The Woodland Workbook

Stand Management

Managing Hardwood Stands for Timber Production

Hardwoods require attention to grow a large size and high quality crop, and compared with conifers, the kind of attention required is somewhat more involved and complex. More so than for conifers, the time you spend managing hardwoods will be returned to you in increased wood production, increased quality (and so value), and shorter rotations.

This publication is designed, first, to help you understand how Northwest hardwoods grow. This is critical to a general understanding of hardwood management and to adapting general recommendations to your hardwood stand. Second, this publication will describe a hardwood management program.

How hardwoods grow

There are two important differences between the growth of conifers and that of most hardwoods. These differences lie in patterns of height growth and in tree form.

Height growth

Conifers grow in height for a long time. In contrast, most hardwoods grow very fast in height when they are young, but they slow this height growth at a relatively young age. They reach their maximum height in 50 to 100 years while many conifers continue to grow in height into their second century.
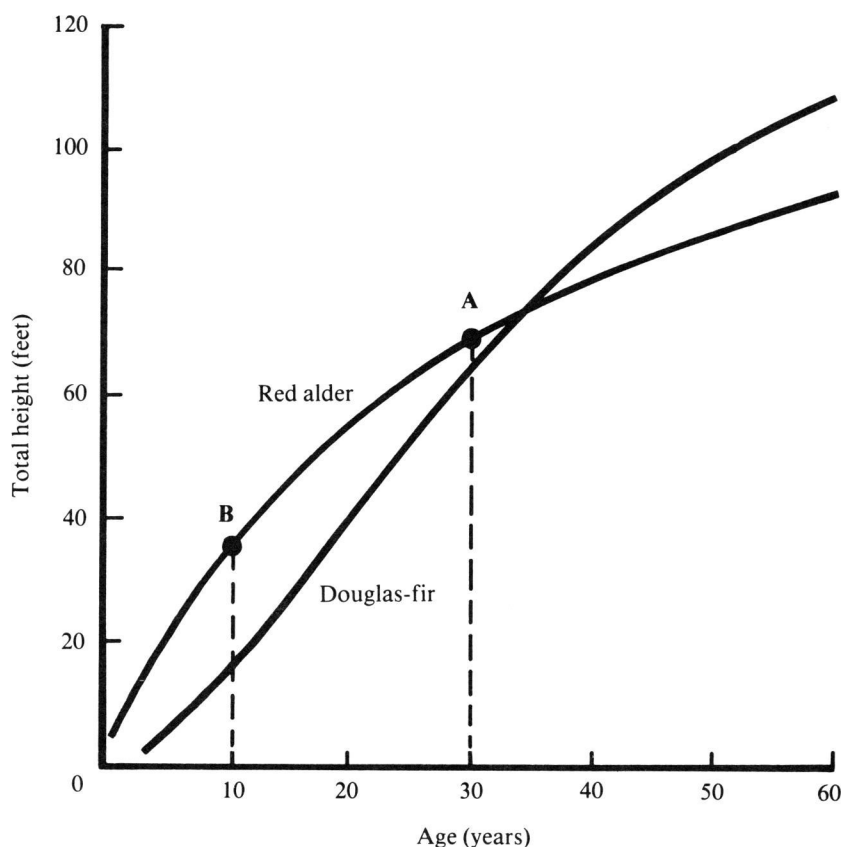

Figure 1.—*Height growth of red alder and Douglas-fir on the same site type*

Douglas-fir and red alder are two species that grow in the same areas. Figure 1 shows how the height growth of these species changes with time. The steepness or slope of the curve is the tree's growth rate. Note that young alder grows very fast, but that by age 30 its rate of height growth (the slope at A) is only half what it was at age 10 (the slope at B).
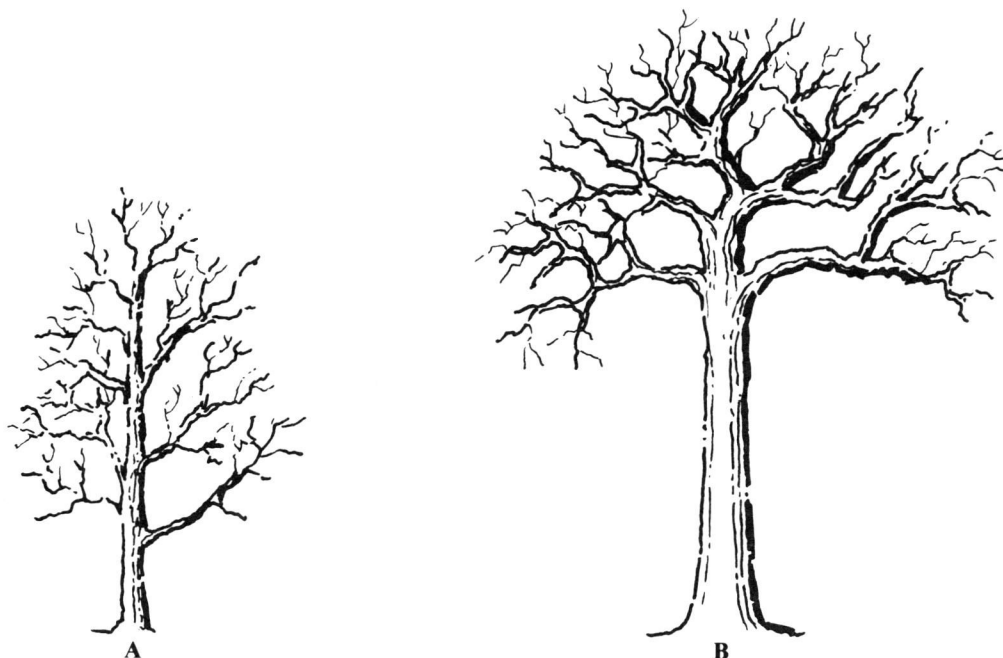
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Figure 2.—*The juvenile (A) and common mature (B) forms of hardwood trees*

In other words, the curve is only half as steep at B as it is at A. (Figure 5 shows how to find the natural growth rate.) Douglas-fir growth rate, on the other hand, decreases very slowly.

Because tree *height* is a major factor determining tree *volume* (stem diameter is the other), shorter trees will contain less wood volume. The height limit of hardwoods is one reason that mature hardwood stands contain less timber volume than mature softwood stands. Because height growth regulates, in part, volume growth, a slowing in height growth may slow stand volume growth to the point where a harvest is advisable. Thus, rotation length for hardwoods may be less.

Crown spread

Hardwoods that are growing rapidly in height have a form much like that of conifers. They have a straight main stem and short, small-diameter branches. Because this form occurs in younger trees, it is called the *juvenile form* (figure 2, tree A). Some species, cottonwood for instance, always have this form.

The crowns of most hardwoods begin to spread as height growth slows around middle age. There is a shift in the way the crown develops, and this weakens or eliminates the dominance of the main stem of the tree. This, in turn, allows branches to grow longer and larger in diameter. Frequently, as you follow the main stem of a large tree up into the crown, you can no longer tell which is the main stem and which is a branch. Although slightly exaggerated, familiar examples of this are yard or roadside maple and oak trees.

As tree crowns grow wider, the number of trees in a stand necessarily drops. This lowers the total stand volume. Of course, a bigger crown means that stem diameter growth on the remaining trees is greater.

This *mature form* (figure 2, tree B), also imposes limits on the merchantable log length in a tree. In conifers, the height of the merchantable log is determined by the small-end diameter limit and occurs within the tree crown (figure 3, tree A). If the diameter gets too small, you cannot use it. In most hardwoods, the abrupt reduction in diameter caused by large branches usually limits the merchantable height to the bottom of the tree

crown (figure 3, tree B). This limits tree volume.

Red alder is a species that, in its mature form, often has a main stem within the crown. This stem, however, contains large knots, is of low quality and so has low value. Even for a species like alder, then, the effective merchantable height is still the bottom of the crown because this is where the high quality, valuable wood is found.

You can control the development of the mature tree form to some extent. Keeping stand density high encourages branch pruning and keeps crowns small. This increases the merchantable height of the tree. However, the high density, while giving you more merchantable height, also results in small-diameter stems.

In addition, if you hold density high for too long, height growth has slowed to the point where thinning the stand will increase stem diameter growth only slightly. While a late thinning will allow crowns to expand in width, the crown depth increases only as fast as the tree grows in height.
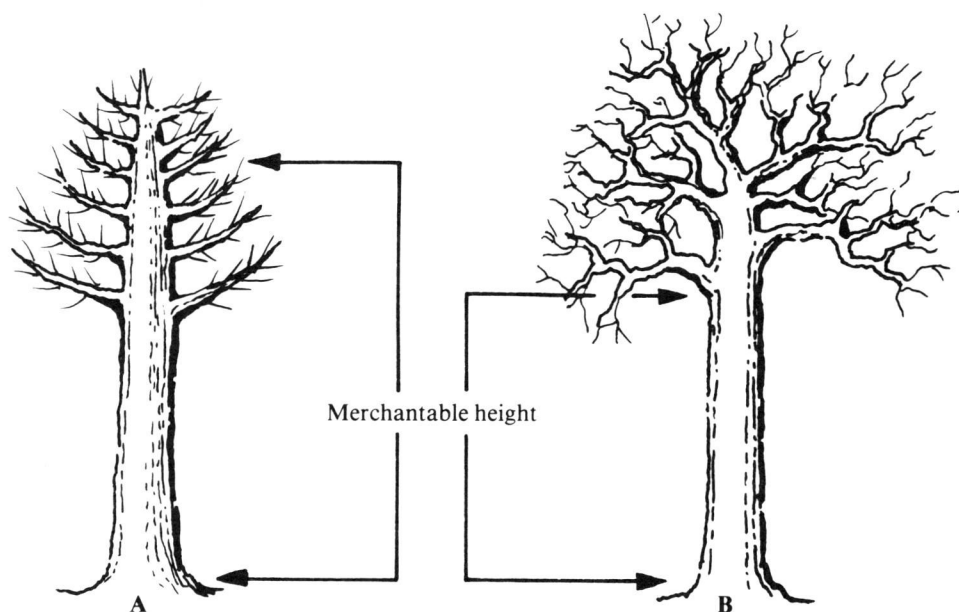
Figure 3.—*Merchantable height in conifer-form (A) and hardwood-form (B) trees*

Figure 4 shows an example of the results of early and late thinnings. A tree released by a thinning at age 20 (tree A) has a merchantable height of about 35 feet and a crown depth of about 20 feet. In 10 years, the crown depth will increase to about 35 feet. This large crown results in rapid stem diameter growth. If the release has been postponed until age 40 (tree B), the crown depth would increase in 10 years from 15 feet to 25 feet. This smaller crown will result in slower stem diameter growth.

Can you see the dilemma that is developing? High density is needed to promote merchantable height growth, but low density is needed to promote stem diameter growth. This is a problem peculiar to hardwoods. Conifers always maintain the juvenile form and have small diameter branches. The next section discusses one way to resolve this dilemma.

Managing hardwoods for high quality

Hardwoods are grown for many products. The goal of the management program described here is the production of a large volume of high value saw logs. Management
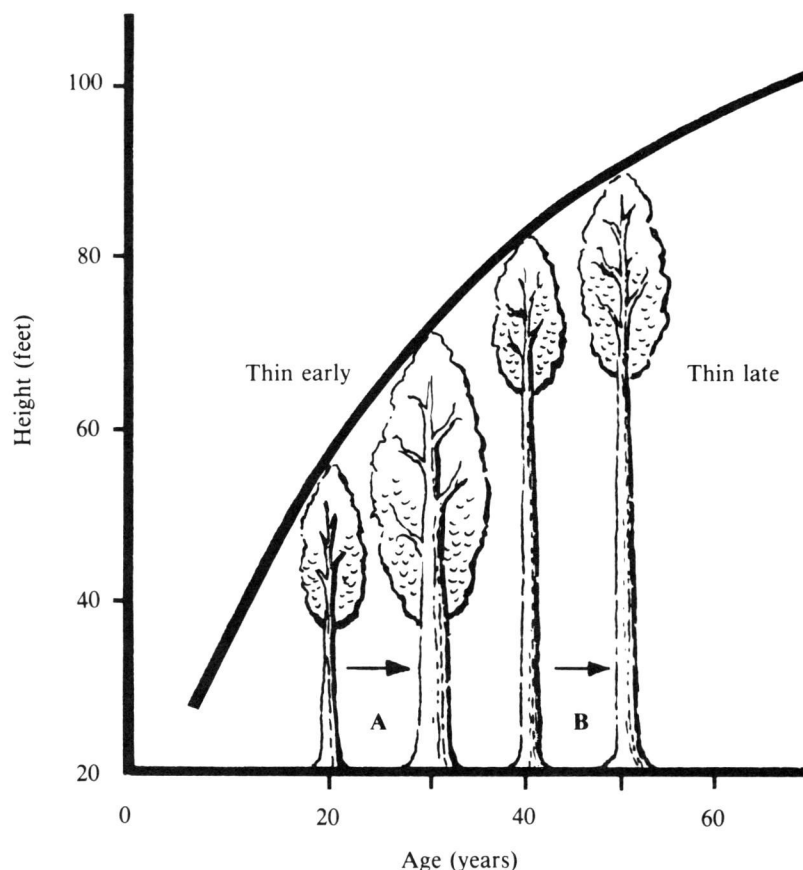

Figure 4.—*The effects of early and late thinning on crown development*

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for fine face veneer and plywood veneer employs the same concepts but gives the best financial returns in a slightly different way.

Controlling tree spacing (density management) is always a key element of forest management. Selecting the right leave trees is another. To solve the dilemma of the conflicting conditions required to promote diameter and merchantable height growth, you could compromise by managing a stand at an intermediate density.

Unfortunately, this still fixes merchantable height where it was after the first thinning. Rarely will it increase after this. And diameter growth will be slow because density is too high to allow full crown development. So this solution is not a good one.

A correct solution to the dilemma is a two-part rotation. Keep density high during the first part. During the second part, keep density low by regular thinnings. The objective of this program is to establish a predefined merchantable height and then grow the stem rapidly in diameter. By focusing on increasing merchantable height when tree height growth is the fastest, the tree will reach the desired length in the shortest time.

Then, as height growth slows or as the natural tendency for the crown to spread becomes too strong to control by density management, begin a regular program of thinning. The thinnings should allow rapid and continuous crown expansion. At the same time, crown depth will increase as the trees continue to grow taller. Increasing the crown size will increase stem diameter growth.

Timing of thinning is very important. A thinning program begun too early will limit merchantable height to less than what is possible. Thinning too late means that increasing crown depth through tree height growth will be slow or limited (remember figure 4). This reduces stem diameter growth.

Here are two very important considerations for choosing the timing for the first thinning.

1. Thin when you have the merchantable height that will return you the most money. If your local mill will pay more per board foot for 32- than 30-foot logs, grow 32-foot logs. Or if logging or hauling costs are reduced by having logs above some length, grow that length of logs.

2. Thin when the rate of height growth has dropped to one-half its maximum. You will need a height growth curve (see ''When to thin,'' next section) and a measure of current height growth to do this.

Decisions about the timing of the first thinning—and every later thinning—need to incorporate both of the above economic and biologic considerations.

The discussion so far has covered thinning in the most common hardwood situation—management of an established stand. What should be done with a thicket of seedlings? Leave it alone?

You can space dense stands of regeneration. This means that most of the seedlings can be removed to give a desired spacing pattern to the residual seedlings. Space fast growing species like alder and cottonwood at age 3 to 4; slower species like oak and maple at age 6 to 8. The goal of spacing should be to produce an evenly-spaced pattern of vigorous seedlings 8 to 10 feet apart. Later decisions about thinning would follow the same rules as described for unspaced stands. Some species that have been spaced on high quality sites may not require a later thinning.

A management example

When to thin

Red alder is a species that we know how to manage (see EC 1197, *Managing Red Alder*), so we will use it as an example. There are certain tools or types of information that are necessary to make decisions. We have these for alder but not for the other Oregon hardwoods. As you go through this example, we will show you how to collect or estimate the missing information.

The first tool needed is a height growth curve like figure 1. With it, you can set some limits on when the first thinning should be. Remember that the primary goal of growth before the first thinning is establishing the merchantable height. This thinning, then, should come after the trees achieve desired merchantable height and before height growth has slowed to less than about one-half its maximum.

The desired merchantable height is determined largely by economics. Certain log lengths are more desirable than others. A mill will pay more per board foot if you meet their specifications. For example, if a mill will pay $190 per thousand board feet (MBF) for logs over 30 feet long and over 10 inches in diameter, and they will pay only $165 per MBF for logs under 30 feet and over 10 inches in diameter, you would want to delay thinning until your trees had more than 30 feet of merchantable height.

If your stand is over 30 feet tall, you can make a height-growth curve for your hardwood stand by cutting down one of the taller trees, cutting it into 5-foot-long pieces (figure 5A), and counting the rings on the bottom of each piece (figure 5B). Subtract the ring count at the bottom of each section from the total tree age (basal or stump ring count) to get the age at each 5-foot interval of height.

Plot on graph paper each combination of age and height (figure 5C) and then draw a line that connects or comes near most points to get your height growth curve. The curve will apply only to your stand and will help you to choose the proper age of first thinnings.

It is easy to measure the growth rate along some portion of the

References to other publications

When you are referred to another OSU Extension Service publication, or to one from another publisher, you will find additional information in ''For further reading,'' page 7.
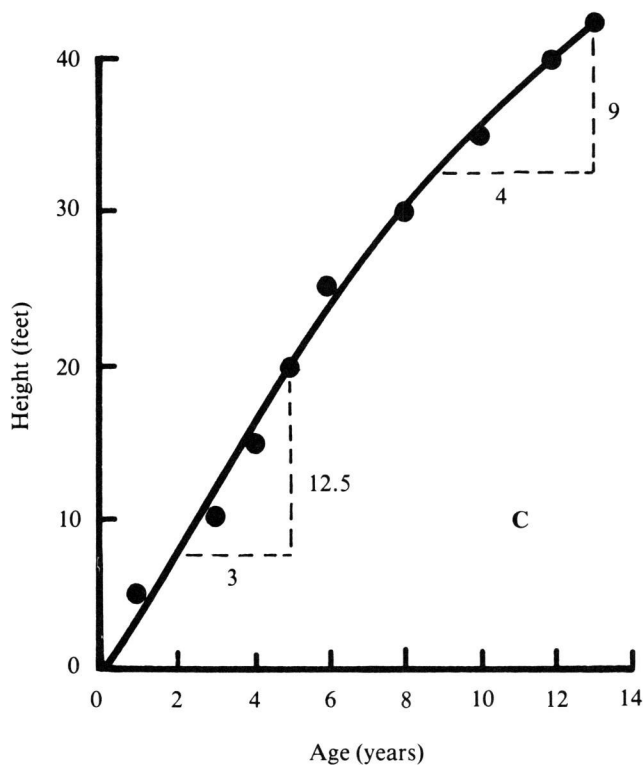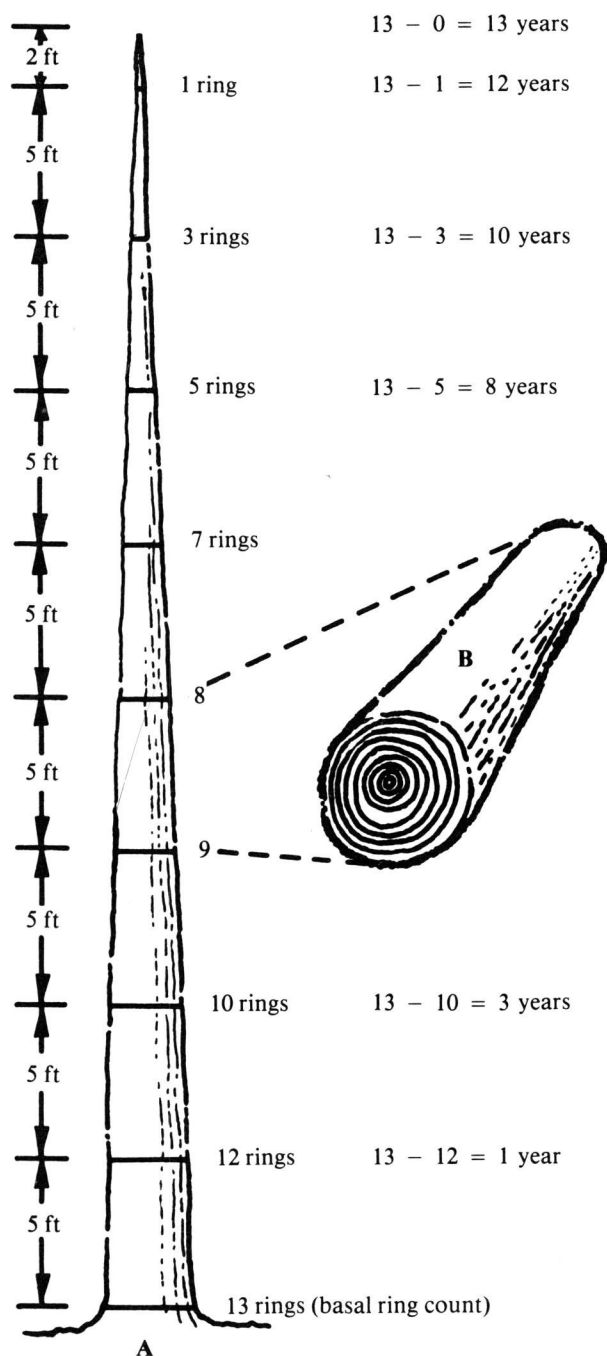
Figure 5.—*How to construct a height-growth curve:*

1. Section a tree (A).
2. Count rings on the base of each section (B).
3. Convert ring count to age at the height (basal ring count minus ring count at each height).
4. Plot results to get a height-growth curve (C).

Height-growth rate (the slope of the growth curve) can be found for any section of the curve—for example, between ages 2 and 5—by dividing the height growth in that section of the curve (12.5 feet in the C example) by the time required to grow the height, 3 years. This gives a growth rate of 4.2 feet per year. Similarly, at the upper end of the curve, the growth rate for years 9 to 13 is 9 divided by 4, or 2.25 feet per year.

height-growth curve. In figure 5C, the tree grew 12.5 feet between age 2 and 5—that is, 12.5 feet in 3 years. Dividing the height growth (12.5) by the time it took to grow (3) gives a growth rate of 4.2 feet per year. Similarly, between ages 9 and 13, the growth rate was 2.25 feet per year.

Using the alder in figure 4 as an example, the first thinning should be near age 20 for two reasons:

1. The trees will be about 55 feet tall and will have 30 to 35 feet of merchantable height (near the economic optimum for red alder).

2. Height growth is well above one-half its maximum, still fast enough to provide good expansion of the crown.

To use figure 5C to decide on a first thinning, you would note two facts. First, merchantable height is probably less than desirable if total

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Table 1.—*A stocking guide for red alder*

| Average tree volume (cubic feet) | Density after thinning | | | |
| | Maximum | | Minimum | |
	Density (trees per acre)	Spacing* (feet)	Density (trees per acre)	Spacing* (feet)
1	1,300	5.8	740	7.7
2	830	7.2	460	9.7
3	640	8.2	350	11.2
4	525	9.1	285	12.4
5	450	9.8	250	13.2
7	360	11.0	200	14.8
10	270	12.7	155	16.8
15	230	13.7	115	19.5
20	180	15.6	95	21.4
30	140	17.6	75	24.1
40	115	19.5	60	26.9
50	100	20.9	55	28.1

*Average distance between trees.

tree height is only 41 feet. Second, height growth, while it has slowed somewhat (the curve is less steep at the top), it has not dropped to less than one-half its maximum rate (2.25 ÷ 4.2 = 0.54, more than 0.5). So your decision is that it is not yet time to thin. You cannot tell when the thinning should be. Plan to return in 5 years and make a new graph.

How much to thin

When thinning, how many trees should you leave? The tool normally used to make this decision is a stocking guide. Starting from information on the size and density of your stand, the guide tells you what density (trees per acre) will result in the most growth. There is a stocking guide for alder (see table 1 and EC 1197, *Managing Red Alder*) but not for other Northwest hardwoods. For example, the table tells you that if your average tree volume is 5 cubic feet, you want to thin to about 250 trees per acre. If you have as many or more than the maximum number of trees, it is time to thin to get the density (number of trees) down near the minimum.

If you have no stocking guide, you will have to make some approximations. The reason for thinning is to allow the crowns of the crop trees to expand. A tree with a bigger crown will grow faster in diameter. So when you thin, remove trees whose crowns touch the crown of crop trees. Remove enough trees to free 2 or 3 sides of the crop tree. If trees are small or naturally have narrow crowns, leave many trees. In older stands and later thinnings, leave fewer trees. In the alder example, leave about 250 trees per acre at age 20.

In practice, when doing a thinning without a stocking guide, it is easiest to begin by identifying the crop trees that you will keep until the end of the rotation. Select and mark 150 to 200 well-spaced trees. Then thin around each crop tree.

Which trees should be left as crop trees? A crop tree will always grow bigger in diameter. Rarely can it outgrow a defect like a fork, crook, or sweep. It is also unlikely to increase much or at all in merchantable height. So selection of crop trees should focus on the trees that will have the greatest value when they increase in diameter. These are the straightest stems, less often the fattest ones. So leave stems that are straight, are as defect-free as possible, and have the desired merchantable height. It is less important to leave

trees of larger diameter. Note, too, that crop trees should be trees *in* the main canopy, not *under* it.

Because tree crowns will eventually expand to fill the space made by a thinning, additional thinnings are required to allow continued crown expansion. These thinnings should be every 10 to 15 years—whenever the canopy closes after the previous thinning. Follow the same rules as in the first thinning when deciding which trees to cut or leave.

Final harvest decisions tend to be based more on economic than on biological factors. Each species in a region has special market requirements. Investigate the market situation in your area before starting on a management program. Then you will grow the product that will give the best return.

First, special log lengths may bring higher prices, so you can time your first thinning to produce these lengths. Second, there may be price benefits for certain diameters, and thus could affect the timing of the final harvest. So time thinnings and the final harvest to give the best possible combination of length and diameter, and the best economic return.

Some final considerations

You have learned some of the basics of hardwood growth and management. Critical differences between hardwood and conifer growth and form result in some fundamental differences in management strategies. These descriptions have been general. You will need to adapt the general principles for each species. EC 1197, *Managing Red Alder,* does this for alder. Consult your county Extension or State foresters about other species.

None of this discussion has addressed the overall picture of hardwoods in the forest products economy. Several important points need to be made.

1. Many areas of Oregon that do grow hardwoods have little or no market for hardwoods; managing hardwoods in these areas is pointless.
2. Per-acre volumes at final harvest are low, between 5,000 and 15,000 board feet per acre depending on species, site, and rotation length—compared with 30,000 board feet and higher in conifer stands. Note, however, that rotation length for some hardwoods is considerably shorter than conifer rotation lengths.
3. To make money in hardwoods, landowners must focus management strategies on high value products or short rotations. Either strategy will compensate economically for the low volume production.

In spite of all this, hardwoods can be grown for a profit. And hardwoods are an important part of our aesthetic resources, adding a diversity to our landscape and a striking reminder of the changing of seasons.

For further reading

For OSU Extension Service and PNW publications, enclose the amounts indicated and mail your order to Bulletin Mailing Office, Oregon State University, Corvallis, OR 97331-4202.

Emmingham, William H., and Norman E. Elwood, *Thinning: An Important Timber Management Tool,* Pacific Northwest Extension publication PNW 184 (Oregon State University, Corvallis, reprinted 1985). Single copy 50¢ plus 25¢ postage.

Hibbs, David E., *Managing Red Alder,* Oregon State University Extension Service Circular 1197 (Corvallis, in press, 1986).