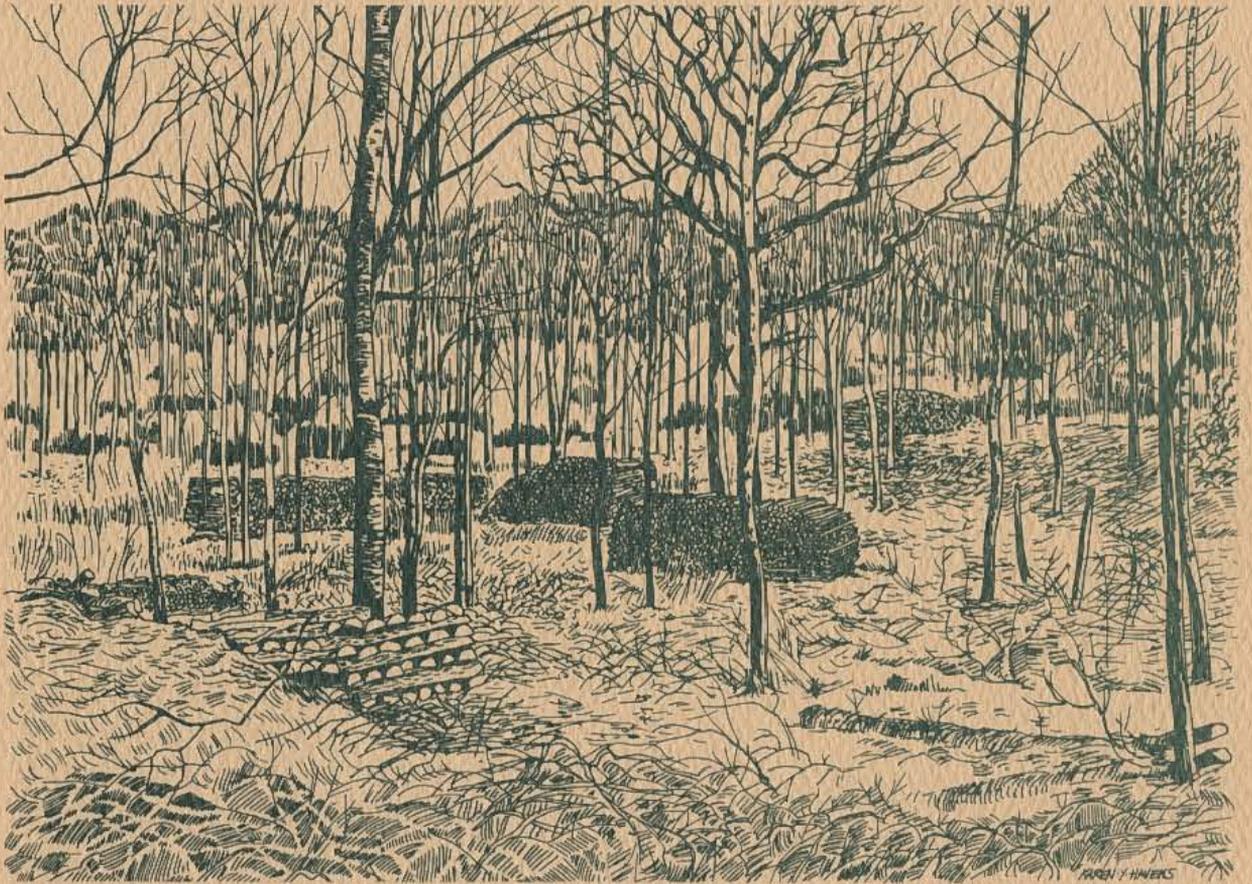

MANAGING OAK FORESTS FOR FUELWOOD

by Thomas E. Lyons and Stephen H. Broderick



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RAE CHAMBERS

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INTRODUCTION

This bulletin is about growing fuelwood in a way that maximizes BTU production and enhances other forest benefits. If you burn wood, you may wish to maintain a constant annual supply of fuelwood from your woodlot. Like most landowners, however, you probably have other interests as well: observing or hunting wildlife; obtaining some income from your property; hiking, cross-country skiing, or otherwise enjoying the forest's beauty. If done properly, growing and harvesting fuelwood can help one realize, and actually improve, these other benefits.

Whenever a tree is cut, the forest's potential to produce quality wood products, the value of the wildlife habitat, and other forest characteristics are affected in some way. Too many landowners, however, select and cut trees for firewood without any real knowledge of what effects their actions are producing. As a result, minimum visual impact is often what is sought, and landowners go through the forest cutting only dead trees or crooked, small, and sick-looking trees. In some cases, this approach produces positive results. In others, it can reduce those very benefits which the landowner values most.

This bulletin focuses on how to grow and manage Connecticut's most plentiful forest type, oaks and the hardwoods that grow with them, for firewood. It begins with an overview of how oak forests grow. It follows with a discussion of how those natural growth characteristics can be managed to maximize the annual growth rate of fuelwood. Finally, it discusses how fuelwood management can be logically integrated with other forest goals and objectives. The appendices include examples of how forest management is implemented on small woodlots, along with a glossary of some of the technical terms used here, and a directory for sources of further information.

All Connecticut woodlot owners should find something of value here; woodlot owners with limited acreage who desire an annual flow of firewood should find it particularly helpful.



MANAGING OAK FORESTS FOR FUELWOOD

HOW OAK FORESTS GROW

Forest Succession

We live in a part of the world where virtually any acre of ground, if left untended, will begin at once to revert to forest. There is a definite pattern, or "succession," of events in the development of a new forest after a fire or a field abandonment. Initially, fast-growing, sun-loving species, called "pioneers," invade the area. Aspen, red-cedar, and gray birch are typical pioneers in Connecticut. These trees grow rapidly at first but are relatively short-lived, and by the time thirty or forty years have passed they begin to be overtopped by other, longer-lived tree species.

Oaks and hickories are typical of the species which overtop the pioneers and form the intermediate stage of forest succession. These trees usually appear about the same time as the pioneers, but grow more slowly in the early years. If left untouched for 150 years or so, this intermediate forest will eventually give way to the "climax" stage of forest succession, dominated by sugar maple, beech, hemlock, and other species that tolerate heavy shade and can slowly develop

under the existing forest canopy. This does not happen often, however. Fires, hurricanes, or people with chainsaws usually intervene. When they do, forest succession is interrupted.

Sprout Reproduction

Rarely do we have to worry about planting seedlings to establish an oak forest. Oaks are fairly prolific seeders, and good acorn crops occur every few years. In addition, most southern New England hardwoods, including the oaks, will sprout readily from freshly cut stumps. The established root systems enable these "stump sprouts" to grow more rapidly than seedlings for the first several years. Because of this, an oak-mixed hardwood forest which is cutover will generally replace itself with a new oak-mixed hardwood forest of sprout origin. The replacement of a forest with stump-sprouts is known as *coppice* reproduction.

Many of our existing hardwood forests began with coppice reproduction following a period of heavy cutting in the first decades of this century. Numerous multi-stemmed trees in a forest provide a clue that the forest probably

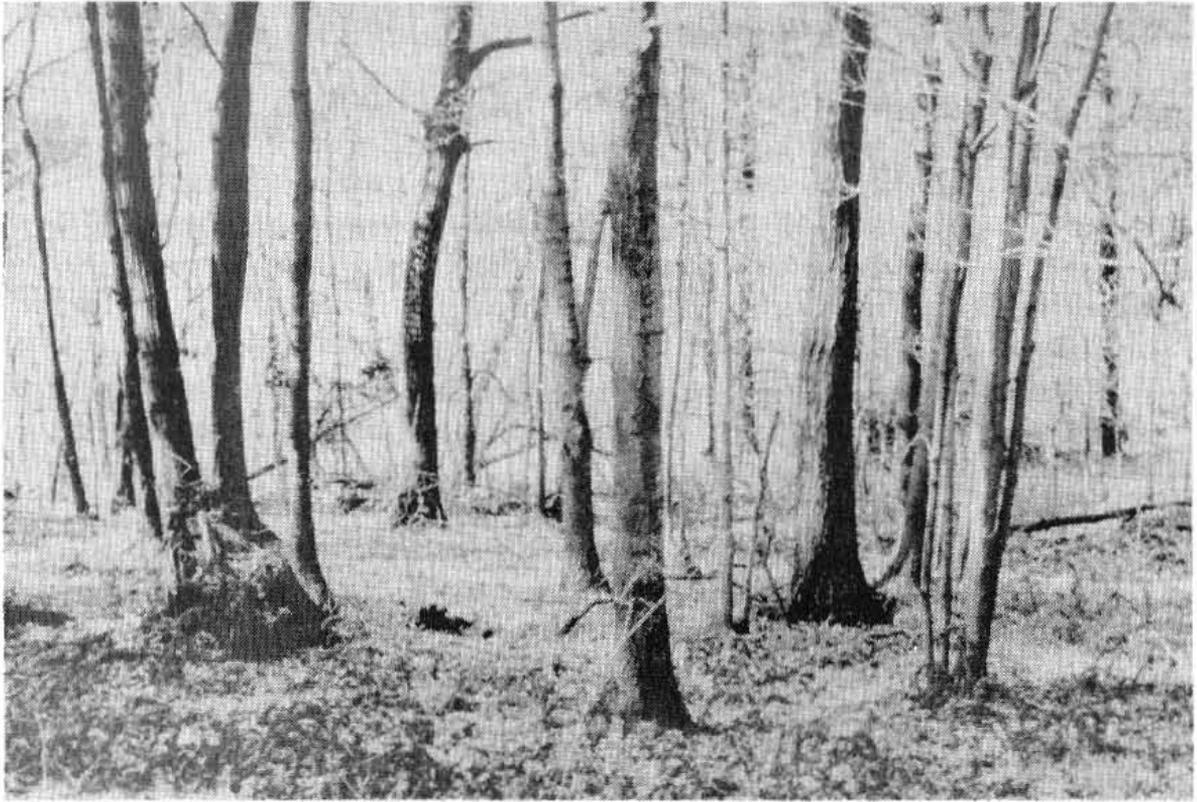


Figure 1. A poletimber stand of oak, which developed from stump sprouts after heavy cutting.

sprouted after a heavy cutting. Figure 1 displays a typical stand, dominated by oaks which started as stump sprouts.

The amount of sprouting that occurs, and the speed of sprout growth, are affected by the age of the harvested tree and the amount of sunlight reaching the stump. The younger a tree is when cut, the more vigorous the sprouting will be. Oaks over 50 years of age gradually lose their sprouting ability. Stumps in full sun sprout most vigorously, while stumps in very heavy shade rarely sprout at all. Heavy cutting encourages

sprouting by allowing sunlight to reach the forest floor. Light selective cuts, on the other hand, keep the ground shaded and do little to encourage sprouting.

Soils and the Site

Of equal importance to the amount of sun a tree receives is the type of soil it is growing in. In Connecticut, moisture is the most common soil factor limiting tree growth. Most of our soils simply have either too much or not enough. Just as with sunlight, each tree species has a moisture niche where it competes best with

other species. Figure 2 shows where some of the more common species grow best. On the very wettest mucks, red maple (also called swamp maple or soft maple) is about the only tree that can survive. In slightly drier situations, white ash, elm, hemlock, and white pine will appear with the swamp maples.

Oaks grow best on moist but well-drained soils such as those commonly found slightly up slope from a wetland. Here the soils are deepest and moisture conditions are ideal. Northern red oak and

white oak in particular thrive on such soils and can develop into high-quality timber stands.

As one moves upslope, soils typically become drier, coarser, and shallower. White, black, scarlet, and chestnut oaks are common on such sites, often in nearly pure stands. When young, these oaks quickly form deep root systems which allow them to obtain enough moisture to survive. Soon, however, their needs for moisture, rooting depth, and nutrients begin to exceed availability, and growth stagnates.

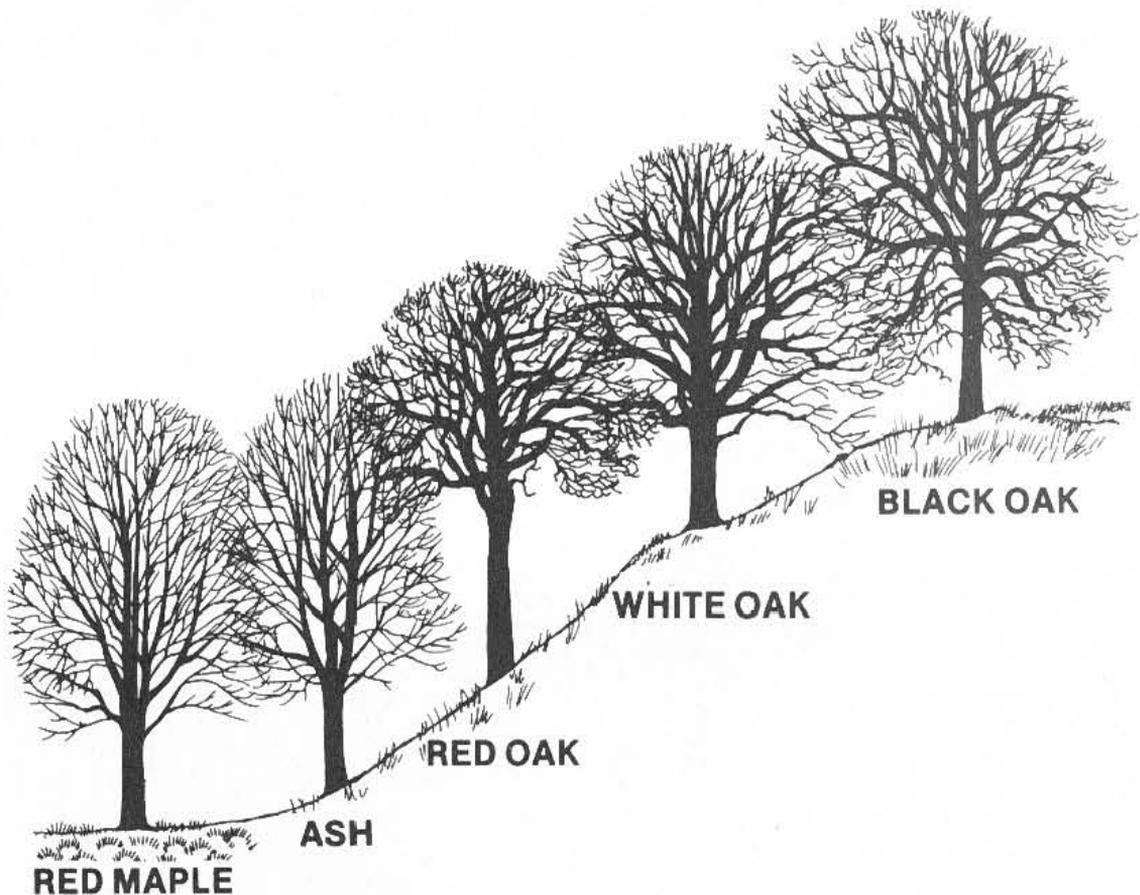


Figure 2. Site preferences for tree species common in Connecticut.

MANAGING OAKS FOR FUELWOOD

Fuelwood can be produced in a variety of ways. A common method of forest management in oak-mixed hardwood forests generates fuelwood as a by-product of producing high-quality sawlogs. *Timber management* first generates fuelwood when the stand is thinned to remove competition from the best potential timber trees. Often, the stand is thinned several more times at regular intervals, producing more fuelwood and some sawtimber as well. When the stand is finally mature, the remaining trees, including many high-quality sawlogs, are cut to start the stand again. The total period of time between the start of a new stand and the removal of its last mature trees is called a *rotation*.

An alternative system of fuelwood management is *patch-cutting* with coppice regeneration. Patch-cutting involves removing all or nearly all of the trees within an area of from one-half to five or more acres. Patch-cutting in

oak forests has two major advantages in fuelwood production. Removal of all trees in an area is more economical, as the cutter does not have to work around trees which will remain on the site. Most importantly, removing all trees eliminates competition for sun and nutrients, providing the necessary conditions for rapid growth of new oak-mixed hardwood sprouts.

Timber management takes a long time, but the rewards include a high price for the final, high-quality products. Patch-cutting involves letting the stand grow for a much shorter period, and then removing most or all of the trees in the patch. The value of the final product is reduced, but the owner does not have to wait nearly as long between harvests. Which system is best? That depends on a number of factors, including your needs and objectives, and the age and nature of the existing forest.



TOM PARKER

Maximizing Fuelwood Production

The authors conducted a study of yields from stands on sites of varying quality to determine the type of fuelwood management program which would give the greatest long-term financial return to the owner. Classes of site quality were developed from the *site index*, a measure of the ability of a site to grow tall trees. The site index is a number which represents the height a vigorously growing tree can be expected to attain at age 50. The site index of oak in poor sites was 41-50. Sites of medium quality had indexes of 51-60, and good sites were considered to be those which had an index of 61-70. Financial return of yield was represented by the amount of money which would have to be deposited in a bank (at a standard rate) today to accrue to the same value (at the time of harvest) as the harvested wood products.

Our work began with the analysis of results from earlier studies (Schwarz 1907, Westveld 1925 or 1927), to determine the ability of Connecticut's forests to produce wood chips for industrial fuel. Chip harvesting is not very common in Connecticut today, but recent interest in the use of industrial wood fuel holds promise for increasing chip demand in the years ahead. Chipping involves removing smaller trees and tree

branches, so that a younger stand will produce a large volume of chips faster than the same stand would produce a large volume of cordwood. The second part of our procedure was evaluation of U.S. Forest Service information from sample areas in over 100 oak-mixed hardwood stands in southern New England.

The results of this study, including the estimated optimal rotations (the rotation ages which maximize long-term value growth) for both chips and cordwood on poor, medium, and good sites, are presented in Table 1. The table includes the age of the harvested stand and the average annual growth rate, in volume produced (cords per acre per year) and energy produced (BTU per acre per year). The yield tables, from which the optimal rotations were determined, are presented in Appendix 2 of this bulletin.

The optimal cordwood rotations are guidelines to be used on sites where maximization of fuelwood production is the primary management objective. They are 25 years on the good sites, 30 years on the medium sites, and 55 years on the poor sites. If stands managed for fuelwood are not harvested at those specified ages, there will be a long term decline in the rate of both value growth and wood growth. This occurs because stands older than these specified

ages are no longer growing fast enough to produce rates of value growth comparable with those of younger stands.

For each site class, the optimal rotation for chipping material is much shorter than the optimal rotation for cordwood. Should future demand cause the price of

chips to approach the price of cordwood, the total value of managing these stands for chips would be much greater than the value of managing for cordwood. A better market for chips, therefore, would mean much greater utilization of our hardwood resources.

Table 1. Recommended rotation ages for producing cordwood or chipping material, by site class.

Site Index Range	SITE CLASS		
	Poor 41-50	Medium 51-60	Good 61-70
CORDWOOD:			
Rotation Age	55	30*	25*
Annual Growth (cords/acre/year)	0.33	0.31	0.42
BTU Growth (mil. BTU/acre/year)	7.9	7.2	10.2
CHIPPING MATERIAL:			
Rotation Age	20	20	20
Annual Growth (cords/acre/year)	0.33	0.50	0.63
BTU Growth (mil. BTU/acre/year)	7.8	12.0	15.1

*The growth rates used to determine the optimal rotation ages for growing cordwood on medium and good sites are estimated from analysis of stands age 35 years and older.

FUELWOOD MANAGEMENT VS. TIMBER MANAGEMENT

Are the potential returns from cordwood management great enough to make it financially competitive with timber management? Information from over 100 oak-mixed hardwood stands in southern New England was analyzed in an attempt to answer this question. Prices for each different grade of timber were gathered from the Connecticut quarterly stumpage price report (produced by the Cooperative Extension Service) and from forest industry sources in Connecticut. Long term financial returns from timber production were calculated for each site class under two management scenarios:

1. Unmanaged timber stands which are simply harvested at the optimal rotation ages;
2. Managed timber stands in which fuelwood is produced as a by-product of periodic timber stand improvement thinnings.

These returns were then compared to returns from the fuelwood rotations listed in Table 1.

The study showed that active forest management, designed to produce high quality timber as a primary product and fuelwood as a by-product, is likely to produce greater long term returns than management for fuelwood only, regardless of site class. The study also showed, however, that the quality and value of timber can vary tremendously from stand to stand, even within the same age and site classes. Within each site class, some study stands would produce greater returns if allowed to grow to timber size, while others would produce greater returns if patch-cut at the optimum cordwood rotation age. Thus no "rule of thumb" regarding this choice can take the place of an on-the-ground professional appraisal in cases where maximum long term financial return is the primary management objective.

ALTERNATIVE SYSTEMS FOR RAPID FUELWOOD PRODUCTION

The following may be considered as alternatives to the types of management we have already discussed:

Coppice-with-Standards

Whenever possible, coppice fuelwood production should be restricted to stands which have little or no potential to develop into quality timber. Some landowners may want to produce fuelwood by patch-cutting certain sites, but they have a scattering of high-quality trees within the most suitable area. It would be a waste to remove a healthy, straight, well-pruned tree just to fuel the woodstove. European forest managers who have had to grow both sawtimber and fuelwood on scarce forestland address this problem with a system called "coppice-with-standards."

Coppice-with-standards involves maintaining scattered trees for the production of high-quality sawlogs, while the majority of the trees are harvested for fuelwood and regenerated by stump sprouting. The premiums paid for hardwood sawlogs of very high quality make it worthwhile to keep

these trees until they mature as sawtimber, while the remainder of the stand is harvested more frequently for fuel. The trees selected as the "standards" should have long straight boles and large crowns, and they should show no signs of disease (Figure 3).

Although this system is not frequently put into practice, successful examples do exist. One forty acre woodlot in Connecticut had American beech (a coppicing tree from the "climax" successional stage) as the fuelwood producer, with root-suckers developing into saplings which were cut off at 20-25 year intervals. The standards were northern red oaks with large crowns and branch-free boles, and the sawlogs regularly fetched a high price.

If a stand has a few trees which display superior growth and form, but there are not enough to warrant managing for timber alone, you may want to consider the coppice-with-standards system. Fuelwood production will be slightly reduced as a result of competition from the standards, but the return from high-quality sawlogs should more than make up for this.

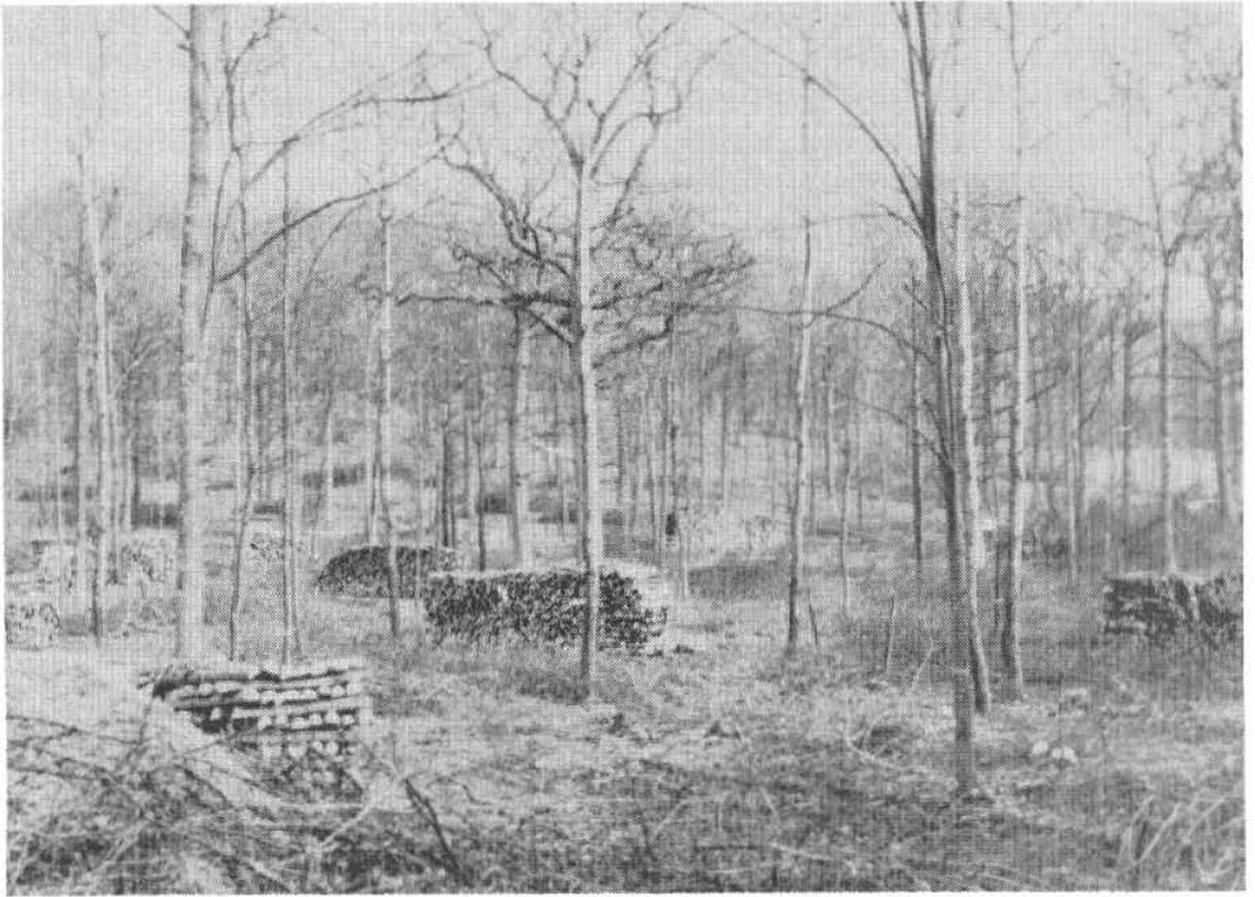


Figure 3. Coppice-with-standards in practice. Standards, which are being grown for high-quality timber, remain after the harvest.

Energy Plantations

The greatest production of fuelwood from each acre of land is achieved in an "energy plantation," containing fast-growing tree species managed on very short rotations. Starting a plantation generally requires planting stock, replacing the development of the oak-mixed hardwood forest by natural succession. Hybrid poplars are the most commonly used plantation trees. Although most other hardwoods have greater BTU pro-

duction per unit volume, the best hybrid poplars produce a tremendous volume of wood in only a few years. Currently, however, Connecticut has no market for poplar fuelwood, an industrial fuel poorly suited to the home woodstove. Further, selection of the wrong variety of poplar can result in very disappointing yields, and hybrid poplars require very intensive care. Oaks can be grown in plantations, and they are less demanding than poplars, but they

require a longer rotation time. Black locust is another tree which may be considered for plantation stock. Besides producing a high-energy wood, this species grows well in poor soil and sprouts readily.

The key to making an energy plantation viable is intensive management. Only high-quality, large seedling stock is selected for planting. Great care must be made to keep the newly established plantation free of weeds. Fertilization is often recommended once

the trees have grown to a height where they will overcome competing weeds. Also, great efforts are often necessary to keep animals from feeding on the new seedlings. The demanding requirements of energy plantations generally restrict their development to the highest-quality sites, usually on abandoned agricultural land. It is extremely doubtful that converting well-established forest stands to a plantation would prove to be profitable.

INTEGRATING FUELWOOD MANAGEMENT WITH OTHER OBJECTIVES

We have been examining the relative advantages and disadvantages of short rotation management systems for rapid production of fuelwood. In this section we will discuss how these systems can be fit into a management plan which reflects a landowner's other interests and objectives.

Enhancing Wildlife Habitat

Diversity is the key to good wildlife habitat. Different species of wildlife need different types and ages of forests. Many species, including deer, grouse, woodcock, and rabbit, depend on the early-succession forest. Some songbirds and other species require the mid-succession forest, and others

thrive only in late-succession forests.

Much of Connecticut is now covered with a relatively uniform, 60 to 80 year old hardwood forest. There is little of the diversity which can provide good habitat for many species. If this type of forest dominates your woodlot and the surrounding area, carefully planned patch-cutting for fuelwood can improve habitat diversity as well as BTU production and value growth.

In a patch-cut area, stump sprouts and root-sprouts of species which were previously part of the forest canopy will quickly re-occupy the site. In the first few years after the cut, rapid changes in the cutover area represent a

boon to many species of wildlife. The opening of the canopy increases growth of existing vegetation and encourages the establishment of many plant species which require full sunlight. The new and invigorated plant growth is accompanied by a rise in the local insect population. The increase of these food sources and increased cover for protection and nesting will encourage use of the area by many different birds, mammals, and other animals.

Dead and dying trees (snags) and trees which contain cavities are often removed as firewood, but these trees represent important

components of the habitats of many wildlife species. Cavity trees provide homes for dozens of species of birds and mammals. Snags are particularly valuable to woodpeckers and bark-gleaning birds. Leaving these trees, whenever possible, in and on the edges of the cut patches, as well as on the rest of the property will help to guarantee a healthy wildlife population. Leaving snags will not interfere with the reproduction of a patch. Cuts may be designed around cavity trees or the huge, spreading "wolf trees"; these form excellent centers of activity for wildlife (Figure 4). The



Figure 4. A one-year-old patch-cut, dominated by a white oak "wolf tree."



cutter may even consider leaving some downed logs. The male ruffed grouse may use these as “drumming logs,” beating his wings when standing on them in a spring courtship ritual.

In areas where the deer population is heavy, patch-cutting in oak-mixed hardwood stands may be too successful in encouraging wildlife. Browsing of sprouts can greatly reduce the chances for the desired development of the new stand. Leaving the “slash” (tops from the harvested trees) brings food within reach of the deer, and the opening created by the cut spurs new growth in stump sprouts and other plants. The abundance and variety of food attracts deer from surrounding uncut areas. If the tree sprouts are browsed repeatedly, other species

of plants which are not desired by either you or the deer may become the only green things growing in the area.

Seeing a deer in the woods is a delightful experience, and clearing small areas in your property will increase the chances of frequent sightings. Too many deer, however, will destroy not only tree growth but habitat for many other wildlife species as well.

The size and shape of a cut can have a great bearing on the “deer pressure” which the regeneration will receive. Deer do not like to venture far into the open; they prefer to stay near the edge of the forest cover. Larger cuts which create wide, open spaces are less likely to receive thorough browsing. Consider the following examples for cutting three acres. Cutting three long, narrow one-acre strips will create openings in which a feeding deer will never be far from the security of the forest edge, and this type of cut will receive the maximum browsing from the local deer population. Cutting the same three acres as a single large circle will mean that the area around the center of the cut is relatively far from the edge. While a large deer population and lack of alternate food sources could induce deer to venture into the center of this area, there is an increased chance that the sprouts in the center would survive.

If you would like to restrict harvests to smaller patches, many wildlife species will still benefit. For example, American woodcock

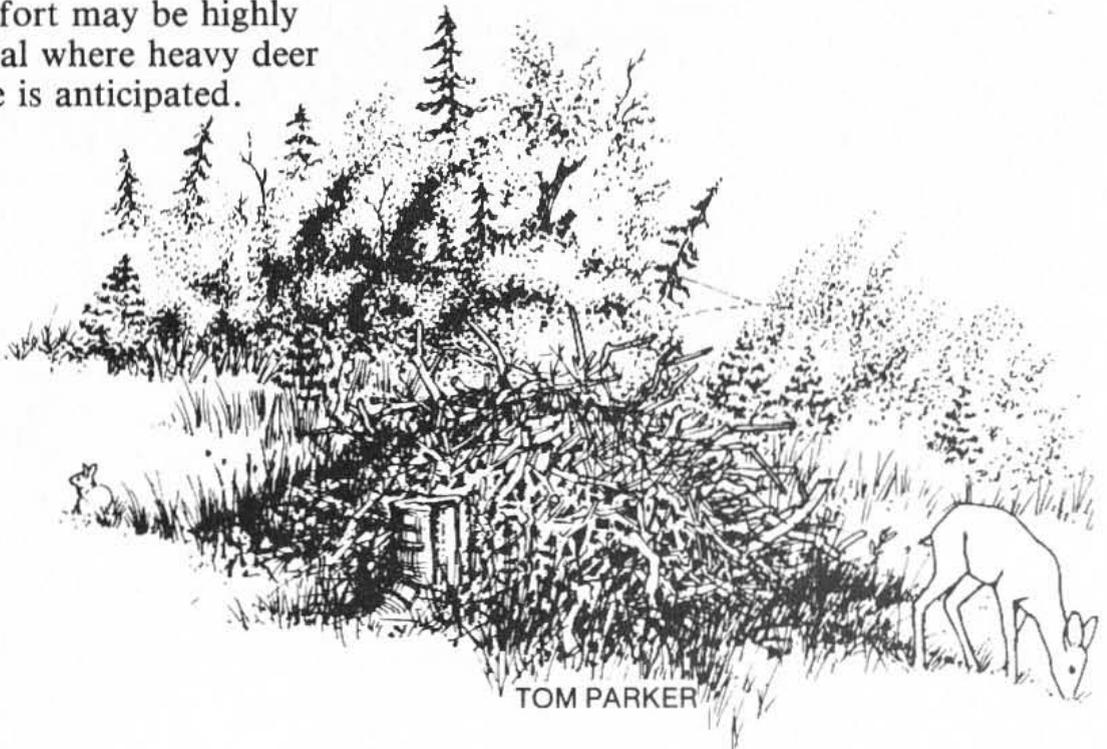
use brushy openings as small as 0.5 acres for "singing grounds," where the male birds create a spectacular display in the spring. If you have a limited acreage and want to produce a continuous supply of firewood, a program of harvesting a number of small patches at some regular interval will provide the wood and promote diversity in wildlife habitat.

What to do with the slash remaining after harvesting is important in integrating the production of fuelwood with the enhancement of wildlife habitat. Creating piles of slash over fresh stumps can benefit both wildlife and tree growth. Slash piles provide cover for some species of birds and mammals. At the same time, the tangle of branches in these piles can make it difficult for deer to get to the new sprouts. If you can use slash to protect the stumps of harvested oaks, the deer will have reduced access to the sprouts. The extra effort may be highly beneficial where heavy deer pressure is anticipated.

Maintaining Aesthetic Values

No area of southern New England is far beyond easy access. Plans for the location and technique of tree harvests should consider how the cutover areas will look both to you and passersby.

Cutting five acres as a single, square five-acre patch may be easy to lay out, but the cutover area will not be as pleasant to visit as an area in which five acres were cut in two or more patches in irregular shapes, following contours. The irregular design of the individual patches will enhance the aesthetic quality of the area. Patches cut in shapes with irregular edges tend to be more pleasing to the eye, and they provide greater amounts of edge per unit area than regular geometric shapes like rectangles or circles. Increasing the amount of edge is important for wildlife, as the variety of species and their population density increase with the amount of edge



available in an area. Figure 5 shows an aerial view of part of a property which was patch-cut the previous year. There are patches throughout the property of various sizes and shapes, with many irregular edges.

Designating an area for cutting should consider vegetation and other features to be left within or left out of the patch. Wildlife habitat values and aesthetic values generally increase with increased plant species diversity, and the forester may wish to plan patches

to leave "edge" trees of as many species as is practical. Old fruit trees, juniper, dogwood, aspen, and speckled alder are examples of species which, like wolf trees and cavity trees, may be retained for their wildlife value. Small clumps of vegetation may be left as "islands," providing wildlife cover immediately after the cut. The old stone fences which occur throughout New England represent a source of cover which should be left undisturbed.



Photo By William and Virginia Welch.

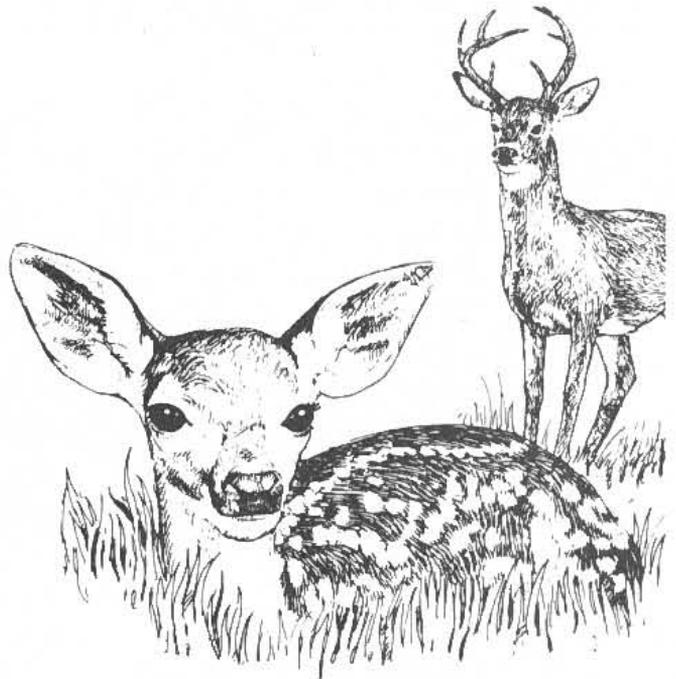
Figure 5. Aerial view of a property which was recently patch-cut. The harvested areas vary in shape, with some irregular edges.

APPLYING RECOMMENDATIONS FOR FUELWOOD MANAGEMENT

We have been discussing the practical use, and limitations, of managing a portion of forest properties primarily for the production of fuelwood. Managing forestland for multiple objectives must be approached with the knowledge that the forest has a limited productivity and potential. Land which is cutover for fuelwood will not produce timber for many decades. Breaking up a continuous, mature forest with several patches of young vegetation will encourage some forms of wildlife but discourage others. These tradeoffs must be considered in any plan for management.

The amount of land which is put into fuelwood production depends on the total size of the property, the amount of cutting and fuelwood which the landowner would like or allow, and the amount of land which is to be reserved for other purposes. If you would like a continual supply of cordwood from your land, you may have to adjust the amount of cutting over several years. Planning this transition to a well-managed forest is best approached with the assistance of a professional forester. The back of this guide lists sources of information and assistance which will help you to meet your forest management goals.

Appendix 1 contains three case studies which demonstrate the integration of patch-cutting for fuelwood into a multiple-use management plan. The management recommendations are designed to consider the landowner's objectives, as well as the suitability and potential of the property for meeting these objectives.



SUMMARY

1. Oaks and associated hardwoods sprout and regrow readily from freshly cut stumps of fuelwood-size trees. Patch-cuts, which allow full sunlight to reach the forest floor, result in the most rapid sprouting and maximize long term fuelwood production.

2. A study was conducted to determine the rotation ages (intervals between patch-cuts) which maximize long term production of cordwood (stovewood) and of chips (industrial wood fuel). Those rotation ages, along with the average wood volumes and BTU's produced per acre per year, are listed in Table 1. They are offered as management guidelines for sites where maximization of fuelwood is the primary management objective.

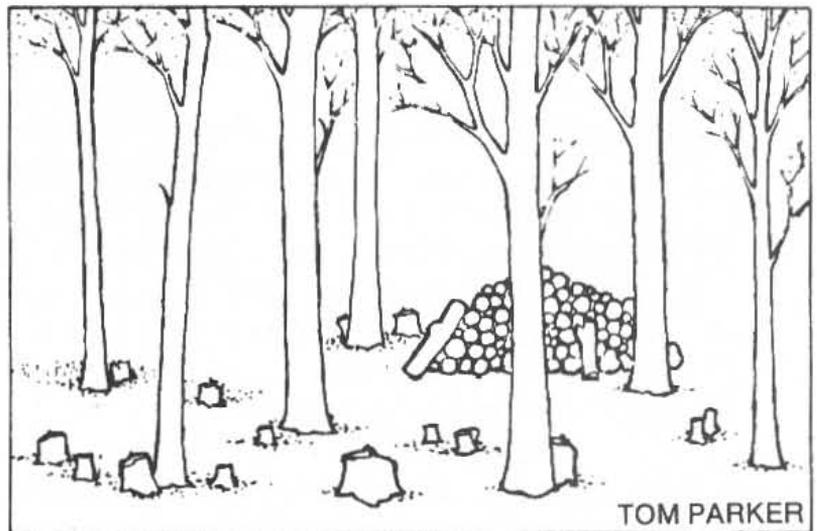
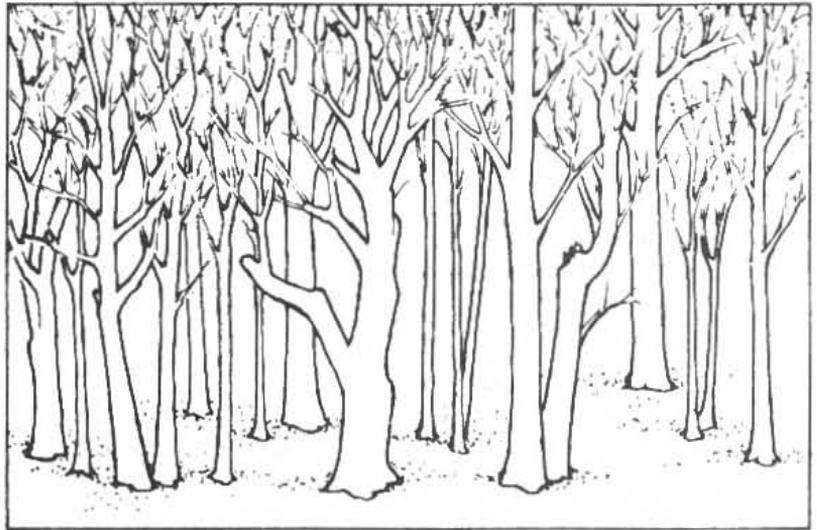
3. In general, active timber management of oak-mixed hardwood stands, which generates fuelwood as a by-product, will provide greater long term financial returns than management for fuelwood only, regardless of site class. Because of the high variability in timber quality that occurs from stand to stand, however, the opposite will be true in many cases. No "rule of thumb" regarding the choice between timber and fuelwood management can replace an on-the-ground professional appraisal in cases where maximum long term financial return is the primary management objective.

4. There are alternatives to patch-cutting for rapid production of fuelwood. Coppice-with-standards is a good method where there are scattered trees which may yield high-quality sawtimber. Hybrid-poplar energy plantations produce the greatest volumes of fuelwood but they involve high costs for establishment and maintenance, and the market for industrial fuelwood is not yet established.

5. Management for maximum fuelwood production can be logically integrated with other objectives, such as wildlife habitat improvement and aesthetic considerations. In uniform cordwood or timber sized hardwood forests, a program of patch-cutting for fuelwood can increase diversity and improve habitat.

Much of Connecticut's woodland forms an unmanaged resource base. The products which are most often desired from the mixed-hardwood forests — timber, fuelwood, wildlife, and recreation based on aesthetics — are available, but the potential of our woodlands to deliver these is much greater than is now being realized. Changes in technology and market demand can be expected to shape the future of

forest management in Connecticut. These changes provide an increasing incentive to begin management on land which may have been previously considered "marginally productive." With the acceptance and adoption of proper silvicultural practices, Connecticut's landowners can expect substantial benefits from the economic and aesthetic improvements in the management of mixed-hardwood forests.



TOM PARKER

APPENDIX 1: EXAMPLES OF MANAGEMENT RECOMMENDATIONS

The following three case studies come from the files of Cooperative Extension Service staff. In each case, patch-cutting is integrated with other management activities to meet the landowner's objectives. These examples show only prescriptions; they do not include the detailed information on forest status and the schedule of future treatments which are an important part of a complete forest management plan.

EXAMPLE 1.

Landowner A has a 10 acre forest consisting of 3 separate forest types:

Stand 1. 2 Acres: red maple poletimber, 8''-12'' diameter, low quality, understocked. Wet, poor site.

Stand 2. 4 Acres: oak-ash sawtimber, 14''-22'' diameter, good quality, adequately stocked. Good site.

Stand 3. 4 Acres: oak-mixed hardwood poletimber, 6''-10'' diameter, low quality, slightly overstocked. Dry, poor site.

Landowner A defined her objectives as (1) maintaining aesthetic beauty, (2) obtaining regular fuelwood supply, (3) improving wildlife habitat.

Recommendations:

Stand 1. This stand is directly behind the house where aesthetics take priority. Patch-cut approximately 1/2 acre to obtain fuelwood, increase visual diversity and improve habitat. Leave a large old "wolf" white ash in the cut's center for aesthetics and wildlife value.

Stand 2. A high-quality stand in terms of both value and aesthetics. Main stand is high-quality, including potential veneer stock, but landowner A has no interest in timber harvesting. Thin out valueless pole-sized red maple, birch, etc. which are overtopped by main stand, and leave for aesthetics and/or a rainy day.

Stand 3. Patch-cut as needed for home fuelwood. Skip years when fuelwood is available from other activities outlined above. Alternate fuelwood cutting on Stands 1 and 3 to maximize wildlife habitat diversity.

EXAMPLE 2.

Landowner B has a 30 acre forest consisting of four separate forest types:

Acres

- | | | |
|----|----------|---|
| 12 | Stand 1. | Oak-mixed hardwood sawtimber, 14''-20'' diameter, overstocked, good quality, dense sugar maple understory. Good site. |
| 7 | Stand 2. | Black birch-mixed hardwood small sawtimber, 10''-16'', overstocked, low quality. Average-poor site. |
| 6 | Stand 3. | Oak-hickory poletimber, 8''-14'', overstocked, average quality, average site. |
| 5 | Stand 4. | Sugar maple all-aged. Slightly overstocked. Good site. |

Landowner B defined his objectives as "good stewardship"; specific interests were to generate income where possible, to improve habitat, to obtain regular firewood supply, and to enjoy the property recreationally.

Recommendations:

- Stand 1. Wait five years until sugar maple understory is head high, then do thinning to improve the overstory value growth rate and promote growth of the sugar maple understory.
- Stand 2. This poor quality stand shows no potential for good sawtimber. Patch-cut, 1/2 acre at a time, to obtain fuelwood and improve habitat. Skip years in which fuelwood is available from operations on other types, i.e. tops from Stand 1 thinning.
- Stand 3. Thin to improve the stand for sawtimber. Re-evaluate 8 years after thinning to plan next activity.
- Stand 4. Manage for an uneven-aged stand of sugar maple and hemlock. Selectively harvest timber in conjunction with harvest on Stand 1.

EXAMPLE 3.

Landowner C has an 18 acre forest which is all one age and type — oak/hickory sawtimber. About half of the property is on above-average to good growing sites, where the dominant trees are of good quality, 14" to 18" in diameter, and overstocked. The other half is on poor growing sites, where the dominant trees are 10" to 14" in diameter, low quality, and slightly overstocked. Three acres on the poor sites include scattered white pine in the overstory.

Landowner C has his own farm tractor and prefers to do most woods work himself. His objectives are (1) obtain an annual supply of firewood; (2) earn an income if possible; (3) improve wildlife habitat.

Recommendations:

1. Contract with a consulting forester to thin the good sites, yielding both fuelwood and small sawtimber. Arrange to retain a 2 to 3 year fuelwood supply as a condition of the contract.
2. In 3 to 4 years, begin annual thinnings on the poor sites to meet Landowner C's personal fuelwood needs. When the dominant trees reach a 16" average diameter, begin patch-cuts in the smallest parcels possible that allow Landowner C to put a marketable volume of logs roadside. Once patch-cut, these areas will be managed on fuelwood rotations.
3. Retain the pines as seed trees and ultimately convert the three acre area to white pine.



RAE CHAMBERS

APPENDIX 2:
YIELD TABLES FOR FUELWOOD PRODUCTION
IN SOUTHERN NEW ENGLAND

Table 2. Empirical yield tables for oak-mixed hardwood forests, from 1984 Forest Survey, USDA Forest Service. Tables were constructed from 108 sample plots in fully-stocked stands. Yields shown are for harvesting all poletimber and larger trees for cordwood (cords per acre), or for harvesting sawtimber trees for timber (board feet per acre).

For cordwood, minimum d.b.h. is five inches and top diameter is four inches. A cord contains 85 cubic feet of wood. For sawlogs, minimum d.b.h. is eleven inches for hardwoods, nine inches for softwoods, and top diameter is nine inches for hardwoods, seven inches for softwoods.

Empirical yield tables are useful to managers of forest resources who are interested in estimates of current commercial forest volume or in short-term projections of future conditions.

SITE CLASS 41-50

CORDS/ACRE

	Age				
	31-40	41-50	51-60	61-70	71-80
Oak	---	9.2	16.3	14.9	15.0
Other	---	1.1	1.9	4.9	6.7
Total	---	10.3	18.2	19.8	21.7

BOARD FT./ACRE

	Age				
	31-40	41-50	51-60	61-70	71-80
Oak	---	685	1581	3041	3451
Other	---	140	54	365	284
Total	---	825	1635	3406	3735

SITE CLASS 51-60

CORDS/ACRE

Age

	31-40	41-50	51-60	61-70	71-80
Oak	9.8	12.7	14.2	17.7	19.2
Other	1.2	2.2	3.2	4.7	4.8

Total	11.0	14.9	17.4	22.4	24.0
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BOARD FT./ACRE

Age

	31-40	41-50	51-60	61-70	71-80
Oak	473	989	2038	3430	4250
Other	1	279	828	701	592

Total	474	1268	2866	4131	4842
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SITE CLASS 61-70

CORDS/ACRE

Age

	31-40	41-50	51-60	61-70	71-80
Oak	12.3	13.0	18.1	14.8	21.4
Other	2.5	5.3	6.1	12.7	7.5

Total	14.8	18.3	24.2	27.5	28.9
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BOARD FT./ACRE

Age

	31-40	41-50	51-60	61-70	71-80
Oak	505	1740	3712	3401	5568
Other	66	649	493	2767	1982

Total	571	2389	4205	6168	7550
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Table 3. Yield table from oak forests in New Haven County, CT (from Westveld 1925 or 1927). Minimum top diameter is two inches. A cord contains 85 cubic feet of solid wood.

Age	CORDS/ACRE				
	Site Index				
	47	55	63	71	79
10	1.3	2.8	4.3	5.5	6.2
20	6.5	10.0	12.6	14.2	15.5
30	10.7	15.6	19.0	21.3	22.9
40	13.8	19.5	23.7	26.3	28.2
50	16.3	23.0	27.5	30.3	32.5
60	18.3	25.5	30.5	33.4	36.0
70	20.0	27.7	33.0	35.9	38.7
80	21.2	29.3	34.8	38.0	40.9
90	22.0	30.5	36.2	39.4	42.6
100	22.6	31.2	37.0	40.5	43.8

A set of yield tables also exists for oak-mixed hardwood forests in the Housatonic Valley in Connecticut (Schwarz 1907). These tables utilize a minimum diameter of one inch.

GLOSSARY

Browse: Palatable twigs, shoots, leaves, and buds of woody plants which are favored by deer.

Chipping material: Trees which are made into chips for industrial wood fuel. Chip harvesting equipment allow trees less than 6'' in diameter to be commercially harvested, down to a 2'' top diameter.

Coppice: Refers to forest stands originating primarily from sprouts.

Cordwood: Firewood used in traditional woodstoves and furnaces. Generally, trees less than 6'' dbh, and tops and branches of less than 4'' diameter are too small to be harvested commercially for cordwood.

D.B.H.: Diameter of a tree at breast height (4.5 feet above the ground).

Habitat: Natural setting where an animal is likely to survive and reproduce.

Patch cut: Harvesting of all or nearly all trees within a small area (0.5 to 5 acres).

Poletimber: Trees which are larger than saplings but too small for sawtimber. Generally, trees 5'' to 11'' dbh.

Sawtimber: Trees large enough to be harvested commercially for timber products. Generally, trees 11'' dbh or larger.

Stand: A group of forest trees of sufficiently uniform species composition, age and condition to be considered a homogeneous unit for management purposes.

Understocked, overstocked, etc.: Refers to the number and density of trees in a forest stand.

Wolf tree: A large older tree with a spreading crown and little or no timber value. These often have great value for wildlife.

SOURCES USED IN PREPARATION OF THIS BULLETIN

*These publications are recommended for additional reading by the landowner.

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McEvoy, T.J. 1980. "The Silviculture Implications of Fuelwood Production in Southern New England." *Connecticut Woodlands* 45(2)3-4.

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