Bottomland Oak Afforestation in the Lower Mississippi Alluvial Valley

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Introduction

The 11 million hectare Lower Mississippi Alluvial Valley (LMAV), which is the geologic floodplain of the lower Mississippi River, is a prominent physiographic region in the southern United States. Seven states (Arkansas, Louisiana, Mississippi, Missouri, Kentucky, Illinois, and Tennessee) border the lower stretch of the River, and have a portion of their land base in this alluvial physiographic region (Figure 1). Over the past 10,000 years, the River has meandered within the LMAV (Saucier 1994). These meanderings carved channels and deposited sediment loads that created a dynamic and heterogeneous landscape which is characterized by several geomorphic features or "sites" readily distinguished by soil characteristics and hydrologic regimes. The fertile alluvial soils and humid, temperate climate of the LMAV support broadleaf forests rich in species diversity, including no less than 15 species of bottomland oaks (*Quercus* spp.) (Stein et al. 2003). With such a diversity of bottomland oaks, the different species are found stratified among, and often as a dominant overstory component, on most of the sites across this alluvial landscape. The only exceptions are the most recently formed land adjacent to the river channel and the wettest swamp sites (Hodges 1997).

Bottomland oaks have always been among the most highly treasured tree species in the LMAV. Archeological evidence illustrates that bottomland oak acorns were consumed by the Native Americans living in the region (Gibson 2001), and the superior wood quality of bottomland oaks attracted pioneering lumbermen into the region (Winters et al. 1938). Though the once extensive bottomland forest of the LMAV has been greatly reduced, the bottomland oaks that thrive in the region are still favored by managers. Silvicultural practices in the LMAV often favor management for bottomland oaks because their mast production is desired by managers concerned with enhancing wildlife habitat and their quality wood still demands a premium at sawmills. The purpose of this manuscript is to briefly describe the bottomland forest and native oaks of the LMAV, the degradation and loss of forest cover in the LMAV, early afforestation efforts aimed at reestablishing bottomland oaks in the region, and recent afforestation efforts in which bottomland oaks comprise a component of a diverse suite of vegetation established to restore bottomland hardwood ecosystem functions.

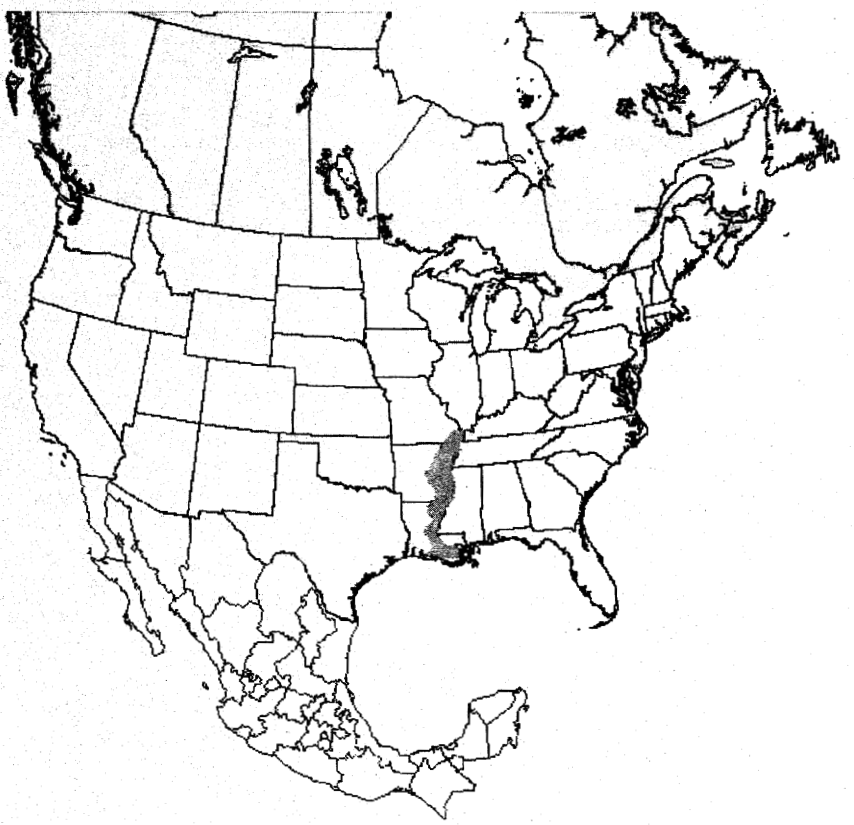

Figure 1 Location and extent of the Lower Mississippi Alluvial Valley.

The LMAV Forest and Bottomland Oaks

The deciduous forest currently occupying the LMAV became the dominant flora in the region around 5000 years before present following an extended dry period when grassland species were the predominate flora (Delcourt et al. 1980, King and Allen 1977, King 1981). More than 60 broadleaved tree species are considered native to the LMAV, and as mentioned, no less than 15 of these species are bottomland oaks (Putnam et al. 1960). Some species occurring in the LMAV, such as cherrybark oak (*Q. pagoda* Rafinesque) and Shumard oak (*Q. shumardii* Buckley), also grow on upland sites across the southern United States, while other species, such as overcup oak (*Q. lyrata* Walter) and Nuttall oak (*Q. texana* Buckley), grow only on floodplains. Despite the rich diversity of oaks in the LMAV, none are endemic only to this region, as they have ranges that extend into other river bottoms throughout the southern United States.

Bottomland oaks in the LMAV seldom grow in pure stands, but rather develop in association with other tree species. For example, cherrybark oak and swamp chestnut oak (*Q. michauxii* Nuttall) typically grow in association with sweetgum (*Liquidambar styraciflua* L.) on ridges that exhibit relatively high relief and older,

well developed soils (Hodges 1997, Putnam and Bull 1932) (Figure 2). In contrast, overcup oak is generally found growing in association with water hickory (*Carya aquatica* (Michx. f.) Nuttall) on sites characteristic of backwater flats that are relatively low in elevation, and have poorly drained, less developed soils (Hodges 1997, Putnam and Bull 1932) (Figure 3.). These species - site relationships are driven by interactions between inherent species physiology and floodplain site conditions such as flooding regime, soil drainage, nutrient availability, and competition. More detailed descriptions of the ecological characteristics of bottomland oaks occurring in this region can be found in Gardiner (2001).

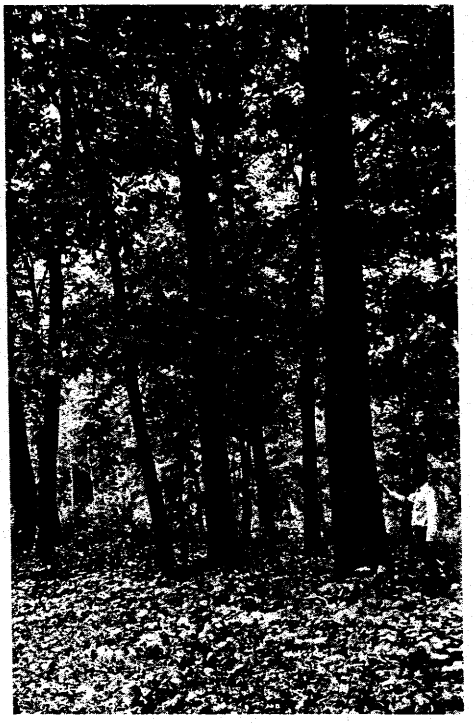

Figure 2. A cherrybark oak-sweetgum stand type photographed in Lee County, Arkansas (from *Putnam and Bull*, 1932)

Though bottomland oaks grow in association with other tree species, they often comprise a significant proportion of the overstory canopy. Importance of a particular oak species in a bottomland forest is determined largely by its dominance in the various species

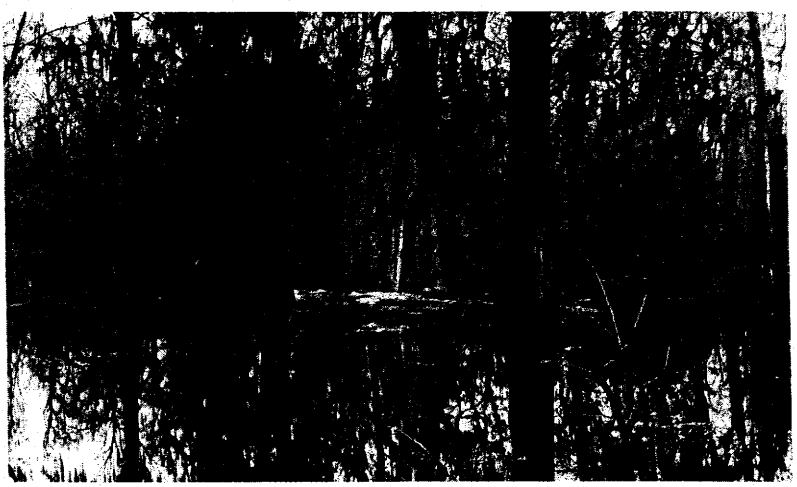

Figure 3. An overcup oak - water hickory stand type photographed in Concordia Parish, Louisiana *(from Putnam and Bull 1932)*.

associations that exist in bottomland hardwood communities and availability on the floodplain of the particular geomorphic sites occupied by those species associations (Hodges 1997, Tanner 1986). Tanner (1986), who reported on a 1937 to 1939 inventory conducted in a virgin bottomland forest in northeast Louisiana, provided an informative illustration of bottomland oak distribution and abundance among floodplain sites. To contrast two site types from his report, his description revealed that more than 60 percent of the trees greater than 30 cm diameter at breast height growing on low flat sites were overcup oak and Nuttall oak, while oaks, primarily water oak (*Q. nigra* Linnaeus), and willow oak (*Q. phellos* Linnaeus), comprised 35 percent of the trees on ridge sites (Tanner 1986). Thus, different bottomland oak species are generally found stratified among the various sites in floodplains on which they exhibit varying levels of abundance.

Forest Degradation and Loss in the LMAV

Occupation of the LMAV by sedentary populations of Native Americans began as early as 5000 years before present (Connaway 1977, Smith 1986), which appears to coincide with the rise of the deciduous forest in the region. It can be reasoned that earliest human impacts to the forest probably stemmed from activities of these first sedentary populations of Native Americans. The extent of Native American impact to the forest of the LMAV is currently unknown, but it is presumed that as populations expanded, appreciable land clearing and/or burning would have occurred around villages and on hunting grounds (Hamel and Buckner 1998). Hamel and Buckner (1998) suggested that much of the forest condition described by European explorers to the region would have developed from formerly cleared and/or burned areas. Notes of large expanses of switchcane (*Arundinaria gigantea* (Walter) Muhlenberg), a disturbance-dependant species, and extensive stands of old field tree species such as sweetgum are among the evidence leading Hamel and Buckner (1998) to their suggestion.

Beginning in the 1800s, more significant and enduring deforestation began as European settlers were drawn to the productive soils of the region for agricultural production (Cobb 1992). The River and its tributaries provided convenient transportation through the region, and the abundant natural resources were rich for building new societies, but the extensive forest was an obstacle to European settlers who were intent on developing agricultural production in the LMAV (Cobb 1992). Estimates indicate that nearly half of the LMAV land base had been cleared for agriculture by the 1930s (Stanturf et al. 2000), a noteworthy figure considering that prior to the survey the Civil War interrupted agricultural production causing abandonment of many LMAV farms and reversion of many fields back to forests (Lentz 1928, Winters et al. 1938).

The 20th century brought additional deforestation to the LMAV. Expansion of agricultural production in the region was facilitated by completion of the mainline levee system along the River channel. The levee system, which was initiated in 1928, serves to contain floodwaters within a narrow waterway flanking the River channel through the LMAV to the Gulf of Mexico. With floodwaters contained between levees, landowners were able to extend farming operations onto soils previously too wet for crop production. The last major deforestation pulse swept through the region during the 1960s and 1970s when the soybean (*Glycene max* (L.) Merrill) commanded a premium price in world markets (Sternitzke 1976). Between 1964 and 1974, forest area in the region declined by more than 105,000

hectares annually (Sternitzke 1976). Today, only 26 percent of the original forested area remains in the LMAV, and most of the remaining forests are found in small isolated patches, on land that is too wet for crop production (Gardiner and Oliver 2005). The largest forested tract remaining in the LMAV is the 240,900 ha Atchafalaya Basin in southern Louisiana. Other large tracts, such as the White River National Wildlife Refuge, are located near the River where they remain unprotected from annual floodwater inundations (Gardiner and Oliver 2005).

Early Bottomland Oak Afforestation

Attempts to establish bottomland oak plantations on former agricultural fields in the LMAV were documented as early as the 1940s (Maisenhelder 1957). These early plantings were generally small, experimental plantations used to reestablish forest cover on poor cropland. Recommendations at the time suggested that the site be prepared by disking to remove competing vegetation, and that the planting should be cultivated until the established stock outgrew competing vegetation (Maisenhelder 1957). Though knowledge gained from this early work would advance future development of bottomland oak afforestation practices, wide scale deforestation in the LMAV continued to outpace these early plantation establishment efforts for several decades.

In the early 1960s, scientists at the U.S. Forest Service, Southern Hardwoods Laboratory in Stoneville, MS began strengthening research programs to improve techniques for nursery culture of bottomland oak seedlings, and practical methods for establishing oak plantations (Maisenhelder and McKnight 1962, Kennedy 1993). However, the decade would end with demand from world markets driving soybean prices to a premium, and deforestation rates peaking to capitalize on the prices (Sternitzke 1976). Nevertheless, this oak regeneration research would eventually support a forest restoration effort that was mounting on public holdings in the LMAV.

The deforestation surge declined in the late 1970s with the crash of soybean prices, and Federal and State natural resource managers began implementing practices to restore forest cover for wildlife habitat on former agricultural fields within public holdings (Newling 1990, Haynes and Moore 1988). Because these plantings were driven primarily by objectives to develop wildlife habitat, land managers were concerned with the establishment of hard mast producing trees, chiefly the bottomland oaks (King and Keeland 1999). These oak plantations were typically established by planting 1-year-old bareroot seedlings or direct seeding acorns. Depending on site type, species commonly planted included Nuttall oak, willow oak, water oak and cherrybark oak (Allen 1990). Though research indicated that site preparation and subsequent competition control greatly enhanced plantation establishment, these practices were often sacrificed (Allen 1990), presumably because plantations were being established on a larger scale than previous efforts. Schoenholtz et al. (2001) reported that about 800 hectares of forest were established on public holdings in Arkansas, Louisiana, and Mississippi between 1968 and 1985, but success of these practices proved inconsistent because of several factors including weedy competition, extended flooding during the growing season, poor quality nursery stock, poor planting practices, and animal damage (Haynes and Moore 1988). Where bottomland oak plantations were successfully established, forest cover has been restored and bottomland hardwood ecosystem functions are returning (Haynes and Moore 1988). Examples of these plantings can be found on Yazoo National Wildlife Refuge in Washington County, Mississippi, Panther

Swamp National Wildlife Refuge in Yazoo County, Mississippi, and Red River Wildlife Management Area in Concordia Parish, Louisiana.

Bottomland Oak Afforestation in the Conservation Program Era

Afforestation in the LMAV surged in the 1990s following the 1985 and 1990 Congressional Farm Bills which funded the Conservation Reserve Program (CRP) and the Wetland Reserve Program (WRP) (Kennedy 1990, Loesch et al. 1995, Schoenholtz et al. 2001). With grain surpluses flooding markets, these programs were established through the U.S. Department of Agriculture to reduce production by removing highly erosive soils and wetland soils from agriculture. Through these programs, landowners may receive land rental and cost-share funding for approved conservation practices including afforestation on qualified land. The monetary incentives offered through the CRP and WRP have proven successful in removing a substantial amount of land from crop production. For example, a large percentage of the 70,000 hectares planted in Louisiana, Arkansas, and Mississippi between 1986 and 1998 was land enrolled in one of these conservation programs (Schoenholtz et al. 2001).

Several other benefits have been realized following implementation of these conservation programs. Co-benefits resulting from afforestation practices include wildlife habitat, carbon sequestration, biodiversity enhancement, and fiber and timber production. Furthermore, participation in these conservation programs has shifted afforestation efforts from limited public holdings to predominantly private holdings (Gardiner and Oliver 2005). As afforestation has now reclaimed well over 200,000 hectares of the LMAV in Louisiana, Arkansas, and Mississippi, more than 75 percent of this land is privately owned (Gardiner and Oliver 2005).

The majority of plantings established under the first WRP and CRP contracts were predominantly oak plantations (Schoenholtz et al. 2001). King and Keeland (1999) reported that between 1987 and 1997, 78 percent of all seedlings outplanted in the LMAV were bottomland oak species. Bottomland oaks were widely planted

Figure 4. A recently developed afforestation system in which Nuttall oak is interplanted beneath a 2-year-old eastern cottonwood plantation.

because earlier afforestation research and plantings on public land provided the knowledge and operational practices from which the conservation programs were modeled. Additionally, hardwood nurseries were accustomed to producing bottomland oak seedlings, and it was a general feeling among researchers and managers that other native tree species would enter the stand through natural processes. However, time has demonstrated that this did not often happen, and the resulting relatively pure stands of bottomland oaks typically developed into poor quality stands with low species diversity (Allen 1997, Stanturf et al. 2001). More recently, however, experience and research findings have impacted practices such that there has been a slow transition to establishment of species mixtures. While bottomland oaks are still primary species in afforestation throughout the LMAV, they are generally planted in mixtures of 2 to 3 species of other bottomland trees. Advantages of mixed species stands over pure bottomland oak stands have been illustrated for biodiversity (Hamel 2003) and for development of quality bottomland oak stands (Lockhart et al. 2006). Additionally, recent policy changes have allowed for the use of newly developed, unconventional afforestation practices to establish plantations. For example, a 2005 revision to the CRP allows for establishment of an eastern cottonwood (*Populus deltoides* Bartr. ex Marshall) - Nuttall oak interplanting system that rapidly restores forest cover on agricultural land and provides a favorable understory environment for establishment of oak reproduction (Gardiner et al. 2004) (Figure 4).

Summary

Representing the largest expanse of alluvial soils in North America, the LMAV historically supported a vast bottomland hardwood forest rich in oak species diversity. The many bottomland oaks that thrive in the LMAV provided sustenance to Native Americans and opportunity to hardwood timber enterprises, but their firm rooting in the rich alluvial soils could not prevent centuries of deforestation for agricultural production that has reduced forest cover in the region to 26 percent of its original size. As bottomland oaks have always been valued, and they are ecologically fundamental components of bottomland forests, they have been the primary species used in afforestation and forest restoration efforts in the region. Earliest afforestation practices established bottomland oaks in single species plantations, but more recent plantings have included other tree species to address more complex objectives and gain additional co-benefits from the plantings. As forest restoration activities advance in the LMAV, bottomland oaks will remain integral among species mixtures outplanted in afforestation practices designed to improve ecological and economical sustainability of forests in the Region.

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