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BOTTOMLAND HARDWOOD MANAGEMENT DEMONSTRATIONS FOR SOUTH CAROLINA'S LOWCOUNTRY FOREST CONSERVATION PROJECT

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ABSTRACT

Southern bottomland hardwood forests occur on river floodplains of the southeastern United States, and ecological processes are driven by seasonal floodwaters from the river. Conservation and management of southeastern US coastal plain ecosystems is a priority in South Carolina's *Lowcountry Forest Conservation Project*. The project is a partnership of Clemson University, Ducks Unlimited, the Joseph W. Jones Ecological Research Center, Lowcountry Open Land Trust, South Carolina Coastal Conservation League, The Conservation Fund, and The Nature Conservancy. A goal of this project is to create and disseminate economically and ecologically viable methods for conservation-based bottomland hardwood management on private lands, including restoration of degraded forests. Southern bottomland forests have been extensively altered by past cutting practices, as well as past agricultural use, indiscriminate cattle grazing, uncontrolled fires, and lack of attention to regeneration. Early harvest practices included high-grading to remove the most valuable stems, leaving behind the poorest. Repeating this practice through the years has resulted in under-stocked stands of low-quality trees in many forests. Four sites have been selected to establish demonstration areas to show people different management techniques that are currently being used to enhance timber and wildlife values. Funding for the project is provided by the Doris Duke Charitable Foundation. One model of bottomland hardwood management that can be used to achieve conservation goals in the southeastern United States is the system currently practiced by the Anderson-Tully Corporation in bottomland forests of the Mississippi River. The adaptation of this management method is presented here.

KEYWORDS. bottomland hardwoods, forestry, management, South Carolina

INTRODUCTION

The term "southern bottomland hardwood forest" has often been used to describe the vast bottomland and alluvial swamp forests that occur on river floodplains of the southeastern United States (Conner and Sharitz, 2005). Ecological processes are driven by seasonal floodwaters from the river and species composition changes along a gradient of flooding frequency (Hardin and Wistendhal, 1983; Hupp and Ostercamp, 1985; Brinson, 1990). Native Americans and early colonists almost always located along major streams of the southeastern United States because of their navigability. As a result, bottomland forests were among the first to be logged in the Southeast, and almost all southern forests have been harvested one to several times. Early harvest practices included high-grading to remove the most valuable stems, leaving behind the poorest. Repeating this practice has resulted in under-stocked stands of low-quality trees. In addition, single tree selection, as practiced in the 1950s and 1960s, favored the development of shade-

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tolerant species and resulted in shifts in forest composition to lower-value tree species. Despite their dense tree cover and the difficulty of clearing these sites, bottomland hardwood forests were the first ecosystems in the southern United States to be converted to agriculture. Early colonists also cleared and farmed bottomlands because of the fertility of the soils.

Despite mismanagement of these forest lands, bottomland hardwood forests of the southern United States are still extremely heterogeneous with more than 70 species of commercially valuable trees, half that many more non-commercial species, and large numbers of shrubs and woody vines (Figure 1). Until recently, low hardwood prices provided few incentives for better management of these forests. Hardwood prices have improved recently and, with that, interest in hardwood management has increased. Bottomland hardwood forests are typically managed for timber production and wildlife habitat. Management is often difficult because of periodic flooding and because these forests contain such a wide diversity of tree species, each unique in its biological requirements and silvical characteristics.

Figure 1. Healthy bottomland stand that can use some management (photo by John Hodges).

The present condition of most floodplain forests reflects the effects of both natural factors and past human activities. Continual high-grading or harvesting of the better quality trees has substantially reduced the productivity and quality of timber in many areas. Most of the remaining bottomland forests contain many inferior and less desirable tree species than the original forests. It is estimated that 90% of bottomland hardwood forests in the southern United States require some silvicultural treatment to approach potential site productivity.

The goal for the Lowcountry conservation forestry management strategy is to present landowners with forest management approaches that conserve and restore biological diversity and also realize an economic return. Successful adoption of these management approaches for cypress/tupelo and bottomland hardwood forests in the project area will advance conservation within Lindenmayer and Franklin's (2002) principles. They seek to maintain landscape connectivity, heterogeneity, stand structural complexity, and integrity of aquatic ecosystems by using different conservation strategies at various spatial and temporal scales that take advantage of uneven aged management and management systems that mimic patterns of natural disturbance.

Conservation forestry sites on private lands will be important connectors among reserves. At a smaller scale, conservation forestry will maintain the ecological connections between upland and wetland forests, critical for many rare and imperiled species. These silvicultural approaches foster forest heterogeneity at both the landscape and stand scale, rather than simplifying the forests (Palik and Pederson, 1996), and both approaches mimic natural disturbance patterns in harvesting decisions. Integrity of aquatic ecosystems will be advanced by integrated conservation management across both upland and wetland forests.

Bottomland hardwood and wetland forests embedded in upland pines present a great challenge because of the lack of knowledge relative to conservation forestry management. They also may provide our biggest opportunity in terms of conservation. Current management in the region typically involves large-scale clearcuts conducted during drier years. One model of hardwood management that can be adapted to achieve conservation goals is a system practiced by Anderson-Tully Corporation in the bottomland forests of the Mississippi River. This system is based upon the guidelines in Putnam et al. (1960), summarized in Meadows (1996), for management of southern hardwoods. In short, the harvest system uses individual tree or small-group selections to promote desirable species and to maintain a diverse, uneven-aged forest cover.

THE ANDERSON-TULLY MANAGEMENT SYSTEM

The first thing a landowner must do is articulate the expectations they have for their land. They may be, but rarely are, purely financial. Aesthetic and wildlife values of bottomland forests often take precedence over dollar returns. Some landowners don't want any hardwoods cut, not realizing that judicious treatment can improve wildlife and recreational values.

The second prerequisite for management is an inventory of what the landowner has. For hardwoods, an inventory should go beyond size and quality of merchantable stems by species. Information about the understory species composition and other competing vegetation (vines, privet etc.) is important for future management decisions. This may be accomplished by tallying saplings, poles, and sawtimber on standard cruising plots and then also assessing understory vegetation on smaller plots (e.g., 1.5 to1.8 m radius plots).

The nature of bottomland hardwood silviculture in southern forests has changed greatly in the last 25 years, and it will continue to evolve as concerns about issues such as maintaining biological diversity and clean water increase and as people recognize the ecological services (such as flood control, wildlife habitat) that these bottomland forests provide. The following recommendations are derived from experience by the Anderson-Tully Company in managing bottomland hardwood stands in the Mississippi Valley and represents methods included in their management guidelines. The Anderson-Tully plan calls for a stocking of 148 desirable trees per hectare between 15 and 30 cm DBH (6.9 m^2 /ha of basal area). Stands stocked with red oak, sweet pecan, sycamore, and ash on good soils are preferred.

Timber should be managed to produce quality hardwood sawlogs and the most value over the long term. However, one operation cannot be performed without considering its effects on the whole environment. Timber management practices must be as compatible as possible with good wildlife management practices and performed in such a way as to protect or enhance soils and water quality. Timber management goals should be accomplished as much as possible in harmony with natural processes which will also usually be the most economical, and usually the most favorable for the habitat and wildlife populations. Expensive cultural practices to change natural systems should not be used, except on a very limited scale. This policy will involve keeping each acre as well stocked as possible with the proper diameter distribution of the most desirable species. Species to be favored in management should be those that have the best combination of quality, growth, and value for the site, and still be compatible with good wildlife management. Timber management practices are based on a tree class system. Species are grouped into three species classes according to their growth, form, and quality. The tree class system is based on these species classes and the general condition of the individual tree, especially crown class.

Preferred growing stock trees (Figure 2) cannot be cut except to reduce density where no other tree classes are available. Otherwise, they are only cut at the end of the rotation in the final removal. **Cutting stock trees** must be cut during the first cutting cycle because all or part of them may be lost, or because they are undesirable species. **Reserve growing stock** trees may be cut or left according to the judgment of the forester. Many factors affect this judgment in deciding which reserve growing stock trees to take or leave. These factors include density, site, species, market demand, trees in association, relative form, quality, maturity, and risk. Another factor considered is the effect on wildlife populations. Most mast and other food producing species, including oaks, pecan, hackberry, persimmon, cherry, and beech are favored in timber management practices including timber marking and regeneration.

Mixed bottomland hardwood stands are generally not managed by "classical" silvicultural methods. The approach generally should be to "let the stand conditions dictate the method." Where small areas advanced regeneration occur, group select cuts can be used, but where

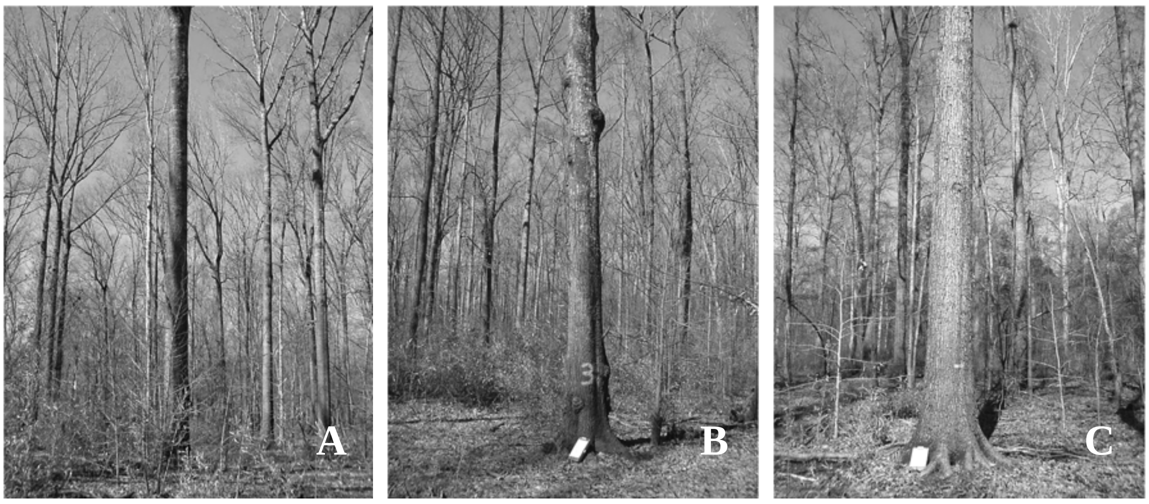

Figure 2. Examples of Preferred Growing Stock (a), Cutting Stock (b), and Reserve Growing Stock (c) trees (photos by John Hodges).

regeneration is not present and needs to be obtained, a shelterwood method is more appropriate. In any stand, the method may vary from group selection to shelterwood or a combination of the two.

Dense, young pole stands should receive a weeding type cut where a hardwood pulpwood market exists. The first removal should include short-bodied, rough, crooked, forked, and damaged individuals. A minimum of 148 pole size stems per hectare should be considered good stocking. At least 74 sawtimber trees should be carried through the last half of the rotation. The rotation age should not be set in the management of mixed hardwoods, but should be the result of good silvicultural practices. Early thinnings encourage early mast production, and long natural rotations favor sustained mast production for wildlife.

Intermediate improvement cuts during the latter half of the rotation should cut basal area back to below 18 m^2/ha. All cutting stock trees, and enough reserve growing stock trees necessary to accomplish this should be removed. Reserve growing stock stems of poorer crown class, form, and quality, and of least desirable species, should be removed first. Reserve growing stock trees competing with preferred growing stock individuals should also be removed. Special attention should be given reserve growing stock trees over-topping desirable sapling and pole reproduction. The crowns of preferred and reserve growing stock trees left during timber marking should be assured of adequate growing space until the next cutting cycle.

Through proper regulation, timber can be improved to increase its growth and quality. This can be done by conversion to a mixture of faster growing species and species with more quality and value. In addition, the proper diameter distribution and density should be maintained for optimum growth and adequate regeneration. In order to accomplish these objectives, the condition of timber stands must be determined and analyzed periodically. This can be done through a continuous forest inventory system (CFI).

In order to determine the volume, growth, quality, and condition of timber stands, a growth and volume plot system can be established. This plot system will be used to remeasure stands during the dormant season at one to five-year intervals after establishment. In these permanent plots all trees 2.5-cm DBH and larger are tallied by 5-cm diameter classes by species, volume, tree class, log grade, utilization class, timber type, and "next cut" judgment. Areas and volumes can be computer tabulated by density, and growth projected on the basis of past growth rate.

An allowable cut for the stands could be calculated every five years, using volumes and growth rates from current and past CFI tabulations. Grosenbaugh's formula (Journal of Forestry, October 1958) is used by inserting simple interest growth rates, present volume, and the volume goal at the end of the long term (25 to 40 years). This goal has been set at 10.6 m^3/ha (150 ft^3/ac Doyle Scale) for bottomland hardwoods. This allowable cut is allocated among species by a formula that uses the percentage of cutting stock and reserve growing stock in each species. This calculation assumes that all cutting stock, plus a percentage of the reserve growing stock, will be removed during the first cycle. The allowable cut is converted to a proposed cut by dropping non-merchantable sizes and grades. GIS (Geographical Information System) is used to help administer the orderly regeneration of the company's properties, meaning that area regulation also plays a role in ATCO management schemes.

For the proper application of timber management policies and practices, it is necessary for foresters to become very familiar with the condition of each stand on the ground. A stand file containing stock and stand table inventories by major species and tree classes must be maintained. With each inventory cruise, the data will be entered into computer files for tabulation of volumes by tree class, species and DBH.

Young, pure even-aged stands should be thinned as soon as the thinning is marketable. The purpose of these early thinnings is to preempt mortality and place growth on the crop trees. Early removals also stimulate browse production. With some species such as sweetgum, early thinnings prevent stagnation and increase the growth rates of the better individuals. These early thinnings should reduce the basal area to 18 m^2/ha. Removals should be confined to suppressed and intermediate individuals and other trees that are damaged or defective. Combination pulpwood-sawlog thinnings must be well supervised. The size and shape of the crown is often more important than height in young even-aged stands. Generally speaking, the merchantable stand should be removed in several cutting cycles. On excellent sites, four or five cuts may be used.

From a silvicultural standpoint, there are four mixed hardwood stages that must be considered in the management of bottomland hardwoods. The forester must determine which stage of stand development he is working with before he can do a good job of timber marking. There may be two or more stages within the same compartment:

- The first stage is the young stand before the first weeding type cut. The first priority of this type of cut should be to reserve the future crop trees. All short-bodied, rough, crooked, forked, and damaged individuals should be removed regardless of diameter. This cut will depend on a hardwood pulpwood market. At least 198 poles (15-30 cm) per hectare of the better species should be left if possible. These trees should be those of larger diameter, straight, clean, long-bodied, and with well developed crowns. Drastic thinning should be avoided to prevent epicormic branching.
- Improvement cuts in intermediate stands should be made to reduce density and therefore mortality, and to place more growth on the better species and individuals of higher quality and better crowns. All cutting stock trees and that part of the reserve growing stock trees needed to reduce the basal area to 18 m^2/ha should be cut. Reserve growing stock trees of the poorest quality and lowest vigor should be removed first. Reserve growing stock mast-producers near water should be left wherever possible to provide food for waterfowl. Large individual oak and sweet pecan should be left in special cases (squirrel trees) as long as possible, especially where a good deal of value is not involved. All trees that are left must have well developed crowns. Each succeeding improvement cut should leave the higher quality individuals of the faster growing species in the best growing condition.
- In an old stand of timber in need of regeneration cutting, the general principles of the improvement cut should apply. In addition, the timber marker should give attention to regenerating the stand (see natural regeneration below).
- The harvest of old residual timber should be delayed until advanced regeneration of desirable species has become established.

The best hardwood species in terms of growth and quality (and therefore value) are the more shade intolerant species. Theoretically, the best way to regenerate these species is to clearcut. However, clearcutting for regenerating mixed hardwoods for sawlog production has many disadvantages. The cost of site preparation alone is almost prohibitive. All stems down to one-inch in diameter should be removed. This also means that valuable pole size growing stock must be sacrificed since we do not usually have a hardwood pulpwood market, and all log size trees must be cut and sawn regardless of market conditions. The reproduction obtained as a result of clearcutting is usually variable and inconsistent. If group selection cutting is done properly, some quantities of the faster-growing species can be established along with the tolerant species, and plenty of browse and cover for wildlife also provided.

The mixed hardwood forest is likely to be a mixture of even-aged patches rather than an orderly stand. When the timber nears 45 to 50 years of age, the forester should keep natural regeneration in mind and take advantage of every regeneration opportunity during the timber marking process. With group selection cutting in mixed hardwoods, large openings should also be made with diameters at least twice the height of the surrounding trees. In addition, any openings that already exist should be enlarged. In each succeeding cutting cycle these openings should be enlarged by removing reserve growing stock trees on their edges, to allow any reproduction obtained to develop, and to provide adequate browse and cover for wildlife. During the first regenerating cycle, 10 to 20 percent of the area should be open or in reproduction. Any patches of seedlings or saplings of desirable species should be given adequate room to grow by removing competing stems in the overstory. Areas containing significant amounts of undesirable species should be treated with herbicides at the time of timber marking to encourage regeneration of desirable species. The timber marker should be alert to release pole size stems being suppressed by reserve growing stock trees. Patches of undesirable species in the understory should not be released but kept suppressed as much as possible. Unless a complete understory has been established, in the next to the last cycle, a shelterwood-type cut should be made by leaving only a few stems per acre (9 m^2/ha of basal area) to encourage regeneration. When reproduction is complete, the residual stand may be salvaged. Ground scarification, preferably during or following logging operations, should be accomplished where it will aid regeneration, especially on mixed soils.

On sites that have not regenerated naturally to desirable species, some form of interplanting will be necessary. If an undesirable understory or competing overstory is present, it should be treated with herbicides prior to or at the time of planting. Planting stock must have ample light to grow and develop. Where markets exist, pulpwood weeding operations should be employed rather than herbicide treatment. Trees to be cut should be marked so that culls and individuals of poor quality, form and condition of desirable species may also be removed.

CONCLUSION

The nature of hardwood silviculture in southern bottomland forests has changed greatly in the past 25 years, and will continue to evolve in the years to come. Landowner and public concerns about issues such as maintaining biological diversity and clean water, and a stronger appreciation of the ecological services such as flood control that forested floodplains provide, have resulted in modifications to management practices in southern bottomlands. As forest land bases continue to shrink, research must develop additional alternative management systems that will simultaneously provide for the production of desired commodities and the maintenance of critical environmental values that are important to each landowner.

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