Transactions of the Illinois State Academy of Science (1998), Volume 91, 1 and 2, pp.33-46

received 7/7/97
accepted 10/27/97

Forest Compositional Change at the Confluence of the Illinois and Mississippi Rivers

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ABSTRACT

Historic and current forest survey data were used to chronicle forest compositional change at a study site located between the Illinois and Mississippi rivers. Tree species importance values (IV) indicate silver maple (*Acer saccharinum* L.) was a co-dominant species in 1817 (IV=16.1). However, by the time another forest survey was conducted just prior to river impoundment in 1938, silver maple had already become the most dominant species (IV=84.7). Silver maple also increased in IV during the decades following river impoundment (IV=98.2) and again following the great flood of 1993 (IV=110.0). The very successful growth and establishment of silver maple since the arrival of early Euro-American settlers is a strong indication that humans have altered one or more of the key natural processes that once favored a more biologically rich forest community. The diversion of Lake Michigan water into the Illinois River valley in the early 1900s and river impoundment in 1938 have probably favored more water tolerant species such as silver maple. Likewise, fire was an important disturbance mechanism affecting some presettlement floodplain plant communities, but today fire is a rare occurrence along the Illinois and Mississippi rivers. Silver maple dominance will likely continue well into the 21st century unless flooding and fire regimes are used to promote a more diverse plant community.

Key Words: Floodplain, forest, bottomland, river, hydrology, flood, fire, disturbance

INTRODUCTION

The Upper Mississippi River System (UMRS) includes the mainstem Mississippi River above the confluence of the Ohio River, and several of its major tributaries, including the Illinois River. During the 1930s, navigation dams were constructed on the UMRS above St. Louis, Missouri. The most detailed assessment of the short-term effects of river impoundment on trees along the UMRS was reported by Yeager (1949). His work documented tree mortality at Calhoun Point (the same study area examined herein) over an eight year period following completion of Lock and Dam 26 in 1938. Since then, little attention has been paid to assessing the long-term effects of river impoundment on floodplain forests. A major problem has been the lack of historic forest data to evaluate compositional trends. We found the original data basic to the work of Yeager (1949) within the archives of the Illinois Natural History Survey in Champaign, Illinois. This presented us with an opportunity to duplicate the forest sampling effort of 1938 and to assess the longer-term effects of river impoundment at Calhoun Point. We also assessed tree mortality resulting from the 1993 flood -- the largest flood on record in the vicinity of St. Louis. In conjunction with data from a presettlement forest reconstruction of the study area (Nelson, et al., 1994), this paper presents forest compositional changes that have occurred since early Euro-American settlement (1817).

Like most of the 79 large river-floodplain ecosystems worldwide, the UMRS has been significantly altered for agriculture, navigation, and flood protection (Belt, 1975; Welcomme, 1985; Dynesius and Nilsson, 1994). During the 1930s, that portion of the Mississippi River above St. Louis, Missouri, was modified with a series of 27 low head dams (ranging in height from 5.6 to 49.0 ft.). A major tributary, the Illinois River, was similarly impounded with a series of five navigation dams (7.0 to 49.0 ft. High). An immediate impact of each dam was a permanent rise in the annual low-water surface elevations and the permanent inundation of the lowest floodplain habitats. Immediately upstream of each navigation dam a lake-like impoundment was formed. Farther upstream, however, impoundment effects become less pronounced and riverine conditions reappear. Unlike the high-head reservoir dams built across many narrow river canyons throughout the western United States, the navigation dams of the UMRS are not designed to hold back and store enormous volumes of water, but rather they maintain a minimum 9-foot deep navigation channel during the low-flow season. As river discharge increases, flood waters pass through opened gates and around the locks and gates over spillways (Sparks, 1995). Thus, in spite of river modifications, the UMRS retains seasonal flood pulses characteristic of large river-floodplain ecosystems (Sparks et al., 1990).

Before lock and dam construction, canals and flow alterations had significant effects on the hydrology of the Illinois River. The Illinois-Michigan Canal was completed in 1848 thereby connecting Lake Michigan and the Illinois River. The population of the city of Chicago began to increase dramatically during the late 1800s and sewage disposal became a serious health problem. In 1871, the flow of the sewage-laden Chicago River was reversed away from Lake Michigan into the Illinois-Michigan Canal and ultimately into the headwaters of the Illinois River. The diversion was somewhat effective at protecting the city's water supply, but periodic flooding of the Chicago River still allowed sewage to enter Lake Michigan. For a few years large volumes of water were diverted using pumps (1894-1900), but a more efficient solution was in place by 1900 when the Chicago Sanitary and Ship Canal was completed. Between 1900 and 1938, diverted flows of Lake Michigan water ranged between 2,990 ft^3/sec. and 10,010 $ft.^3$/sec. (average = 7,222 $ft.^3$/sec.). This diversion increased low midsummer river levels by 2.8 feet near Havana (river mile 120), thereby increasing the surface area of backwater lakes and inundating thousands of forested acres (Bellrose et al., 1983; Starrett, 1972). The amount of diverted water allowed to enter the Illinois River was substantially reduced after 1938 and continues to be strictly regulated (3,200 $ft.^3$/sec.).

Artificially raising river water levels, either by diversion or impoundment, can seriously affect the composition of floodplain forests (Havera et al., 1980). The degree of effect is primarily dependent upon elevation and flood tolerances of resident species (Hosner and Minckler, 1963). Following river impoundment, 100 percent tree mortality occurred in areas subject to permanent inundation (Yeager, 1949; Green, 1947). At higher elevations, however, percent tree mortality was lower and varied among species. While the short-term effects of river impoundment on trees are well documented, the long-term effects of raised water levels on trees growing at or above the new shoreline are much less clear.

STUDY AREA

Our study area lies at the confluence of the Illinois and Mississippi rivers and is known locally as Calhoun Point. The 2,200 acre point was acquired by the U.S. Army Corps of Engineers in the 1930s as flood easement for construction of the Alton Lock and Dam 26, located 20 miles downstream (Fig. 1). During the 1950s, Calhoun Point was incorporated into the Mark Twain Wildlife Refuge of the U.S. Fish and Wildlife Service. Today, the area is managed by the Illinois Department of Natural Resources to provide habitat for waterfowl, fish, and other wildlife. All three agencies cooperate in planning long-term management strategies for Calhoun Point.

Floodplain topography within Calhoun Point is complex, with many sloughs, abandoned side channels, and backwater lakes and ponds within the area (Fig. 1). Natural levees and ridges form the highest elevations where soils are well drained. The lowest elevations are typically flat with poorly drained soils. As with most forests of the UMRS, timber has been harvested from within Calhoun Point and presumably began with fuelwood procurement for steam boats in the early 1800s (Nelson et al., 1994). No logging, however, has taken place in the study area since it was acquired by the Federal government in the late 1930s. Some areas may never have been cut over: Yeager (1949) reported seeing many huge and overmature maples, elms, oaks, and sycamores.

METHODS

The presettlement forest data for this study were obtained from the General Land Office (GLO) surveyors field notes of Calhoun Point and other nearby areas upstream along the Illinois River floodplain in 1817 (Nelson et al., 1994). The GLO surveyors recorded in their field notes the types and diameters of bearing trees used at section corners, as well as bearing tree distances and bearings. If trees were not available at a section corner, the surveyors noted "prairie" in their field notes and erected a mound of earth. Although the GLO survey data were obtained differently from the other forest data used in this study, these are the only quantitative forest data available from the presettlement period.

Cornelius H. Muller, while working with the Illinois Natural History Survey (INHS) in 1938, established 11 belt transects across Calhoun Point in order to map and sample the predam vegetation. Within these 50-foot-wide belt transects, which were purposely placed in such a manner as to adequately cover the outstanding habitats of the area, Muller recorded all trees and saplings. Trees were considered to have a diameter breast height (dbh) $\geq$ 5 inches. One of Muller's colleagues, Lee Yeager, tagged most of the trees in 6 of the belt transects to monitor mortality rates over the 8 years following river impoundment. The total length of these 6 transects was 3.5 miles. We retrieved Muller's original data sheets and his summary report from the INHS archives but, unfortunately, were unable to locate any of Yeager's original field notes or datasheets. Yeager did, however, publish his findings in a INHS bulletin titled: “Effect of permanent flooding in a river-bottom timber area”, which is cited throughout this paper (Yeager, 1949).

In order to assess forest compositional trends up to the present time, we sampled the forest vegetation along the same six transects used by Yeager and initially established by Muller (Fig. 1). We did the field work during the summer of 1996 using compass headings and starting points provided on Muller's vegetation maps and datasheets. Aerial photographs (taken in 1994) were also used to assist in establishing transects in the field. For each time period (1817, 1938, and 1996), we calculated relative dominance, relative density, and importance value (IV) for each taxon recorded. Tree diameter was used to compute the basal area per tree. The total basal area per taxon, divided by the total basal area of all trees provides an estimate of relative dominance. Relative density was obtained by dividing the number of individual trees per taxon by the total number of trees sampled. An IV, based upon a sum total of 200, was then obtained for each taxon by adding relative dominance and relative density values.

Initially, the main objective of this study was to evaluate the long-term effects of river impoundment on forest composition. However, the effects of the 1993 flood were so apparent during our field sampling that we decided those effects had to be assessed as well. Thus, during our transect sampling, we noted whether each individual tree was alive or dead. If a tree was dead, it was closely examined to determine whether it died after the 1993 flood or whether it was likely dead before the flood. This was not difficult because trees killed by the flood usually had portions of their bark, twigs, and buds still intact, whereas trees dead before 1993 showed more advanced signs of decay. The 1996 data were then divided into two categories, the trees that were alive before 1993 (preflood) and the trees that were alive after 1993 (postflood).

Since 1878 the U.S. Army Corps of Engineers has recorded daily river water levels at the Pearl, Illinois gage. We plotted these data over time to assess hydrologic patterns affecting the study area (Fig. 2). While the location of the gage station is 43.2 miles upstream of Calhoun Point, the data are representative of the hydrologic changes affecting the study area.

RESULTS AND DISCUSSION

Hydrology

The hydrologic time line plotted in Fig. 2 can be broken down into three distinct time periods; 1.) prediversion, 2.) diversion-predam, and 3.) postdam. In spite of the effects of Lake Michigan water diversion (beginning in 1894) and the effects of river impoundment (beginning in 1938), the annual hydrologic pattern within each time period is still characterized by flood pulses (Junk et al., 1989). Although flood pulses are still pronounced, annual low-flow periods have been severely affected. In the prediversion period, river stages dropped in late summer to approximately 412.5 feet above mean sea level at river mile 43.2. In the second period, identified by diversion of Lake Michigan water, river stages were artificially raised because of increased discharge. As a consequence, water levels never dropped below 417.0 feet. In the current period, identified by river impoundment (postdam), water levels have never dropped below 418.0 feet. Another change apparent in the postdam hydrologic pattern is increased irregularity, whereas before 1894 the hydrographs were generally smooth. These changes in hydrologic patterns over a relatively short time are a reflection of many human alterations to the Illinois River and its basin. Today, river stages rise and fall more quickly due to river constriction by levees, increased water delivery via channelized tributaries, and destruction of wetlands and other native vegetation types throughout the region. Another important consideration is the possibility that the climate affecting the UMRS is now in a wet cycle (Singh and Ramamurthy, 1990).

<u>Presettlement Forest Community</u>
According to survey records of the General Land Office (GLO), the presettlement forest composition at Calhoun Point can be described as a mixture of several codominant taxa (Table 1). Hackberry (*Celtis occidentalis*) had the highest IV at 30.4, followed by pecan (*Carya illinoensis*) at 30.0, American elm (*Ulmus americana*) at 22.1, willow (*Salix* spp.) at 20.7, cottonwood (*Populus deltoides*) at 20.4, silver maple at 16.1, pin oak (*Quercus palustris*) at 11.5, and other oaks at 10.8. Plat maps and tree density estimates indicate that prairie, savanna and open woodland communities were also common to the presettlement floodplains of the lower Illinois River valley (Turner, 1934; Zawacki and Hausfater, 1969; Nelson, et al., 1994). Fire has long been recognized as an important disturbance mechanism affecting prairies, savannas, and open woodlands throughout the uplands of the midwest. Fire, however, is not generally considered to have been important along large river floodplains because conditions were presumably too wet. We speculate that fire was an important disturbance mechanism affecting presettlement plant communities along the floodplains of the lower Illinois River valley -- particularly on the higher elevation sites. We have no reason to believe that fires moving across upland landscapes would be easily extinguished upon arriving at the edge of the Mississippi and Illinois river floodplains. This would be especially true during periods of drought when the floodplains became extremely dry and susceptible to fire. Conversely, flood regime was probably the principal disturbance mechanism affecting plant communities on the lower elevations.

<u>Diversion-Predam Forest Community</u>
The dominant tree at Calhoun Point in 1938 was silver maple. By the time Yeager and Muller conducted their surveys to assess the anticipated effects of river impoundment, silver maple had already become the dominant species with an IV of 84.7 (Table 1). In the 121 years since the original GLO survey, human settlement along the Illinois River increased phenomenally with profound effects on the hydrology and native vegetation of the valley (Turner, 1934; Starrett, 1972; Nelson et al., 1994). Forests were logged for steamboat fuelwood and for home construction, cooking, and heating, whereas floodplain prairies and savannas were converted to agriculture. Near the end of the 19th century, the city of Chicago began diverting Lake Michigan water into the Illinois River via the Chicago Sanitary and Ship Canal. This diversion artificially increased minimum water surface elevations approximately 4.5 feet (river mile 43.2) between 1894 and 1938 (Fig. 2). The diversion flooded and ultimately killed thousands of acres of bottomland forests. The rise in water table likely caused a shift in species composition favoring more water

tolerant species such as silver maple and forcing out some of the less flood tolerant oaks. Agriculture also affected forest composition throughout the UMRS. Floodplain farming is most extensive on the higher elevations where flooding is less frequent and soils are better drained. Many lands now used for farming may once have supported extensive oak savannas and woodlands.

The increasing dominance of silver maple on the floodplains of the upper Mississippi and Illinois Rivers has received little attention compared with increasing sugar maple dominance in the uplands of the midwest. Ecologists studying presettlement vegetation patterns in the uplands of the midwest have long attributed the development and maintenance of prairies, savannas, and open woodlands to frequent disturbance by fire (Ebinger, 1986; Packard, 1993). Maples are fire sensitive and thus are not prevalent in forest stands that are periodically burned (Abrams, 1992). Prairies, savannas, and open woodland communities were important features along the floodplains of the lower Illinois River valley before settlement (Turner, 1934; Zawacki and Hausfater, 1969; Nelson et al., 1994). Fire, therefore, was likely an important disturbance mechanism affecting some floodplain plant communities, particularly those communities on the highest elevations. Even as late as 1938, Muller noted the effects of fire in and around Calhoun Point: "Burns are most common on the sandy levees in the central part of the area where the naturally more open forest allows greater shrub and grass growth, thus providing more fuel. Disturbances in this central area of more open growth produce effects which are more lasting than in the elm and maple forests of lower elevations". Muller further observed; "Several severe burns have occurred in this type [pin oak-bur oak forest]. Evidence of such [a burn] about two years old can be seen on the north side of Brushy Lake. Here the area is coming up in root sprouts and saplings of ulmus, quercus, etc., and shrubs seem to have been definitely favored by the burn". Silver maple, like its cousin the sugar maple, is highly susceptible to fire and thus would not have survived well at higher floodplain elevations that periodically burned and that were rarely flooded. Conversely, by raising the water table on the floodplain and reducing fire frequency, humans have inadvertently altered the natural disturbance regimes under which the presettlement vegetation had evolved.

Postdam-Preflood

River impoundment in 1938 again raised water levels and transformed many of the low ridge sites within Calhoun Point into mud flats. Tree mortality among all taxa on these sites ranged between 50 and 100% (Yeager, 1949). Silver maple exhibited nearly 50% mortality and pin oak exhibited 100% mortality. Yeager did not quantify seedlings in the understory, but silver maple regeneration must have been successful because the relative density of silver maple increased during the decades after impoundment. During the same time period, the relative dominance of silver maple also increased as trees grew larger in diameter. Just before the 1993 flood, silver maple represented almost half (98.2) the total IV of all trees within Calhoun Point (Table 1). Other taxa that substantially increased in IV include ash (*Fraxinus* spp.), box elder (*Acer negundo*), hackberry, and willow. With the exception of hackberry, each of these taxa are very flood tolerant (Bratkovich et al., 1993). Hackberry, though more sensitive to flooding, is moderately shade tolerant and was most often observed as an abundant understory species with only a few scattered individuals ever reaching the canopy. Willow was most often observed growing on newly formed sites created by heavy sedimentation around backwater lakes and sloughs. Taxa with the greatest declines in IV included American elm and pin oak. The introduction of Dutch elm disease to the United States in 1930 may explain the decline of American elm at Calhoun Point whereas hydrologic alterations are likely most responsible for the decline of pin oak. Perhaps equally as important as the damaging effects of a pathogen on one species are the competitive advantages it can furnish another. Whereas Dutch elm disease now prevents American elms from ever reaching the overstory, the disease, by eliminating a competitor, gives silver maple an advantage in reaching the overstory. Other postdam forest studies have also documented silver maple as the dominant tree species throughout much of the UMRS (Havera et al., 1980; Yin et al., 1994).

<u>Post-flood</u>

The great flood of 1993 was a unique event in terms of its areal extent and duration (Fig. 2). Most spring floods along the UMRS end by late June, but the 1993 flood lasted throughout much of the 1993 growing season. The U.S. Army Corps of Engineers report the duration of flooding at Grafton was 195 days between March 26 and October 10, 1993 (US Army Corps of Engineers, 1994). A forest survey conducted in the aftermath of the 1993 flood indicates tree mortality was approximately 37.2% among trees (dbh > 4 inches) along the floodplains of the lower Illinois River and a nearby segment of Mississippi River (Yin et al., 1994). Mortality was even higher (80.1%) for understory saplings (Yin et al. 1994). At Calhoun Point, our data indicate the overall mortality of trees was 44.1%. This slightly higher mortality estimate is likely the result of mortality occurring after the 1994 study. Overall, there was a 30.0% reduction in live basal area along the six transects sampled at Calhoun Point due to the 1993 flood (trees ≥ 5.0 inches dbh).

The long-term effects of the 1993 flood have yet to unfold completely, but it is likely that silver maple will continue to be the overwhelming dominant species. After the flood, silver maple again gained dominance (IV=110.0), while most other taxa declined (Table 1). Larger silver maples generally survived the flood, but oaks exhibited high flood mortality regardless of age or size. Survivorship among mature trees is important because these trees will provide the seed for the next forest. Thus, seeds of silver maple will be very abundant, while oak acorns will be very limited. Silver maple seedlings are also moderately shade-tolerant which should enable them to regenerate well beneath moderately impacted forest stands.

CONCLUSIONS

The trend of increasing silver maple dominance at Calhoun Point is a strong indication that the natural disturbance pattern has been altered over the past 180 years. At the ecosystem level, hydrologic alterations and reduction in fire frequency are two of the most important processes to consider. Increases in rainfall of 25% during the four-month flood season (March-June) during the last 20 years contribute to increasing flood heights and frequency (Singh and Ramamurthy, 1990). Human alterations of the watershed, the floodplain, and the river itself are also important and perhaps dominant factors. Any increase in river water levels to deepen the navigation channels of the UMRS will undoubtedly further reduce forest diversity. Likewise, forest diversity will decrease if "great floods" like that of 1993 continue to increase in frequency and intensity.

Most of Illinois (83.1%) is now in row crop agriculture, pasture, or urban and suburban developments (SCS, 1992). In such an altered landscape, it is surprising that half the floodplain of the Illinois River, and of the Mississippi River upstream from St. Louis, remains unleveed and open to flooding by the rivers (Delaney and Craig, 1997). There is an opportunity to restore and maintain a substantial portion of the natural communities observed in the early 19th century by the GLO surveyors on the river floodplains. The floodplains and rivers could provide nearly contiguous, linear corridors of natural vegetation for outdoor recreation, wildlife, and for bird migrations (both rivers are part of the Mississippi flyway) in a landscape whose uplands are otherwise dominated by row crop agriculture.

If society considers it desirable to restore and maintain the natural communities of the floodplain, the following steps would have to be taken. (1) Minimum water elevations should not be increased. Such increases might be proposed as part of the on-going planning by the Corps of Engineers for an expansion of navigation capacity on the UMRS. (2) Unnaturally frequent and extreme flooding during the growing season should be reduced by increasing water detention and desynchronizing flood peaks from tributary basins, and by increasing the capacity to store and convey floodwaters on the floodplain. Flood heights would decrease on a floodplain less constricted by levees. Selected levee districts might be used to convey floodwaters, after flooding easements or outright purchases were negotiated with landowners. (3) Some tree taxa, particularly oaks, would need to be planted because of the limited natural seed sources currently available. Successful oak establishment would benefit native wildlife and enhance recreational opportunities. (4) Prairies should be restored and fire reintroduced to the floodplain. Lands currently used for row crop agriculture within wildlife refuges and in state managed wildlife areas could be restored to prairies and savannas. The native wet-prairie or moist soil plants could replace corn as food for migratory waterfowl, but additional state funds might be needed to replace income from farming leases that currently defray operating expenses on some state wildlife areas.

ACKNOWLEDGMENTS

Partial funding of this project was provided through a grant from the U.S. Environmental Protection Agency (ID #NP985224-01-0). This research was supported by the U.S. Army Corps of Engineers and the Biological Resources Division of the U.S. Geological Survey through the Upper Mississippi River System Long Term Resource Monitoring Program and by the Illinois Department of Natural Resources. We thank Robert Cosgriff and Kathleen McKeever for their valuable assistance in collecting and compiling field data. Special thanks are extended to three anonymous reviewers for thier helpful comments and suggestions.

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Figure 1. Location of Calhoun Point study area at the confluence of the Illinois and Mississippi rivers. At top are the locations of the six transects across the study area which were used to sample forest composition. Adapted from Yeager (1949).

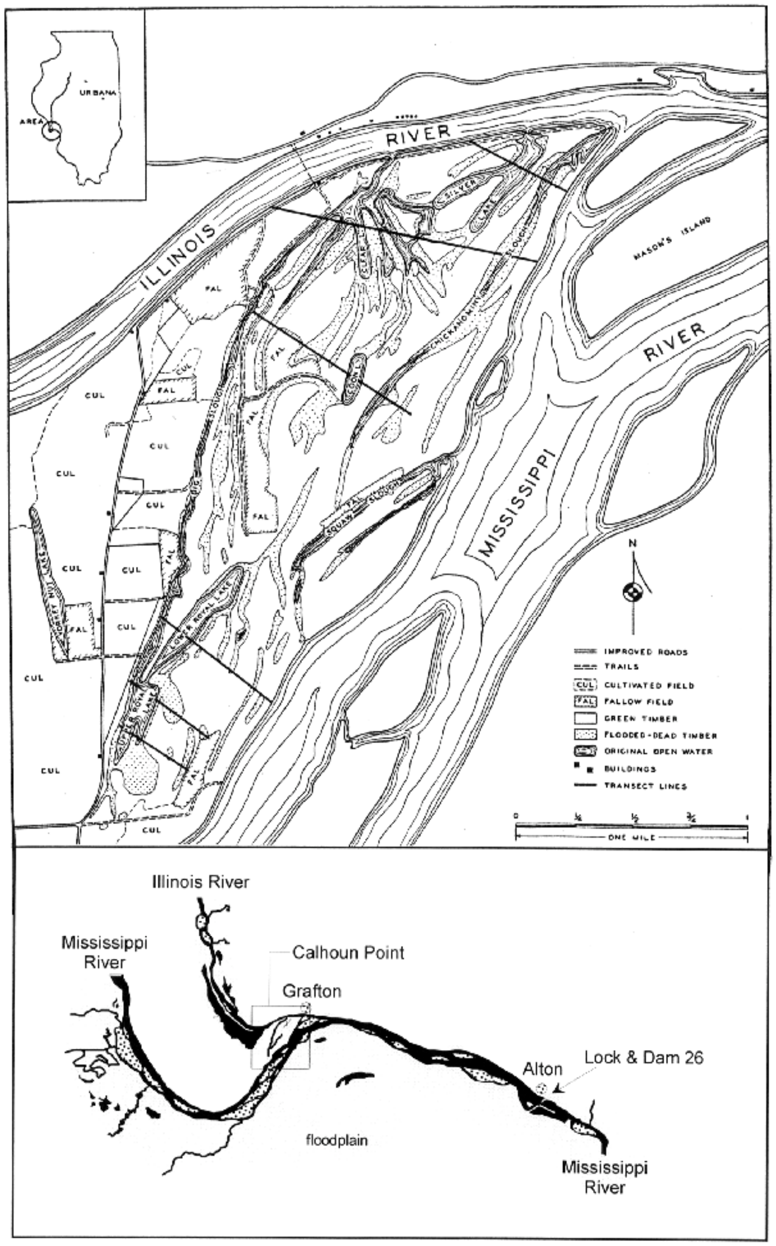
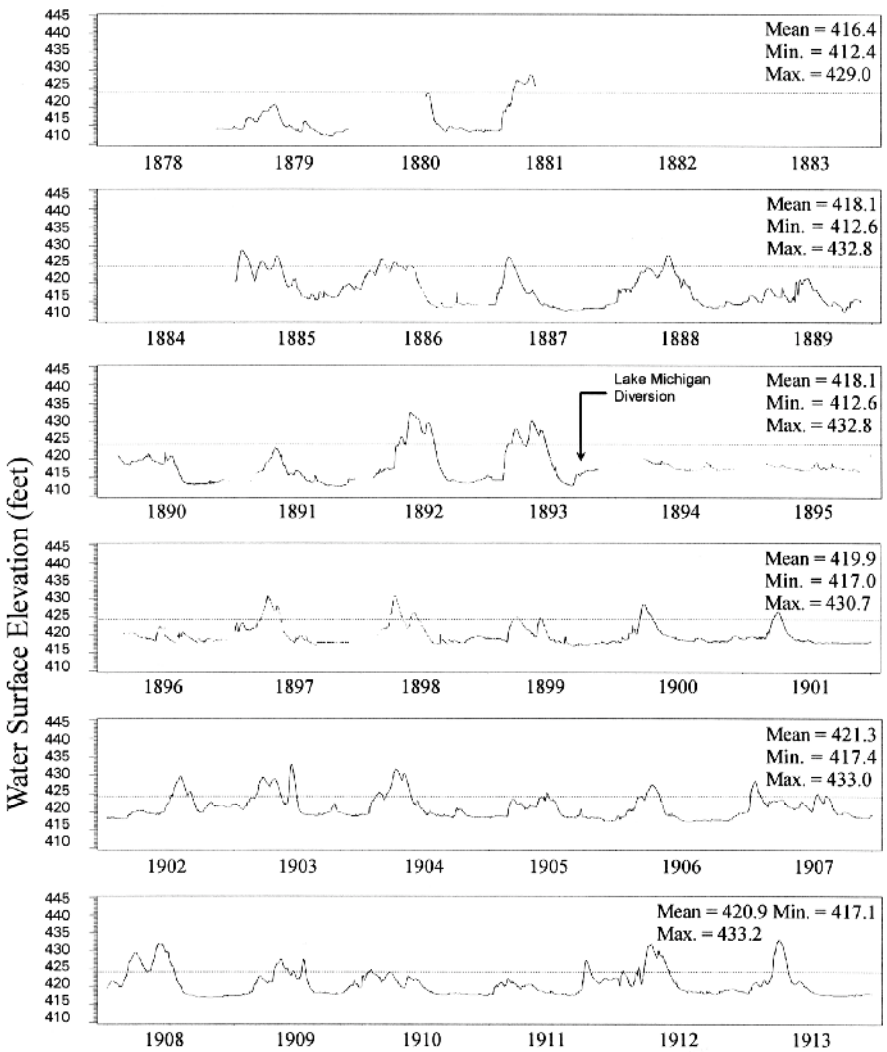


Figure 2. Historic daily water surface elevations (measured as feet above mean sea level) recorded at Illinois River mile 43.2 (distance upstream of the confluence with the Mississippi River). Gaps in the hydrograph are days when water levels were not recorded. Flood stage is indicated by dashed horizontal line (424.0 ft). Mean, minimum, and maximum water surface elevations presented for each six year time period.



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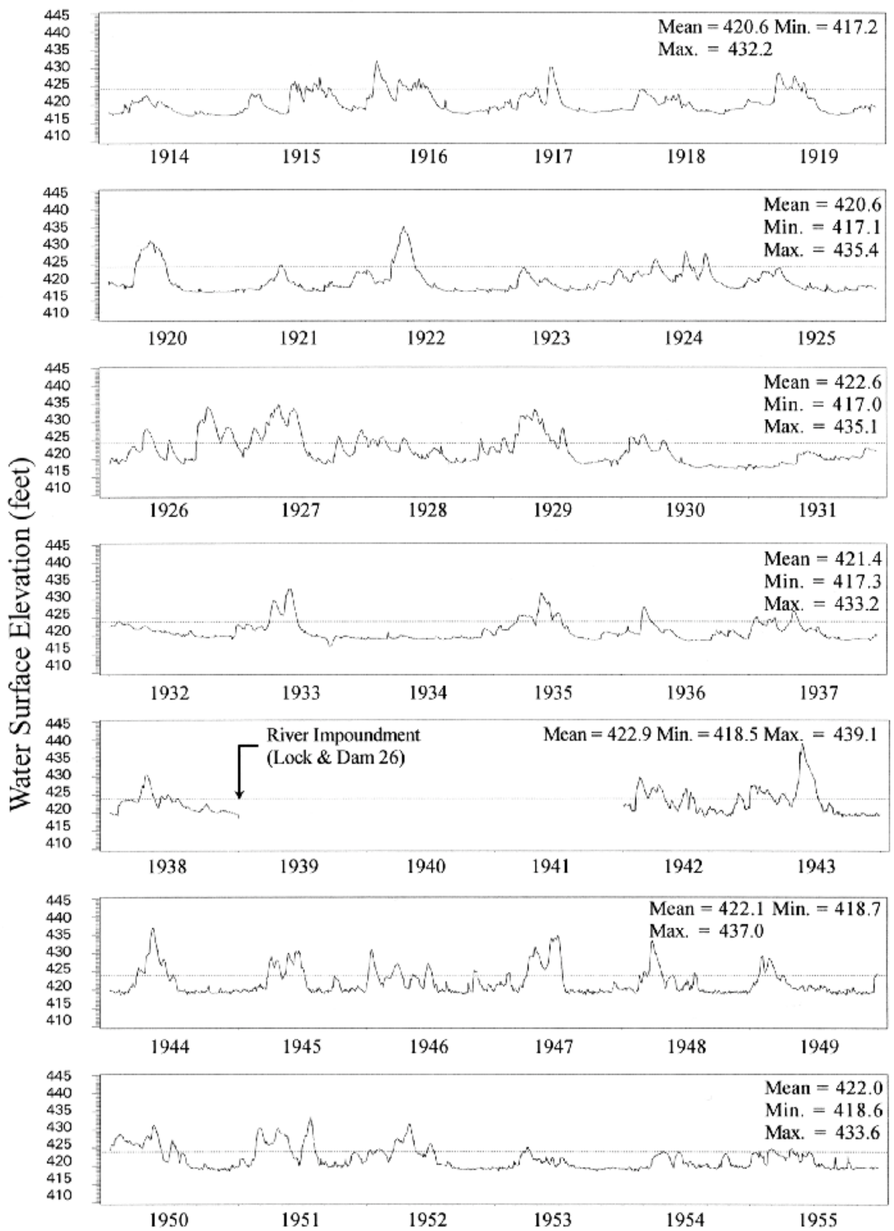

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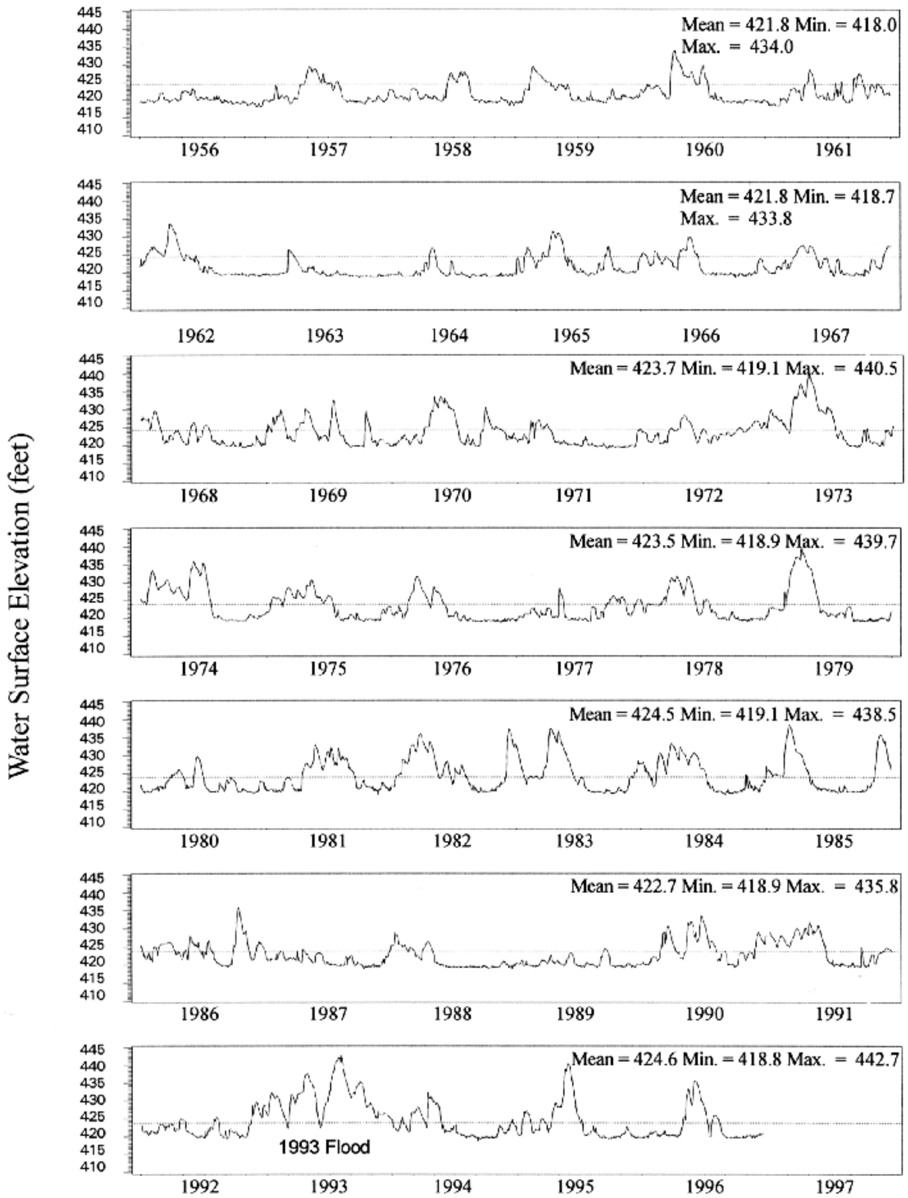

Table 1. Relative dominance, relative density, and importance value (rel. dom + rel. den) for live trees (dbh ≥ 5 inches) sampled along six transects at Calhoun Point in 1938 and 1996. Presettlement data (1817) obtained from General Land Office survey records of Calhoun Point and surrounding floodplain areas (Nelson et al. 1994). Taxa ranked by IV in 1817.

	1817 Sample (Presettlement)			1938 Sample (Diversion-predam)			1996 Sample (Postdam)					
							Pre 1993 Flood			Post 1993 Flood		
Genus species	Rel. Dom.	Rel. Den.	I.V.	Rel. Dom.	Rel. Den.	I.V.	Rel. Dom.	Rel. Den.	I.V.	Rel. Dom.	Rel. Den.	I.V.
Celtis occidentalis L.	12.9	17.5	30.4	4.2	1.6	5.7	5.1	12.4	17.5	0.1	0.1	0.3
Carya illinoensis (Wang.) K. Koch	20.7	9.3	30.0	6.3	7.4	13.7	4.5	2.8	7.3	6.2	4.7	10.9
Ulmus americana L.	12.8	9.3	22.1	12.1	16.1	28.2	3.0	6.8	9.8	2.1	5.6	7.8
Salix spp.	8.3	12.4	20.7	1.1	1.3	2.5	5.3	3.9	9.1	6.2	5.9	12.1
Populus deltoides Marsh.	10.1	10.3	20.4	3.9	1.2	5.1	4.7	1.4	6.1	5.7	2.1	7.8
Acer saccharinum L.	5.8	10.3	16.1	44.2	40.5	84.7	53.0	45.2	98.2	57.5	53.0	110.0
Quercus palustris Muench.	8.4	3.1	11.5	11.4	6.4	17.8	4.1	2.3	6.5	2.1	1.5	3.7
Fraxinus spp.	4.8	6.2	11.0	5.5	5.6	11.1	11.8	12.7	24.5	13.5	15.9	29.4
Quercus lyrata Walt./*Q. alba* L./ *Q. velutina* Lam.	5.6	5.2	10.8	0.2	0.2	0.4	0.0	0.0	0.1	0.1	0.0	0.1
Acer negundo L.	1.7	4.1	5.8	1.4	4.1	5.5	4.9	8.2	13.1	4.0	7.2	11.2
Gleditsia triacanthos L./ *G. aquatica* Marsh.	2.1	3.1	5.2	4.6	4.1	8.8	0.0	0.0	0.1	0.0	0.0	0.1
Morus spp.	1.4	2.1	3.5	0.4	1.4	1.8	0.0	0.1	0.1	0.0	0.1	0.1
Cercis canadensis L.	1.0	2.1	3.1	0.0	0.1	0.1	....	....	....	....	....	....
Platanus occidentalis L.	1.8	1.0	2.8	1.3	0.5	1.8	0.5	0.2	0.7	0.4	0.2	0.6
Crataegus spp.	0.8	1.0	1.8	0.3	1.2	1.6	0.1	0.4	0.5	0.1	0.4	0.5
Quercus macrocarpa Michx.	0.7	1.0	1.7	2.6	1.6	4.2	1.5	0.9	2.5	0.8	0.9	1.7
Betula nigra L.	0.4	1.0	1.4	1.4	0.8	2.2	0.6	0.5	1.1	0.4	0.3	0.7
Diospyros virginiana L.	....	....	....	1.5	3.1	4.6	0.8	1.8	2.5	0.5	1.2	1.7
Gymnocladus dioicus (L.) K. Koch	....	....	....	0.1	0.2	0.2	....	....	....	....	.....	....
Forestiera acuminata (Michx.) Poir.	....	....	....	....	....	....	0.1	0.4	0.4	0.1	0.6	0.7
Totals	98	98	196	100	100	200	100	100	200	100	100	200