THINNING

An Introduction to a Timber Management Tool

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Thinning -- An Introduction To a Timber Management Tool

Thinning means cutting some trees in immature stands to increase the growth of remaining trees and the total yield or value of usable wood. Thinning is done mostly in even-aged stands wherein the trees are all of approximately the same age.

Immediate value of trees removed may pay thinning costs, in which case it is called *commercial thinning*. If the value of the trees does not return enough to pay the cost of thinning, it is termed a *precommercial thinning*.

Four primary objectives may be met by a good thinning program:

1. To use or sell trees that would otherwise die and decay.

2. To redistribute the total fiber growth of the stand on fewer trees, of higher quality, thereby increasing the amount and value of usable fiber produced.

3. To reduce the investment capital in the form of standing volume in order to increase the profitability of growing trees.

4. To increase the amount of total wood fiber produced in the stand (See page 8).

In order to understand thinning, it is necessary to have some knowledge of how trees grow and of how groups or stands of trees develop as they grow from seedlings to mature trees.

Basic Tree Growth Pattern

Trees, as all living things, grow by forming new cells. New cells are formed in the cambium located just inside the bark along the entire length and circumference of the tree bole, branches, and roots. Adjacent to this growth area is the transportation network for the tree. Water and nutrients are transported upward in the xylem (sapwood) and food manufactured in the leaves is transported downward in the phloem, an adjacent region between the cambium and the bark. Thus if a tree is "girdled," by cutting a notch all the way around the stem, the phloem is severed and the tree will die unless the notch is bridged by new growth.

Except in the extreme tips of growing shoots, new cells formed in the cambium remain in place. The cambium layer moves outward as the tree grows in diameter, ever-surrounding the tree, forming new cells outside the old ones. Thus, a nail driven in a 10-inch diameter tree at a height of 5 feet above the ground will always remain 5 feet above the ground and will always be in the center 10 inches of the bole no matter how large the tree grows. The nail eventually will be "buried" by new wood formed around and over it.

Cells formed in the spring when growth is rapid have thin walls and form wood that is light in appearance. Later in the summer, when growth slows, cells have thicker walls, which appear to be darker. These alternate light and dark layers make up annual rings, which can be seen on a stump or log end. A paired light and dark layer form an annual ring, the wood produced in one growing season. Annual rings enable informed persons to trace the growth history of the tree.

Basic Growth Processes

Three basic growth processes are important to understanding thinning—photosynthesis, respiration, and translocation-assimilation. These processes might be termed energy storage, energy release, and cell formation.

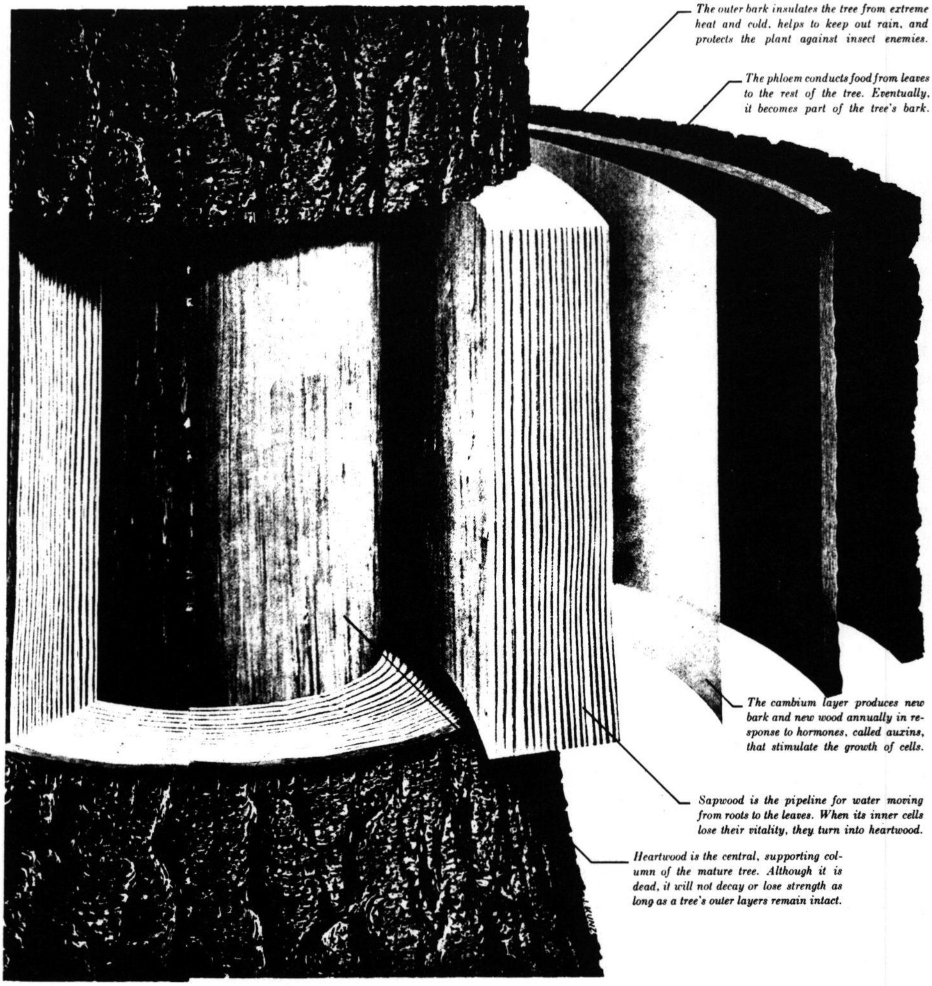

Figure 1. Water and nutrients move in the sapwood from roots to leaves. Immediately outside the cambium is the phloem, through which food is transported from the leaves to the rest of the tree. Illustration courtesy The St. Regis Paper Company, New York, N.Y.

Energy-storage (Photosynthesis)

Photosynthesis is a process occurring in the leaves whereby carbon dioxide and water are converted to carbohydrates, which are the basic food of the tree. Sunlight is necessary for photosynthesis. When water and nutrients are plentiful, light and temperature principally determine and limit the rate of photosynthesis. In the process of photosynthesis, energy is stored in the food.

Cell formation (Translocation-assimilation)

In order that tree growth can occur through formation of new cells in the cambial areas, carbohydrates manufactured in the leaves must be transported to all parts of the cambium. There the carbohydrates must be "assimilated" into new cells. Both this transporting of food and its conversion to new cells require energy. This energy is provided by respiration.

Energy-release (Respiration)

Respiration is a process whereby the carbohydrate manufactured in photosynthesis is broken down, thereby releasing energy. Although this breakdown and energy release is necessary, excess breakdown may occur, thereby using more carbohydrate than that necessary. Unlike photosynthesis, respiration occurs in *all* living cells of the tree rather than only in the crown. Temperature is most important in regulating the rate of respiration.

Summary

The important points to remember are that photosynthesis, controlled largely by light availability and temperature, produces the basic food necessary for tree growth; and that respiration, controlled largely by temperature, utilizes this food in the process of releasing energy (sometimes excess energy) necessary for tree life and growth.

How Thinning Affects Individual Tree Growth

Effects on the tree's environment

Removing some of the trees that compete for limited water and nutrients makes more water and nutrients available for the remaining trees.

Thinning also results in an opening of the crown canopy of the forest, resulting in less shading of remaining tree crowns, particularly for the lower portions. Thus, more light is available for the remaining trees.

Effects on tree growth

The increased water, nutrients, and light resulting from thinning increases photosynthesis. More food is produced, and generally more carbohydrate is available for new cell formation and growth.

This increased growth occurs normally as increased diameter growth rather than increased height growth. Over a very wide range of tree density per acre, height growth is constant for a given species and site. The primary effect of thinning, therefore, is an increase in diameter growth of the remaining trees.

Effect of species and age

The tree growth response to thinning generally varies with age of the tree, more so for some species than others. Foresters have long observed that older trees do not respond to thinning as readily nor as dramatically as younger trees. This is particularly true for species that are relatively intolerant of shade. In general, the more shade-tolerant species are more likely to respond to thinning at older ages. The tolerance of common Pacific Northwest species varies as shown.

Tolerant

western hemlock
grand fir
western redcedar
spruce

Intermediate	*Intolerant*
Douglas-fir	western larch
sugar pine	ponderosa pine
western white pine	lodgepole pine
	noble fir

Tree shock

There are exceptions to the generalization that thinning increases the growth rate of remaining trees. Some such instances have been with relatively young trees. In these cases, trees continue to grow at the same rate—or actually display slower growth. This undesirable reaction to thinning is called *shock*.

Shock normally occurs in trees with relatively small crowns, more specifically 30 to 40 percent in trees whose vertical length of crown is less than one-third of the total tree height. Shock is unlikely in stands that have been thinned repeatedly so that trees maintain adequate crowns.

There is no universally accepted interpretation of shock. One commonly advanced explanation holds that the limited crown size prohibits a photosynthetic increase sufficient to offset the increased respiration that may result from direct sunlight on the stems of remaining trees. Trees in dense stands tend to have thinner bark, which may exaggerate this effect.

How Thinning Affects Stand Growth

Thinning is applied to stands of trees rather than to individual trees. The fact that thinning ordinarily increases the growth of individual remaining trees may not mean that total stand growth is increased, since there are fewer trees in a thinned stand. The effects of thinning on stand growth and development are best understood after a discussion of stands under natural, unthinned conditions.

Crown classification

A crown classification systems is useful in discussing stand development. A commonly used system has the following four classes:

1. *Dominant:* Trees with crowns extending above the general level of the crown cover and receiving full sunlight from above. Sides of crowns are well-developed, but possibly somewhat crowded.

2. *Co-dominant:* Trees with crowns forming the general level of the crown cover and receiving full light from above but little from the sides. Tree crowns are medium-sized for the stand and are more crowded on the sides than are the dominants.

3. *Intermediate:* Trees shorter than those in the two preceding classes but with crowns extending into the crown cover formed by dominant and co-dominant trees; receiving a little direct light from above but none from the sides, usually with small, crowded sides.

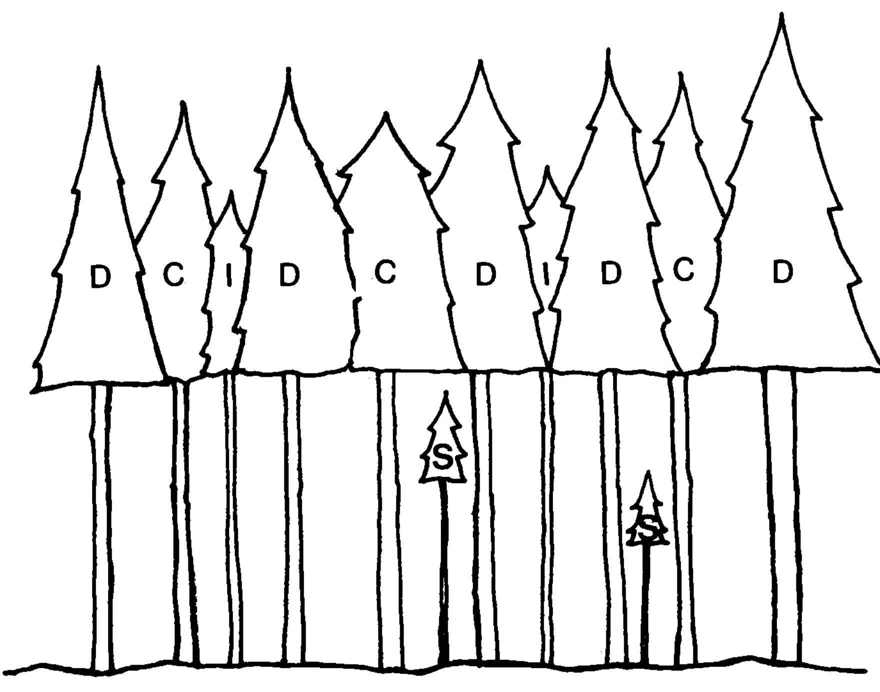

Figure 2. Crowns of trees in even-aged stands are classified into crown types: D = Dominant, C = Co-dominant, I = Intermediate.

4. *Suppressed (over topped)* Trees with crowns entirely below the general level of the crown cover, receiving no direct light either from above or from the sides.

Stand development under natural conditions

As illustrated in Figure 3, a very young, even-aged stand is composed entirely of dominant trees, since the seedlings do not shade each other. As the trees grow, height becomes critical to their survival. Shorter trees are shaded by taller trees. At some point, increased shading reduces photosynthesis, and growth is further reduced. The tallest trees remain in the dominant crown class, while shorter ones drop down to the co-dominant, intermediate and suppressed classes. Once lost, a height advantage normally is not regained, barring a catastrophe that limits the dominant trees. As this process continues year after year, the stand develops into one having trees in all four crown classes. The process continues as long as the even-aged stand exists. All trees compete for light, water, and nutrients. Some trees in the dominant class remain there; others gradually are left behind until they are in the co-dominant class. Some trees in the co-dominant class remain there, but others fall behind and become members of the intermediate class. Trees in the intermediate class generally

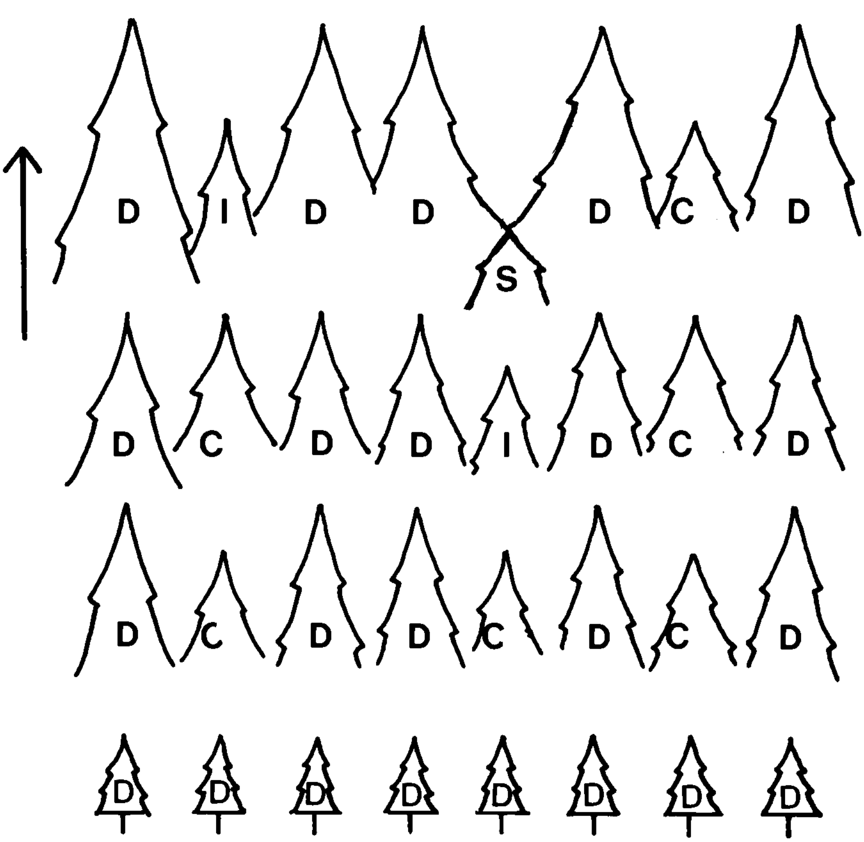

Figure 3. Trees differentiate into crown classes as stands become older.

become overtopped and eventually die. With increased stand age, this differentiation into different crown classes becomes more pronounced, and the number of trees in the stand is reduced constantly. In an unmanaged stand, the remains of dead trees rot in place.

Effect of thinning on stand development

Thinning can alter the stand development process. The magnitude of the alteration depends on the particular way thinning is conducted. If trees are removed from dominant and co-dominant crown classes, the competition faced by remaining trees in these crown classes is reduced. With competition reduced, a smaller number of intermediate and suppressed trees will develop in the stand. The remaining trees will grow faster, and will thus be larger at a given age than trees in an unthinned stand.

If trees are removed from the intermediate and suppressed classes, competition faced by larger trees may not be reduced much. Suppressed trees, in particular, do not compete significantly with larger trees. The effect of this type of thinning on stand development will be less pronounced than for thinnings where dominant and co-dominant trees are removed.

Effect of thinning on yield

On a given site, the total amounts of water, nutrients, and light are fixed. This limits the total number of tons of wood fiber that will be produced by any tree species within a given period of time. It implies that total fiber growth is fixed and cannot be increased by thinning. Even if this is true, thinning can increase the *usable* fiber produced by the stand.

Thinning channels the limited light, water, and nutrients into fewer trees, each of which grows faster as a result. Unless thinning is so severe that too few trees are left to fully occupy the site, the total fiber growth that the site is capable of producing is concentrated on fewer stems. The result of concentrating the fiber-producing capacity on fewer trees is a few large logs rather than many small logs. Large logs usually have a higher value per unit of volume than small logs for two basic reasons. The logging cost is lower since a few big logs are cheaper to handle than many small logs; and the products that can be made from large logs (veneer, timbers) are worth more than many which can be made from small logs.

In a natural stand, part of the gross growth goes on trees that die from competition or other factors, go unsalvaged, and eventually decay. To the extent that thinning "captures" this mortality, it increases the amount of usable (and salable) fiber produced by a stand.

Can thinning increase total fiber growth?

There has been considerable debate over the belief that total fiber growth, as expressed in cubic volume or weight terms, is fixed for a given species on a given site.

Some experimental thinning plots have shown an increase in cubic feet growth in heavily thinned stands. Results from other plots show no increase.

The explanation probably lies within the different efficiencies of individual trees to convert a site's fixed growth resources into wood fiber. Just as humans grow differently on the same diet, so do trees. Some trees use available growth resources to produce more height and diameter growth than do others of the same species in the same stand. This is due to differences in genetic makeup. When the more efficient-growing trees are left during thinning and the less efficient ones are cut, the overall growth efficiency of the stand is increased. Therefore, the gross growth of the stand should also increase. But, if the trees left are no better than average in their growth efficiency, gross growth will stay the same or, possibly, decrease.

How to Thin

In deciding how to thin, several questions must be answered. When should

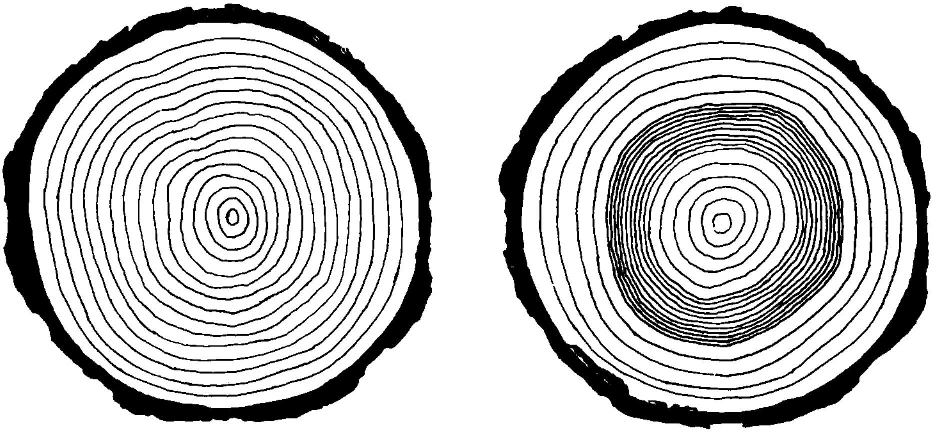

Figure 4. Thinnings should occur frequently so that the width of growth rings remain relatively constant. The drawing shows growth on a tree where thinning was postponed until severe restrictions in diameter growth occurred.

thinning be done? How many trees should be removed? Which trees should be removed? What logging methods should be used?

When to thin

To achieve maximum increase in usable fiber, thinning should begin early, usually when trees are between 10 and 20 years old. Actually, the density of the stand rather than its age dictates when thinning can be effective. Thinning before competition begins achieves little; but once crowns of adjacent trees begin to touch, thinning then will reduce competition.

Thin before the vertical length of tree crowns drops below 40 percent of total tree height. Beyond this point, use care to prevent shock from thinning. Early thinnings, which are likely to be precommercial thinnings, are used increasingly in Douglas-fir. If capital and labor are available for precommercial thinning, current (1977) estimates indicate it will be a profitable investment on good sites if costs are kept within a range of $50 to $100 per acre.

Consider subsequent thinnings after competition sets in again due to increasing tree sizes but before severe reductions in diameter growth occur. As competition increases in a stand, the annual rings of individual trees become thinner. Rapid increases in the width of growth rings of these trees following thinning often are used as dramatic examples of the benefits of thinning. Ideally, however, thinning should be done *before* severe dropoffs in diameter growth occur.

The interval between thinnings should depend on the intensity of thinning. Lighter thinnings result in more rapid crown closure and resumption of competition following thinning; thus light thinnings are conducted more frequently than heavy thinnings. Intervals between thinnings commonly range from 5 to 15 years in the Northwest.

Thinning intensity

If the intensity of thinning is too light, growth is spread over too many trees to achieve maximum benefits. If the intensity is too heavy, considerable amounts of nutrients, water, and light are outside the reach of remaining trees, and the total productive capacity of the site is not used. Also, for some species, windthrow following thinning may be a problem. For these reasons, the intensity of thinning is an important management choice.

In the Douglas-fir stands west of the Cascades, a common guide to the number of trees to be left is the "D+" rule. According to this rule, the average spacing (in feet) of remaining trees should be equal to the average stand diameter (in inches) plus some constant. For example, if the average diameter of trees in the stand is 12 inches and a D+5 rule is followed, the average spacing of the remaining trees will be 17 feet, or a resulting stem density of 150 trees per acre. Use of the D+5 spacing guide does not indicate an arbitrary 17-foot by 17-foot spacing between adjacent trees without regard to tree vigor, tree quality, and other considerations.

It is commonly advocated that D+4 or D+5 thinnings be made in early years (until trees are about eight inches in diameter at breast height), followed by somewhat heavier thinnings (perhaps D+6) in later years. This should be considered only as a rough guide. Research results on thinning intensities incorporating both economic and biological effects are sketchy and fragmented. Experience in thinning over the years in the Northwest has resulted in a gradual increase in the intensity of thinning.

Tree selection

Ideally, the trees that remain after a thinning should be in the dominant and co-dominant crown classes. They should be straight and vigorous, have relatively small limbs and considerable clear bole, and be as uniformly spaced as possible. Unfortunately, compromises must be made in tree selection because it depends upon the age, condition, and past thinning history of the stand. A young Douglas-fir stand that has been precommercially thinned presents an entirely different set of selection problems than does a middle-aged Douglas-fir stand never before thinned. In the middle-aged, heretofore, unmanaged stand, the initial thinning removals will likely be concentrated on diseased trees, on rough, limby trees in the dominant and co-dominant crown classes, and on poor quality trees in lower crown classes, with little regard for spacing of remaining trees. The thinning primarily upgrades stand quality. In the younger, previously thinned stand, the concerns will deal more with crown classification, spacing, and competition considerations, thus aiming for maximum fiber production from the site on good quality trees.

The woodland owner who is a novice at thinning should visit stands that have been thinned in different ways to gain a better feel for tree-selection criteria.

Logging methods

Selection of logging methods and equipment is important. Logging systems differ in their capability of handling logs of different sizes, adaptability to steep slopes, road access requirements, site disturbance potential, availability, potential damage to remaining trees, and cost.

Conclusion

Thinning is the chief stand-management tool available to woodland owners. State service foresters, industrial foresters working with woodland owners, and consulting foresters can provide valuable assistance in planning and conducting thinning operations. It is important that the woodland owner understand thinning and define goals before contracting professional help.