THE BOTTOMLAND HARDWOODS OF THE HATCHIE RIVER, THE ONLY UNCHANNELIZED MISSISSIPPI TRIBUTARY

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Abstract—Documenting the natural condition of the floodplain forests of Mississippi River tributaries becomes ever more elusive as cultural alterations continue to obscure their "original" character. The 4,532 hectare Hatchie National Wildlife Refuge (HNWR) in West Tennessee provides the best-available opportunity to document the floodplain forests that once flourished along the major tributaries of the Mississippi Embayment. Of five major Mississippi tributaries in Tennessee, the Hatchie is the only one that remains unchannelized. Characterizing these "original" floodplain forests was the purpose of this study.

Forest cover types were classified according to species and soil-site relationships. Since these poorly drained soils do not have distinct pedogenic horizons, the single determinant used for distinguishing soil types was depth to gleying (DTG). Six DTG classes were used to delineate soil drainage/tree species relationships. The tree species comprising the forest cover types were classified as "indicator" or "plastic" based on their apparent affinity for specific ranges in DTG. Indicator species were restricted to specific topographic and soil conditions while the plastic species were found on a wide variety of topographic and soil conditions.

INTRODUCTION

Of the five major Mississippi tributaries in West Tennessee all except the Hatchie have been channelized to prevent flooding and/or enable farming. Where successful, this process destroyed the original wetland condition. This major alteration of the bottomland hydrology over much of the Mississippi Embayment has caused serious disruption of both wildlife habitat and forest productivity. Current management options being considered include returning the channelized tributaries to their original channels.

Although the Hatchie continues to follow essentially its natural course, the composition and structure of floodplain forests have been altered by agricultural clearing, siltation, and "high grading" that has removed commercially valuable trees leaving trees of lesser value to restock the area. Only on the Hatchie National wildlife Refuge (HNWR) (established in 1962) are there remnant examples of the character of the "original," pre-historic forests. Historically, these sites supported high quality forests that were widely distributed over the Mississippi and tributary river bottomlands. However, sedimentation, land clearing, and channelization have greatly reduced both the acreage in, and stature of, this resource (Turner and others, 1981). The composition and character of the original forest communities that once dominated these floodplains were largely controlled by the ability of component species to tolerate various degrees and periods of inundation and soil saturation. The first bottoms usually had standing water during part of the year followed by varying degrees and depths of soil drainage.

Since the early 1800's, changing land uses in the alluvial valleys of the Mississippi Embayment has resulted in a rapid decrease in bottomland hardwood forest cover types (Sternitzke, 1975 and 1976). As early as 1818, these fertile bottomlands were cleared for cotton production. By 1825 the region had developed into an important cotton producing area. Most of the well drained sites adjacent to the river were being cleared while the frequently flooded bottoms remain in forest (Sternitzke, 1955).

Again in the 1960's large areas of bottomland forests were cleared for agricultural crops, especially soybeans. This high-return crop was well-suited to these productive sites. Sedimentation, channelization, and beaver impoundments have further deminished both the acreage and quality of the bottomland forest resource (Sternitzke, 1955 and Wells and others, 1974). Between 1950 and 1971, the acreage in bottomland hardwoods decreased by one-fourth in the southeast.

Sedimentation from the eroding uplands continues to degrade the bottomland hardwood resource. The soils of West Tennessee are primarily derived from loess, and are highly erodible. Poor agricultural practices were noted as early as 1860 and continued for more than a century. Sedimentation has caused increased flooding due to impaired drainage through deposition in the floodplains and channels (U.S.D.A., 1977). However, in the last decade there has been a significant improvement in the soil-loss problem in West Tennessee, largely through no-till agricultural practices (from 14.1 tons per acre per year in 1977 to

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7.1 tons per acre per year in 1992 according to the National Resource Inventory). Channelization, levees (both natural and artificial), and siltation have created a habitat that is well suited for beavers, whose impoundments have caused high mortality in some of the last remaining bottomland forests (Byford, 1974).

Trends in conversion to agronomic crops have changed over the past decade primarily due to abandonment of agricultural lands. Although bottomland forest acreage is now increasing (Tennessee Agricultural Statistics, 1980-1982, and 1987-1991), their composition and character has been greatly altered.

According to current definitions, much of the original bottomland hardwood acreage could have been classified as “wetland.” Wetlands have recently been recognized as among our most valuable and important ecosystems. Wetlands are transition zones typically found between open waters and land resources. These “in-between places” provide a setting for the dynamic interactions that occur where terrestrial and aquatic systems meet, which make wetlands ecologically valuable (Jensen, 1988). The continuing loss of these diverse transition zones is a major ecological concern.

OBJECTIVES

The objectives of this study were:

(1) to characterize the “natural” bottomland hardwoodre source on a section of a major Mississippi tributary in West Tennessee that remains relatively undisturbed,

and

(2) to determine the relationships between soil-site properties and forest cover types of the Hatchie water shed.

THE STUDY AREA

The Hatchie River is a drainage system for southwestern Tennessee. Its headwaters drain north-central Mississippi before entering Tennessee along the Hardeman-McNairy county line. It flows in a northwest direction through Hardemen and Haywood counties, finally forming the border between Tipton and Lauderdale counties before entering the Mississippi River approximately 56 miles north of Memphis.

The bottomland soils are Entisols (Soil Survey Staff, 1975). Due to their recent development, they do not have distinct pedogenic horizons (Buol and others, 1973). Depth to redoximorphic features such as redox concentrations, redox depletions and reduced matrix (gleying) were the soil properties used to distinguish between different soils in these broad floodplains. The alternating bands of grey/brown or “gley horizons” are indicative of anaerobic conditions caused by saturation most of the year. This prevents the oxidation reactions that impart the reddish color characteristic of most better drained soils.

The Hatchie National Wildlife Refuge (HNWR) is located near Brownsville, Tennessee. It extends approximately 40 km in an east-west direction along the Hatchie River floodplain. This area contains remnants of the only “natural” forests to be found on a major Mississippi tributary in Tennessee. Although siltation from poor farming practices on adjacent uplands has modified site conditions, these forests approximate the “original” or “natural” condition of tributary floodplain vegetation.

STUDY METHODS

Only sites considered to be relatively “undisturbed” were selected for characterizing “natural” forest conditions. Prior to land acquisition for the HNWR, approximately one-half of the forest land had been disturbed by fire, grazing, and/or timber cutting. Only 1,214 ha or approximately one-third of the total Refuge acreage was considered suitable for this study.

Compartment maps of the Refuge (scale of 1/24,000) were used to locate suitable study areas. Sample points were located every 100 m along lines 800 m apart; the first line was randomly located. Any portion of a transect within 400 m of a major disturbance, such as powerlines, highways, or drainage canals, was eliminated. Small adjustments were made to keep the vegetation tallied at each sample location completely within a topographic drainage class. A total of 127 plots was established along 12 transects.

Soils and vegetation were sampled at each sample location. Topographic position and evidence of abnormal flooding were noted. Depth to, and degree of development of reduced matrix (gleization) were used to distinguish different soils. Soil samples were collected from the 0 to 30 cm, 30 to 60 cm, and 60 to 120 cm depths for laboratory analysis to determine pH, K and P levels. Depth to gleying (DTG) was determined using a soil auger.

Arborescent vegetation was sampled using a 2.5 m^2/ha prism. Crown position, diameter breast height (DBH- at 1.3 m ground), and total height were estimated for each “count” tree. DBH and total height estimates were periodically checked using a diameter tape and an Abney level, respectively. Each tree was assigned to a crown class as follows; dominant, codominant, intermediate, and overtopped (Smith, 1962). Dead trees were noted with comments on the gap size their death created. Abundance and height were determined for understory trees and shrubs (between 1 and 4 m in height).

The arborescent vegetation of the study area was characterized for each of six DTG classes. DTG Class 1 represented the poorest drainage condition with mottling apparent in the surface soil. As class number increased mottling was progressively deeper and surface horizons were better aerated. These DTG classes and the soil series they represent were:

Class	Depth-to-gleying	Mapped as
1	Surface gleying	Waverly
2	> 0 but < 15 cm	Waverly
3	15 to 30 cm	Falaya
4	30 to 45 cm	Falaya or Collins
5	45 to 60 cm	Collins
6	60 to 120 cm	Collins or Vicksburg

Characteristics of the four major soil series present were (Brown and others, 1973, 1978; Flowers, 1964):

1) Waverly series - poorly drained soils in the lowest part of the floodplain (coarse-silty, mixed, acid, thermic Typic Fluvaquents).
2) Falaya series - better drained soils on flats and ridges (coarse-silty, mixed, acid, thermic Aeric Fluvaquents).
3) Collins series - moderately well-drained soils on narrow ridges that follow stream channels (coarse-silty,mixed, acid, thermic Aquic Udifluvents).
4) Vicksburg series - well-drained soils on the highest ridges (coarse-silty, mixed, acid thermic Typic Udifluvents).

Soil pH, K and P were analyzed on 273 soil samples from 91 plots by the University of Tennessee Agricultural Extension Service Soil Testing Lab in Nashville. Correlation coefficients and their corresponding probabilities were calculated using SAS (1985). Only coefficients significant at $p = 0.05$ and lower were used in soil/site - forest cover correlations.

RESULTS AND DISCUSSION

Field sampling revealed little evidence of pedogenic horizon development in soils that underlie the wide, nearly level floodplain of the Hatchie River. These Entisols developed in alluvium and are characterized by an ochric epipedon.

Of the 127 plots sampled, 39 were on soils of the Waverly series, 58 were on Falaya soils, 26 were on Collins and 4 were on Vicksburg. The well drained sites were on natural levees immediately adjacent to the Hatchie River while poorly drained sites were in sloughs and swamps away from the river (generally in old river channels and ox-bow lakes) (figure 1).

Forest cover types were segregated along a soil aeration gradient which was reflected by DTG. Overstory trees and woody understory vegetation were characterized for each DTG class. Figure 1 summarizes the relationship between topographic position, DTG, and overstory trees. Some

Overstory	A.Beech* Yellow poplar* White oak* Sweetgum Swamp Chestnut Oak Cherrybark Oak	Sweetgum Cherrybark Oak* Willow Oak Swamp chestnut Oak Water Oak Silver Maple Swamp Hickory Shagbark Hickory*	Sweetgum Willow Oak Overcup oak Swamp Hickory Baldcypress Silver Maple Chestnut Oak	Overcup oak* Baldcypress* Willow Oak	Sweetgum Willow oak Cherrybark Oak Swamp Chestnut Oak Overcup oak* Swamp Hickory Water Oak Pin Oak	Sweetgum Cherrybark Oak Swamp chestnut Oak Willow Oak]Shagbark Hickory* Water Oak Swamp Hickory Mockernut Hickory*	Tupelo gum* Baldcypress Overcup Oak	Sweetgum Swamp Chestnut Oak Water Oak Shagbark Hickory* Cherrybark OakShumar-d Oak Mockernut Hickory* Yellowpoplar A.Beech	Sweetgum CherryBark Oak Swamp Chestnut Shagbark Hicory* Water Oak Mockernut Hickory* Blackgum*
Understory	A.Holly Pawpaw Estern Hophorn-beam Stiff Dogwood Cane	A.Elm A.Hornbeam Sweetgum Deciduous Holly Swamp Chestnut Oak	Planer Tree A.Elm A. Hornbeam Sweetgum Deciduous Holly	PanerTree Deciduous Holly	Planer tree A. Hornbeam A.Elm Sweetgum Deciduous Holly	A.Elm A.Hornbean Grapevine Greenbriar Sweetgum Swamp Chestnut Oak Shagbark Hickory*	Buttonbursh PlanerTree Virginia Willow	A. Hornbeam Sweetgum Grapevine]Greenbriar Shagbark Hickory* SwampChe-stnut Oak Pawpaw	A.Hornbeam A.Elm Swamp Chestnut Oak Sweetgum Shagbark Hickory* Cane

*Indicator Species

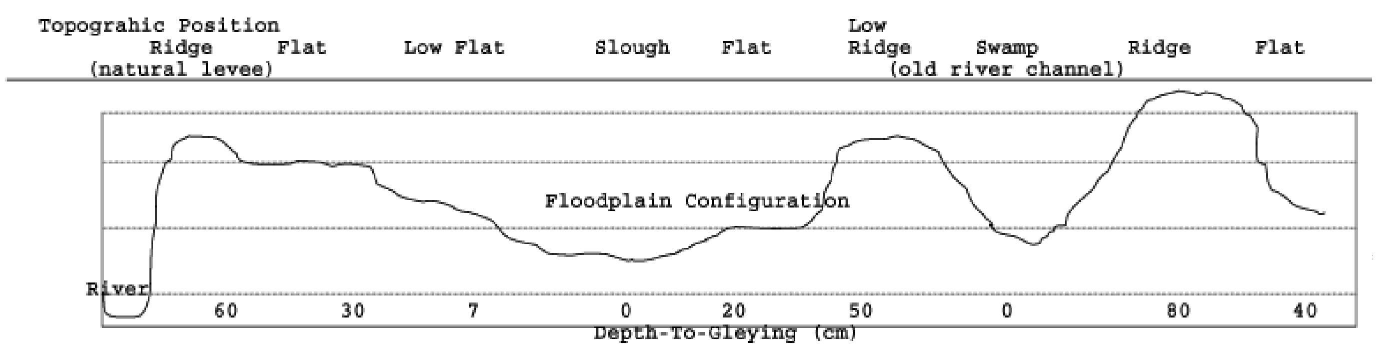

Figure 1—Overstory and understory species and topographic position in the Hatchie Wildlife Refuge.

species were found only on specific DTG classes while others were very plastic, occurring on all or most DTG classes. The site-specific trees are good indicators of soil drainage and, in turn, soil series. Indicator species and their associate DTG classes and soil series are:

TUPELO gum DTG = 0 cm (Surface gleying) Soil Series = Waverly

The presence of tupelo gum (*Nyssa aquatica* L.) was indicative of swamp areas where gleying occurred at the ground surface (DTG 0 cm). While surface water may disappear in areas supporting tupelo gum during the midsummer and fall, surface soil moisture remains at or near saturation throughout most of the growing season. These soils are commonly called “mucks.”

BALDCYPRESS DTG = 0-20 cm: Soil Series = Waverly

As soil aeration improved, tupelo gum was replaced by bald-cypress (*Taxodium distichum* (L.) Rich). This intolerant conifer is unique in that it is maintained in and along ox-bow lakes and is favored by frequent flooding which suppresses its more shade- tolerant competition. In bald-cypress groves, DTG was commonly from just below the surface to 20 cm. This “deciduous evergreen” grew best on “mucks” but occurred on a wide range of soil draniage conditions. In the absence of frequent flooding, baldcypress was replaced by overcup oak (*Quercus lyrata* Walt.).

OVERCUP oak DTG = 0-20 cm: Soil Series = Waverly

While overcup oak was relatively plastic in its occurrence (DTG 0 to 20 cm), it was most common on areas where flooding was annual but not continuous. Along with tupelo gum and baldcypress, overcup oak was one of the most flood-tolerant species. It was common in sloughs and swamps. However, it grew better on low-lying clays or silty clay flats in first bottoms and the terraces of larger streams.

TERRACE hickories DTG = 20-50 cm: Soil Series = Falaya & Collins

The terrace hickories, shagbark (*Carya ovata* (Mill.) K. Koch) and mockernut (*Carya tomentosa* (Poir.) Nutt.), marked a transition from low flats (DTM = 7 cm) to flats and low ridges (DTG = 20-50 cm). Shagbark hickory was the predominant species, adapting successfully to a variety of soil conditions. Mockernut hickory, a common associate of shagbark, was found on somewhat better-drained sites than those favoring shagbark. Soil conditions favorable to mockernut hickory ranged from deep, fertile surface horizons to poorly drained loams with a fragipan. Both shagbark and mockernut hickory were common on dry sites and ridges where swamp chestnut oak (*Quercus michauxii* Nutt.) and water oak (*Quercus nigra* L.) were the predominant species.

Where shagbark and mockernut hickory were a significant component of the overstory, understory vegetation included seedlings of shagbark hickory and American elm (*Ulmus americana*, L.) and swamp chestnut oak saplings.

BLACKGUMDTG = 40 cm: Soil Series = Falaya & Collins

Blackgum (*Nyssa sylvatica* Marsh.) was not a dominant species in any of the forest associations identified but did reflect specific drainage conditions. It was consistently found on flats where DTG was 40 cm or greater. It grew best on well-drained, light textured soils on low ridges of second bottoms or on high flats of silty alluvium. On upland sites loams and clay loams produced the best growth. Where blackgum was common in the overstory, American elm and American hornbeam (*Carpinus caroliniana* Walt.) were frequent understory components.

AMERICAN BEECH - yellow-poplar - white oak DTG = 60-80 cm: Soil Series = Vicksburg

The most consistent indicator species for the better-drained soils were American beech (*Fagus grandifolia*, Ehrh), yellow-poplar (*Liriodendron tulipfera* L.), and white oak (*Quercus alba* L.). These hardwoods marked a shift from flat, wet sites to high well-drained ridges. Yellow-poplar and white oak were especially indicative of improved soil drainage. Soils were usually alluvial, deep, fertile, moist, and highly productive.

Common understory associates included planer tree (*Planer aquatica* (Walt.) J.F. Gmel.) and American hornbeam which were replaced on drier sites by a dense understory of stiff dogwood (*Cornus foemina* Mill.), pawpaw (*Asimina triloba* (L.) Dunal), eastern hophornbeam (*Ostrya virginiana* (Mill.) K. Koch), and American holly (*Ilex opaca* Ait. f. *opaca*).

Although these high ridges contained the more valuable commercial species, the average stand basal area progressively decreased as depth to gleying increased. This was due in part to competing vegetation other than trees; approximately 50 percent of these sites had extensive encroachment from vines.

A comparison of the forest types found on first bottoms of the HNWR with the Society of American Foresters (SAF) Forest Cover Types for the Southern Forest Region revealed that the following were represented: 1) baldcypress (101), 2) baldcypress-tupelo (52), and yellow-poplar-white oak-northern red oak (102) (Eyre, 1980).

The terrace hickories presented a unique situation. Although they do not comprise a designated SAF forest cover type, their silvical characteristics suggest that their occurrence in river bottoms is not unusual. According to Burns and Honokala (1990), shagbark and mockernut hickory grow best in humid climates and tolerate a wide range in soil-site conditions. Common associates of the terrace hickories include indicator species such as tupelo gum, yellow-poplar, blackgum, white oak, and American beech plus a number of bottomland hardwood species.

CONCLUSION

This study revealed well-defined relationships among native tree species, soil series, topography, and soil drainage classes in the first bottom of the Hatchie River. These include:

1) The most poorly drained sites were the “mucks” found in swamps and sloughs. Topographically these were generally the lowest points with gleying at the ground surface - soils were of the Waverly series. Indicator species included baldcypress and tupelo gum. Similar associations were found in ox-bow lakes.
2) Low flats, flats, and low ridges provided better-drained sites. Depth to gleying varied from 20 to 50 cm indicating better drainage of the surface horizons. These better drained soils belonged to the Falaya series. Common indicator species included the terrace hickories and blackgum.
3) The natural levee immediately adjacent to the river provided the best drained site in the first bottom. It was generally the highest feature in the first bottom and had a high sand content that encouraged rapid drainage. These well-drained soils belonged to the Vicksburg series. Indicator species were American beech, yellow-poplar, and white oak. Similar associations were found on former levees along abandoned stream channels and oxbow lakes.

These forest cover - soil drainage relationships provide insight as to the likely character of the “original” floodplain forests that once bordered the mid-continent section of North America’s largest river and its major tributaries.

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