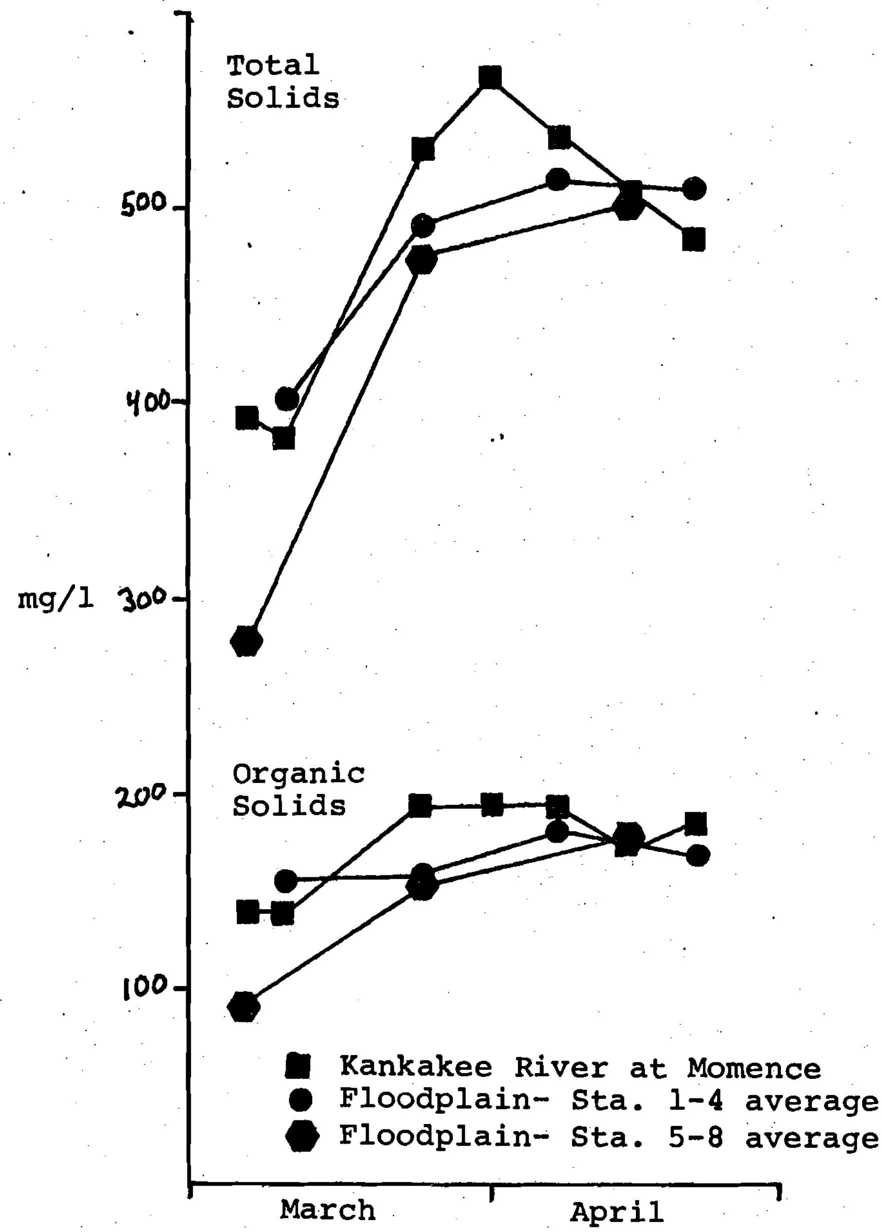


Figure 16. Comparison of Total and Organic Solids in Floodplain Standing Water and in Kankakee River.

they indicate that the southern floodplain (Stations 5-8) generally had lower sediments and dissolved materials than the river. To infer any more from these data would require more frequent sampling at all locations.

Nitrate levels were also very similar for samples taken in the floodplain and in the river. This parameter was included in the study because it was speculated that the close proximity of the sediments to the overlying waters on the floodplain might lead to nitrate removal as shown by Engler _et al._, (1974). That study found that nitrate was removed in laboratory studies of intermittently-flooded freshwater swamp soils. Our study gave no indication that this was occurring over the flooded sediments in the Momence Wetlands. Thus the question of whether the floodplain acts as a nitrogen sink during flooding remains unresolved from these surface water data.

_Shallow groundwater_ - Water quality was observed in 4 shallow wells installed at stations 1 through 4. These data are given in Table 4. During flooding, the water level in the well was in hydrostatic balance with the water level on the floodplain and little differences in water quality were noted between the surface waters and the well water. As the flooding waters receded, however, the quality of the water changed dramatically. Samples taken after the flood were high in total and suspended solids as

Table 4

Water Quality of Floodplain Well Samples at Momence Wetlands

| Parameter | Date 3/24[1] | 4/14[1] | 4/21[1] | 5/5[2] | 5/19[1] | 6/2[2] |
|---|---|---|---|---|---|---|
| Total Phosphorus, mg/l | 0.14 | 0.20 | 0.17 | 1.01 | 0.26 | 1.50 |
| Ortho - Phosphorus, mg-P/l | 0.76 | 0.81 | 0.05 | 0.12 | 0.16 | 0.91 |
| Total solids, mg/l | 555 | 547 | 639 | 510 | 644 | 999 |
| Total organic solids, mg/l | 169 | 165 | 235 | 155 | 255 | 140 |
| Total inorganic solids, mg/l | 386 | 382 | 404 | 355 | 389 | 859 |
| Total suspended solids, mg/l | 15 | 18 | 27 | 10 | 60 | 430 |
| Total dissolved solids, mg/l | 540 | 529 | 612 | 500 | 584 | 565 |
| Nitrates, mg-$NO_3$/l | 1.48 | 1.27 | 2.10 | 1.46 | 584 | 565 |

1 Average of three samples.

2 Average of four samples.

would be expected but variable in dissolved nutrients. Figure 17 shows that while dissolved ortho-phosphates increased as the water level decreased, the level of nitrates decreased. This suggests that denitrification does occur in the saturated soils but available phosphorus becomes concentrated in the soil water as it comes in contact with soil particles. Because these two nutrients are most often limiting to the productivity of the floodplain forest, the decreasing N/P ratio suggests that the floodplain forest may be ultimately limited by nitrogen availability in the soils. The nitrate data also suggest that the nitrate that is left behind after the river recedes does not all find its way back to the river in the drier season despite the high mobility of nitrate in groundwater systems. Thus, while little nitrate is removed while the floodplain is flooded, a significant amount may be lost after the river recedes and the upper soils are saturated and anaerobic .

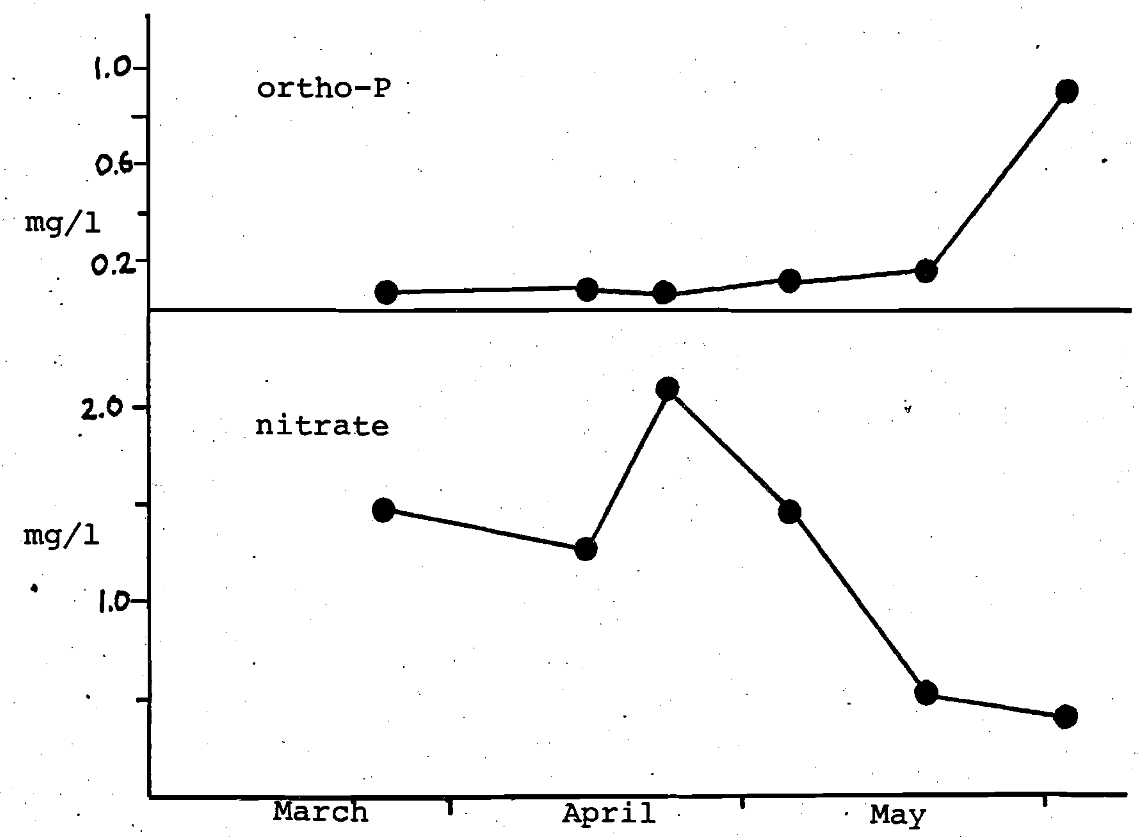


Figure 17. Average Concentrations of ortho-Phosphates (mg-P/l) and Nitrates (mg-$NO_3$/l) in Shallow Wells During and After Flooding (Averages for Stations 1-4).

## Floodplain Sedimentation

The deposition of sediments from the flooding river may be an important input of nutrients and soil material to the floodplain forest. Furthermore, the sediments that collect on the floodplain may aid in reducing the sediment load in the river, thus reducing problems associated with downstream depositions of sediments such as sanbars and filled-in resevoirs. As stated by Leopold _et al._, (1964), "It is...apparent...that if overbank flooding by sediment-laden waters does occur, some deposition will in all likelihood, be associated with it." It comes as no surprise that the richest and most desirable soils for agriculture are often found in formerly flooded soils along rivers.

Few studies have been able to quantify the amount of sedimentation that occurs during the flooding of a riparian ecosystem. This part of the study sought to quantify the amount of sediments deposited on the Momence Wetlands during the spring flood of 1979. While some of the deposition is obviously due to shifting sediments from adjacent locations. the measurements presented here will give an upper limit to the sediment collecting ability of the floodplain systems along the Kankakee River.

_Sediment Deposition_ - A summary of the sedimentation results is given in Table 5. Complete data are given in Appendix B. Data are presented in terms of grams deposited

Table 5

Summary of Results of Sedimentaion on Momence Floodplain For Two Transects.

| | West Transect(D)[1] | East Transect(E)[1] |
|---|---|---|
| **Total Sedimentation, g/m$^2$** | | |
| Average | 471 | 680 |
| Range | 25.-3760 | 38-3440 |
| Standard Deviation | 815 | 899 |
| Standard Error | 174 | 167 |
| **Inorganic Sedimentation, g/m$^2$** | | |
| Average | 378 | 547 |
| Range | 21-3309 | 28-2849 |
| Standard Deviation | 713 | 735 |
| Standard Error | 152 | 103 |
| **Organic Sedimentation, g/m$^2$** | | |
| Average | 93 | 133 |
| Range | 4-451 | 10-592 |
| Standard Deviation | 111 | 149 |
| Standard Error | 24 | 28 |
| Phosphorus Concentration, mg/g (n=15) | 2.23 | 2.30 |

[1]Number of Samples are 22 for West Transact and 29 for East Transect.

per square meter. Table 6 presents the averages and standard errors for all of the samples. There was considerable range of sediment accumulation measured (45 to 3760 g/m$^2$), and the averages of the two transects were somewhat different (471 and 680 g/m$^2$) for the west and east transects respectively. The samples were consistent in the organic fraction, averaging 20% as organic substrate with a total range of only 12 to 48 percent for all samples. The high inorganic content indicates that the sediments are more characteristic of suspended river sediments that of resuspended materials from the floodplain itself.

The total sedimentation of 590 g/m$^2$ during the flooding of the Kankakee River is similar to that estimated by Mitsch _et al._, (1977) during flooding of a riparian cypress swamp in southern Illinois (447 g/m$^2$ ). The phosphorus deposition of 1357 mg/m$^2$ on the Momence Wetlands is considerably less than the 3600 mg/m$^2$ estimated for that same cypress swamp. An estimate of 3250 mg/m$^2$ of phosphorus input to floodplain cypress swamp in Florida (Brown, 1978) is also much higher than the value measured in the Momence Wetlands. This is not surprising as each of the studies cited above involves riparian ecosystems being fed by phosphorus-rich rivers. The river that flooded the southern Illinois cypress swamp, particularly, had clayey sediments that were estimated to contain 8.0-9.8 g P/ g dry weight (Mitsch _et al._, in press)

Table 6

Average and Standard Errors for Both Transects of Sediment Deposition for Samples Collected in Momence Wetlands During Flooding by Kankakee River.

| | Floodplain Deposition (ave. $\pm$ std error) |
|---|---|
| Total Sediments (n=51) | 590 $\pm$ 121 $g/m^2$ |
| Organic Sediments (n=51) | 116 $\pm$ 19 $g/m^2$ |
| Inorganic Sediments (n=51) | 474 $\pm$ 103 $g/m^2$ |
| Phosphorus Deposition[1] | 1357 $mg/m^2$ |

[1]Average P concentration multiplied by average total sedimentation.

while the Momence Wetlands sediments averaged 2.3 g P/g dry weight. The water chemistry of the floodplain also indicates low concentrations of phosphorus in the Kankakee River waters, the average being 0.54 mg/l (see water chemistry section) compared to 1.81 mg/l measured in the southern Illinois cypress swamp durign flooding (Mitsch et al., 1977). The sandy sediments of the Kankakee River, then, are less concentrated in nutrients than the clay sediments of rivers more typical of the Midwest.

Frequency Distribution - A frequency diagram, showing the different number of samples collected for each range is shown in Figure 18. Sixteen of the 51 samples analyzed had low (0-100 $g/m^2$) sedimentation measurements, suggesting an exponential decrease in frequency vs. sedimentation rate. These low depositions were offset, however, by 4 measurements that were above 2200 $g/m^2$. It is unclear what caused the high measurements. The three highest depositions were all measured close to the river channel at 5-15 meters from the river channel. This suggests that higher depositions near the channel may be part of the natural levee building process of our floodplain sites. This will be discussed further in the next section. The infrequent sedimentation at higher values suggest that even 51 plates may not be sufficient to determine the average sedimentation on our study plots. If the four high samples are eliminated, the average sedimentation for the remaining plates is 373 $g/m^2$. This probably

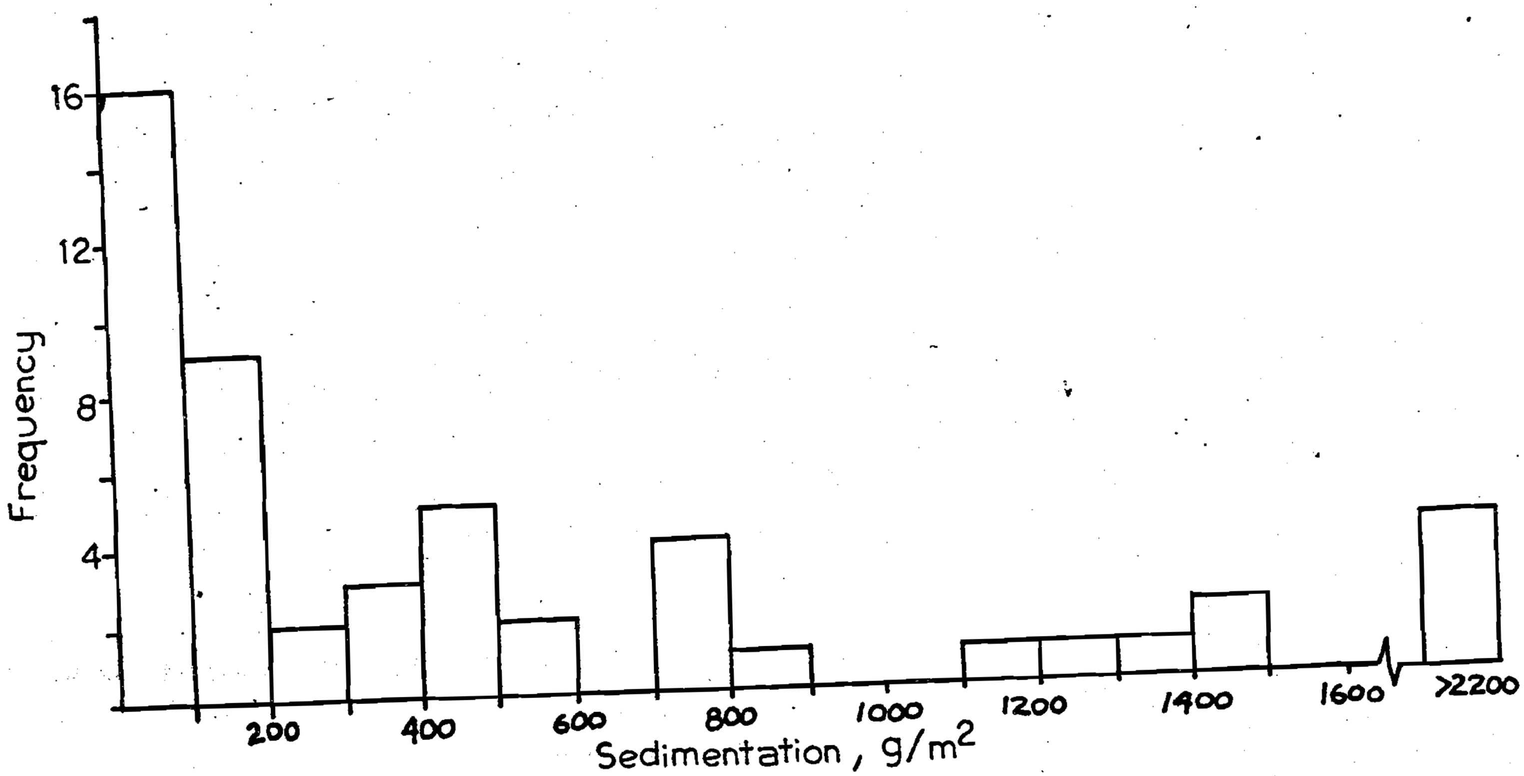


Figure 18. Frequency Diagram for Sedimentation Samples Collected in Momence Wetlands.

represents a more accurate measure of sediments depositing on the Momence floodplain. More study of the frequency of deposition along the levee may show whether these measurements are due to "pockets" of excessive sedimentation or whether errors in sampling procedure were responsible.

Spatial Patterns - Figure 19 is a plot of sediment deposition versus distance from the river channel. The development of floodplains suggests that greater depositions usually occur closest to the river, thus forming, over many years, a natural levee adjacent to the river with decreasing depositions inland. The three sedimentation measurements in excess of 3000 g/$m^2$ did occur within 15 m of the river, but more data would have to be collected to substantiate this fact. The large variations in the data suggest that the sediment deposition process on floodplains is "randomly patchy", that is, it does not occur uniformly from one location to the next and no definitive spatial pattern is exhibited.

Total Deposition and Error Analysis - It is apparent that the sediments collected in the field with flat collection plates were a combination of materials contributed from the river and from adjacent areas on the floodplain that became resuspended during flooding. Large particles, mostly leaf litter, were removed before analysis to minimize measurement of resuspended materials. However, the estimates can be

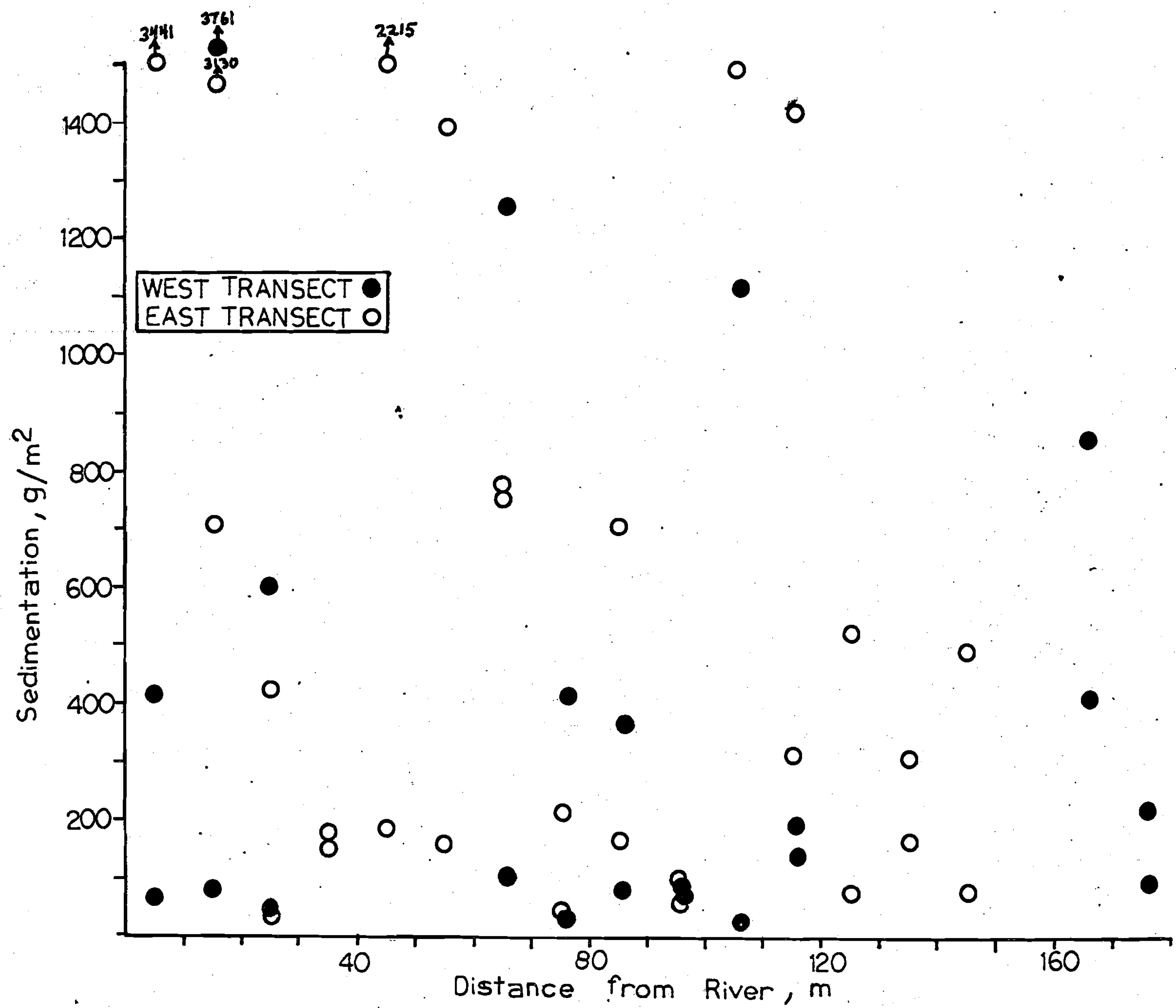


Figure 19. Total Sedimentation versus Distance from Main Channel of Kankakee River.

assumed to represent an upper limit of the sediment contribution from the Kankakee River to the Momence Wetlands during flooding. The low organic content of the sediments (20% average) suggests that much of the material collected had river origin rather than floodplain origin, but the uncertainty remains. Future studies of this type would benefit if the collecting plates are fastened slightly above the forest floor to minimize the resuspension error.

With the above-mentioned caveat, however, an estimation of total deposition on the floodplains from the Kankakee River can be obtained by assuming that the total deposition of 590 grams/$m^2$ resulted from river sediments. The 770 hectares of floodplain wetlands in the Momence Wetlands study are then estimated to have collected 4500 metric tons of sediment during the spring flood of 1979. This value will have more significance when it is compared with the total sediment discharge during the flood period for the Kankakee River.

# CONCLUSIONS

## Study Conclusions

This study of the Momence Wetlands along the Kankakee River in northeastern Illinois during the flood season of 1979 has resulted in the following conclusions:

1. The Momence Wetlands have flooded almost every year since river records began in 1917. The wetlands have remained flooded for at least 10 days in 66% of those years. The riparian ecosystem is thus well tuned to frequent flooding and may change significantly if flood control measures are taken in this area.
2. The floodplain wetlands retained about 6.2 million cubic meters of floodwater between March 3 and April 23, 1979, this representing about 2.3% of the floodwater that is discharged from the study area. The storage of floodwaters by floodplain wetlands could be very significant if similar areas are allowed to flood naturally in Indiana rather than being eliminated by artificial levees, channel modification and drainage.
3. Water quality does not change appreciably as the river flows over the floodplain wetlands although the resulting water quality during flooding is a result of natural and man-made inputs. There

was no significant difference between river water quality and surface water on the floodplain during the flood season. Groundwater that remains in the floodplain after flooding, however, changes significantly as the floodwater recedes.

4. Significant amounts of sediments are collected on the floodplain during flooding, these sediments originating from both the river and adjacent floodplain areas. No significant increase in sediment loads were noted in the floodplain water quality, thus indicating that there is a net deposition of sediments from the river during flooding.

5. Floodplain wetlands, particularly those that are frequently flooded, play an important role in maintaining natural water and sediment dynamics in the adjacent river.

## Additional Needed Research

This study, one of the first of its kind on floodplain ecosystems during the flood season, has resulted in the identification of several needed studies.

1. Future sedimentation studies are needed to determine the net input of sediments to the floodplain. This may be accomplished by keeping the collecting plates well above the soil level to minimize resuspension from the floodplain litter.

2. The growth of floodplain trees in response to floodplain flooding can be determined through analysis of tree rings of selected tree species that a) show good annual rings, and b) are on the fringe between flooded and upland areas.
3. The importance of the riparian ecosystem on the river water quality can be further investigated by studies of groundwater input to the river during dry season.
4. Sediments are important for transport of nutrients to the floodplain forest. Quantification is needed of the nutrients that are transported by the sediments and are biologically available through leaching after the flood has receded.
5. Comparative studies of sedimentation on other riparian ecosystems are needed to better describe the importance of this input to ecosystem structure and function.

REFERENCES

American Public Health Association. 1975. Standard Methods For the analysis of water and wastewater, 14th ed. A.P.H.A. Wash. D.C. 1193 p.

Barker, B., J. Carlisle and R. Nyberg, 1967. Kankakee River basin study. A comrehensive plan for water resource development. Bureau of Wasterways, Dept. of Public Works and Buildings, State of Illinois, Springfield.

Brown, S. L. 1978. A comparison of cypress ecosystems in the landscape of Florida. Ph.D. diss. Univ. of Florida, 569 p.

Johnson, R. R. and J. F. McCormick, tech. coord. 1979. Strategies for protection and management of floodplain wetlands and other riparian ecosystems. Proc. symp. Dec 11-13, 1978, Callaway Gardens, Ga., Gen Tech Rep. WO-12, Forest Service, U.S. Dept. Agric. Wash. D.C. 410 p.

Kurz, D. 1978. Vegetation of the Momence wetlands. Unpublished report, Natural Land Institute, Rockford, Illinois.

Leopold, L. B., M. G. Wolman and J. P. Miller, 1964. Fluvial processes in geomorphology. W. H. Freeman, San Francisco 522 p.

Meyer, A. H. 1935. The Kankakee marsh of northern Indiana and Illinois, Mich. Acad. Sci. 21:359-396.

Mitsch, W. J., C. L. Dorge and J. R. Wiemhoff. 1977. Forested wetlands for water resources management in southern Illinois. Res. Rept 132, Water Resources Center, Univ. of Ill., Champaign-Urbana. 275 p.

Mitsch, W. J., M. D. Hutchison and G. A. Paulson. 1979. The Momence wetlands of the Kankakee River in Illinois - an assessment of their value. Final report to the Institute of Natural Resources, Chicago, Ill. Doc. 79/17, May 1979.

Mitsch, W. J. C. L. Dorge and J. R. Wiemhoff. In press. Ecosystem dynamics and a phosphorus budget of an alluvial cypress swamp in southern Illinois. Ecol.

Odum, E. P. 1979. Ecological importance of the riparian zone. Pages 2-4 IN Johnson, R. R. & J. F. McCormick (tech, coord.) Strategies for protection and management of floodplain wetlands and other riparian ecosystems Proc. Symp. Dec 11-13, 1978, Callaway Garden., GA., Gen Tech. Rep. WO-12, Forest Service, U.S. Dept. Agric. Wash. D.C.

APPENDIX A

MOMENCE WETLANDS WATER QUALITY DATA

Sample Location: Kankakee River at Momence

| Parameter | Date (1979) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 3/6 | 3/10 | 3/24 | 3/31 | 4/7 | 4/14 | 4/21 | 5/5 | 5/19 | 6/2 |
| Total Phosphorus, mg/l | 0.552 | 0.429 | 0.843 | 0.537 | 0.230 | 0.353 | 0.184 | 0.244 | 0.322 | 0.728 |
| Ortho-P, mg/l | 0.117 | 0.138 | 0.613 | 0.230 | 0.037 | 0.061 | 0.061 | 0.086 | 0.074 | 0.043 |
| Total solids, mg/l | 392 | 384 | 532 | 568 | 536 | 508 | 484 | 492 | 560 | 556 |
| Total organic solids, mg/l | 140 | 140 | 192 | 192 | 192 | 172 | 184 | 164 | 252 | 137 |
| Total suspended solids, mg/l | 68 | 22 | 14 | 64 | 26 | 33 | 19 | 15 | 12 | 23 |
| Total inorganic solids, mg/l | 252 | 244 | 340 | 376 | 344 | 336 | 300 | 328 | 308 | 419 |
| Nitrates, mg-$NO_3$/l | 1.70 | 2.60 | 1.64 | 2.50 | 1.45 | 2.50 | 2.02 | 3.20 | 1.20 | 0.75 |
| River Flow, cfs x 1000 | 10.8 | 7.9 | 6.4 | 7.0 | 5.5 | 6.0 | 4.9 | 5.5 | 3.4 | 2.3 |

# MOMENCE WETLANDS WATER QUALITY DATA

Sample Location: Surface Water on North Floodplain (Transect D)
Stations 1 and 2

Date (1979)

| Parameter | 3/10 (1) | 3/10 (2) | 3/24 (1) | 3/24 (2) | 4/14 (1) | 4/14 (2) | 4/21 (1) | 4/21 (2) | 5/5 (1) | 5/19 (1) |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Phosphorus, mg/l | 0.429 | 0.245 | 0.497 | 1.79 | 0.484 | 0.629 | 0.291 | 0.169 | 0.148 | 0.644 |
| Ortho-P, mg/l | 0.067 | 0.080 | 0.067 | 1.50 | 0.190 | 0.006 | 0.037 | 0.061 | 0.067 | 0.490 |
| Total solids, mg/l | 416 | 376 | 480 | 492 | 508 | 560 | 508 | 520 | 524 | 728 |
| Total organic solids, mg/l | 164 | 120 | 172 | 140 | 180 | 192 | 148 | 176 | 168 | 324 |
| Total suspended solids, mg/l | 15 | 27 | 13 | 23 | 25 | 84 | 18 | 16 | 34 | 19 |
| Total inorganic solids, mg/l | 252 | 256 | 308 | 352 | 328 | 368 | 360 | 344 | 356 | 404 |
| Nitrates, mg-$NO_3$/l | 2.80 | 2.80 | 1.64 | 1.58 | 2.80 | 1.50 | 1.76 | 1.80 | 14.5 | 0.26 |
| Stage, Ft. | 4.18 | 4.18 | 3.30 | 3.30 | 3.16 | 3.16 | 2.98 | 2.98 | 3.01 | 1.38 |

MOMENCE WETLANDS WATER QUALITY DATA

Sample Location: **Surface Water on North Floodplain (Transect E) Stations 3 and 4**

| Parameter | Date (1979) 3/10 (3) | 3/10 (4) | 3/24 (3) | 3/24 (4) | 4/14 (3) | 4/14 (4) | 4/21 (3) | 4/21 (4) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Phosphorus, mg/l | 0.429 | 0.484 | 1.81 | 0.261 | 0.307 | 0.245 | 0.383 | 0.184 | | |
| Ortho-P, mg/l | 0.107 | 0.107 | 1.47 | 0.086 | 0.107 | 0.025 | 0.006 | 0.117 | | |
| Total solids, mg/l | 380 | 432 | 448 | 548 | 516 | 472 | 504 | 512 | | |
| Total organic solids, mg/l | 148 | 188 | 132 | 180 | 200 | 152 | 164 | 180 | | |
| Total suspended solids, mg/l | 19 | 59 | 26 | 16 | 26 | 29 | 24 | 13 | | |
| Total inorganic solids, mg/l | 232 | 244 | 316 | 368 | 316 | 320 | 340 | 332 | | |
| Nitrates, mg-$NO_3$/l | 2.70 | 2.60 | 2.20 | 1.25 | 2.40 | 1.45 | 1.76 | 2.20 | | |
| Stage, Ft. | 4.18 | 4.18 | 3.30 | 3.30 | 3.16 | 3.16 | 2.98 | 2.98 | | |

MOMENCE WETLANDS WATER QUALITY DATA

Sample Location: Surface Water on South Floodplain (Transect B)
Stations 5 and 6

| Parameter | Date (1979) 3/6 (5) | 3/6 (6) | 3/24 (5) | 3/24 (6) | 4/14 (5) | 4/14 (6) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Phosphorus, mg/l | 0.353 | 0.291 | 1.93 | 0.184 | 0.429 | 0.429 | | | | |
| Ortho-P, mg/l | 0.190 | 0.107 | 1.64 | 0.084 | 0.337 | 0.190 | | | | |
| Total solids, mg/l | 280 | 292 | 508 | 476 | 520 | 492 | | | | |
| Total organic solids, mg/l | 88 | 92 | 188 | 156 | 192 | 180 | | | | |
| Total suspended solids, mg/l | 20 | 7 | 18 | 4 | 28 | 24 | | | | |
| Total inorganic solids, mg/l | 192 | 200 | 320 | 320 | 328 | 312 | | | | |
| Nitrates, mg-$NO_3$/l | 2.20 | 1.60 | 1.40 | 2.40 | 2.90 | 3.00 | | | | |
| Stage, Ft. | | | | | | | | | | |

# MOMENCE WETLANDS WATER QUALITY DATA

Sample Location: Surface Water on South Floodplain (Transect C)
Stations 7 and 8

| | Date (1979) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Parameter | 3/6 (7) | 3/6 (8) | 3/24 (7) | 3/24 (8) | 4/14 (7) | 4/14 (8) | | | | |
| Total Phosphorus, mg/l | 0.445 | 0.383 | 0.230 | 0.221 | 0.353 | 0.337 | | | | |
| Ortho-P, mg/l | 0.092 | 0.153 | 0.067 | 0.107 | 0.046 | 0.117 | | | | |
| Total solids, mg/l | 256 | 280 | 460 | 444 | 520 | 492 | | | | |
| Total organic solids, mg/l | 88 | 80 | 160 | 120 | 168 | 152 | | | | |
| Total suspended solids, mg/l | 16 | 17 | 9 | 20 | 34 | 19 | | | | |
| Total inorganic solids, mg/l | 168 | 200 | 300 | 324 | 352 | 340 | | | | |
| Nitrates, mg-$NO_3$/l | 1.80 | 1.70 | 2.30 | 1.25 | 2.60 | 2.40 | | | | |
| Stage, Ft. | | | | | | | | | | |

# MOMENCE WETLANDS WATER QUALITY DATA

Sample Location: Surface Water on South Floodplain - River Birch Community (Transect A) Stations 9 and 10

| | Date (1979) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Parameter | 3/6 (9) | 3/6 (10) | 3/24 (9) | 3/24 (10) | 4/14 (9) | 4/14 (10) | | | | |
| Total Phosphorus, mg/l | 2.12 | 1.69 | 0.276 | 0.276 | 0.291 | 0.261 | | | | |
| Ortho-P, mg/l | 0.414 | 0.184 | 0.067 | 0.086 | 0.061 | 0.086 | | | | |
| Total solids, mg/l | 336 | 532 | 496 | 524 | 528 | 516 | | | | |
| Total organic solids, mg/l | 172 | 144 | 168 | 184 | 196 | 180 | | | | |
| Total suspended solids, mg/l | 11 | 231 | 7 | 11 | 25 | 16 | | | | |
| Total inorganic solids, mg/l | 164 | 388 | 328 | 340 | 332 | 336 | | | | |
| Nitrates, mg-$NO_3$/l | 1.76 | 1.30 | 1.35 | 2.36 | 1.45 | 1.45 | | | | |
| Stage, Ft. | | | | | | | | | | |

MOMENCE WETLANDS WATER QUALITY DATA

Sample Location: South Well on Transect D
Station 1

| Parameter | 3/24 | 4/21 | 5/5 | 5/19 | 6/2 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Date (1979) | | | | | | | | | |
| Total Phosphorus, mg/l | 0.153 | 0.276 | 1.99 | 0.442 | 1.147 | | | | | |
| Ortho-P, mg/l | 0.107 | 0.086 | 0.117 | 0.338 | 0.985 | | | | | |
| Total solids, mg/l | 492 | 476 | 444 | 592 | 844 | | | | | |
| Total organic solids, mg/l | 160 | 176 | 128 | 220 | 174 | | | | | |
| Total suspended solids, mg/l | 20 | 29 | 15 | 162 | 223 | | | | | |
| Total inorganic solids, mg/l | 332 | 300 | 316 | 372 | 670 | | | | | |
| Nitrates, mg-$NO_3$/l | 3.00 | 0.84 | 2.05 | 0.61 | 0.33 | | | | | |
| Stage, Ft. | | | | | | | | | | |

MOMENCE WETLANDS WATER QUALITY DATA

Sample Location: North Well on Transect D (Well with level recorder)

| Parameter | Date (1979) 4/14 | 5/5 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Phosphorus, mg/l | 0.368 | 0.344 | | | | | | | | |
| Ortho-P, mg/l | 0.230 | 0.117 | | | | | | | | |
| Total solids, mg/l | 320 | 336 | | | | | | | | |
| Total organic solids, mg/l | 92 | 107 | | | | | | | | |
| Total suspended solids, mg/l | 21 | 13 | | | | | | | | |
| Total inorganic solids, mg/l | 228 | 228 | | | | | | | | |
| Nitrates, mg-$NO_3$/l | 1.42 | 1.40 | | | | | | | | |
| Stage, Ft. or | | | | | | | | | | |

# MOMENCE WETLANDS WATER QUALITY DATA

Sample Location: **South Well on Transect E**
**Station 3**

| Parameter | Date (1979) 3/24 | 4/14 | 4/21 | 5/5 | 5/19 | 6/2 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Phosphorus, mg/l | 0.092 | 0.129 | 0.092 | 1.29 | 0.012 | - | | | | | |
| Ortho-P, mg/l | 0.086 | <0.006 | 0.046 | 0.184 | <0.012 | - | | | | | |
| Total solids, mg/l | 720 | 792 | 880 | 808 | 828 | - | | | | | |
| Total organic solids, mg/l | 212 | 232 | 340 | 256 | 336 | - | | | | | |
| Total suspended solids, mg/l | 12 | 13 | 37 | 7 | 9 | - | | | | | |
| Total inorganic solids, mg/l | 508 | 560 | 540 | 552 | 492 | - | | | | | |
| Nitrates, mg-$NO_3$/l | 0.53 | 1.00 | 1.50 | 1.30 | 0.30 | - | | | | | |
| Stage, Ft. | | | | | | | | | | | |

MOMENCE WETLANDS WATER QUALITY DATA

Sample Location: North Well on Transect E
Station 4

| Parameter | Date (1979) 3/24 | 4/14 | 4/21 | 5/5 | 5/19 | 6/2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Phosphorus, mg/l | 0.169 | 0.107 | 0.138 | 0.428 | 0.338 | 1.85 | | | | |
| Ortho-P, mg/l | 0.037 | <0.006 | 0.025 | 0.067 | 0.122 | 0.84 | | | | |
| Total solids, mg/l | 452 | 528 | 560 | 452 | 512 | 1154 | | | | |
| Total organic solids, mg/l | 136 | 172 | 188 | 132 | 208 | 106 | | | | |
| Total suspended solids, mg/l | 14 | 20 | 15 | 7 | 9 | 637 | | | | |
| Total inorganic solids, mg/l | 316 | 356 | 372 | 320 | 304 | 1048 | | | | |
| Nitrates, mg-$NO_3$/l | 0.90 | 1.36 | 1.50 | 1.10 | 0.68 | 0.49 | | | | |
| Stage, Ft. | | | | | | | | | | |

Appendix B

Sediments Collected on Momence Wetlands Sediment Plates After Flooding By Kankakee River

| Sample | Distance from River, meters | Sediments Collected, $g/m^2$ Total | Organic | Inorganic | Phosphorus, mg-P/g dry wt |
|---|---|---|---|---|---|
| | | West Transect | | | |
| D1 | 5 | 65.6 | 15.7 | 49.9 | - |
| D1A | 5 | 410.3 | 103.0 | 307.4 | - |
| D2 | 15 | 77.4 | 18.5 | 58.9 | 2.50 |
| D2A | 15 | 3760.6 | 451.1 | 3309.1 | - |
| D3 | 25 | 35.2 | 8.9 | 26.3 | 2.73 |
| D3A | 25 | 597.1 | 147.9 | 449.2 | - |
| D4 | 66 | 1256.2 | 173.4 | 1082.8 | - |
| D4A | 66 | 105.2 | 18.2 | 87.0 | - |
| D5 | 76 | 407.5 | 80.4 | 307.9 | - |
| D5A | 76 | 25.4 | 4.2 | 21.2 | - |
| D6 | 86 | 79.2 | 19.7 | 59.5 | 1.93 |
| D6A | 86 | 360.8 | 121.5 | 239.2 | - |
| D7 | 96 | 79.2 | 19.7 | 59.5 | 2.36 |
| D7A | 96 | 81.1 | 21.0 | 60.1 | 3.87 |
| D8 | 106 | 21.8 | 5.4 | 16.4 | - |
| D8A | 106 | 1122.5 | 303.7 | 818.8 | - |
| D9 | 116 | 135.0 | 41.1 | 93.9 | 1.70 |
| D9A | 116 | 184.1 | 88.1 | 96.0 | 0.52 |
| D14 | 166 | 403.6 | 110.9 | 292.7 | - |
| D14A | 166 | 854.0 | 207.1 | 646.9 | - |
| D15 | 176 | 216.6 | 60.0 | 159.6 | - |
| D15A | 176 | 91.2 | 27.3 | 63.9 | |
| AVERAGE - West Transect | | 471 | 93 | 378 | 2.23 |
| | | East Transect | | | |
| E15 | 5 | 3440.7 | 592.0 | 2848.8 | - |
| E14 | 15 | 705.4 | 164.0 | 541.4 | - |
| E14A | 15 | 3129.6 | 405.7 | 2723.8 | - |
| E13 | 25 | 423.7 | 96.0 | 332.7 | - |
| E13A | 25 | 38.2 | 10.5 | 27.7 | 1.65 |
| E12 | 35 | 150.9 | 30.2 | 120.7 | 2.41 |
| E12A | 35 | 179.2 | 35.0 | 144.2 | 2.67 |
| E11 | 45 | 185.5 | 37.9 | 147.6 | 2.37 |
| E11A | 45 | 2214.9 | 398.9 | 1816.1 | - |
| E10 | 55 | 1396.7 | 271.6 | 1125.2 | - |
| E10A | 55 | 156.4 | 30.4 | 126.0 | - |
| E9 | 65 | 754.7 | 159.9 | 594.8 | - |

Appendix B (Continued)

| Sample | Distance from River, meters | Sediments Collected, g/m$^2$ Total | Organic | Inorganic | Phosphorus, mg-P/g dry wt. |
|---|---|---|---|---|---|
| E9A | 65 | 777.6 | 160.0 | 617.6 | - |
| E8 | 75 | 43.7 | 10.5 | 33.3 | - |
| E8A | 75 | 210.7 | 49.2 | 161.5 | - |
| E7 | 85 | 701.2 | 191.0 | 510.2 | - |
| E7A | 85 | 160.6 | 41.7 | 118.9 | - |
| E6 | 95 | 95.0 | 23.5 | 71.5 | 3.51 |
| E6A | 95 | 56.0 | 13.4 | 42.6 | 2.73 |
| E5 | 105 | 1490.7 | 344.3 | 1146.4 | - |
| E5A | 105 | 47.4 | 10.7 | 36.7 | 2.83 |
| E4 | 115 | 1423.7 | 294.2 | 1129.6 | - |
| E4A | 115 | 309.8 | 83.2 | 226.6 | 0.27 |
| E3 | 125 | 520.2 | 135.7 | 384.5 | - |
| E3A | 125 | 75.7 | 19.3 | 56.4 | - |
| E2 | 135 | 159.3 | 38.8 | 120.5 | - |
| E2A | 135 | 305.5 | 77.1 | 228.4 | - |
| E1 | 145 | 485.1 | 121.6 | 363.5 | - |
| E1A | 145 | 71.9 | 19.5 | 52.4 | - |
| AVERAGE - East Transect | | 680 | 133 | 547 | 2.30 |