STAND IMPROVEMENT WORKSHOP
3/21/08

Stand improvement means progressively improving the quality and growth of a stand through thinning. The goals of this class are to:

1) help you "eyeball" trees to maker better thinning decisions;
2) give you some useful guidelines for tree spacing, and discuss their limitations; and
3) answer your questions about thinning and share knowledge and experience within the group.

Handout Contents

I. Basic Philosophy: Thin for Quality and Health, Not Spacing

Your chainsaw is revved up and you're about to sink the bar into a nearby Douglas-fir sapling. But which one? You're surrounded by hundreds of them, some smaller, some larger, all pretty close together, but not uniformly spaced. There are some madrone trees too, and cedar, and a few spindly pine. You heard somewhere that trees should be ten feet apart …..twelve feet ….or was it fifteen feet? You can't quite remember. What to do?

Many landowners ask about proper or optimum spacing when thinning trees. I'd suggest not getting too hung up initially on spacing, but instead focus on tree quality and health (vigor). If you leave primarily high quality trees and take out mostly low quality trees, it's hard to go wrong. You're likely to have a healthier, more vigorous, more fire-resistant, and more valuable stand in the long run.

Is spacing between trees unimportant? Not at all. Trees need adequate growing space to thrive. However, rigidly adhering to exact spacing (e.g., 14' x 14') may lead you to cut trees that should be left and to leave trees that should be cut. This is especially true in natural stands where spacing between trees is highly variable. In plantations where spacing between more regular, using pre-determined spacing or stand density rules makes more sense. Remember, that spacing guidelines are just that, they are guidelines and as such should remain flexible for leaving the best tree. Also, remember that as trees grow bigger, they progressively need more space, so space trees out wide enough so that they will grow well until the next thinning, which hopefully will be commercial

So what makes a high quality tree? Following are some guidelines for "leave" and "cut" trees that relate to tree quality. These are all characteristics you can "eyeball" out in the woods.

Characteristics of "leave" trees:

- Good live crown ratio (30% or greater)
- Good height growth for species and age
- A-shaped crown ("pointy top")
- Abundant foliage with good color
- Good form (straight, without sweeps, crooks, forks, etc.)
- Species is well suited to the site over the long term

Characteristics of "cut trees"

- Poor crown ratio (<30%)
- Poor height growth and crown form (flat or rounded top, lopsided)
- Foliage is sparse or off-color
- Poor form or has signs of damage or internal decay
- Species not well suited to the site

II. EVALUATING INDIVIDUAL TREE VIGOR & QUALITY

You can learn to "eyeball" trees to evaluate tree quality and vigor by looking at crown characteristics and tree form.

Specific characteristics to look for include:

- Crown ratio
- Crown class
- Crown shape
- Crown color and density
- Height growth
- Radial growth (if you have an increment borer)
- Stem form
- Branch form
- Evidence of insect & disease problems

Each of these characteristics is discussed and illustrated on the following pages.

Tree species is another important factor to consider. The ecological suitability of the species to the site, shade tolerance, growth rates, and marketability are some of the factors to think about when making thinning choices in mixed species stands.

Crown ratio

The crown ratio is the percentage of the total height of the tree that is occupied by the live green crown. For example, a tree that is 75 ft tall and has crown on the upper 25 feet of the tree (figure 1) has a live crown ratio of 33%.

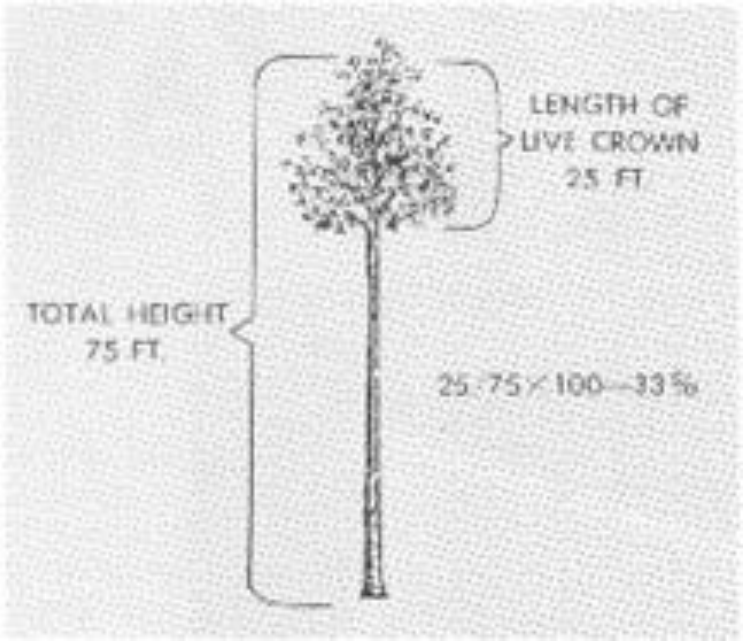


Figure 1. Live crown ratio

- The rate of tree growth slows down in most species when the live crown ratio drops below 40%.
- Trees with crown ratios of 30% and greater often respond well to release (removal of surrounding competing trees).
- Ideally, thinning should occur before crown ratios drop below 30-40%.

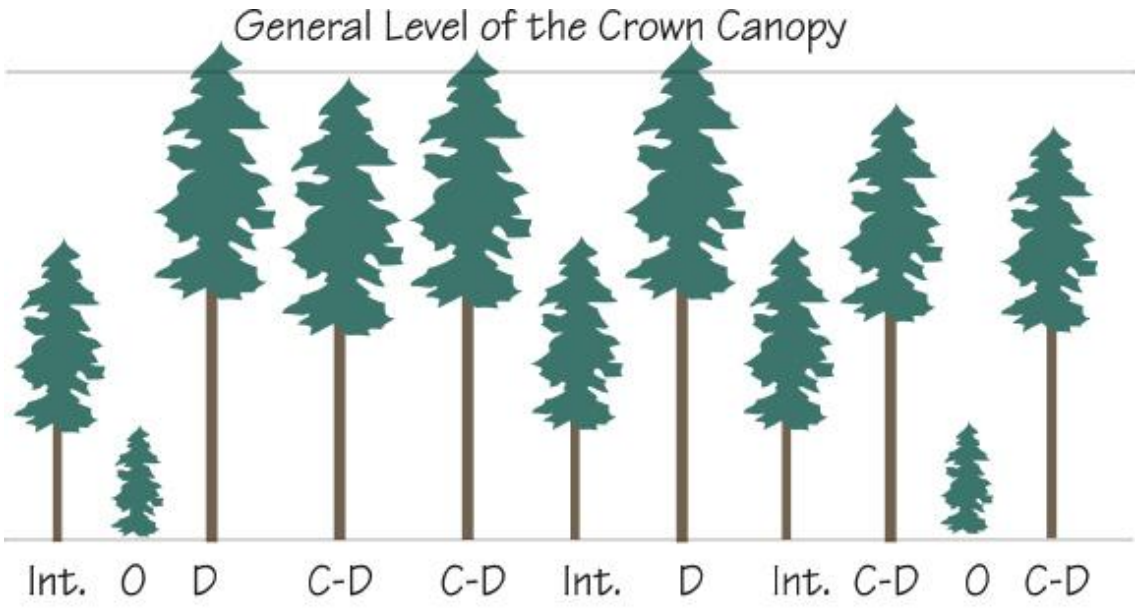
- Trees with crown ratios of less than 30% often respond poorly to release. They may experience thinning shock or sunscald, and/or grow very slowly. Trees with very small crown ratios may simply die after thinning. This often happens after diameter limit thinning (removal of all trees above a certain diameter limit) or high grading (removal of all dominant and codominant trees, leaving only intermediate and suppressed trees).

- Gradual, light thinnings are recommended for very dense stands where few if any leave trees have desirable crown ratios.

- Estimating crown ratio. When crowns are lopsided, visually transpose crown from the longer side to the shorter side to create a symmetrical crown, then estimate the crown ratio. Needless to say, this is a bit subjective and takes practice. Using a clinometer to measure the height to the base of the live crown will improve the accuracy of your estimate.

Crown class

Trees in forest stands are often divided into different "crown classes." In many cases these classes are closely correlated with growth. Typically, most of the growth occurs in dominant and co-dominant trees. Intermediate and overtopped trees may be numerous (more so than shown in the diagram below) but account for little of the stands growth. In addition, these trees often respond poorly to release, i.e., removal of nearby dominant or co-dominant trees. An exception would be understory trees that were shade tolerant and/or had healthy crown ratios.



1. = Dominant (D) — Trees with crowns extending above the general level of the crown canopy. They are somewhat larger than the average and have well developed crowns which may be somewhat crowded on the sides.

2. = Codominant (C-D) Trees — Trees with crowns forming the general level of the crown canopy. The crown is generally smaller than that of the dominant trees and usually more crowded on the sides.

3. = Intermediate (Int) — Trees with crowns below, but still extending into, the general level of the canopy. The crowns are usually small and quite crowded on the sides.

4. = Overtopped (O) — Trees with crowns entirely below the level of the canopy.

Figure 2. Crown clases

Other Crown Characteristics

Figure 3. This sugar pine has a pointy crown, indicating rapid height growth and good vigor.

Crown shape/form

Pointy-topped crowns indicate rapid height growth, such as with the sugar pine in the photo to the left. Rounded tops mean height growth is slow. Good height growth is a sign of good vigor. However, as trees age, height growth slows, and the tree tends to develop a round or flat top.

Full, symmetrical crowns are preferred over ragged or lopsided crowns. Lopsided crowns develop when a tree is crowded on one or more sides. Trees with lopsided crowns are more vulnerable to blowdown and breakage in snow and ice storms.

Crown color/needle density

A dark green color indicates good vigor. Light green or greenish yellow foliage ("chlorotic foliage") is a sign of stress. This may be due to nitrogen deficiency, root disease, bark beetle attacks, or simply moisture stress.

Figure 4. Douglas-fir with thinning crown and distress cone crop. It died within the year.

Crown thinning or sparseness

A sparse or thinning crown, resulting from needle loss or a lower density of needles, is another sign of stress. This can often be best determined by comparing a thin or sparse crown with a denser crown on a nearby tree.

An abundant crop of undersized cones is sometimes an indication that the tree is severely stressed and on its way out.

Figure 5. Arrows point to internodes on Douglas-fir. Each internode represents one year of growth.

Height growth

Height growth can be determined by examining the length of the leader, if visible, or, on some species, the length of internodes (the distance between branch whorls). In Douglas-fir, pines, white fir

and other true firs, tree age can be determined by counting the internodes.

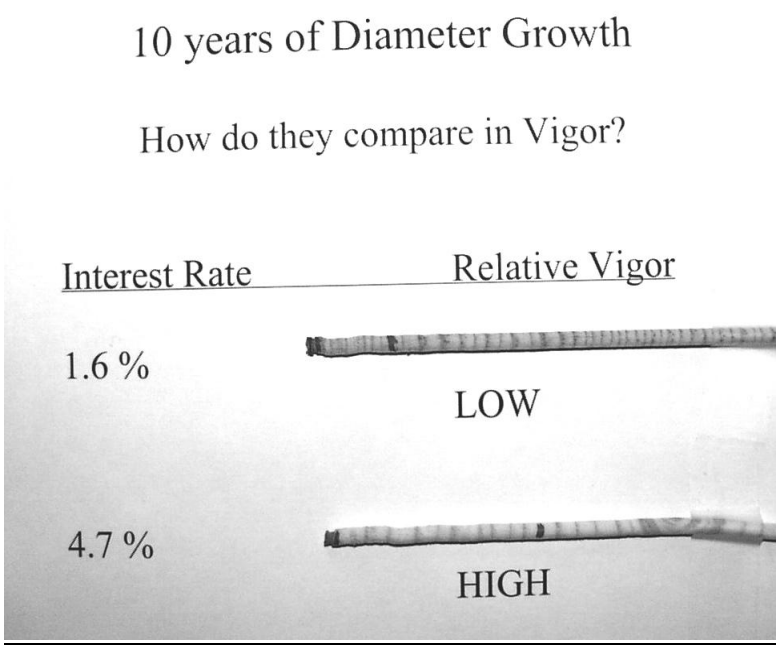


Figure 6. Increment cores

Radial growth

Increment cores can be especially useful in showing how a tree is growing. A pattern of steady growth is desirable; a pattern of decreasing ring width indicates that growth is slowly down. Thinning at the right time often prevents decreasing ring width. After thinning, a pattern of increasing ring width shows that the tree has "released." It may take a few years for the tree to "build enough crown" to show a release.

Typically, radial growth is measured in 1/20s of an inch. To get diameter growth, simply double the amount of radial growth. For example, a tree with 5/20$^{ths"}$ of growth over the last 5 years grew 10/20$^{ths"}$ or ½" in diameter. At this rate, the tree is growing 1" in diameter per decade. There is a scale on many compasses with inches divided into 20th that is convenient for such measurements.

Another way to look at radial growth is the number of rings per inch, in other words, the number of years it takes the tree to grow 1" in diameter. Generally, <10 rings per inch is considered good vigor, while >20 rings per inch shows poor vigor. In the above example, the tree grew 10 rings per inch.

Stem form

The form of the tree stem (=bole or trunk) is an important consideration in thinning. All other things equal, trees with straight trunks and little taper are most desirable as leave trees. Undesirable stem features include cat faces, sweep, pistol butts, crooks, and broken tops or other breakage. However, trees with broken tops or other defect may be very desirable from a wildlife perspective.

Branches
Trees that have large limbs (sometimes from being open-grown), many limbs, and ramicorn branches (large, upright angled branches) are less desirable from a timber standpoint as leave trees than trees with fewer and smaller branches. However, from a wildlife perspective, trees with large branches may be desirable.

Tree form and branch form are to a large degree genetically controlled.

Evidence of insect and disease problems
Some insect and disease problems, such as bark beetles and root rot, are more serious and usually warrant tree removal. Other problems like dwarf mistletoe or blister rust may or may not warrant removal, depending on the circumstances. Still other problems are less serious but still should be monitored closely. Here, we focus on signs and symptoms of these problems. Consult other publications for more detailed information about how to prevent and manage them.

Figure 7. Pitch tubes

Bark beetles
Look for pitch pockets on the tree trunk, boring dust, and a uniformly thinning crown (either the whole crown or, in the case of the ips beetle, the top), as opposed to dieback of random branches. Usually kills trees or tops (ips).

Root disease
Look for yellowing foliage and thinning crowns. Usually several trees in an area will be affected, not just one. There is usually a progression of symptoms from most severe in the center of the root rot pocket to less severe at the outer edges. Kills trees.

Blister rust
Affects sugar pine and western white pine. Look for branch dieback and sunken cankers on branches or the main trunk, often exuding pitch. May eventually kill trees, and reduces tree vigor.

Dwarf mistletoe
Look for dense, upward pointing clusters of branches (witches' brooms). The mistletoe plant itself may or may not be visible. May eventually kill trees, and reduces tree vigor. Trees with heavy mistletoe infections will spread the infection to adjacent trees, especially those lower in the canopy.

Figure 8. Conk. Red ring rot fungus.

Stem rot

Look for conks and swollen knots on the tree trunk. These are a sign of rot. Degrades wood value and can be a safety hazard, but usually is not an immediate threat to tree health.

III. TREE SPECIES CONSIDERATIONS

Tree species is an important factor to consider in thinning decisions. Some important aspects of species selection include shade tolerance, drought tolerance, and marketability.

Shade tolerance. Species vary in their tolerance to shade. More tolerant trees can usually grow at higher densities, and are more likely to release if they are in the understory and surrounding trees are removed. Intolerant trees require more space. They are less capable of releasing when they are in the intermediate or suppressed crown classes. Over time, more tolerant species may become established underneath less tolerant species. A common example is Douglas-fir coming in underneath ponderosa pine.

Relative shade tolerance of common SW OR upland forest species

Intolerant	Medium tolerance	Tolerant
Ponderosa pine	Douglas-fir	White fir
Jeffrey pine	Incense cedar	Other true firs
White oak	Sugar pine	Bigleaf maple
Black oak		
Madrone		

Drought tolerance. In SW Oregon this is a critical consideration, since moisture is most often the limiting factor for tree growth. Local trees species vary greatly in their ability to tolerant moisture stress. Sometimes less drought tolerant species may become established in suitable microsites, but are not really well suited to the site. Examples include Douglas-fir growing in the understory on a pine site, and white fir growing in the understory of a Douglas-fir site.

Relative drought tolerance of common SW OR upland forest species

Very high	High	Moderate	Low
White oak	Madrone	Douglas-fr	White fir & other true firs
Black oak	Incense cedar		Bigleaf maple
Ponderosa pine	Sugar pine		

Marketability
Species also vary in their marketability. Of the conifer species, Douglas-fir historically has fetched the highest prices and has the most markets. Prices for ponderosa pine and the whitewoods (white fir and other true firs, as well as hemlock) are lower than for Douglas-fir. Prices for incense cedar have increased substantially in the last few years. Markets for most hardwoods are harder to find.

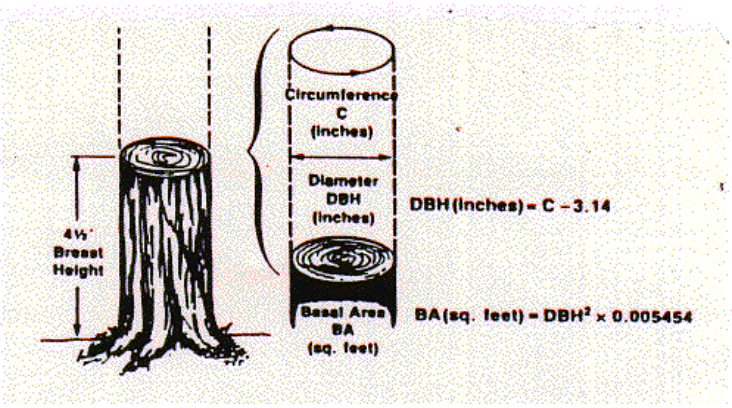
While Douglas-fir seems a good bet for future marketability, it's worth noting that low value trees in the past, such as incense cedar and red alder, now enjoy high prices. With an uncertain future, it may be worth maintaining a diverse investment portfolio (species mixture).

IV. STAND DENSITY & SPACING

A common question that arises in thinning is, "How far apart should the trees be?" As noted above, when thinning in natural (non-plantation) stands, it's helpful to focus initially on tree quality and vigor without relying too much on strict spacing or stand density guidelines. Such guidelines can be helpful, however, when used periodically to check if you are thinning enough, or too much.

Tree per acre or spacing in feet, without reference to tree diameter, is not very useful and can be outright misleading. Thinning to 150 trees per acre can be way too much, or way too little, depending on tree diameter. Thinning to an arbitrary spacing, e.g., 10 feet, isn't meaningful either unless tree diameter is specified.

Basal area. Basal area is a widely used measure of stand density. It is defined as the cross sectional area of a tree at breast height (4.5' above ground). Basal area is measured in square feet and is typically stated as a per acre figure, e.g., 120 ft^2 of basal area per acre.



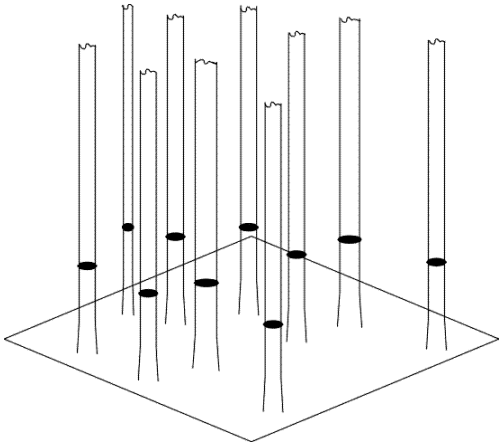
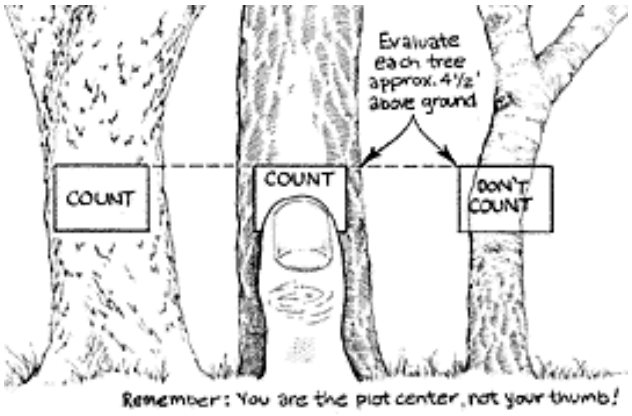


Figure 9. The sum of individual tree basal areas is basal area per acre

Basal area is measured using a prism, angle gauge, or relaskop. You can also get a rough estimate of basal area using your thumb. Here's the formula:

Basal area factor = 43,560 x $(W/(2 \times R))^2$ where W = width of thumb in inches and R = distance from eye to thumb in inches. Example:
Basal area factor = 43,560 x $(0.75"/(2x25"))^2 = 9.8$
What this means is that every time you count a tree (see below), the tree is accounts for about 10 ft^2 of basal area. If you stand on one point (the plot center) and turn all the way around, counting 10 trees, the stand has 100 ft^2 of basal area per acre.



Basal area guidelines: The following guidelines prescribe a range of stand densities for different forest types in SW Oregon. The dry mixed conifer type is found where precipitation fell below 30" annually. The mixed conifer type is widespread where annual precipitation exceeds 30" annually. The cool mixed conifer type is generally found at elevations above 4,000 ft. where white fir is abundant and often found in the understory. In all types, the basal area recommendations are based on maintaining stands with low risk of bark beetle attack for ponderosa or sugar pine. Entomologists consider pine in SW Oregon to be at risk of bark beetle attack when the surrounding basal area exceeds 180 ft^2 per acre. These guidelines should also be suitable for maintaining vigorous stands composed of other species. However, Douglas-fir and white fir could be managed at higher basal areas.

Forest type	Recommended basal area range (square feet of basal area per acre)
Mixed-conifer dry	60-120 ft^2/acre
Mixed conifer	80-140 ft^2/acre
Mixed conifer cool	80-180 ft^2/acre

D+ guidelines. D+ is a simple way to evaluate tree spacing. When a D+ "rule" is given, it goes along with a number, such as D+6. What does this mean? The D refers to the diameter of tree, in inches. The number is a constant added to the diameter that gives the desirable spacing in feet. Let's say our desired spacing is D+6. A stand with an average diameter of 12" should have an average spacing of 18 feet between tree trunks. Similarly, a leave tree in another stand that is 15" in diameter should have no trees closer than 21' feet. Commonly smaller D+ values such as D+4 are advocated for thinning in younger stands, stands with smaller average diameters, and for initial entries in very dense stands. Larger D+ values are suited for older stands and larger trees. More intolerant species, such as ponderosa pine, should have larger D+ values for a given diameter. In mixed species stands, use the D+ value for the most shade intolerant species and/or species needing the widest D+ value, if you want to hold on to that species. For Douglas-fir, a reasonable range of D+ values is D+4 to D+10. For pines, the spacing would be a bit wider.

V. TYPES OF THINNING (HIGH VS. LOW THINNING)

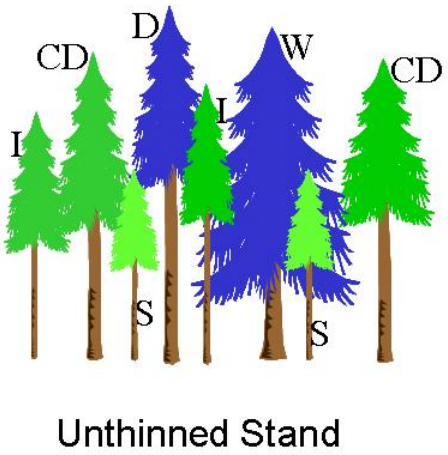


Figure 10. Unthinned stand.

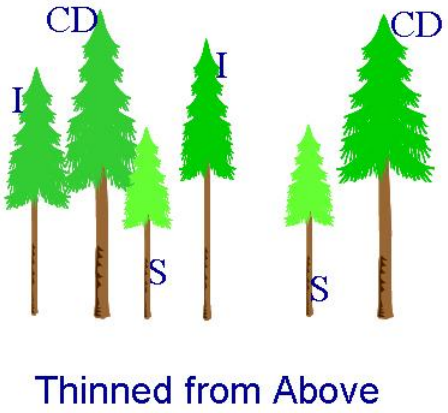


Figure 11. High thinning

High thinning removes a portion (10-15%) of the dominant and co-dominant trees, at each entry, to free up site resources for other trees.

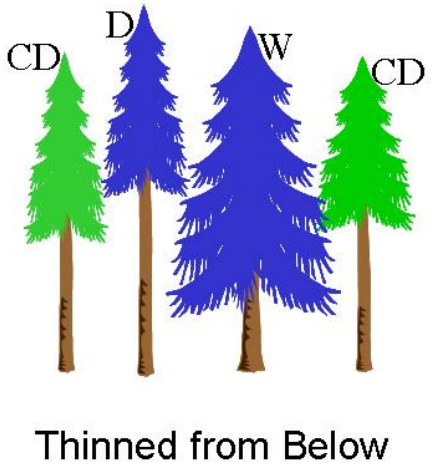


Figure 12. Low thinning.

Low thinning removes the smaller trees (suppressed, intermediate, and small co-dominants, which are usually of low or declining vigor).

Which is best?

Low thinning has several advantages:

- It mimics natural stand development patterns.
- It captures trees that would otherwise be lost to mortality.
- It is much easier to apply on the ground than high thinning, which requires considerable judgement to apply correctly.
- Over time, it results in bigger trees, more growth, and more value.
- Low thinning improves tree vigor and reduces fire hazard more than no thinning or high thinning

Disadvantages include:

- Higher logging costs
- Lower initial revenue because smaller, less valuable trees are removed

"Remove the sick, lame, and lazy, and leave the healthiest and best growers"

VI. MARKETS FOR THE MATERIAL

This list includes possible buyers for small diameter (too small to be a sawlog) material.

Rogue Valley Fuel
Allan Surgeon
7990 11TH St. White City
890-0704
Currently (10-06) buying Douglas-fir and pine. Especially needs pine. For posts and poles. Max diameter 8"-9" on large end, down to 3" small end. Length 16'+, up to 50', though will take smaller lengths, e.g. pickup loads. No rot, no standing dead, limbs cut flush, pistol butt cut off. $40/ton. Will have major need for material this winter. Call for specs.

Northwest Pole Company
Darryll Starr
734-4790
Purchases Douglas-fir, cedar, and pine, 1"-8" diameter for poles, furniture. Need for material varies. Has pole peeler. Does logging too.

Kaufmann Wood Products
24126 Redwood Hwy, Kerby
592-2568
Purchases primarily Douglas-fir for construction and furniture, also manzanita. Uses poles from less than 3" up to 12", 8' minimum length.

Mac's
Grants Pass
955-0103
Purchases madrone, manzanita, cedar and other small poles and wood for pet products.

VII. FINANCIAL ASSISTANCE

Oregon Department of Forestry
Matt Krungelvich
664-3328
5286 Table Rock Road
Money is available for precommercial thinning and slash treatment to improve forest health. 5 acres minimum, $230/acre cost share. No plan required. See application form.

Natural Resources Conservation Service
The Natural Resources Conservation Service (NRCS) administers the Environmental Quality Incentives Program (EQIP). Cost share funding is available for a variety of practices including **fuels reduction, thinning, pruning, slash treatment, reforestation, and riparian planting**. A management plan is required to participate in this program. For more information, call NRCS at 776-4267.