United States
Department of
Agriculture

Forest Service

**Southern Forest
Experiment Station**

New Orleans,
Louisiana

General Technical Report
SO-40
November, 1982

Low-Quality Hardwood Stands

Opportunities for Management in the Interior Uplands

Charles E. McGee

SUMMARY

Low-quality hardwood stands present opportunity and challenge in the Interior Uplands. This guidebook discusses the primary causes of low-quality hardwood stands and offers management options for regenerating or improving these stands. Methods for evaluating stand and site potential are provided. A technique for comparing stands and prescribing treatment is also suggested.

Contents

Low-Quality Hardwood Stands

Opportunities for Management in the Interior Uplands

Charles E. McGee

OPPORTUNITY AND CHALLENGE

The Interior Uplands of Alabama, Kentucky, and Tennessee include the Cumberland Plateau and the Highland Rim or the Pennyroyal, as the Rim is called in Kentucky. About 13 million acres of the region are forested, much of it in low-quality hardwood stands. The actual percentage depends on how low-quality stands are defined. The 1980 Tennessee Forest Survey showed that 20 percent of all commercial forest land had over 40 percent stocking of rough and rotten trees (Birdsey 1982). Sixty percent of all Tennessee commercial forest land contained over 20 percent stocking of rough or rotten trees. Thirty percent of all commercial forest land was less than 50 percent stocked with acceptable growing stock. Less than 10 percent of commercial forests were 50 percent stocked with desirable growing stock.

Low-quality hardwood stands in the Interior Uplands present great opportunities and tough challenges. The opportunity for improving yields from upland hardwoods is immense as millions of acres produce but a fraction of their capability. Many sites capable of producing 200 board feet per acre or more annually, now produce little or nothing. Sites capable of providing great diversity and substantial wildlife habitat now support low-quality stands that are monotonous in appearance and provide limited food and cover for wildlife populations. Since these stands are functioning at such a low level of productivity, better management can increase yields many times. Why then, with opportunities for improvement so plentiful, have so many owners been reluctant to take advantage of them? The best explanation seems to be that economics and technology have not provided adequate incentives to foster a more positive attitude toward upland hardwood management. In fact, many current woodland practices produce even more low-quality stands.

The primary purpose of these guidelines is to encourage a positive management outlook for the stands. The guidelines provide landowners with the causes of low quality and help them gain a better understanding of ways to improve, naturally regenerate, or convert these stands. The guidelines also provide field foresters with simple techniques for evaluating, rating, and prescribing stand treatments.

WHAT IS A LOW-QUALITY HARDWOOD STAND?

Any stand that contains a substantial number of low-quality trees, or that does not contain a substantial number of acceptable growing stock trees, can be classified as low-quality. Most landowners will classify a stand as low-quality if it does not contain a recognizable and manageable portion of "good" trees. For the purposes of this guide, emphasis will be on low-quality hardwood stands that contain mature trees and that have been cut over one or more times. A general rule is that any stand with more than 50 square feet per acre of basal area of manageable trees should not be included in the low-quality category (fig. 1).

CAUSES OF LOW-QUALITY HARDWOOD STANDS

Eastern hardwood stands have generally developed without the benefit of silviculture or any deliberate management. These stands have been subjected to fires, insects, diseases, and repeated cutting. Many are composed of leftovers from past cuttings, some second growth, and a variable population of shade-tolerant trees. These cull-burdened stands present serious management problems (Trimble 1963) and

Charles E. McGee is Principal Silviculturist, Sewanee Silviculture Laboratory, maintained at Sewanee, Tenn. by the Southern Forest Experiment Station, Forest Service—USDA, in cooperation with the University of the South.

Figure 1.—*A recently high-graded low-quality hardwood stand. Long range productivity for this stand is low without cultural treatment.*

whatever stand quality exists is directly related to site quality (Carmean and Boyce 1973). This combination of past treatment, wildfire, and site quality has produced the low-quality stands of the Interior Uplands.

Past Treatment

For the past 150 years most timber cutting in the Interior Uplands has been high-grading. Some areas have been cut over many times. The continued removal of only the largest and highest-value trees with, in most cases, no stand improvement has produced low-quality stands. Unfortunately, many landowners feel that their only alternative is to cut whatever they can market and leave the rest. In view of the condition of many of the stands and the current economic situation, there remain powerful incentives to continue the practice.

Fire

Until relatively recent times wildfire was a regular occurrence throughout the region. Vast unbroken stands of timberland on the gently rolling plateau tops and rim flats provided excellent fuel as well as ideal conditions for burning. These conditions—coupled with a burning ethic—made wildfire the norm. It is not unusual for mature trees to show evidence of six or more hot fires (fig. 2). If high grading initially resulted in low quality, wildfires helped keep the stands that way.

Site Quality

Some areas in the Interior Uplands are characterized by low or very low site quality (table 1). These include the Barrens of the Eastern Rim and Pennyroyal, limestone rockland on lower slopes of the escarpment, shallow soils on the Cumberland Plateau and narrow cherty ridges and south slopes of the Western Rim and Pennyroyal. All have been subjected to fire and occasional cutting, further diminishing stand quality.

More than half of the Interior Uplands are medium sites. Areas with site indices for pine of 70–75 and 60–70 for upland oaks are capable of producing good pine and hardwood. However, once they are cut over or burned, recovery is slow.

Substantial acreages of low-quality stands are also growing on good sites, such as the north and east slopes in the highly dissected portion of the Western Rim and Pennyroyal and hollows on top of the Plateau. Significant acreages of very good sites now support low-quality stands that could produce excellent hardwoods. These include the coves and northerly portions of the escarpment that often escape wildfire. These also have poor access, which limits logging; so it is here that the best stands are found. While many of these fine stands could be improved even further, this paper will deal exclusively with low-quality hardwood stands. For clarity, site quality (table 1) is divided into five categories:

Table 1.—*Relative site quality terms in relation to species and site index*

Site quality	Species		
	Loblolly pine	Oak	Yellow-poplar
Very poor	....	40–49	....
Poor	60–69	50–59	70–79
Medium	70–79	60–69	80–89
Good	80–89	70–79	90–99
Very good	90+	80+	100+

Other Causes

In certain areas insects, diseases, ice, wind, and grapevines have reduced hardwood stands into the low quality category. Infestations of defoliators such as the elm spanworm and fall cankerworm have weakened and sometimes killed oaks and other hardwoods. White oak and red oak borers annually cause serious damage to oak stands and are a serious threat to low-quality stands because the trees lack vigor. Cankers, wilts, and rots also cause substantial damage throughout the region. Butt rot is troublesome in areas that have been periodically cut or burned.

Stump sprouts of the oaks, especially scarlet oak, are susceptible to butt rot. Many diseased trees were passed over in cuttings; consequently, they largely populate low-quality stands.

Mature hardwood stands growing on exposed ridges are especially vulnerable to ice storms and high winds following a partial cutting. Ice degrades some stands each year, particularly those containing grapevines. Yellow-poplar is especially susceptible to ice damage and young pole-sized stands containing grapevines can be severely damaged.

WHY THE PROBLEM CONTINUES

At worst, low-quality stands represent a liability; at best, an economic challenge. Some causes of low quality are controllable; yet improvement has been slow. Why? The answer is simple—the average owner has no economic incentive to improve the stand.

Figure 2.—*Wildfire has contributed substantially to origin and continued occurrence of low-quality hardwood stands.*

Some fully-stocked hardwood stands are virtually worthless for traditional timber products. Improvement of such stands may require a cash outlay, the amount depending on management objectives and harvesting methods. Many owners are reluctant to spend hard-to-get funds on these stands, feeling they can get higher and more certain yields in other endeavors. Moreover, they often view stumpage as a windfall and are not aware that they could increase future yields by reinvesting in the forest. Most owners have a good understanding of the economics involved but lack knowledge of stand and site potential. They are also aware of the long-term nature and uncertainty of forest investments, as well as the outrageous cost of money. So they are conditioned to expect little return from their low-quality stands.

SOLUTIONS TO THE PROBLEM

Utilization

Improved utilization and expanded markets for low-quality wood products are essential to realistic management of low-quality stands. While traditional markets for sawtimber, crossties, and roundwood will continue to be important, three relatively new utilization concepts have special appeal for low-quality stands:

Shearing and Chipping

On suitable terrain, shearing and on-site chipping make good use of poor quality trees (Koch 1980). Removal of most of the woody vegetation by shearing enhances the opportunity for natural regeneration or for planting trees at reduced costs (fig. 3). Many low-quality stands are characterized by large culls and small trees under 4 inches that present special problems for shearing and chipping (McGee 1980).

Short Log Utilization

Some low-quality stands contain sound trees that do not contain enough clear length to make traditional logs. As markets for short logs are developed, management of low-quality stands will become more practical (Reynolds and Schroeder 1977). Short log production would be especially useful on poor sites where it is almost impossible to grow full-length logs in a reasonable span.

Fuelwood

Increasing demand for fuelwood offers attractive opportunities for some low-quality stands. Stands close to good roads and urban centers are the best candidates. However, if the demand continues, operators who will travel further and operate under adverse conditions are likely to become active in the market. In an active firewood market most trees in a low-quality hardwood stand can be used but most firewood cutters avoid large culls or trees less than 6 inches dbh.

Silviculture

Costs of cultural activities are a serious obstacle to management of low-quality stands but costs can be reduced.

More Efficient Methodology

Thinning low-quality stands generally is not practical because the basal area of marketable trees plus acceptable growing stock is low, and the cost of control for the large number of culls is high. In many cases the best solution is to eliminate the entire stand and regenerate. However, stand elimination and regeneration may not be practical or needed over an entire ownership. Intermediate treatment, including thinning or timber stand improvement, should definitely be considered for stands that can benefit from it.

Benefits must outweigh the costs when intermediate cultural treatments are applied. Paradoxically, treatment of low-quality stands may require more care than good stands. Variations in site quality, quality and quantity of growing stock, and opportunities for utilization should be appraised carefully, and treatment should be restricted to those stands and sites where a positive cost benefit can be achieved. For example, removal of scattered culls overtopping a much younger stand of poles may be very worthwhile. Conversely, if the overtopped poles are old and in poor form, the operation may be a waste of effort (Mills 1976, McGee 1981b).

If the stand is to be regenerated, site preparation should be incorporated as much as possible into the harvest operation. Deadening undesirable trees can be efficiently accomplished prior to harvest (Loftis 1978). But it is much better to utilize a tree than to spend money to deaden it.

Modification of Standards

Many landowners would prefer not to spend large sums of money for regeneration and rehabilitation. However, reduced costs resulting from carefully modified standards can encourage these owners to initiate management. Goals for success and certain treatment objectives should be cautiously reordered or lowered if the savings result in improved productivity.

Figure 3.—*A low-quality stand that has been sheared and chipped. Whole trees as small as 1 inch dbh were harvested. The site is now ready for artificial or natural regeneration without additional site preparation.*

The cost of eliminating a low-quality hardwood stand, preparing the site, and converting it to a pure stand of pine is about $200 per acre. The results are usually successful with a well-stocked stand in neat rows with 400 or more free-to-grow trees per acre. However, site preparation and planting costs could be cut dramatically if 50 free-to-grow pines per acre were acceptable. If costs for the low-standard planting could be held at $50 per acre, then 4 acres could be treated at the cost of one intensively treated acre. Yields from the 4 acres of mixed plantations would probably surpass yields from one intensively treated acre, meaning a better net profit.

Site preparation for natural regeneration following conventional logging can cost $100 per acre or more to control unmerchantable hardwoods. If most unused trees are lopped or injected, good hardwoods will usually follow. The best procedure is to utilize as many trees as possible, stratify the area by site potential and first attend to the better sites (not necessarily the better stands). In a typical Plateau region regeneration area, site index for oak may vary substantially and there usually is more undesirable vegetation on the better sites.

If funds are severely limited, attention should be focused on the most damaging competition, usually the large cull trees. For example, if only $1,000 is available for site preparation following commercial clearcutting on a 30-acre area, a complete vegetation control job cannot be done. If half of the area is site 55 and half is 65, the effort could be split with about $45 per acre for the 15 acres of site 65 and $21 per acre for site 55. The $45 per acre would provide control for most of the large culls and some undesirable pole-sized trees, such as red maple. Twenty-one dollars per acre would allow control of only the larger culls on the poorer site. There will be some disadvantage in splitting the funds but overall productivity will be greater.

Incentive Programs

Since most low-quality stands require cultural activity in addition to harvest, a forestry incentive program designed specifically for improvement of low-quality stands would be ideal. Incentive programs should require identification of the cause of low quality, as well as allowing flexibility in intensities of treatment and emphasizing long-range improvement of stands.

MANAGEMENT ALTERNATIVES FOR LOW-QUALITY STANDS

Management alternatives for low-quality hardwood stands include many of the same options available for good-quality stands. However, selection of options for poor stands should follow a different pattern. Selection of options for good-quality stands usually can be based on the appearance and condition of the stand itself. Additional information is needed for low-quality stands. It is important to determine why the stand is low quality and to determine the basic quality of the site. The difficulty involved in making these determinations often leads to grouping of low-quality stands into one management category which can often lead to serious silvicultural mistakes.

Traditionally, owners of low-quality hardwood stands have either converted to pine, continued periodic logging of salable trees, or ignored the stands altogether. Intermediate stand management or improvement has seldom been applied. In many cases, stand conditions preclude intermediate management, but some opportunities are being overlooked. The following section considers options for regeneration, intermediate management, exclusion from management, continued opportunistic high grading, and multiple use:

Converting to Pine

Loblolly Pine

Converting low-quality hardwood stands to loblolly pine has been widely practiced in the region and reasonable success has been achieved on most of the medium and good-quality sites. Best results are where site preparation was intensive and hardwood control was complete (fig. 4). There are problems both on poor sites and very good sites. On the poor sites pine yields may not justify the costs. On the very good sites only the most intensive site preparation inhibits development of hardwood sprouts that can seriously retard loblolly growth. On medium sites, less intensive preparation can be prescribed *if* the owner will accept a mixed loblolly pine-hardwood stand and some loss in pine growth. Where utilization of hardwoods is almost complete, as in a shearing and chipping operation, pines can be introduced into the stand with greatly reduced site preparation costs, but pine distribution and growth will improve with increased intensity of site preparation (McGee 1980) (figs. 5–6).

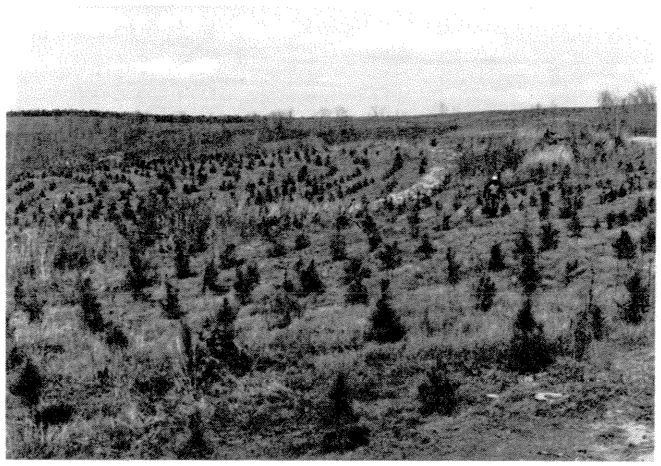

Figure 4.—*This plantation of loblolly pine replaces a low-quality hardwood stand following intensive site preparation that included windrowing and disking. Almost 100 percent of the loblolly saplings are free to grow.*

Eastern White Pine

Eastern white pine has not been planted as widely as loblolly. However, enough plantings have been successful on the higher elevations of the Cumberland Plateau to indicate considerable potential (Smith and Baird 1979). High potential sawtimber yields from mediocre sites in 50–60 years make conversion to white pine an attractive option.

White pine is tolerant to early shade and can be established in cutover stands several ways. One technique has been to plant the pine where pulpwood and larger sawtimber trees have been harvested. The pines are then released from the residual hardwoods at age 3–5 by a herbicide applied in July or August (Moyer 1979).

Intensive site preparation prior to planting can also be used. However, the white pine are very slow starters and unless the control of hardwoods is complete, later release may be needed. White pine can also suffer from heat scorch during hot, dry summers following intensive site preparation. Partial early shade may be an important benefit, particularly in the southern end of the region.

Figure 5.—*A loblolly pine plantation established following harvest by shearing to 4 inches dbh with no additional site preparation. About 50 percent of the four-year-old loblolly saplings are free to grow.*

Figure 6.—*A loblolly pine plantation established following shearing to 4 inches dbh plus injection of residuals. About 75 percent of the four-year-old loblolly saplings are free to grow.*

Shortleaf Pine

Shortleaf pine can be planted throughout the Interior Uplands but is best suited to the northern Cumberland Plateau, the northern part of the Western Highland Rim in Tennessee and the entire Pennyroyal of Kentucky (Smalley 1979c). Shortleaf pine should be considered where diversification is important, where the long-term goal is production of sawtimber, and where ice and snow may damage loblolly pine (Russell 1979).

Shortleaf pine grows slowly in its early years, so site preparation in cutover stands will have to be relatively intense to ensure that seedlings survive.

Natural Regeneration for Hardwoods

Major unexploited opportunities exist to regenerate low-quality hardwood stands by natural regeneration (fig. 7). These stands will regenerate to some extent following any kind of harvest or disturbance, but quality, quantity, and distribution will depend on species, age and distribution of the existing stand, site quality, harvesting methods, and cultural activities.

Poor and very poor sites.—Natural regeneration of low-quality hardwood stands on poor and very poor sites presents some special problems but also some opportunities. Potentially slow growth and poor tree quality argue against spending much money on these sites. However, much can be accomplished at little or no cost by appropriate harvesting. If the stand is to be regenerated, the more material harvested the better. Many thousands of acres of low-quality stands on poor sites are well suited for shearing or other broadscale operations. The resultant regeneration will be primarily of sprout origin and will contain a variety of desirable and undesirable species (McGee 1980). There will also be a few barren spots. Overall, the regeneration resulting from a heavy or complete harvest cut will usually produce a stand that will be better than the harvested low-quality stand. Landowners should not expect high quality hardwoods on these poor sites, even under the best of circumstances. Most of the regrowth will be suitable for pulpwood, fuelwood, chips, or short logs.

If traditional logging methods are employed, the logger should use as much of the residual stand as practicable. But when culls, poles, and many small tolerant stems remain, the landowner must decide how much can be spent on natural regeneration. Such stands may contain numerous culls or relicts and the felling or deadening of these trees should be the highest priority. Of second priority will be the felling of nonmerchantable trees that would interfere with regeneration. These trees may be numerous and the cost of total control may be prohibitive.

Despite the problems with regenerating low-quality stands on poor sites, landowers should view hardwoods as the best potential crop. Unsuitable for agriculture or even conversion to pine, these stands should be targets for controlled and opportunistic regeneration and improvement.

Medium sites.—Low-quality hardwood stands growing on medium sites can be regenerated readily by clearcutting. Many stands are on terrain that can be sheared. However, some regeneration can be expected after partial cuts or even high grading. Regeneration will develop from stump sprouts, advance regeneration and new seedlings. The expected regeneration mix will be highly variable, depending on the size of openings, the available seed source, the size, distribution, and species of the overstory removed, the condition of advance regeneration, and the climate during the harvest and for several years thereafter. Medium sites can produce hardwood sawlogs, tie logs, pulpwood, fuelwood, and other products. However, production of veneer and better quality sawlogs will be limited.

Control of competing vegetation will be more important than on poorer sites. Without effective control or utilization of culls and less desirable trees, medium sites will remain in the low-quality category. While potential for volume and quality growth is fair to good, the economics of site preparation should be carefully monitored. Injection or utilization of large culls and relicts is a high priority activity on sites scheduled for regeneration. Control or utilization of intermediate trees should also be achieved at a somewhat higher level than on poorer sites. If trees in the 2- to 12-inch diameter class cannot be used, then expenditures from $30 to $60 per acre should be anticipated for their control. Control can be achieved by injecting undesirable species with herbicide prior to logging and following the logging with felling unmerchantable stems that will produce desirable sprouts.

Good and very good sites.—Regenerating low-quality hardwood stands on good and very good sites requires specific action if the site's potential is to be realized. Even though existing stands may be classed as low quality, stumpage revenues can be substantial. Portions of this revenue should be used to prepare the site for improved future yields.

Recognizing good sites among areas that may have been cutover several times and possibly burned can be difficult. Quite often good cutover sites that need to be regenerated will contain, in addition to culls, large numbers of less desirable species (e.g. red maple, dogwood, sourwood, some oaks, blackgum). If these trees are not killed or cut, they can dominate the site and the stand will continue to be low quality. Grapevine, honeysuckle, and kudzu can also inhibit regeneration on good sites. Vegetation control may cost $40–$100 per acre but can be greatly reduced by intensive utilization. Pre-harvest control of grapevines and injection of red maple should receive high priority. Culls and relicts should also be cut or deadened if not utilized.

Figure 7.—*Natural upland hardwood regeneration consisting of seedlings, seedling sprouts, and stump sprouts following shearing on a medium site.*

Good sites now supporting low-quality hardwoods can grow high quality sawlogs and veneer. Yellow-poplar, white oak, northern red oak, white ash, black walnut, and black cherry should do well but past cutting practices will probably determine how well these species regenerate. While clearcutting will usually result in good regeneration, reliable inexpensive techniques are not available for controlling the species mix or for favoring one species over another in the preferred group. A frequent trend following clearcutting on good sites is for yellow-poplar, white ash, and other light-seeded species to predominate where mixed oaks may have previously dominated. This trend is a problem for owners with strong commitments to wildlife habitat or fine oak production. The usefulness of shelterwood cutting in stimulating oak regeneration is uncertain at this time (Sander 1977). Cleaning or crop tree release may be advisable on some good sites but should be considered only after the stands have been regenerated 8 to 12 years. It is also very expensive.

Planting Hardwoods

Yellow-Poplar

It is possible to plant yellow-poplar on medium, good, and very good sites where a natural seed source is not available (fig. 8). Acceptable growth and fair quality can be obtained from yellow-poplar planted on medium sites with moderate site preparation. Site preparation should include injection of all trees 2 inches dbh and larger. Excellent growth can be achieved on good and very good sites but more intensive preparation will be needed as the site quality increases. In every case site selection, quality of planting stock, and care of the yellow-poplar seedlings prior to planting is critical (Russell 1977).

Oaks

Improvement of low-quality hardwood stands by planting oaks cannot be generally recommended at this time. Numerous studies have shown early survival of planted oaks to be relatively high, but growth, even with cleanings, is very slow (McGee 1981a).

Black Cherry and Black Walnut

Black cherry and black walnut can be planted on some sites in the region with reasonable chance of success. However, extreme care must be taken on site selection, site preparation, care of planting stock, and the seed source. A planter should be committed to the necessary silvicultural follow-up and should familiarize himself with available guidelines before entering into large scale planting of these species (Schlesinger and Funk 1977, Williams 1974, Auchmoody 1973).

Intermediate Management

Thinning

Thinning from below often has little practical application in low-quality hardwoods because the best stems usually are removed in thinning. Moreover, most low-quality stands are already understocked with acceptable growing stock and a conventional thinning would only compound the problem. However, there are cases where stands on very poor, poor, or even medium sites have become overstocked at 50 to 70 years of age. A commercial pulpwood thinning that reduces basal area to 50 to 60 square feet will increase the growth of the residuals.

Timber Stand Improvement

An improvement cut plus cull tree control is often prescribed for timber stand improvement. Many low-quality hardwood stands can be immediately improved by harvesting overmature or less desirable trees and by killing culls and undesirable trees. However, there is a hazard that the residual stand may not justify the effort. Typical low-quality stands contain many pole-sized trees that appear vigorous and have good form. Usually, these poles—particularly oaks—are older than they appear. When released, these trees usually accelerate in diameter growth but height increases are uncertain, and increased epicormic sprouting will occur, especially on white oak (McGee 1981b).

Since most low-quality stands are candidates for clearcutting and regeneration, it is important that stands that can benefit from improvement be identified and treated appropriately. In some owerships, where large acreages of low-quality stands are being brought under management, clearcutting of the total area may be impractical and improvement cuts advisable even if the outlook for improvement is not great.

Figure 8.—*A successful yellow-poplar plantation on a medium site. This stand has been cleaned, but cleaning is not essential for establishing yellow-poplar on these sites.*

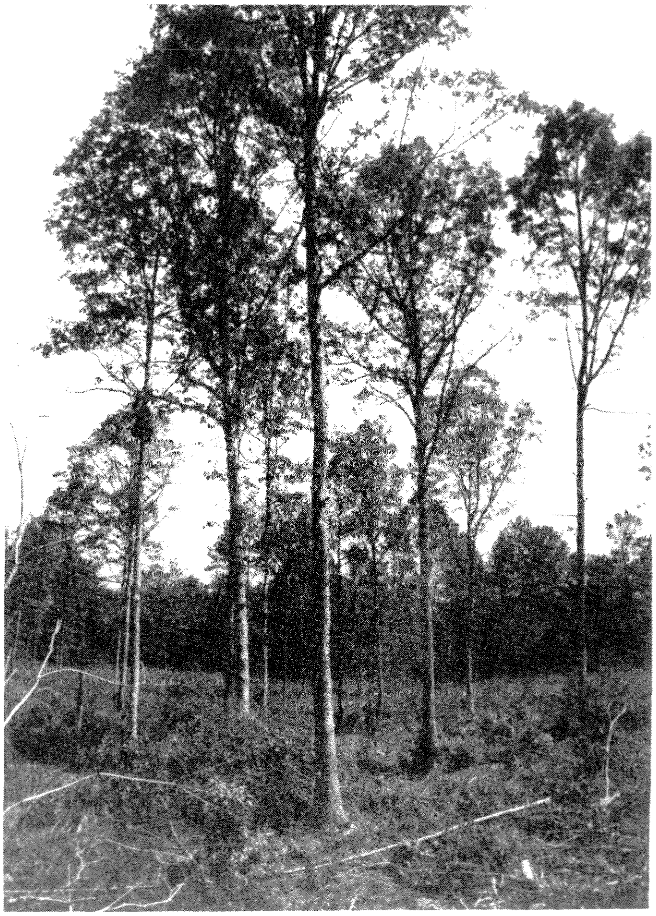

Figure 9.—*A sparse stand of manageable trees developed from a fully stocked low-quality stand.*

Sparse Stand Management

For some low-quality hardwood stands there is an opportunity to avoid immediate complete harvesting and to provide a source of logs and revenue in 10 to 20 years (fig. 9).

Some low-quality stands contain 20 to 40 dominant or co-dominant trees per acre in the 10- to 14-inch diameter class that are of desirable species and have good form and vigor. If these trees are harvested, the returns will be minimal. If the rest of the stand is cut, these trees will increase rapidly in diameter and can move into higher quality and value classes. Such a residual stand with perhaps 30 to 40 square feet of basal area could, counting in-growth, produce 150 to 200 board feet per acre per year for the next 10 years on medium or better sites (Dale 1972).

There are a number of problems in managing sparse stands. First, the residual trees must have the potential to move quickly into higher size and value categories. Epicormic sprouting may reduce the value increment for some trees. Second, there must be a means to log the mature and overmature trees and control culls without damaging the residual sparse stand. Third, smaller trees 2 to 10 inches dbh should be harvested, lopped, or injected. If these smaller trees are utilized or cut, regeneration can be expected to begin with moderate impact from the sparse residual overstory. Finally, there must be a means to log the sparse residual stand in 10 to 20 years.

Sparse stand management should not be viewed as an overall replacement system for regenerating stands but as an option to be used only when the residual stand meets the necessary criteria. The practice, if used judiciously in conjunction with regeneration cutting on adjacent areas, can provide diversity and a deferred source of income.

Opportunistic Cutting

Removal of the best trees with no attention given to the potential of the residual stand is a major cause of low-quality hardwood stands. Due to current economic conditions many landowners are likely to continue diameter-limit cutting, high-grading, and commercial clearcuts even when they know it significantly reduces long-range productivity. These practices provide the maximum cash per unit harvested and require minimum supervision, planning and cash outlay. So it is difficult to justify reducing current revenues or spending for cultural work when alternative investments may approach 15 to 20 percent. It is even more difficult to justify out-of-pocket expenditures that may exceed stumpage revenues.

The only realistic solution for an owner who won't spend money on forest improvement is total utilization. As previously discussed, the development of markets for low-quality hardwoods is essential before "stand improvement" will be attractive to some.

No Management

For a variety of reasons many thousands of acres of low-quality hardwood stands will receive no attention. Leaving moderately stocked, good-quality hardwood stands alone for a while may be a good prescription for improvement. But most low-quality stands left alone are not likely to improve much. Individual trees may increase in value but culls and undesirable trees will also continue to grow so that a stand that is low quality today will, without treatment, remain a low-quality stand.

Many owners of low-quality hardwoods acquired their lands for recreation, wildlife enjoyment or investment and have no primary interest in timber production. The relatively small stumpage revenues that could be generated from these stands do not encourage cutting. Owners let the forest sit idle in the belief that land values will increase, wildlife populations will remain stable and the woods continue to be nice for hiking and camping. The use of some low-quality hardwood lands for these purposes may be good land use and prolonged cultural inactivity justified. Yet many low-quality stands support low populations of birds and wildlife, are really not very nice to view and would have a greater investment value if the trees were more diverse and vigorous.

Some landowners who have viable and progressive forest management programs ignore their low-quality hardwoods. To some extent, such an establishment of priorities may be justified in the short run. But to continue to lump all low-quality stands into one category, regardless of site and potential, and to ignore them is not good business.

Multiple Use Management

Low-quality hardwood stands have considerable current value for wildlife, aesthetics, and watershed protection. Even with great current value, the potential for improvement of multiple use values may be even greater than the potential improvement for timber production. This section will cover some of the problems and opportunities of multiple use.

Wildlife Habitat

Mast.—Low-quality hardwood stands are currently a major source for mast in the Interior Uplands, but the yield in hard mast from many stands is low. The low yields are due to the advanced age of some oaks and hickories and the overtopped condition of younger trees. Mast yields could be improved by removal of culls that retard the development of good mast producers. When a hardwood stand is converted to pure pine, the area will lose most of its mast-producing capability. However, planted pine-natural hardwood mixtures offer substantial wildlife advantages.

Browse.—Browse production in low-quality stands is generally low but will increase with almost any cutting or cultural treatment. Of course, huge sections of land treated in the same way at the same time will not benefit wildlife in the long run.

Den trees.—If all defective trees in low-quality hardwood stands were actively used by animals and birds as dens, nests, and hides, the forest would be overrun. However, many defective trees are not desirable den trees. Squirrels prefer den trees that provide protection from rain, so trees with large defective crowns are not desirable. Similarly, trees with holes running from the base of the tree into the crown are not desirable. In most low-quality stands there are a few highly desirable den trees. When these trees are not used, it is an indication that lack of food and not lack of den trees limits the squirrel population. Considerable timber stand improvement can be imposed on most stands without adversely affecting the squirrel population. In fact, if the improvement enhanced the vigor of the stand, food supplies would likely be increased.

Diversity.—While there is considerable variation in species, tree size, and tree quality within small tracts of low-quality stands, there is often a monotonous repetition of the same stand conditions over wide areas. For those who place a high priority on wildlife habitat and habitat diversity, carefully established stand treatment priorities offer outstanding opportunities for improvement.

Watershed Protection

Low-quality hardwood stands are often found on critical watershed areas. These watersheds need healthy vigorous stands with predictable longevity. Realistic treatment can improve the health, longevity, and predictability of these critical stands.

Aesthetics

Many owners of low-quality stands have strong emotional concerns for the appearance of their forests. With some justification, these owners fear that logging in any form will mar its appearance. It is true that the typical high-grading leaves the forest with broken trees, piles of slash, and a few sorry residual trees. Many stands need to be clearcut but some owners are reluctant to accept this treatment. In most cases, better utilization will improve the appearance of any logged-over stand. The adverse visual impact of a heavy forest cut can also be reduced by wintertime logging, when the tree tops are barren. The development of sparse stands as described earlier in conjunction with intensive harvesting can provide an attractive forest that will have good potential for producing sawlogs.

Injection is a very effective means of controlling undesirable trees, but standing dead trees mar the landscape. Where aesthetics are important, these trees should be felled.

Overall, the appearance of low-quality hardwood stands characterized by defective and deformed trees is not very pleasing. Long range aesthetic values can be enhanced by improving stand health, vigor, and diversity.

EVALUATING AND RATING LOW QUALITY STANDS

Low-quality stands are easy to recognize because of the presence of cull, overmature and undesirable trees. However, the key to management lies not so much in the array of low-quality trees but in trees that are manageable. Several factors should be considered when identifying and rating stands that require immediate regeneration, those that don't have to be treated immediately, and those that justify intermediate management. Rating these stands would involve collecting much of the same data needed for an inventory of good-quality stands. However, the way the data are grouped and emphasized may be different. Also, it is important to remember that the timber stands being evaluated are of low value and that every opportunity for economy in planning and treatment should be examined.

Factors for Rating Low-Quality Stands

Site Quality

To evaluate a low-quality stand, an adequate appraisal of site quality is essential. However, a site appraisal from the existing stand is usually difficult because of past cutting practices. Unless care is taken in the selection of sample trees, the site index value will underestimate true site quality. Other methods of site evaluation that do not depend on direct tree measurements are suggested in the next chapter.

A general rule is that as site quality increases, the priority for action should also increase. Low-quality stands should be partitioned by site quality.

Manageable Trees

An important step in evaluating a low-quality stand is to inspect the inventory of manageable trees. These include all sound trees of acceptable species, making up a composite of desirable and acceptable growing stock.

The number, species, and distribution of manageable trees is the key to prescribing regeneration, cultural treatment, or postponement of action in low-quality stands.

The inventory of manageable trees should be partitioned into species and size categories and identified as desirable or acceptable growing stock. The partitioning should show basal area and numbers of trees. The definitions of desirable and acceptable growing stock will vary substantially by ownership and site quality. Acceptable growing stock includes those trees that can be expected to increase in value; for example, a 12-inch oak that will produce one or two tie logs by the end of the rotation. Most low-quality stands will contain a number of acceptable trees. While acceptable trees present an opportunity for management, they also provide an element of uncertainty that leads to indecision. A tree should not be classed as acceptable if it is likely to become undesirable within the time frame being considered.

If the basal area of manageable trees is less than 50 square feet per acre, the stand can be treated as a low-quality stand. Stands with more than 50 square feet of manageable trees per acre usually will be classified differently.

Cull Trees

Cull trees are often the most predominant component of a low-quality stand. These trees are important and should be inventoried, but they should not be allowed to mask other redeeming features of the stand. The inventory should include the number and basal area per acre of culls. Culls that might be useful as den trees should also be identified.

Undesirable Trees

Undesirable trees may include poorly-formed trees of desirable species (usually too young or small to be classed as culls) as well as undesirable species. Individually, undesirable trees may not have much impact on decision-making for a low-quality stand, but, collectively, they are important. Some stands may contain 400 or more undesirable trees per acre but most will have 150 to 250.

Advance Regeneration

Some low-quality stands have large numbers of desirable small saplings and seedlings. These trees are likely to be found in stands that have been cut over recently. Often they are losing vigor and stem quality as the canopy closes. The number and distribution of these seedlings and saplings should be recorded. Due to a tendency to occur in clumps, numbers per acre can be misleading.

Age

Tree ages can be important in stand management decisions. However, overall age determination in low-quality stands has little value, so age estimates should be made only for the manageable trees. By restricting age determination to these trees, an accurate determination for individual trees can be made using ringcounting of cores. The variety of ages and sizes of trees that occurs in low-quality stands makes even this procedure impractical on a large scale. A solution is to become proficient at estimating ages from appearance. Age appraisers can become reasonably accurate through training and experience.

A word of caution. Even an experienced forester cannot estimate tree age in low-quality stands without specific training. The average forester will almost always underestimate ages of intermediate trees, sometimes by as much as 100 percent, and will tend to overestimate the age of many larger or mature trees. Age estimates within 20 percent are accurate enough for most decisions. However, the age of trees to be used for site-indexing should be established by ring count.

Rating Low-Quality Stands

Treatment for a single low-quality stand can be prescribed by evaluating relevant stand and site factors and managerial goals. However, more than one stand is usually involved in forest planning, and treatment priorities among stands must be established. The following stand rating system will aid evaluation of individual stands and provide a means for ranking several stands:

1. Identify, delineate, and inspect the stand. Gather inventory data. Determine causes for the poor condition of stand. (Most tallying systems for point or plot sampling can be readily adapted to provide the following information.)
2. Develop a per-acre profile of relevant factors.
   Species of manageable trees ____, ____, ____
   Number of manageable trees $\geq$ 14″ dbh ____
   est. age ____
   Number of manageable trees $\geq$ 6″ dbh but less than 14″ ____ est. age ____
   Number of manageable trees $\geq$ 2″ dbh but less than 6″ ____ est. age ____
   Number of desirable stems less than 2″ dbh ____

Basal area of manageable trees ____
Site index ____
Number of culls ____
Basal area of culls ____
Number of undesirable trees ____
Basal area of undesirable trees ____
Total number of trees ____
Total basal area ____

3. Consider treatment options. There are essentially three broad options available for treatment of low-quality stands, e.g. regeneration, intermediate management, or postponement of action.
   A. Regeneration. The need for complete harvest and natural regeneration will increase as (1) number and basal area of manageable trees decrease, (2) number and basal area of culls and undesirable trees increase, (3) site index increases, (4) age of manageable trees increases, and (5) desirable advance regeneration increases.
      If conversion to pine is a management option, the weighting in favor of complete harvest and conversion will increase when (1) site index for pine ranges between 70 and 85, (2) sources of desirable natural hardwood regeneration decrease, and (3) number of intermediate and smaller hardwoods decreases.
   B. Intermediate management. Opportunities for intermediate management including the removal of a portion of the stand and the retention of a residual stand will increase as (1) basal area of immature manageable trees increases, (2) age of manageable trees in relation to size decreases, (3) number of undesirable plus cull trees decreases, and (4) site index increases.
   C. Postponement of action. Postponement will be favored as (1) site index decreases, (2) number of large manageable trees increases, (3) number of small undesirable trees increases, (4) out-of-pocket costs for treatment increase, and (5) desirable advance regeneration decreases.
4. Develop stand recommendations.
   A. Based on the stand profile and the preceding treatment options, list the three major treatment options in order as they seem to apply to the stand. If only one stand is involved, the major recommendation has been made.
   B. When more than one stand is involved, a stand ranking by treatment is needed so that priorities for treatment can be established and compared.

A simple but highly subjective ranking system can be used where each treatment for each stand can be assigned a numerical value from 1 to 10.

For example, consider a stand with the following per-acre profile:

Stand number 1
Size 15 acres
Species of manageable trees white oak, black oak, yellow-poplar
Number of manageable trees ≥ 14″ dbh 18; est. age 110
Number of manageable trees ≥ 6″ dbh but less than 14″ dbh 36; est. age 70
Number of manageable trees ≥ 2″ dbh but less than 6″ dbh 46; est. age 50
Basal area of manageable trees 40 sq. ft.
Number of desirable stems under 2″ dbh 100
Site index: 65 for white oak, 75 for yellow-poplar
Number of culls 14
Basal area of culls 12 sq. ft.
Number of undesirable trees 130
Basal area of undesirable trees 26
Total number of trees over 2″ dbh 242
Total basal area 78

The treatment ranking for such a stand could be:

Treatment	*Priority*
Regeneration	7
Intermediate management	5
Postponement	4

The priority assignment for each treatment will differ for each forest property depending on the range of conditions, goals, etc. In this case, a 7 was assigned to regeneration because of the advanced age of the few manageable trees, medium site quality, and a sizeable number of undesirable trees and culls.

A medium priority 5 was assigned to intermediate management primarily because of the 82 manageable trees 2 to 14 inches dbh. The rating is no higher because of the advanced age of these trees, the medium site and the number of undesirable trees.

The rating for postponement is no higher than 4 because of the age of the larger trees. It is not lower because of the relative sparseness of desirable trees less than 2 inches dbh that would contribute to regenerating the area and because of the small number of trees (36) under 14 inches dbh that could grow into sawtimber-size in the near future.

   C. Stand evaluations and treatment ranking must, where appropriate, take into account multiple use needs and values. Rankings can be adapted to consider needs for mast, browse, diversity, etc.
5. Compare stand priorities. After the stands in a forest property have been evaluated and rated, using the above procedure or a similar method, they can be ranked for treatment priority. An

array of stands such as the following and their treatment ratings can be used to establish priorities for treatment.

	Stand 1 (15 Acres)		Stand 2 (12 Acres)		Stand 3 (21 Acres)	
	Rank	Rating	Rank	Rating	Rank	Rating
Regeneration	1	7	2	6	2	5
Intermediate Management	2	5	1	7	3	3
Postponement	3	4	3	2	1	6

In the above case, assume that the imaginary ratings and rankings apply to real stands in a forest property. Assume further that management can regenerate only one stand in the time frame and might consider intermediate action in one stand. In this case, regeneration would be recommended for stand 1, intermediate management for stand 2, and postponement of treatment in stand 3.

The treatments for stands 1 and 3 are clear. Stand 1 will be completely harvested and regenerated in an appropriate manner. Stand 3 will be evaluated at a later date. However, the intermediate action in stand 2 should be implemented only after careful evaluation of the stand profile and the cost-benefits of any intermediate activity clearly established.

If the priority ratings do not establish clear differences between stands, then stand profiles can be reviewed and rankings revised. Althought many low-quality stands may appear to be similar, stand profiles will often show substantial differences. As stand raters become proficient in developing stand profiles, these differences become more apparent. If after careful evaluation the differences in stand ratings are not great, the sequence of operation may not be important.

A word of caution. A simplistic rating system should not be substituted for common sense and experience. Factors such as accessibility, markets, need for regulation, and multiple use values should always be considered.

EVALUATING SITE PRODUCTIVITY IN LOW-QUALITY STANDS

Height-Age Curves

Management of low-quality hardwood stands requires an assessment of site productivity. A commonly used measure is site index, described as the average height of dominant and co-dominant trees in a stand at an arbitrarily chosen age, usually 50 years. Trees suitable for site index determinations must be dominant or co-dominant (never overtopped) and undamaged. For the most part, few if any trees in low-quality stands of the Interior Uplands meet these criteria because of past land use.

Use of site index also requires appropriate curves for the desired species and geographic location. Schnur's (1937) curves were developed for the entire upland oak region, including the Interior Uplands (fig. 10). If sites are encountered with indices greater than 85, use Olson's (1959) curves for upland oaks developed for the Virginia-Carolina Piedmont and the Southern Appalachian Mountains.

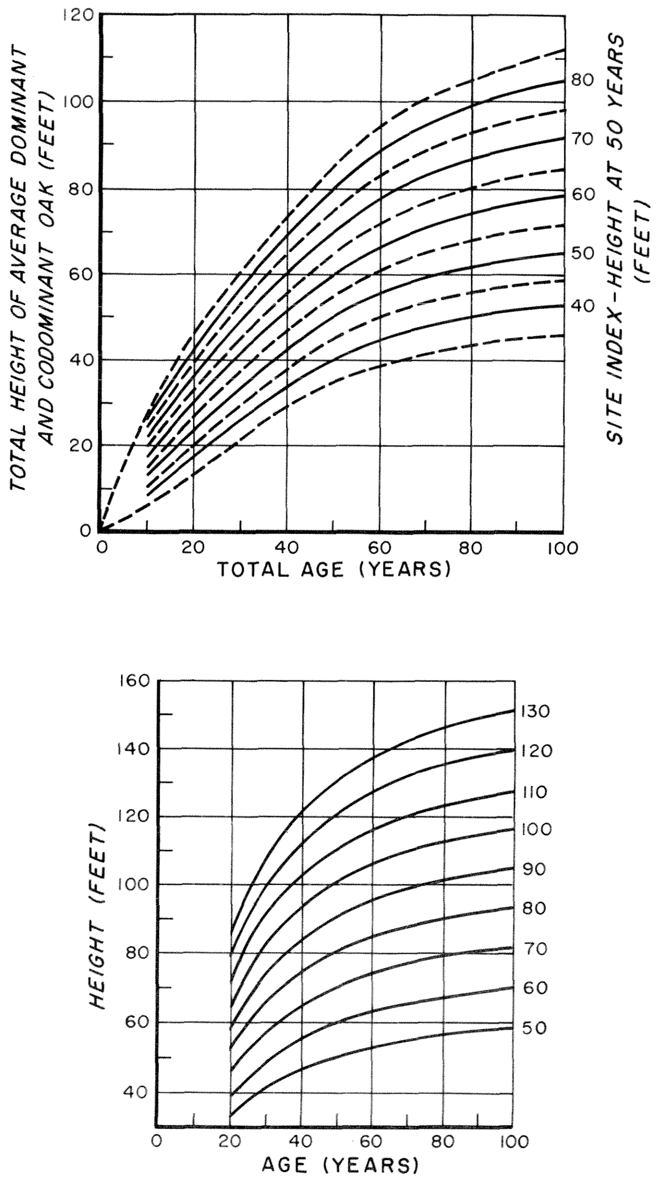

Figure 10.—*Top: Site index curves for upland oak (From Schnur 1937). Bottom: Site index curves for yellow-poplar in the Piedmont of Carolina and Virginia (From Beck 1962).*

Like the oaks, site curves for yellow-poplar have been constructed for the entire species range (McCarthy 1933). These curves may not reflect the height-age relationships of poplar growing in the Interior Uplands. Beck (1962) prepared site index curves for the Southern Appalachian Mountains and the Piedmont Plateau (fig. 10). Compared with McCarthy's curves, the mountain curves were significantly different, but the Piedmont's were similar. In general, McCarthy's curves underestimate site index at young ages and overestimate at older ages when applied to mountain stands. Piedmont curves are probably best for the Interior Uplands.

No site curves for other upland hardwoods have been developed for the Interior Uplands. Curves prepared for other regions should be used cautiously (Hampf 1965).

County Soil Surveys

County soil surveys with woodland interpretations can be used to determine site productivity. However, many counties do not have soil surveys so managers may have to look elsewhere.

Productivity Based on Landforms

For stands lacking trees suitable for the direct estimation of site index and/or those in counties lacking a soil survey with woodland interpretations, use a site classification and evaluation system based on landforms developed by Smalley (1978, 1979a). Smalley divided the Interior Uplands into six regions (fig. 11). Currently, guides for four regions are available (Smalley 1979b, 1980, 1982a, 1982b). Detailed instructions for using the system appear in each guide.

To apply the system, users are required to identify the geographic region and sub-region of a specific stand (fig. 11). Finally, users must identify specific landtypes where the stands in question are found by matching landtype descriptions with existing landforms. Estimates of site index and mean annual growth in cubic feet are listed for selected tree species for each landtype. Site index and yield information in these guides is the best available but in some cases is based on limited data.

Users may find that their direct measurements of site index on a specific landtype differ from the published regional values. In this situation, users should rely on the direct measurements. Users may also encounter considerable variation in direct measurement of site index within a landtype, especially if it contains inclusions of other landtypes too small to recognize.

Users may be surprised to find that adjacent landtypes have the same estimated site index for a given species. Productivity was only one of several criteria for defining landtypes. Differences in the severity of one or more management problems—plant competition, seedling mortality, equipment limitations, erosion hazard, and windthrow hazard—necessitated the recognition of a separate landtype.

Productivity values for selected tree species on those landtypes most likely to support low-quality hardwood stands have been exerpted from the four published site evaluation guides (tables 2–5). The category of upland oaks represents an undifferentiated group consisting of one or more of the following oak species—black, scarlet, chestnut, southern red, northern red, and chinkapin. White oak can also be included if a site index value is not shown separately. Site index values in parenthesis are estimated, i.e., they were not derived from published data.

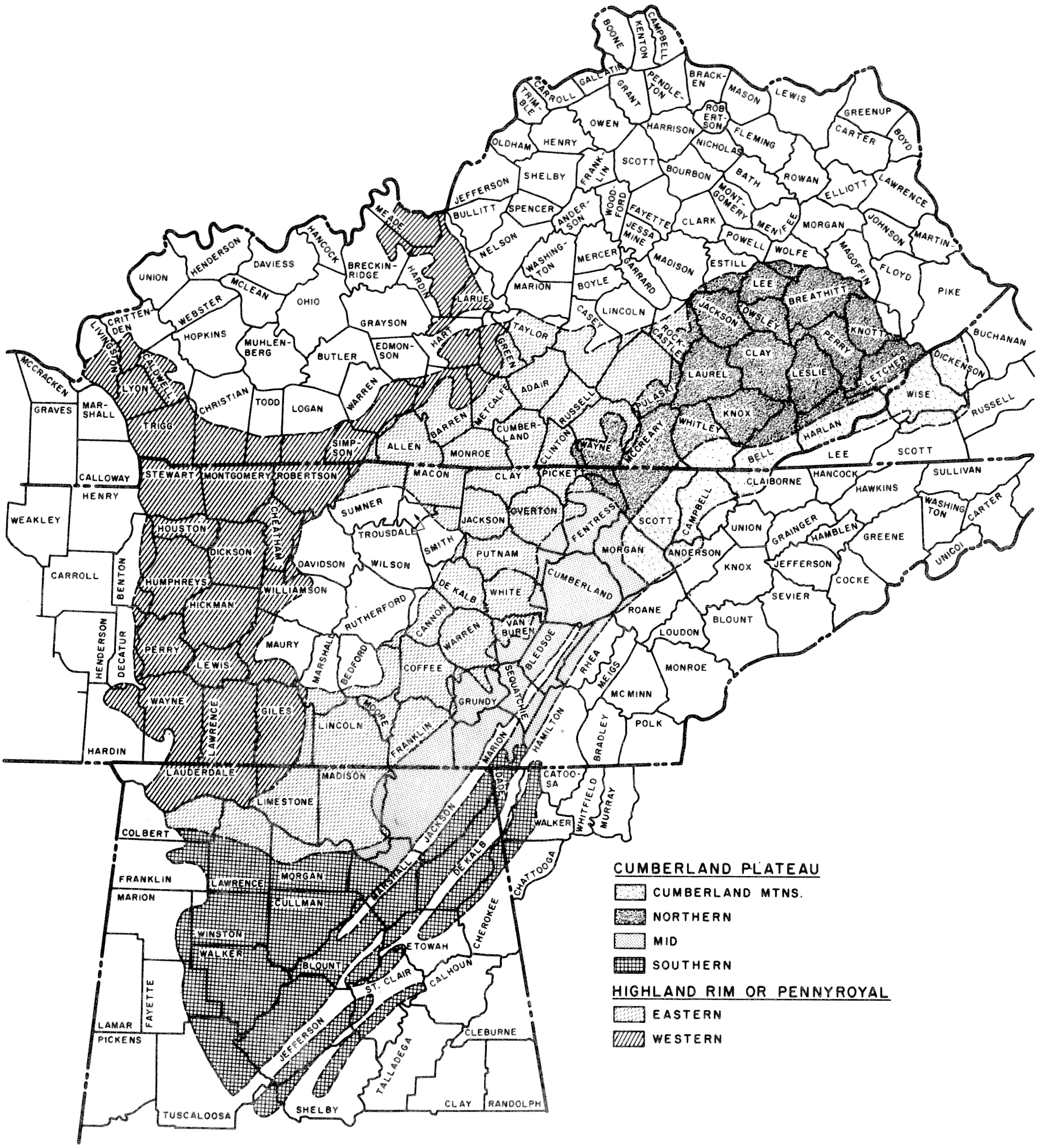

Figure 11.—*Regions of the Cumberland Plateau and Highland Rim physiographic provinces covered by the site classification and evaluation system based on landform (From Smalley 1982).*

Table 2.—*Site index of selected pines and hardwoods growing on landtypes likely to support low-quality stands on the Southern Cumberland Plateau* [1]

Landtype number and name	Site index (base age 50)					
	Loblolly pine	Shortleaf pine	Virginia pine	White oak	Red oaks	Yellow-poplar
Subregions 1, 2, and 3—Sandstone Plateaus						
1 Narrow ridges and convex upper slopes	70	55	60	55	60	....
2 Broad undulating uplands	75	65	70	65	65	75
3 Broad ridges—North aspect	75	65	70	65	65	75
4 Broad ridges—South aspect	70	55	60	60	60	....
5 North slopes	70	55	60	75	70	(80)
6 South slopes	60	50	50	65	60	....
7 Sandstone glades, rock outcrops, and plateau edges	....	50	50	50	50	....
11 Sandstone escarpments, talus slopes, and benches—South aspect	....	65	65	65	65	....
12 Lower slopes, benches and spur ridges—North aspect	....	65	70	(60)	(60)	....
13 Lower slopes, benches and spur ridges—South aspect	....	60	60	50	50	....
Subregion 4—Shale Hills						
14 Narrow ridges and convex upper slopes	60	60	65	55	55	....
15 Broad ridges—North aspect	80	65	70	65	65	(80)
16 Broad ridges—South aspect	70	55	60	55	55	....
17 North slopes	70	60	60	60	60	(90)
18 South slopes	65	55	55	50	50	....
19 Shale rockland and shallow soils	60	50	50	....	....	....

[1] From Smalley, 1979b.

Table 3.—*Site index of selected pines and hardwoods growing on landtypes likely to support low-quality stands on the Mid-Cumberland Plateau* [1]

Landtype number and name	Site index (base age 50)						
	Loblolly pine	Shortleaf pine	Virginia pine	White pine	White oak	Upland oaks	Yellow-poplar
Subregions 1 and 2—True Plateau and Walden Ridge							
1 Broad undulating sandstone uplands	75	65	70	75	....	60	85
2 Broad sandstone ridges—north aspect	70	65	70	75	....	65	80
3 Broad sandstone ridges—south aspect	65	60	65	....	....	60	....
4 Narrow sandstone ridges and convex upper slopes	70	60	65	70	....	65	....
5 North standstone slopes	70	60	65	75	(65)	(75)	95
6 South sandstone slopes	60	55	60	....	60	65	....
7 Sandstone outcrops and shallow soils	....	55	60	....	60	....	....
8 Broad shale ridges—north aspect	80	70	70	80	....	....	90
9 Broad shale ridges—south aspect	(70)	(60)	(65)	(75)	....	....	80
10 Upper shale slopes—north aspect	75	70	70	80	60	70	95
11 Upper shale slopes—south aspect	(65)	60	60	70	....	60	....
12 Lower shale slopes—north aspect	85	75	75	....	....	75	100
13 Lower shale slopes—south aspect	80	65	70	....	....	65	....
17 Plateau escarpment and upper sandstone slopes and benches—south aspect	(75)	65	70	....	65	60	....
18 Lower limestone slopes, benches, and spur ridges—north aspect	....	....	....	....	70	65	85
19 Lower limestone slopes, benches, and spur ridges—south aspect	(65)	55	60	....	50	55	....
20 Limestone outcrops and shallow soils	....	....	(55)	....	....	(55)	....
Subregion 3—Strongly Dissected Southern Portion							
1 Broad undulating sandstone uplands	75	65	70	75	....	60	85
2 Broad sandstone ridges—north aspect	70	65	70	75	....	65	80
3 Broad sandstone ridges—south aspect	65	60	65	....	....	60	....
4 Narrow sandstone ridges and convex upper slopes	70	60	65	70	....	65	....
5 North sandstone slopes	70	60	65	75	(65)	(75)	95
6 South sandstone slopes	60	55	60	....	60	65	....
7 Sandstone outcrops and shallow soils	....	55	60	....	60	....	....
17 Plateau escarpment and upper sandstone slopes and benches—south aspect	(75)	65	70	....	65	60	....
18 Lower limestone slopes, benches, and spur ridges—north aspect	....	....	....	....	70	65	85
19 Lower limestone slopes, benches, and spur ridges—south aspect	(65)	55	60	....	50	55	....
20 Limestone outcrops and shallow soils	....	....	(55)	....	....	(55)	....

[1] Smalley, 1982a.

Table 4.—*Site index of selected pines and hardwoods growing on landtypes likely to support low-quality stands on the Western Highland Rim and Pennyroyal*[1]

Landtype number and name		Site index (base age 50)					
		Loblolly pine	Shortleaf pine	Virginia pine	White oak	Upland oaks	Yellow-poplar
Subregion 1—Highland Rim Plateau							
1	Narrow ridges and convex upper slopes	65	55	55	....	55	....
2	Broad undulating Coastal Plain uplands	80	70	70	....	70	90
3	Broad ridges—north aspect	80	65	65	....	70	90
4	Broad ridges—south aspect	75	60	60	....	65	80
5	Cherty north slopes	75	65	70	....	70	90
6	Cherty south slopes	65	55	60	....	55	....
7	Shaly north slopes	65	55	55	55	....	....
8	Shaly south slopes	60	50	50	50	....	....
11	Lifestone rockland and shallow soils	....	....	55	....	(55)	....
12	Broad silty uplands	80	65	60	....	70	(75)
13	Broad undulating uplands	80	75	75	75	70	90
14	Broad ridges—north aspect	75	70	70	70	70	90
15	Broad ridges—south aspect	70	65	65	65	65	....
Subregion 2—Highland Rim-Nashville Basin Transition							
1	Narrow ridges and convex upper slopes	65	55	55	....	55	....
11	Limestone rockland and shallow soils	....	....	55	....	(55)	....
12	Broad silty uplands	80	65	60	....	70	(75)
16	North slopes	75	....	....	(70)	75	100
17	South slopes	65	....	....	....	60	....
20	Low broad ridges	90	80	....	....	80	90
21	North slopes and narrow ridges	80	....	....	....	70	....
22	South slopes and narrow ridges	70	....	....	....	60	....
Subregion 3—Karst Plain							
11	Limestone rockland and shallow soils	....	...	55	....	(55)	....
12	Broad silty uplands	80	65	60	....	70	(75)
23	Broad undulating uplands	80	80	80	70	85	95
24	Broad ridges—north aspect	80	70	75	70	90	95
25	Broad ridges—south aspect	70	(60)	65	60	75	(80)
26	Narrow limestone ridges and knoblike hills	....	....	....	....	75	...
29	North slopes	80	75	70	70	90	90
30	South slopes	70	65	65	....	80	....
33	Broad ridges—north aspect	....	80	80	....	80	95
34	Broad ridges—south aspect	....	75	75	....	75	85
35	North slopes	....	75	75	80	80	90
36	South slopes	....	65	65	70	70	75
37	Broad undulating uplands	....	70	....	....	70	85
38	Broad ridges—north aspect	....	....	....	....	75	90
39	Broads ridges—south aspect	....	65	..	....	65	80
40	North slopes	....	80	....	75	80	90
41	South slopes	....	70	75	(65)	70	70

[1] From Smalley, 1980.

Table 5.—*Site index of selected pines and hardwoods growing on landtypes likely to support low-quality stands on the Eastern Highland Rim and Pennyroyal* [1]

Landtype number and name		Site index (base age 50)					
		Loblolly pine	Shortleaf pine	Virginia pine	White oak	Upland oaks	Yellow-poplar
Subregion 1—Highland Rim Plateau							
1	Narrow ridges and convex upper slopes	75	65	65	....	55	....
2	Broad ridges—north aspect	80	70	70	....	70	90
3	Broad ridges—south aspect	75	65	65	....	65	80
4	Cherty north slopes	75	65	70	....	70	90
5	Cherty south slopes	65	55	60	....	55	....
6	Shaly north slopes	65	55	55	55	60	....
7	Shaly south slopes	60	50	50	50	....	....
10	Limestone rockland and shallow soils	....	....	55	....	(55)	....
11	Shale rockland and shallow soils	....	50	50	50	....	....
12	Broad silty uplands	80	65	65	....	70	(75)
13	Broad undulating redlands	80	75	75	75	75	90
14	Hilly redlands—north aspect	80	70	70	70	75	90
15	Hilly redlands—south aspect	75	65	65	65	65	80
16	Redland slopes—north aspect	80	75	70	70	90	90
17	Redland slopes—south aspect	70	65	65	70	70	....
20	Narrow limestone ridges and knoblike hills	....	....	....	....	70	....
Subregion 2—Transition to the Nashville Basin							
1	Narrow ridges and convex upper slopes	75	65	65	....	55	....
10	Limestone rockland and shallow soils	....	....	55	....	(55)	....
11	Shale rockland and shallow soils	....	50	50	50	....	....
12	Broad silty uplands	80	65	65	....	70	(75)
22	North slopes	75	....	....	(70)	75	100
23	South slopes	65	....	....	....	60	....
26	Broad undulating ridges	85	80	....	....	75	90
27	Broad ridges—north aspect	85	80	....	....	80	90
28	Broad ridges—south aspect	80	75	....	....	70	80
29	North slopes	75	....	....	....	70	90
30	South slopes	65	60	....	....	65	....
Subregion 3—Transition to the Bluegrass							
10	Limestone rockland and shallow soils	....	....	55	....	(55)	....
11	Shale rockland and shallow soils	....	50	50	50	....	....
31	Crests of knobs and narrow ridges	....	55	55	....	(55)	....
32	Broad ridges—north aspect	....	70	65	....	70	90
33	Broad ridges—south aspect	....	65	60	....	60	75
34	Upper north slopes	....	60	60	....	60	....
35	Upper south slopes	....	55	55	....	(55)	....
36	Lower north slopes	....	(60)	60	....	60	....
37	Lower south slopes and crests of low knobs and narrow ridges	....	....	(50)	....	(55)	....
Subregion 4—Moulton Valley							
1	Narrow ridges and convex upper slopes	75	65	65	....	55	....
2	Broad ridges—north aspect	80	70	70	....	70	90
3	Broad ridges—south aspect	75	65	65	....	65	80
4	Cherty north slopes	75	65	70	....	70	90
5	Cherty south slopes	65	55	60	....	55	....
10	Limestone rockland and shallow soils	....	....	55	....	(55)	....
13	Broad undulating uplands	80	75	75	75	75	90
14	Hilly redlands—north aspect	80	70	70	70	75	90
15	Hilly redlands—south aspect	75	65	65	65	65	80
16	Redland slopes—north aspect	80	75	70	70	90	90
17	Redland slopes—south aspect	70	65	65	70	70	....
20	Narrow limestone ridges and knoblike hills	....	....	....	....	70	....
40	Undulating Coastal Plain uplands	80	65	(70)	....	....	....
41	Broad undulating valleys	70	65	65	....	(65)	(75)

[1] From Smalley, 1982b.

A CHECKLIST FOR MANAGING LOW QUALITY STANDS

1. Identify or delineate the stand.
2. Obtain from personal visitation and inventory data a general feel for the area.
   a. Observe variations in stem distribution.
   b. Observe variation in landtypes and/or apparent site quality.
   c. Study how the stand or area relates to adjacent or nearby stands or areas.
   d. Try to determine why the stand is low-quality.
3. Collect data necessary to develop a profile of the stand.
   a. Basal area of manageable trees (include acceptable plus desirable growing stock).
   b. Basal area and numbers per-acre of culls and undesirable trees.
   c. Determine age of manageable trees. Take increment cores and/or make estimates as needed to determine age of trees on the area.
   d. Observe occurrence and distribution of advance regneration.
4. Collect data needed to describe the site.
   a. Establish site index from height-age curves if possible. Use only those trees that have always been dominant or co-dominant. Do not use trees that have been adversely impacted by fire, insects, disease or logging or that have been overtopped.
   b. Identify and delineate the landtypes included in the area and refer to fig. 11 and tables 2, 3, 4, or 5 for site index estimates.
5. Rate the stand (as outlined in the chapter on Evaluating and Rating Low-Quality Stands or use some similar system) for (1) regeneration, (2) intermediate management, or (3) postponement of action. Each of the above options should be rated for each stand for the setting of priorities between stands.
6. Using the rating system, establish treatment priorities between stands or areas. In many cases, large acreages of low-quality stands may need the same treatment, but owner constraints may limit the acreage that can be treated at one time, hence the acreage must be partitioned and priorities established.
7. After stands are rated and priorities established, consider the options or actions as appropriate, keeping in mind that costs are a major constraint and economy should be the watchword.
8. For stands to be regenerated:
   a. Harvest and utilization should be as complete and thorough as practical. Each unwanted tree that is utilized is one less stem to be controlled.
   b. Recommendations for conversion to loblolly, shortleaf or white pine or for natural hardwood regeneration should be based on the owner's objective, site capability and stand condition. Do not discount the possible advantages of a mixed planted pine-natural hardwood stand.
   c. Site preparation should be geared to owner's expectation from the new stand and his ability to pay for it. In general, the more intensive the preparation, the better the new stand will be. When site preparation funds are limited, expend them where they will pay the greatest return. Highest priority should be given to the control of vegetation that will interfere most with the new stand. The order of treatment might be (1) control large culls, (2) control intermediate trees of undesirable species, (3) lop unmerchantable intermediate stems of desirable species, and (4) control smaller poles and saplings. Remember—try to get as much site preparation as possible accomplished as part of the harvest.
9. For stands that are to receive intermediate treatment:
   a. Identify the residual stand. Identify management goals for the residual stand.
   b. Harvest as much of the non-residual stand as practical. Avoid logging damage to residuals.
   c. Control undesirable stems that cannot be harvested. Large culls should definitely be controlled at this time. Undesirable intermediate trees may or may not need to be controlled, depending upon the size and distribution of the desirable residual trees.
   d. Make definite plans for future treatment. If the residual stand is very sparse and made up mostly of small sawtimber and larger intermediate trees, a final harvest may be projected in 10–20 years. If the residual stand is made up of numerous poles and intermediate trees, the next harvest is likely to be 20–40 years in the future.
10. For stands where action is to be postponed:
    a. Make plans for future treatment.
    b. Reconfirm priorities between the stand and the other stands where action is to be proposed.
11. Don't forget multiple use values. Adapt prescriptions to fit owner's objectives.
12. Final thoughts.
    a. You are dealing with an assortment of poor stands that have resulted from accumulated neglect and mistreatment. Be confident that almost any set of treatments that you rationally prescribe will result in an improved condition and increased productivity.
    b. The costs of cultural activity may be a serious management deterrent. Use imagination and innovation to reduce out-of-pocket costs.
    c. This guide provides simplistic solutions to complex problems. You cannot wait for the "final" answer. Proceed with confidence.

LITERATURE CITED

Auchmoody, L. R. Intensive culture of black cherry. South. Lumberman 227(2824): 113–115; 1973.

Beck, D. E. Yellow-poplar site index curves. Res. Note SE-180. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station; 1962. 2 p.

Birdsey, Richard A. Tennessee forest resources. Resource Bull. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1982. (In press).

Carmean, Willard H.; Boyce, Stephen G. Hardwood log quality in relation to site quality. Res. Pap. NC-103. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1973. 7 p.

Dale, Martin E. Growth and yield predictions for upland oak stands 10 years after initial thinning. Res. Pap. NE-241. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1972. 21 p.

Hampf, Frederick E. Site index curves for some forest species in the eastern United States. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Eastern Region; 1965. 43 p.

Koch, Peter. Harvesting energy chips from forest residues—some concepts for the southern pine region. Gen. Tech. Rep. SO-33. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1980. 24 p.

Loftis, David L. Preharvest herbicide control of undesirable vegetation in Southern Appalachian hardwoods. South. J. Appl. For. 2(2): 51–54; 1978.

McCarthy, E. F. Yellow-poplar characteristics, growth, and management. Tech. Bull. No. 356. Washington, D.C.: U.S. Department of Agriculture; 1933. 58 p.

McGee, Charles E. Expanding options for reforestation of the Cumberland Plateau. South. J. Appl. For. 4(4): 158–162; 1980.

McGee, Charles E. Planting results on the Cumberland Plateau. In: Seedling physiology and growth problems in oak planting: Proceedings of the workshop; 1979 November 6–7; Columbia, MO (abstracts). Gen. Tech. Rep. NC-62. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1981a. 24 p.

McGee, Charles E. Response of overtopped white oak to release. Res. Note SO-273. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1981b. 4 p.

Mills, Thomas J. Cost effectiveness of the 1974 Forestry Incentives Program. Res. Pap. RM-175. Fort Collins, CO: U. S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1976. 23 p.

Moyers, George B. Management of Eastern white pine in the South. In: Management of pines of the Interior South: Proceedings of the symposium; 1978 November 7–8; Knoxville, TN. Tech. Pub. SA-TP-2. Atlanta, GA: U.S. Department of Agriculture, Forest Service, Southeastern Area, State and Private Forestry; 1979: 58–62.

Olson, David J., Jr. Site index curves for upland oaks in the Southeast. Res. Note 125. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station; 1959. 2 p.

Reynolds, James W.; Schroeder, James G. System 6—a way to use small logs to make grade lumber. South. Lumberman 234(2897): 9–10; 1977.

Russell, T. E. Planting and seeding shortleaf pine. In: Management of pines of the Interior South: Proceedings of the symposium; 1978 November 7–8; Knoxville, TN. Tech. Pub. SA-TP-2. Atlanta, GA: U.S. Department of Agriculture, Forest Service, Southeastern Area, State and Private Forestry; 1979: 7–13.

Russell, Thomas E. Planting yellow-poplar—where we stand today. Gen. Tech. Rep. SO-17. New Orleans, LA: U. S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1977. 8 p.

Sander, Ivan L. Manager's handbook for oaks in the north central states. Gen. Tech. Rep. NC-37. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1977. 35 p.

Schlesinger, R. C.; Funk, D. T. Manager's handbook for black walnut. Gen. Tech. Rep. NC-38. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1977. 22 p.

Schnur, G. Luther. Yield, stand, and volume tables for even-aged upland oak forests. Tech. Bull. 560. Washington, D.C.: U.S. Department of Agriculture; 1937. 88 p.

Smith, Henry W., Jr.; Baird, Charles O. Results of thinning in a 27-year-old eastern white pine plantation on the southern Cumberland Plateau of Tennessee. In: Management of pines of the Interior South: Proceedings of the symposium; 1978 November 7–8; Knoxville, TN. Tech. Pub. SA-TP-2. Atlanta, GA: U.S. Department of Agriculture, Forest Service, Southeastern Area, State and Private Forestry; 1979: 143–150.

Smalley, G. W. Classification and evaluation of forest sites in the Interior Uplands. In: Pope, P. E. (ed.): Proceedings second central hardwood forest conference; 1978 November 14–16; West Lafayette, IN: Purdue University; 1978: Addendum p. 1–20.

Smalley, G. W. Classification and evaluation of forest sites for timber production: Introduction of a new system for classifying forest sites based on the physical features of the landscape. In: Forest soils and site quality: Proceedings of a workshop; 1979 May 8–9; Auburn, AL: Auburn University; 1979a: 28–47.

Smalley, Glendon W. Classification and evaluation of forest sites on the southern Cumberland Plateau. Gen. Tech. Rep. SO-23. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1979b. 59 p.

Smalley, Glendon W. Growth and yield of shortleaf pine plantations. In: Management of pine of the Interior South: Proceedings of the symposium; 1978 November 7–8; Knoxville, TN. Tech. Pub. SA-TP-2. Atlanta, GA: U.S. Department of Agriculture, Forest Service, Southeastern Area, State and Private Forestry; 1979c: 28–47.

Smalley, Glendon W. Classification and evaluation of forest sites on the western Highland Rim and Pennyroyal. Gen. Tech. Rep. SO-30. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1980. 120 p.

Smalley, Glendon W. Classification and evaluation of forest sites on the Mid-Cumberland Plateau. Gen. Tech. Rep. SO-38. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1982a. 58 p.

Smalley, Glendon W. Classification and evaluation of forest sites on the eastern Highland Rim and Pennyroyal. Gen. Tech. Rep. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1982b. (In press).

Trimble, George R., Jr. Cull development under all-aged management of hardwood stands. Res. Pap. NE-10. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1963. 10 p.

Williams, Robert D. Planting methods and treatments for black walnut seedlings. Res. Pap. NC-107. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1974. 6 p.

☆U.S. GOVERNMENT PRINTING OFFICE: 1983-669-085/40

McGee, Charles E. Low quality hardwood stands. Opportunities for management in the interior uplands. Gen. Tech Rep. SO-40. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1982. 22 p.

Discusses primary causes of low-quality hardwood stands and offers management options for regenerating or improving these stands.

Keywords: Upland hardwoods, conversion, natural regeneration, high-grading, clearcutting, sparse stands.