Bottomland Hardwood Management
Species/Site Relationships

MISSISSIPPI STATE UNIVERSITY EXTENSION

Hardwood species selection is one of the most demanding forestry management tasks for private landowners and forest managers. The difficulty in choosing the correct hardwood species is in part because of the large number of species. Added to this difficulty is that you must also consider the hardwood species' need for survival and growth, which is based on site and soil conditions. To manage hardwoods well, you should understand the nutritional and moisture needs of the main commercial hardwood species and the types of soil that best meet these needs. In general, the most desirable species will survive and grow well only on a narrow range of sites. Correctly matching the species to the site will result in a stand that is capable of growing and thriving over an extended period of time.

Bottomland Hardwood Sites

All forested sites in the South can be divided into different types of physical geography: uplands, terraces, and floodplains. Uplands are the most common type in the South. Soils in these areas were formed through natural weathering processes from the parent geologic material or from wind-blown materials. Terraces are old floodplains of current or ancient streams. The alluvium in these soils made them fertile at first, but age makes the soils less productive. The nutrient levels in older terrace soils have been broken down. Many older terrace soils also develop layers called hardpans that limit growth.

The term "bottomland hardwoods" generally refers to hardwoods found on current floodplain sites. Soils on these sites are young because they are made of recent stream deposits. They vary in drainage and nutrient levels, thus resulting in a range of hardwood species and productivity levels.

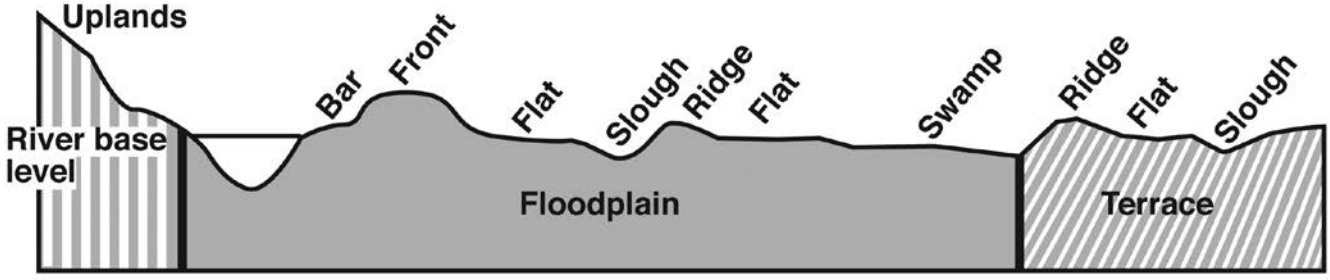
Floodplain sites in the South are divided into major river bottoms and minor stream bottoms. The obvious difference between them is the size of the stream. Major river bottoms are usually associated with large rivers, such as the Mississippi River. Another important difference is in the kind of deposits. The alluvium in major river bottoms can come from hundreds or even thousands of miles away. It may be made up of materials of a variety of textural classes and nutrients. In minor stream bottoms, the alluvial deposits are local and usually are less variable in texture and nutrients. For these reasons, major river bottoms are often, but not always, more productive than minor stream bottoms.

Bottomland hardwoods mainly occur in the Atlantic and Gulf Coastal Plain divisions of the Coastal Plain Province. That's because the nature of the soils in these areas is sedimentary and as such are easily eroded. When the climate was much warmer and wetter, ancient streams eroded away material to form stream valleys. The streams continue to deposit rich sediments. Today, about 30 million acres of bottomland hardwoods are left in the South. This acreage is about one-half of the estimated acreage at the time of European settlement. The change is the result of factors like population increases and farming. A prime example of this type of loss is in the Mississippi Delta where the Mississippi River was leveed to protect cities and valuable rich crop lands from annual flooding.

Site Variation

Site variation within floodplains is mainly associated with elevation differences, where as little as two to three feet have a big effect on site and species. Elevation differences cause changes in drainage class and soil moisture. Even small elevation differences can reflect changes in soil type, texture, structure, and pH. All of these impact species occurrence and growth. Differences in both topography and parent material change the way materials are deposited and the streamflow within the floodplain.

The figure below is a sample cross section of a major stream valley of the coastal plain. It shows topographic features and their usual sequence. Each topographic feature shown may occur several times. Additionally, these topographical features may not occur in the order shown.



Cross-section of stream valley showing minor topographic positions within the floodplain.

Ridges and swamps are far more common in the Atlantic Coastal Plain than they are in the Gulf Coastal Plain. This difference is because of the way the floodplains formed.

The paragraphs below describe the topographical features shown in the figure. Each section also gives the hardwood species commonly found on each feature in major river bottoms. The species listed in the text may or may not be desirable in terms of timber value, but the species listed in the table at the end of this publication are desirable. In major river bottoms, the types of trees will vary depending on the age of the soil and the stage of succession.

Bars

Bars are formed when the concave section of a stream bank erodes and the sediment is deposited downstream on an opposite convex area of the stream. With time and increasing deposits, the bar may become a mud flat. With more deposits, the flat may become a front. Bars are typically very wet and often flooded.

Here black willow is the major pioneer species, but if the land is elevated enough or becomes established between high water levels, eastern cottonwood can also grow. Black willow is more tolerant of water. Both species can withstand some sediment deposit, but if a front forms, they may be replaced by riverfront species.

Fronts

Fronts are the best sites for tree growth in the floodplain. These are natural levees that form when streams overflow their banks and quickly deposit sediment. These areas are usually the highest sites with the best drainage. Fronts usually flood only during extreme conditions. Floods usually only result in more deposits. Almost all hardwood species can grow on these sites.

Cottonwood is the primary species found on fronts and is usually followed by elm, sycamore, sweet pecan, sugarberry, boxelder, and sweetgum. In many places, fronts appear to be two-tiered stands with cottonwoods in the overstory and the other species in the understory. The cottonwood overstory allows enough sunlight to reach the forest floor for other hardwood species to regenerate and develop. This riverfront stand is not final but rather sets the stage for other species that will replace those that originally occupied the site. If replacement is rapid (caused by humans or natural disaster), a red oak and sweetgum stand may grow. If replacement is slow, the stand may return to a mixture of boxelder and sugarberry or to a mixture of boxelder, hackberry, and silver maple. As the site matures, it may again be occupied by sweetgum and red oak. The pH of these soils can greatly affect the species combinations, as high pH will greatly inhibit the ability of red oaks to occupy these sites. The only exception to this rule is that of Shumard oak, which can tolerate high pH soils.

Flats

A flat is a broad, smooth area between two ridges or between a ridge and a front. The soils are mostly clays. Drainage varies from poor to somewhat poor, but standing water is usually absent during most of the growing season. There may be slight elevation differences. Variations classified as “high flats” and “low flats” are based on drainage patterns. Flats make up the largest area in the floodplain. Flats represent a major change in the site quality, as they are not as suitable to the most desirable species.

The types of trees growing on flats are variable. On low flats, overcup oak, water hickory, and cypress dominate. Pure stands of overcup oak are common in some places. On high flats, the most common group is elm, ash, and sugarberry. Other species, such as Nuttall oak, willow oak, and red maple are common in the mixture. Occasionaly, Nuttall oak and willow oak will dominante these types of stands.

Ridges

Ridges are old fronts and are the second best sites for hardwoods. While these areas could vary in elevation from 2 to 15 feet above flats, an elevation of 2 or 3 feet is more common. Drainage may not be quite as good as on fronts, and soil fertility may be somewhat lower. Soils tend to be coarser than those in flats, and drainage is better.

Past events and treatments will affect species occurrence on ridges. A combination of elm, ash, and sugarberry is the most common, but if the site is opened rapidly and regeneration is present, it can be replaced by a stand composed of sweetgum, red oak, water oak, willow oak, cherrybark oak, Shumard oak, and a variety of minor species. Without management, these stands will go back to an elm, ash, and sugarberry mix.

Sloughs

Sloughs are shallow depressions formed from old stream channels that have nearly filled with sediment. They are low areas with poor drainage because of heavy clay soils. Standing surface water is present well into the growing season. These areas support lower quality and less desirable timber-quality tree species, such as overcup oak and water hickory.

These areas are usually occupied by baldcypress, water tupelo and willow. Depending on how close the slough is to a stream or if sedimentation occurs rapidly, good stands of black willow may occupy the site. If sedimentation continues, the black willow will be replaced by elm, ash, and sugarberry. On sites where sediments are deposited slowly at some distance from the stream, overcup oak, water hickory, and green ash will most often follow the willow.

Swamps

Swamps are also old stream channels, but the channel is deeper. Surface water is usually present year-round. Certain species’ ability to grow in these areas is restricted by the water. Bald cypress and water tupelo tend to thrive, but they require dry conditions to regenerate.

In swamps of major river bottoms, baldcypress and water tupelo are the most common species. Depending on depth and duration of flooding, other tree species that sometimes grow include swamp tupelo, water elm, Carolina ash, water hickory, swamp laurel oak, and overcup oak.

Species Occurrence

While a large number of hardwood species occur on floodplain sites, only a few are considered desirable for timber production. The table at the end of this publication shows desirable timber-quality trees by site type. The table is not a complete listing of all species, but the trees listed are considered to be the most appropriate for those sites.

There are other wet sites that support hardwood growth but are not associated with stream floodplains. Sites such as coastal swamps and muck swamps are often covered with hardwoods because they are not suitable for growth and development of pines. Generally, these sites are not as productive as floodplains. The hardwoods growing there, usually baldcypress and water tupelo, are of low quality.

Minor stream bottoms are just smaller versions of major river bottoms. They have the same physical features, and most of the same species can also be found on these sites. Species that occur only on ridge positions in major river bottoms often occur on flats in minor bottoms. River birch is most often the pioneer species on new land such as bars and mud flats. Many different types of trees grow on the fronts and may include yellow poplar, American beech, sycamore, spruce pine, sweetgum, cherrybark oak, Shumard oak, water oak, swamp chestnut oak, and several species of hickory.

Although flooding still occurs, natural forces control the succession and species on these sites. Typical species growing on the well-drained flats and ridges of minor bottoms include sweetgum, cherrybark oak, water oak, swamp chestnut oak, American elm, and hickories. On less well-drained flats, the major species include overcup oak, willow oak, Nuttall oak, swamp laurel oak, persimmon, green ash, sugarberry, and red maple. Tree species growing in sloughs of minor bottoms will vary depending on the duration of flooding. Cypress, swamp tupelo, water tupelo, and water elm are most commonly found where flooding is extended and overcup oak, water hickory, and persimmon will also occur where flooding is not as severe.

Implications for Use or Management

The most important part of hardwood regeneration and management is correctly matching species and sites. Factors that influence this selection include topographical features, elevation, soil characteristics, the presence of pans, pH hydrologyThe pH of these soils can greatly affect the species combinations, as high pH will greatly inhibit the ability of red oaks to occupy these sites. The only exception to this rule is that of Shumard oak which can tolerate high pH soils, and nutrient levels. Soil maps and site visits throughout the year will help you decide which hardwood species would do best in a given area. In most cases, it's better to include a combination of hardwood species and not a single species because of site variability.

If hardwood management objectives include timber, wildlife, or a combination of the two, you must understand species/site relationships and succession. Reforestation or afforestation projects are likely to fail if the species and sites are not correctly matched. Remember that bottomland ecosystems do change. With or without human influences, forest stands will continue to change species. What is found there today will probably not be there 100 years from now and in some cases not even 20 or 30 years from now. The situation can either progress the stand toward what is called the climax species or regress the stand to earlier species.

The species/site relationships discussed in this publication can help you make management decisions that could resolve or reduce conflicts over the use of bottomland hardwood resources. These areas are quite diverse and can accommodate a great variety of interests and uses. You can use active management to keep or increase species diversity of forest stands while meeting other objectives.

Table 1. Site suitability by topographic position of major river bottoms and minor stream bottoms.

Topographic Position	Desirable/Suitable Species	
	Major River Bottoms	**Minor Stream Bottoms**
Bars	cottonwood and black willow	river birch and black willow
Fronts	cottonwood, sycamore, sweetgum, sweet pecan, green ash, water oak, cherrybark oak[1], swamp chestnut, oak[1]	cherrybark oak, Shumard oak, sycamore, sweetgum, yellow poplar
Ridges	willow oak, water oak, sweetgum, sycamore, green ash, cherrybark oak[1], swamp chestnut oak[1]	cherrybark oak, Shumard oak, swamp, chestnut oak
High Flats	Nuttall oak, green ash, sugarberry, willow oak	cherrybark oak, water oak, willow oak, Shumard oak, swamp chestnut oak
Low Flats	overcup oak, water hickory, green ash, persimmon, sugarberry	willow oak, overcup oak, persimmon, green ash
Sloughs	overcup oak, black willow, water hickory	overcup oak and persimmon
Swamps	baldcypress and water tupelo	baldcypress, swamp tupelo, water tupelo

[1]Species may not be found on those sites in the Mississippi River floodplain.

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