CURRENT WOODY VEGETATIVE COMMUNITY STRUCTURE AND COMPOSITION IN A SIXTEEN KILOMETER STRETCH OF THE LITTLE TALLAHATCHIE RIVER INFLUENCED BY THE SARDIS RESERVOIR

Kevin Pigott and Marjorie Holland
Department of Biology
University of Mississippi

INTRODUCTION

The responses of ecosystems to perturbation, especially those involving nonlinearities and irreversibilities, have barely been explored (Daily et al. 1996). There is a need to determine the patterns and responses of ecological indicators to stress and to monitor the recovery of damaged ecosystems (Lubchenco et al. 1991). Therefore, we proposed to determine the pattern of vascular plant species structure and composition in a forested wetland.

Bottomland hardwood forests are one of the dominant types of riparian ecosystems in the United States, particularly in the Southeast (Mitsch and Gosselink 1993). Riparian vegetation occupies one of the most dynamic areas of the landscape with abundance and composition differing greatly among riparian successional stages. With the high diversity of micro-sites and disturbance regimes, there is a greater diversity in the riparian zone than in up-slope habitats (Gregory et al. 1991). Bottomland hardwood wetlands are very diverse with vegetation adapted to long hydroperiods in low lying areas of the wetland to less flood tolerant species occupying higher areas. In bottomland hardwood wetlands, the physical environment is one of the major determining factors influencing species distribution (Bell 1974; Hodges 1998). Bottomland hardwood wetlands are subjected to flooding periodically throughout the year with soils becoming saturated. Also, the prevalent trees associated with this type of habitat are particularly suited to these inundations during the growing season as well as other times of the year (Teskey et al. 1978; Cowardin et al. 1979; Mitsch and Gosselink 1993; DeShield et al. 1995). Thus, the hydroperiod's flooding duration, intensity, and timing are the ultimate factors in determining the structure and function of bottomland hardwood wetlands (Mitsch and Gosselink 1993; Conner 1994).

Flooding introduces needed nutrients into the wetland, but may have a negative impact on the wetland, depending upon season, depth, and duration of the flood. Walbridge and Lockaby (1994) also show flooding may remove nutrients from the wetland. Boggs and Weaver (1994) found changes in community structure, biomass, and nutrient pools are directly related to species dominance. They also concluded water flow alterations may slow the delivery of alluvial and water-borne phosphorus, nitrogen, and potassium to the ecosystem which can strongly influence community composition. Bayley (1995) suggests an overall increase in biodiversity and stability would result if natural flooding events are allowed to occur. However, there may not be a simple relationship between species composition and increased nutrient availability in wetlands (Ehrenfeld and Schneider 1993).

Effects of flooding may not be evident the first years following a flood event. Flooding of less flood tolerant species during their growth season may prove ultimately harmful, while flooding during their dormant period may not be as disruptive (Odum et al. 1995). Long duration flooding may be disruptive to the community regardless of the time of year (Conner 1994). Age of the plant at the onset of flooding is important to the plant's ability to carry out developmental changes, thus increasing long-term tolerance. This is consistent with the observation that mature, flood tolerant trees suddenly exposed to flooded conditions often have a lower survival than the seedlings (Keeley 1979). Flooding may also prove beneficial to certain components of the wetland (Odum et al. 1995), noting that overall productivity may be enhanced by seasonal flooding, but rapidly drops off when saturated conditions are approached.

A shift in species composition can be initiated by management strategies pertaining to control of water entering the wetland (King 1995). Flooding in the wetland may be very important in the survivorship of seeds (Jones et al. 1994). The timing of flood events in relation to seed dispersal, seed germination, and seedling establishment can produce changes in seedling abundance and composition that may lead to altered overstory composition (King 1995). Overstory species adapted to live in the floodplains with high water availability are specialized for conditions of high water availability (Pezeshki 1991). Unlike plants in a more arid environment, lack of water is not generally a limitation (Barbour et al. 1987). Flooding and saturated soil conditions are more threatening to the continued existence of many of those species found in the riparian habitat.

Preserving essential ecosystem properties such as adequate hydroperiods, diversity and adequate quantity of habitat types, viable gene pool, resilience, self-sustainability, and connectivity must also be considered in any management areas (Holland 1996a). Resilience is the ability of an ecosystem to return to pre-disturbance conditions while connectivity (*e.g.*, growth and nutrient cycles, flooding and physiological adaptations of species) refers to the functional relationships in natural ecosystems.

In rehabilitating wetlands, often times soils and hydrology are largely intact and the main goal is to establish the former vegetation. Analysis of the vegetation in a wetland system is usually second only to understanding the hydrology of the area (Erwin 1990). Once a threshold density of preferred species at least two meters tall is obtained, survival of the trees is assured and little can be done to expedite the success of a rehabilitation project (Clewell and Lea 1990). Another goal of a rehabilitation project is the rehabilitation of developed river systems, that is, the recovery of their ecological functions and values (Gore and Shields 1995).

Success of rehabilitation projects comes in various degrees. Watershed rehabilitation should be an integral part of a program to aid recovery of fish habitat, riparian habitat, and water quality improvement (Sedell et al. 1994.) The success of a wetland creation or rehabilitation project may mean the establishment of a biologically viable and sustainable wetland ecosystem, the replacement of the function lost in a wetland being replaced, or comparison against restored wetlands to natural reference wetlands in the region (Mitsch and Wilson 1996).

A beaver impounded landscape is a mosaic of different vegetation types due to the dynamic hydrology of beaver ponds, the diversity of pre-impoundment vegetation, and the changes caused by beaver foraging in the riparian zone (Naiman et al. 1988). Although beaver impoundments and the patches associated with these beaver ponds are small in relation to other types of disturbances (channelization, clearcutting, fire), the cumulative disturbance over time may result in extensive alteration to the ecosystem (Johnston and Naiman 1990). Naiman et al. (1994) found distinct biophysical patches in areas impounded by beavers within the last 63 years. Even though there had been occasional abandonment and drainage of these beaver ponds, none of the previous areas had reverted to forested land. Animals tend to have a substantial impact on ecosystems, and their impact provides a system of feedbacks that would not ordinarily exist in the un-disturbed ecosystem. Thus, an ecosystem level investigation on these alterations needs to be conducted (Naiman 1988) wherever beavers have played a role in landscape development.

By maintaining the ecological health of the watershed, good habitat for organisms like fish and other aquatic and riparian-dependent organisms (*e. g.*, birds, foxes, raccoons, bears, deer, and other wildlife) is promoted (Porter 1981; Sedell et al. 1994). Effects of landscape disturbances due to agriculture, deforestation, and grazing on diversity and population dynamics of stream fish are beginning to be analyzed. These disturbances alter ecological processes over large spatial scales (Schlosser 1995). Knowing fish distribution is important so that ichthyologists and fisheries managers can correctly assess faunal changes that reflect environmental alteration (Harrel et al. 1988). Riparian and macrophyte cover, bank slope, and stream depth are important variables to consider when studying fish distribution (Collares-Pereira et al. 1995). The riparian zones are very important to community dynamics within streams, which may be enhanced with seasonal variations like floods and droughts (Collares-Pereira et al. 1995). Meffe and Sheldon (1988) found a discrepancy in a fish species not expected in the headwater reaches. This discrepancy was attributed to a disturbance in the riparian zone (logging) creating a habitat that would support this species. If habitat is indeed a strong determinant of biotic structure, then post-recovery assemblages should strongly resemble the pre-disturbance state, lending support to the claim of non-randomness in community structure (Meffe and Sheldon 1990). Thus, by restoring or protecting wetland vegetation, other non-target organisms within the environment are also restored or protected.

Research Questions Being Tested

We examined a bottomland hardwood wetland that had its hydraulic regime altered (channelization in 1939). The main research question is, what is the current overstory vegetation community structure along eight belt transects within this existing bottomland hardwood wetland? We measured current overstory vegetation to determine the current composition of woody vascular plant species in an effort to collect data that may determine how the hydraulic regime influences overstory species composition in this wetland area. The overall null hypothesis being tested is: there will be no differences in current woody vegetative community structure along eight belt transects within this study area.

Study Site Description

The study site is located on the Lafayette County/Marshall County lines just north of Oxford, Mississippi. The study site includes about 4,270 hectares of riparian area, drains about 20,670 hectares to its south, and has the potential to affect waters and associated biological communities downstream (Figures 1 and 2). The study site is located adjacent to the Little Tallahatchie River to the east of Sardis Reservoir and to the south of the Little Tallahatchie River Canal. This study area can be described as a forested wetland (Cowardin et al. 1979; Mitsch and Gosselink 1993). There currently is an existing bottomland hardwood forest along the river. This wetland falls within land under US

Army Corps of Engineers (COE) and U. S. Department of Agriculture Forest Service jurisdictions.

The current riverbed was channelized in 1939 as part of the Little Tallahatchie River Channelization Project by the COE under their Congressionally mandated charter for flood control (Moore 1972). Water was diverted from the original riverbed and, a few decades later, from two major tributaries, Puskus and Cypress creeks, into the 20 km Little Tallahatchie River Canal north and parallel to the original Little Tallahatchie River channel. During periods of high flow in the Little Tallahatchie Canal, water can and does flow into the Little Tallahatchie River. Without intervention by humans, beavers impound water, resulting in water entering the original Little Tallahatchie River (Bobby Hudson, personal communication).

The length of the study area is approximately 16 linear km east to west or approximately 37 km by river and is under consideration for a river rehabilitation project by the COE. The study site can be described as a forested wetland (Cowardin et al. 1979; Mitsch and Gosselink 1993). This wetland does receive water during times of high flow into the Little Tallahatchie River due to its location to the immediately downstream Sardis Reservoir.

This research area is under the Ecosystem Restoration Report Stage of the proposed COE rehabilitation project. After the successful completion of this phase (scheduled to conclude in February 1999), the COE rehabilitation project will begin (Warren 1995; Charlier 1996). This project will divert water from the Puskus and Cypress tributaries back into the original Little Tallahatchie River channel. The research described here will provide useful background information to the proposed rehabilitation project.

MATERIALS AND METHODS

Current overstory taxa were sampled for differences in distance from the river, tree elevation, relative frequency, relative density, relative dominance (based on basal area), importance values, diameter at breast height, and species composition among eight belt transects within the study site. Extent of transect flooding was personally measured at each transect monthly (April - December 1997). Additionally, publicly accessible river gage data (from U. S. Army Corps of Engineers and U. S. Geological Survey) were collected for the same time period (April - December 1997).

Hydrological Data

Long term hydrological records were obtained in as much detail as possible for the entire study area (Table 1) for the length of the study. Stage data is available from the USGS web site (http://www.usgs.gov/). Stage data on the Little Tallahatchie River prior to its entrance into Sardis Reservoir is available from 1939 to the present day. Information is also available from the COE on discharge flows from Sardis Reservoir (http://www.155.76.32.229/edh/docs/bullet.txt). This discharge data was critical in determining river stages for establishment of transects. These hydrologic data may provide information on the amount and duration of water received by the study area had it not had its water diverted into the Little Tallahatchie Canal.

No historical hydrologic data are available for the stretch of Little Tallahatchie River studied Any flooding within the study area during the sampling time of this project (April-October) was measured. Visual estimates of extent of flooding along the established belt transects were recorded at monthly intervals. Water depth on noticeable features of the landscape (*e. g.*, trees and researcher placed markers) was recorded by marking depth of water on the marker (or evidence of water depth since last measurement) above ground level.

Establishment of Transects

Observations of all woody vascular plants occurring along eight belt transects extending through the 16 km study area were recorded (Figures 3 and 4). Adjacent belt transects are approximately 2 km apart. Each belt transect is established permanently and its location was established using global positioning system units (Trimble GeoExplorer). The belt transects were surveyed for elevational changes from one end of the transect to the other end using traditional surveying techniques. Along each transect, known distances (every 5m) were determined with a meter tape. The belt transects run perpendicular to both sides of the Little Tallahatchie River original channel (Holland 1974; Holland and Burk 1984, 1990). The transects terminate at a change in elevation of two meters in height from the Little Tallahatchie River. By terminating the transect at 2m, the immediate floodplain of the Little Tallahatchie River was determined.

Classification of Vegetation

Species composition has proven to be a useful indicator of wetland functioning (Mitsch and Gosselink 1993; Patrick 1994; Holland 1996b) and was recorded. Observations for current tree species composition and species diversity were obtained within each belt transect established (Phillips 1959; Mueller-Dombois and Ellenberg 1974; Chapman 1976). Observations of all trees 10.2 cm or greater diameter at breast height (d.b.h.) occurring along these belt transects were recorded in the spring and summer of 1997. The position of each tree relative to the river was recorded. This information, along with elevational information collected, may provide a useful estimation as to the amount of flooding the tree has experienced.

The d.b.h. data were converted into basal area to calculate dominance. Relative dominance was calculated by the following equation: [Relative Dominance = (total basal area of species "a"/total basal area)*100]. Relative frequency values (number of occurrences) were calculated using the following equation: [Relative Frequency = (frequency of species "a"/frequency of all species)*100]. Relative density (number of plants rooted within each transect) was calculated using the following equation: [Relative Density = (density of species "a"/total density of all species)*100. Relative frequency, relative density, relative dominance (based on basal area) values were summed to produce importance values. All formulas used are standard ecological equations (Philips, 1959; Mueller-Dombois and Ellenberg 1974; Chapman 1976).

RESULTS

During the calendar year 1997, the Little Tallahatchie Canal carried a large volume of water (Table 1) which flows into Sardis Reservoir. If high flow conditions exist (as observed this year), that backlog of water will eventually begin to flood low lying portions of the study area. All of the eight transects used in this study exhibited effects of flooding to almost 2m above the river (debris and sediment covered trunks). Overbank flow from the river affected the five easternmost transects for the majority of three summer months with extensive flooding monitored to the 15m mark on transect 4 and to the 25m mark on the easternmost transect 1.

The average length of each transect was 65m with the longest transect being 145m and the shortest being 10m (Figures 3 and 4). The majority of the overstory species sampled occurred within the first 20m of each transect (Table 2 and Figures 3 and 4) with at least one tree specimen observed on every transect sampled. Twelve species of overstory specimens were sampled including: American beech (*Fagus grandifolia* Ehrh.), American elm (*Ulmus americana* L.), bald cypress (*Taxodium distichum* (L.) L. C. Rich), black cherry (*Prunus serotina* Ehrh.), boxelder (*Acer negundo* L.), green ash *(Fraxinus pennsylvanica* Marsh.), red maple *(Acer rubrum* L.), silver maple (*Acer saccharinum* L.), southern red oak (*Quercus falcata* Michx.), sycamore (*Platanus occidentalis* L.), water oak (*Quercus nigra* L.), and willow oak (*Quercus phellos* L.) (Table 2).

Relative dominance was calculated using basal area as a measure of canopy cover (Figure 5a): bald cypress was the most dominant species sampled, silver maple was second most dominant, and sycamore, third. Relative density values were calculated (Figure 5b): silver maple was most dense, bald cypress, second, and sycamore, third. Relative frequency was calculated (Figure 6a): the most frequently appearing species was silver maple, followed by bald cypress, and sycamore. Importance values for all overstory species where then calculated (Figure 6b): bald cypress was the second most important species sampled, while silver maple became the most important species, and sycamore was third in importance.

DISCUSSION AND CONCLUSION

Hodges (1998) indicates the greatest variety of species within the floodplain occurs on the stream fronts with differences in relief of only a few centimeters having a marked influence on distribution and growth of species. This appears to be true for this study, where the majority of the trees sampled occurred within 20m of the river.

The extent of the flooding observed during the spring and summer of 1997 will ultimately influence the current overstory composition; although the depth was typical, the duration was not. High flow conditions were recorded entering Sardis Reservoir from the Little Tallahatchie River (Table 1). The 1997 values reported were the 6th highest values in the 37 years of Little Tallahatchie River stage records.

Sardis Reservoir is maintained for flood control and recreational purposes (Moore 1972). As such, reservoir pool depth is influenced by the amount of water within the watershed both above and below the reservoir. In high flow conditions, such as 1997, the maximum flood pool for Sardis Reservoir is reached (Figure 2). This increase of water in Sardis Reservoir results in extensive flood conditions within the upstream wetland under study. Flooding conditions may not occur in the wetland during opportune times of the year (Mitsch and Gosselink 1993; Conner 1994; Odum et al. 1995). Observed flooding during the study period (April -October 1997) indicates flood conditions existed within this 16km wetland for much of the growth season. According to Mitsch and Gosselink (1993), Conner (1994), and Odum et al. (1995) saturated conditions such as those observed during the growth season may not only decrease system productivity, but may also decrease the overstory species survivability. The anthropomorphic influence of Sardis Reservoir may prove to be the driving force within this 16km stretch of wetland in a similar fashion observed by King (1995) in wetlands affected by reservoirs in Texas.

All of the tree species sampled in this study are adapted to existing in periodically inundated areas (Kellison et al. 1998), which is the predominating hydrology within the study area. Of the 12 overstory species encountered in this study, seven are categorized as widely distributed and are found in most southern floodplains, three species are considered to be distributed in over one-half of southern floodplains, and the remaining two species are considered to occur in less than one-half of southern floodplains, presumably (Kellison et al. 1998). The results of this study indicate silver maple, bald cypress, and sycamore are the more productive (based on basal area), frequent, and dense species in this 16km stretch of the Little Tallahatchie River. A high number of silver maples were sampled. Even though the bald cypresses sampled had a greater basal area, they occurred less often in the areas sampled. The individual responses of the overstory species sampled in this study will ultimately determine the future species composition of the wetland under study.

Data from this study can provide a baseline of information for use in monitoring the future development or change along this stretch of the river. The sampling in 1997 indicates along a 16km stretch of the Little Tallahatchie River, the current dominant overstory species are silver maple, bald cypress, and sycamore species which are characteristic of bottomland hardwood forests in Texas (King 1995), Kentucky (Mitsch et al. 1991) and Arkansas (Smith 1996).

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Table 1. Average Annual Discharge (cubic feet/sec) of The Little Tallahatchie River into Sardis Reservoir.

Average Annual Discharge	Year		Average Annual Discharge	Year	
693.96	1940		1010.78	1969	
415.78	1941		991.22	1970	
459.32	1942		700.20	1971	
271.65	1943	+	796.06	1972	
782.56	1944		1747.43	1973	
901.26	1945		1464.43	1974	
1258.63	1946		1083.29	1975	
833.23	1947		524.01	1976	
1283.58	1948		688.55	1977	
905.71	1949		790.46	1978	
1163.93	1950		1505.87	1979	
1280.56	1951		893.01	1980	
535.54	1952		263.32	1981	
780.01	1953		1253.72	1982	
297.26	1954		1710.41	1983	
689.46	1955		796.88	1984	
566.79	1956		563.56	1985	
1184.65	1957		872.63	1986	
781.68	1958		617.08	1987	
618.84	1959		507.66	1988	
592.88	1960		1246.66	1989	
1156.65	1961		1118.25	1990	
993.35	1962		1754.24	1991	*
434.08	1963		574.74	1992	
1028.78	1964		663.72	1993	
675.83	1965		1282.36	1994	
516.18	1966		824.67	1995	
724.38	1967		1226.24	1996	
1094.68	1968		1428.63	1997	

+ = Lowest average annual discharge
* = Highest average annual discharge

Table 2. Location of Overstory Species in relation to the Little Tallahatchie River (April - October 1997).

Common Name	Scientific Name	0-19m	20-39m	40-59m	60-79m	80-119m	Total
Boxelder	Acer negundo	2	0	0	0	0	2
Red Maple	Acer rubrum	1	0	0	0	0	1
Silver Maple	Acer saccharinum	4	0	5	3	3	15
American Beech	Fagus grandifolia	2	0	0	0	0	2
Green Ash	Fraxinus pennsylvanica	0	1	0	0	0	1
Sycamore	Platanus occidentalis	3	1	0	0	0	4
Black Cherry	Prunus serotina	1	1	0	0	0	2
Southern Red Oak	Quercus falcata	0	1	0	0	0	1
Water Oak	Quercus nigra	1	0	0	0	0	1
Willow Oak	Quercus phellos	1	1	0	0	0	2
Bald Cypress	Taxodium distichum	3	0	3	0	0	6
American Elm	Ulmus americana	2	0	0	0	0	2
	Total	20	5	8	3	3	39

Figure 1. Map of the State of Mississippi Showing the Little Tallahatchie River Drainage and Other Major River Drainages.

Map Created by Kevin Pigott 28 March 1998. Basemap created using 1:100:000 data supplied by MARIS.

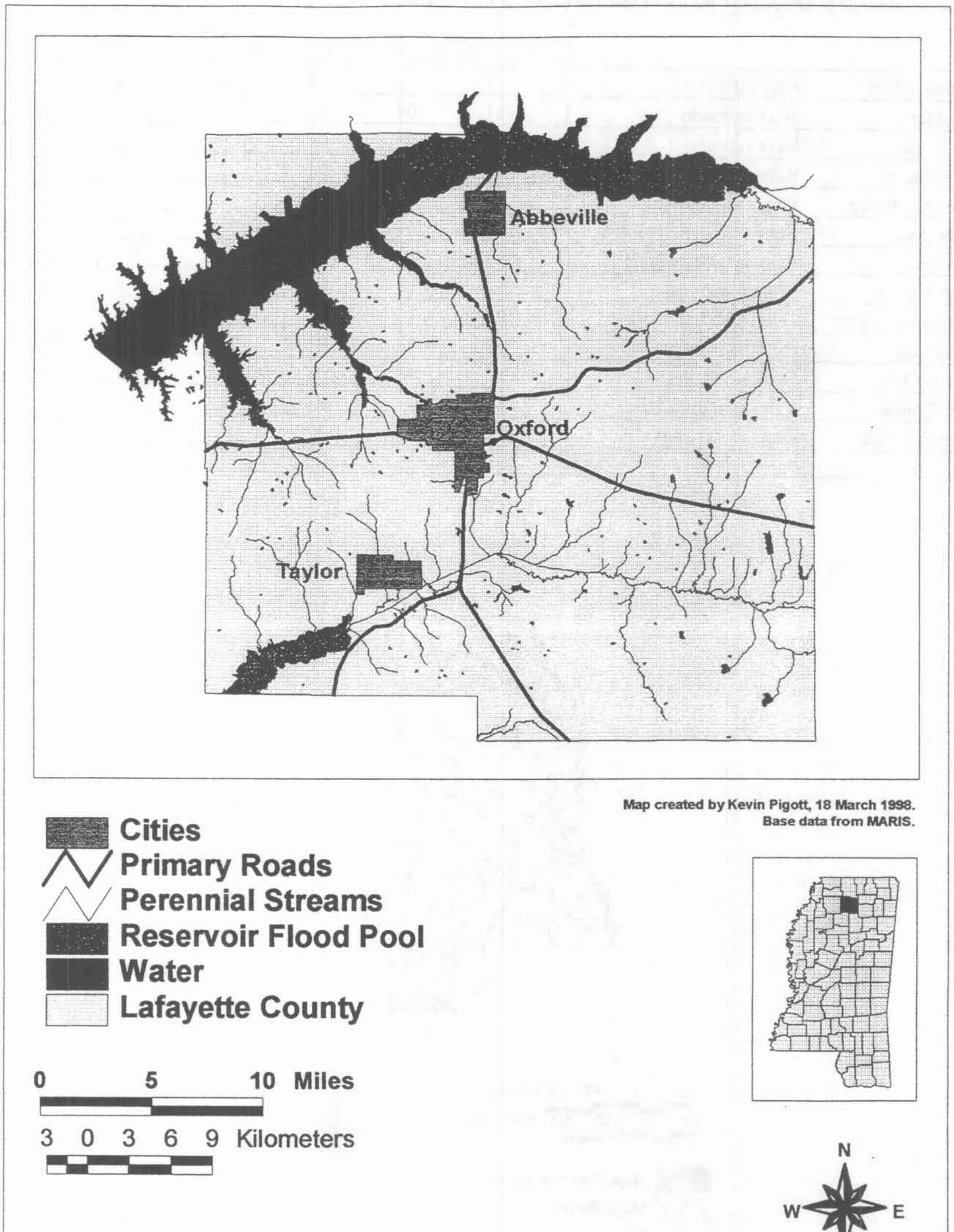

Figure 2. Location of the Study Site.

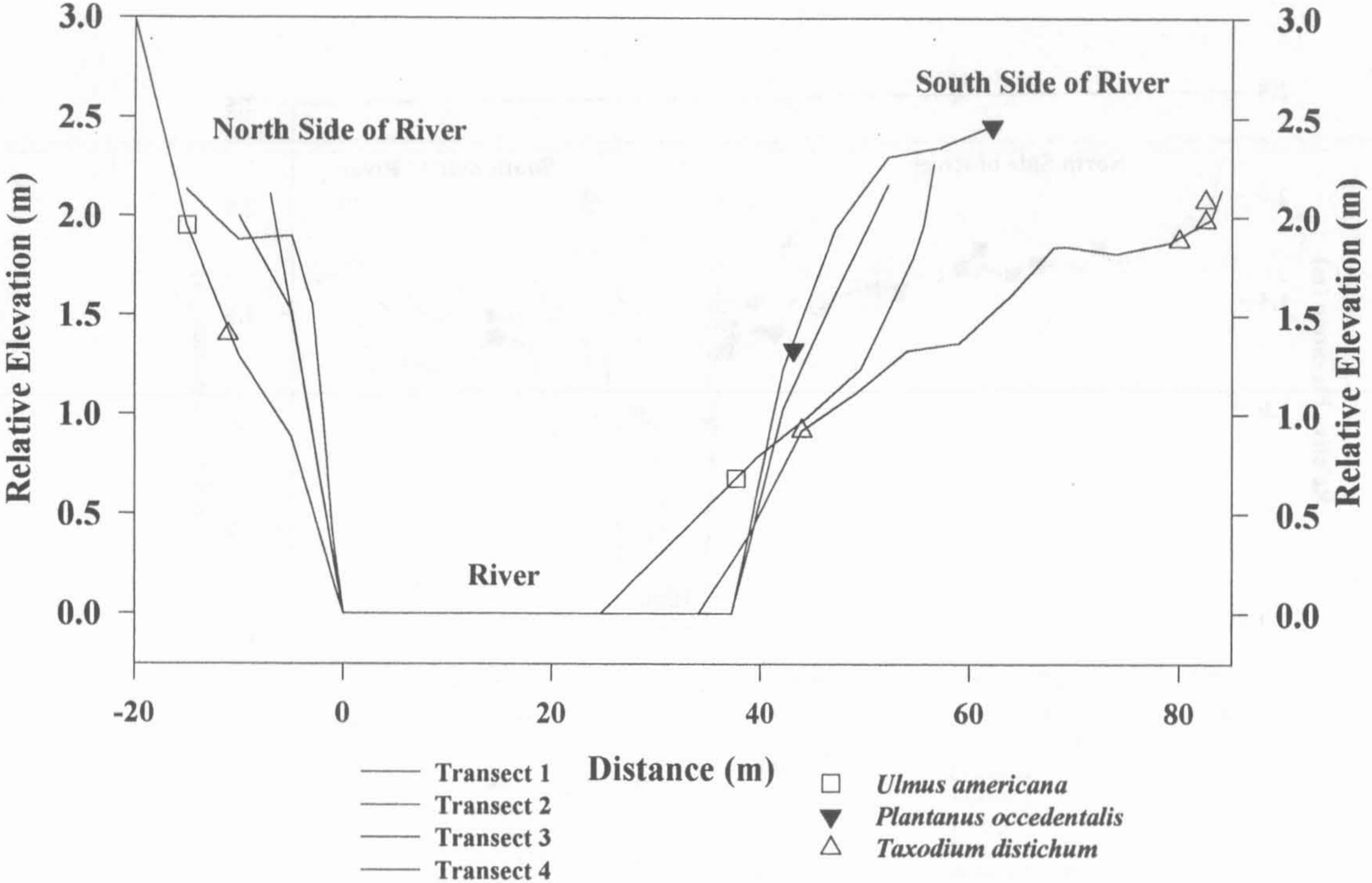

Figure 3. Relative Elevation of Transects 1 - 4 (Eastern) and Overstory Species Location.

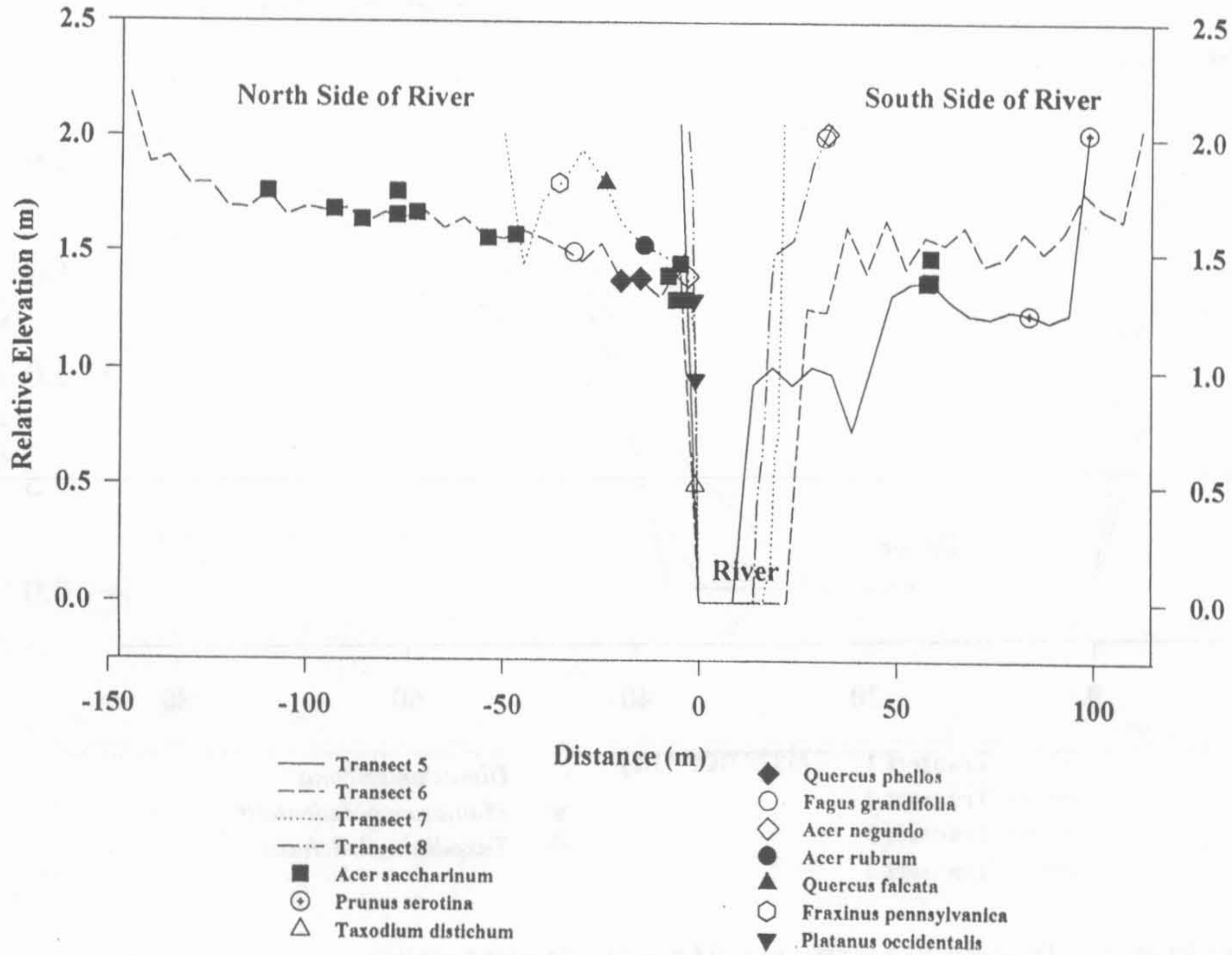

Figure 4. Relative Elevation of Transects 5 - 8 (Western) and Overstory Species Locations.

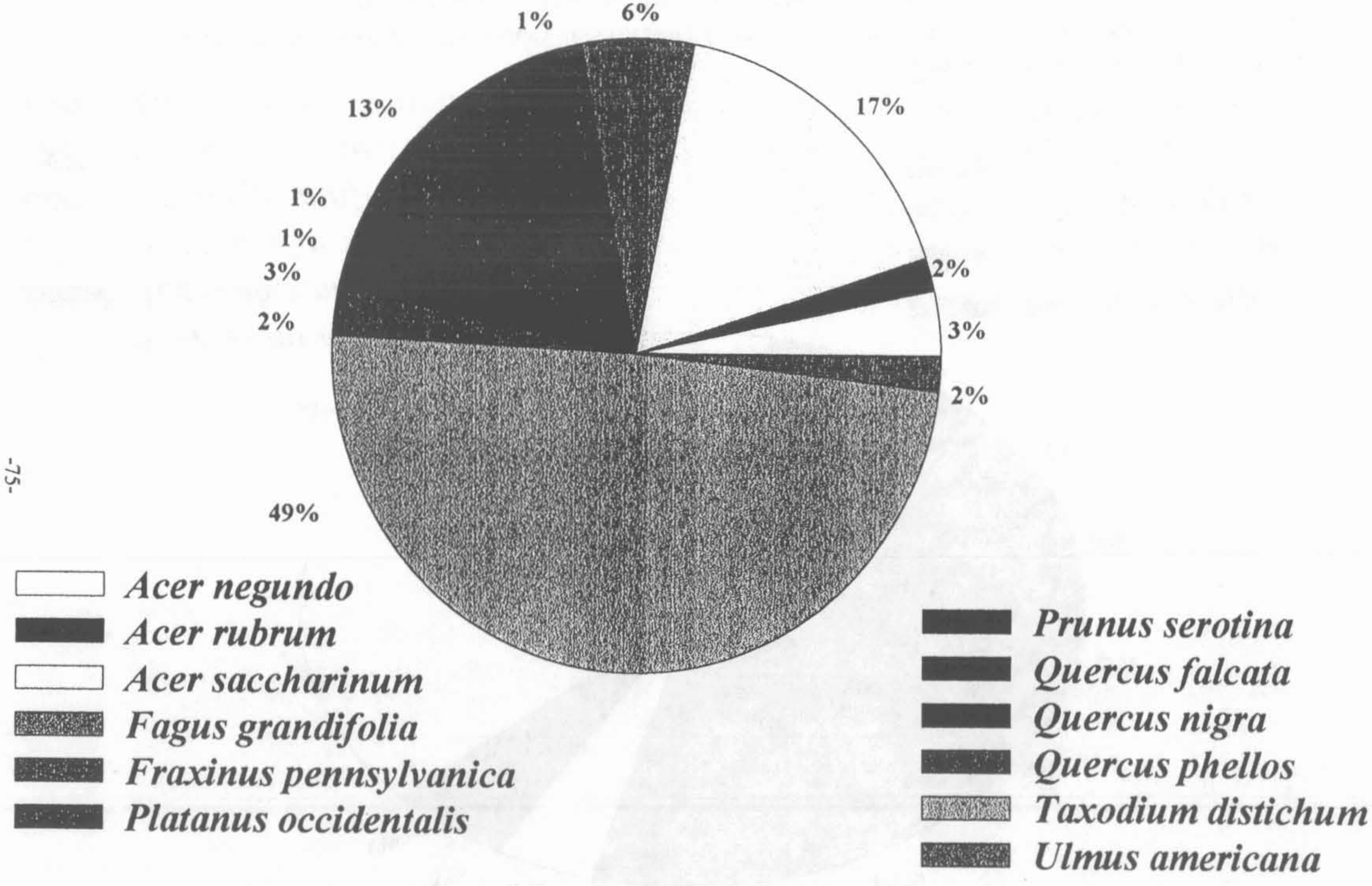

Figure 5a. Relative Dominance of Overstory Plant Species in the Little Tallahatchie River, Lafayette County, MS (April - October 1997)

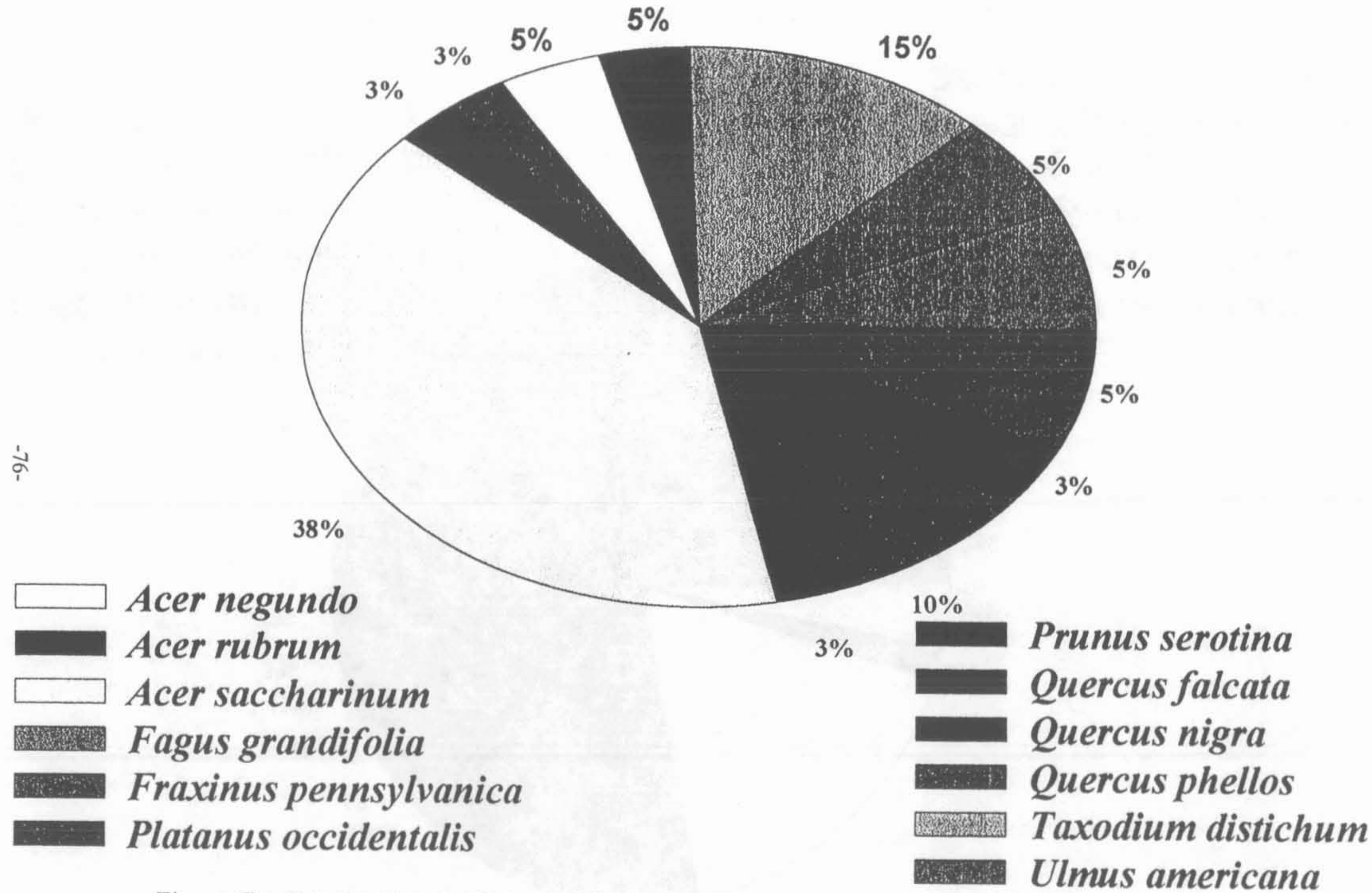

Figure 5b. Relative Density Values of Overstory Plant Species in the Little Tallahatchie River, Lafayette County, MS (April - October 1997)

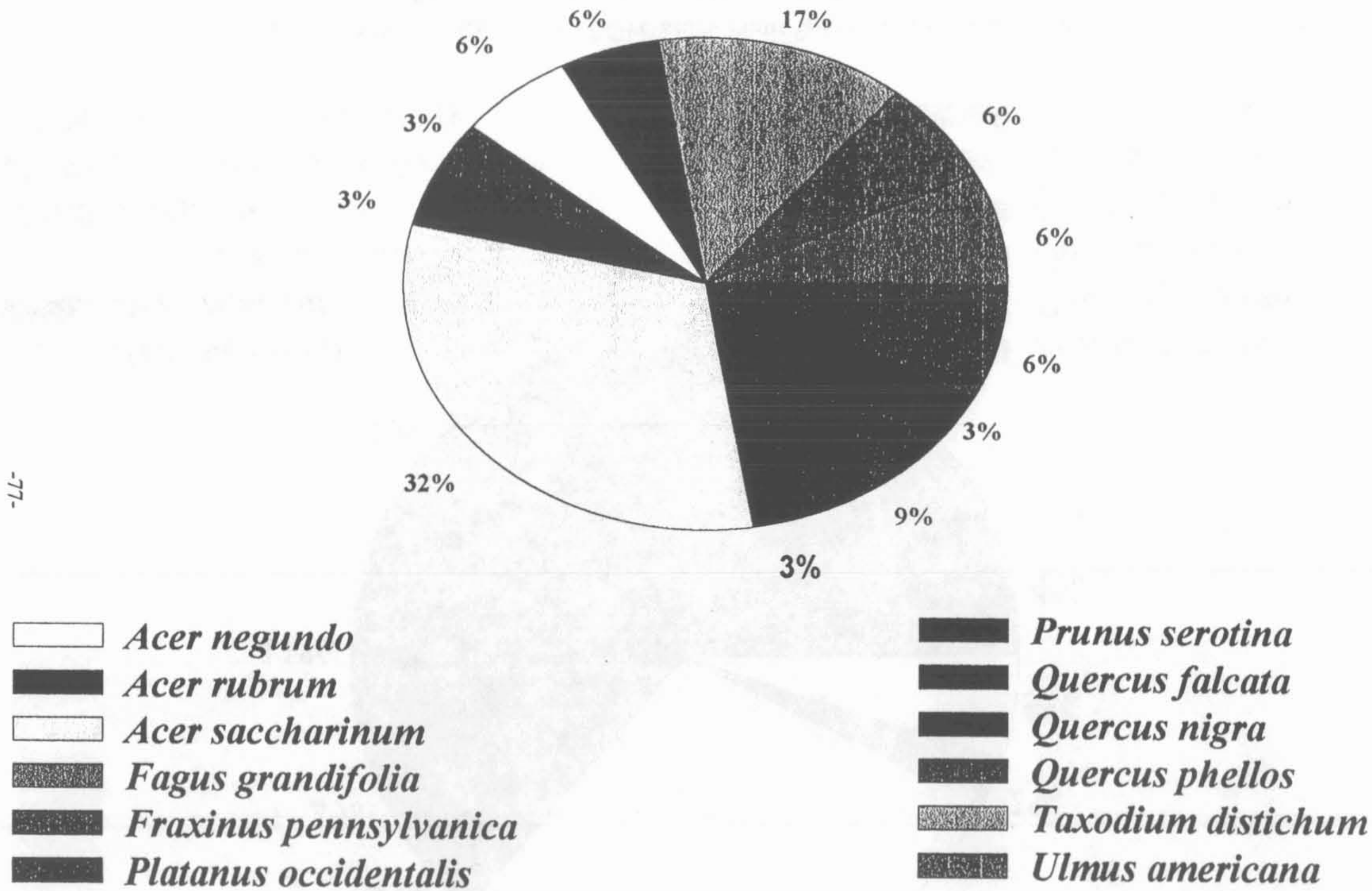

Figure 6a. Relative Frequency Values of Overstory Plant Species in the Little Tallahatchie River, Lafayette County, MS (April - October 1997)

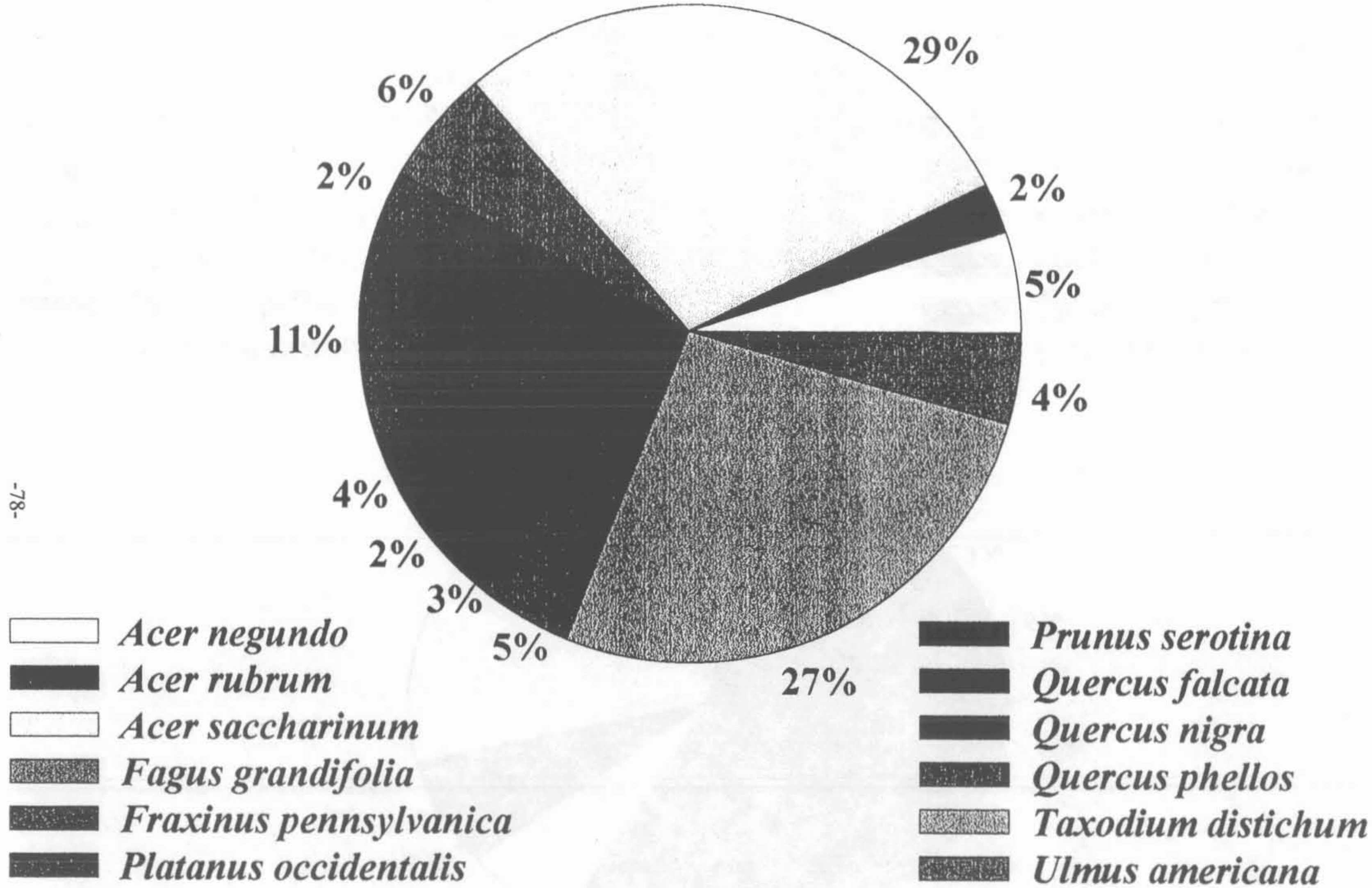

Figure 6b. Importance Values of Overstory Plant Species in the Little Tallahatchie River, Lafayette County, MS (April - October 1997)