

EC 1457
September 1995
\$1.50

The
Woodland
Workbook

Stand Management



Pruning to Enhance Tree and Stand Value

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OREGON STATE UNIVERSITY EXTENSION SERVICE

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Pruning to Enhance Tree and Stand Value

W. Emmingham and S. Fitzgerald

Why Should You Prune?

Pruning removes the lower branches of young trees and allows the early formation of clear, knot-free wood. It is done to increase tree and stand value. In the Pacific Northwest, pruning operations are increasing on nonindustrial private land, timber company land, and state and federal lands.

Recent lumber manufacturing studies show that the value of lumber cut from pruned logs can more than pay for the cost of labor and interest on the money invested in pruning. The value increase depends upon a sawmill's willingness to pay premium prices for pruned logs—a trend that seems increasingly likely.

However, like all forestry investments, pruning must be considered a calculated risk because future markets are unknown. Best estimates indicate that pruning 100 trees per acre for one 16.5-foot log at age 20 will produce an added \$6,000–\$10,000 per acre when harvested 40–80 years later.

Other objectives of pruning

Although pruning is done primarily to enhance clear wood production and tree value, it can fulfill other landowner objectives as well. For example, pruning can increase fire resistance by removing “fuel ladders.” It also can improve access into dense stands. Many owners simply like the looks of a well-pruned stand.

Pruning also can increase the amount of light beneath the tree canopy, which enhances grass and forage production. This is especially important in intensive agroforestry operations where livestock and high-value trees are grown and managed together for added income.

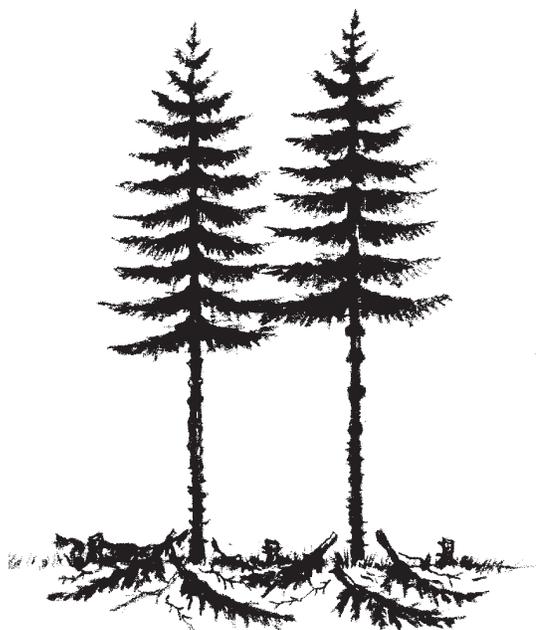
Pruning currently is used to lessen the impact of blister rust in young white pine stands. It also may reduce the incidence of foliage diseases, such as Swiss needle cast, that thrive in humid environments. Pruning also can reduce dwarf mistletoe infections if the mistletoe is confined to the lower branches, and the overall infection level in the stand is moderate to low.

In this publication, we focus on pruning even-aged forest stands that are being managed primarily for timber volume and high value. Pruning regimes used in agroforestry systems are discussed in *Agroforestry: Growing Trees, Forage, and Livestock Together*, EC 1114.

Pruning is intensive management

Because pruning is a technique for adding value to trees growing in forest stands, you can think of it as the woodland manager's “value-added” effort. It is, however, a long-term investment; for example, even under favorable tree growth conditions, it takes 20 years to add a 5-inch layer of clear wood on a tree.

Pruning also is a laborious and costly operation. For example, pruning 100 selected trees per acre likely would take you several days of hard work, or it could cost \$150–\$250 if you hired a contractor to complete the work.



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Basics of Wood Quality in Trees and Stands

Knots and wood quality

Although many factors cause defects in lumber, knots are the primary reason for reductions in lumber grade. A knot is the portion of a branch that becomes incorporated within the bole of the tree.

Knots can be of two types: ingrown or encased (see Figure 1). Ingrown knots are “tight” because they develop when the branch is alive and the wood of the branch is ingrown within the tree bole.

Encased knots are loose because they develop after the branch dies and the wood of the bole grows around the dead branch. Encased knots reduce lumber quality more than tight knots.

Clear wood does not form until the entire pruning wound is covered over. This may take 1 to 10 years,

depending on species, site, tree vigor, branch size, stub length, and quality of pruning work.

Stand and branch development and self-pruning

The number and size of knots on a tree are determined to a large extent by site productivity and stand density and development. Natural or self-pruning of lower branches in forest stands is a slow process. It has three distinct steps: branch death, branch shedding, and healing over of the branch stub.

The self-pruning process is greatly influenced by initial stand density and shade tolerance of the tree. At narrow spacings (e.g., 8 x 8 foot spacing), crown closure (when branches from adjacent trees overlap) occurs sooner than at wide spacings. This increases the speed of branch death and crown lift (the process of progressive upward branch death) because of the intense shading by branches from above and from adjacent trees (Figure 2). As a

result, branches stop growing and die at a small size. In contrast, wide spacings (e.g., 14 x 14 foot spacing) delay crown closure, allowing branches to live longer and grow bigger, resulting in large knots.

Pruning Management Options

Choose stands carefully for pruning

Since pruning is a large investment and payoff is many years away, evaluate potential stands carefully. Not every stand can be pruned profitably, so you should prioritize stands to be pruned.

Select stands on your more productive sites: e.g., site class three or better. They should be accessible for workers and preferably on gentle topography, making multiple thinning entries easy. Stands should be healthy and vigorous.

Do **not** prune stands on exposed, wind-throw-prone areas such as ridges, or sites with a high water table. Avoid pruning stands with high incidence of root rot. Anything that would jeopardize growing the stand for several decades should raise serious questions about the wisdom of pruning that particular stand.

What species can be pruned?

Douglas-fir and ponderosa pine are good candidates for pruning. Recent studies show that pruning these species can be profitable if mills are willing to pay for the value in pruned logs.

The market value of other species is less certain, but species such as western larch, western hemlock, western white pine, and noble fir are considered good candidates for pruning. Most species of conifers can be pruned, although some (e.g., hemlock, true firs, and spruce) are more prone to invasion by wood-decaying fungi. In contrast, both ponderosa pine and Douglas-fir are quite resistant to invasion by such fungi.

We know much less about pruning native Northwest hardwoods, but value of clear wood is much higher than for conifers. Pruning red alder or bigleaf maple in managed stands may pay off as local markets for hardwoods continue to develop.

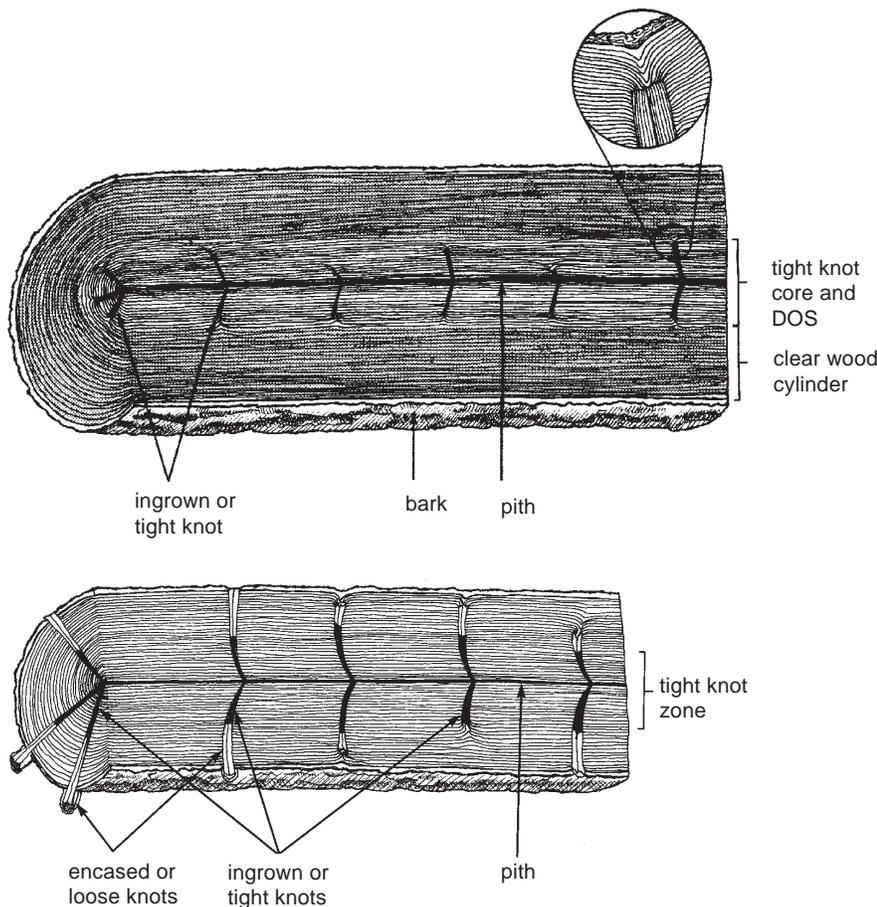


Figure 1.—A pruned and an unpruned log. Note the knotty core, diameter outside stub, ingrown and encased knot zone, and cylinder of clear wood.

Deciding on a pruning strategy

Pruning is part of an intensive management operation and should be planned and carried out systematically only in stands you intend to manage intensively.

The basic objective of pruning is to minimize the knotty core of wood in the most valuable butt log of the tree. First, target a maximum knotty core size, and prune when the tree reaches that size. Second, decide what length of log you wish to market. Third, coordinate the pruning regime with the thinning regime, because density management is the main tool for keeping the tree's diameter growth at a desired rate. To chart your own strategy, you will have to make decisions based on an array of factors while keeping your objectives in mind.

Core size

The knotty core is measured as the diameter outside stub (DOS), that is, to the point where the branch is cut (see Figure 1). Mills commonly peel logs down to a 4-inch core, and smaller cores of about 2 inches are now possible.

Table 1.—*Conifer log lengths and grades: Current markets.*

Length (feet)	Quality	Grade	Relative Price (% of #2 sawlog)
16 + trim	very knotty	utility	30
16 + trim	knots over 2"	#3 sawlog	87
16 + trim	few knots	special mill	133
25 + trim	no knots, 6 rpi	peeler	173
32 + trim	knots less than 2", < 8 rpi	export	190
32 + trim	knots less than 2"	#2 sawlog	100

Note: These market values are given as examples of relative value only. Market values change daily, and over time, the relative value also may shift.

Strategies for keeping the DOS small include pruning in multiple lifts. How high you prune depends on how willing you are to gamble your work or labor costs on the uncertain future log market.

Logs are sold in a variety of lengths to different end users. Conifer mills that peel or slice clear boles into veneer use short logs of 17 or 25 feet. Hardwood mills buy multiples of 10 and 12 feet. Mills manufacturing lumber look for longer logs.

It is worth noting that conifer logs with any knots (even small ones)

qualify only as number 2 sawlogs. Current prices (see Table 1) can give you a general idea of value, but future markets may vary considerably.

The values in Table 1 are for comparison purposes only. When marketing pruned logs, always negotiate a special price based on the DOS, growth rates, and other quality characteristics of the logs from your stand. Remember, log grades used today were not developed with pruned logs in mind.

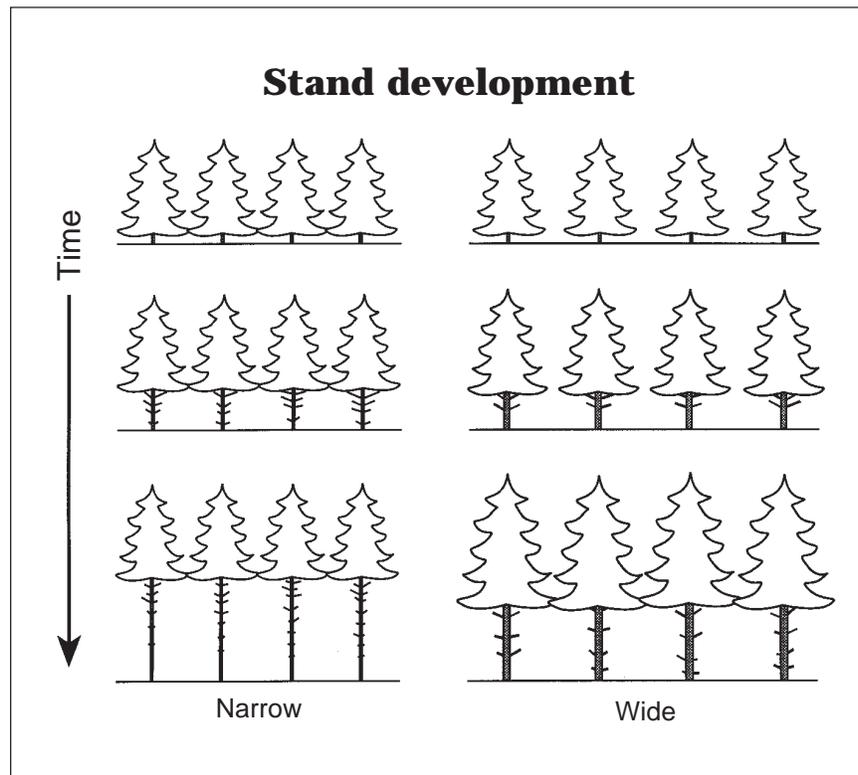


Figure 2.—*Effect of tree spacing on crown lift, branch, and bole diameter.*

Basics of Tree Pruning

In pruning trees, you may remove both live and dead branches. Removing dead branches doesn't affect the tree's photosynthesis "factory" or tree growth. Removing live branches does affect the factory, so be careful to leave the tree with an adequate crown.

A general conservative rule of thumb that applies to all tree sizes and species is to leave 50 percent of the total tree height in live crown (Figure 3). This is particularly important on trees less than 30 feet tall.

Pruning lifts

Let's assume your objective is to prune half the trees in a young stand to 18.5 feet. You could prune to that height all at once, but to maintain 50 percent live crown, the tree would have to be at least 37 feet tall. By the time a pine tree is 37 feet tall, it usually is 8–12 inches dbh. If your objective is to maintain a knotty core of 4 inches, it makes sense to prune the same tree several times.

Each time you prune to a higher level, you give the tree another "lift." Intensive pruning operations use two, three, or more lifts, depending on target pruning height, pruning tools used, and size of operation.

As target DOS is reduced, the number of lifts needed to prune to a given height increases. For example, with Douglas-fir, a target pruning

height of 18.5 feet and a target DOS of 8 inches often can be accomplished in one lift. By the time trees reach 8 inches dbh, they usually are over 37 feet tall and can be pruned to 18.5 feet while retaining 50 percent live crown.

With a 4-inch target DOS and an 18.5-foot pruning height, we need at least two lifts. The first could be to 8 feet when the tree is about 18 feet tall. The second could be done when the tree grows to 37 feet. Different tree species or trees grown at wide spacing will have different diameter and height growth characteristics, so adjust your pruning lift schedule accordingly.

What about high pruning?

Most pruning operations limit pruning to 18.5 feet because pruning higher gets more difficult and expensive. Some foresters prune conifers to 36 feet so the entire 35-foot butt log is a high-value peeler log. This requires a minimum of a two-lift operation to prevent removing too much live crown at any one lift. It also requires much more effort because pruning beyond 18.5 feet requires high climbing or using more specialized equipment such as a mechanical "tree monkey."

The decision to prune to greater heights depends on your stand, site quality, and how long you plan to wait before final harvest. Limit high pruning to productive sites where trees grow tall in a relatively short period of time.

Combining Pruning with Other Management Operations

Thinning

Pruning and thinning operations should be coordinated. Use early thinning (commercial or precommercial) to maintain vigorous and steady diameter growth that will heal pruning wounds quickly and maximize clear wood growth. A good time to start pruning is right after early thinning.

In a well-stocked stand, limbs are small and easy to remove. Small knots heal over quickly. Carefully select trees to prune at this time because they need to survive and grow well until harvest 20–50 years later (see next section). See EC 1189, *Using Precommercial Thinning To Enhance Woodland Productivity*, for tips on avoiding problems such as Ips beetles in pine or sunscald in Douglas-fir.

Prune only the best future crop trees in the stand (Figure 4). This means you should prune only well-formed dominant or codominant trees that can be favored (to leave) in future thinning operations. These trees should have full, healthy crowns and demonstrate good diameter and height growth. Trees should be straight and free of defects such as stem decays, old logging wounds, and other visible damage.

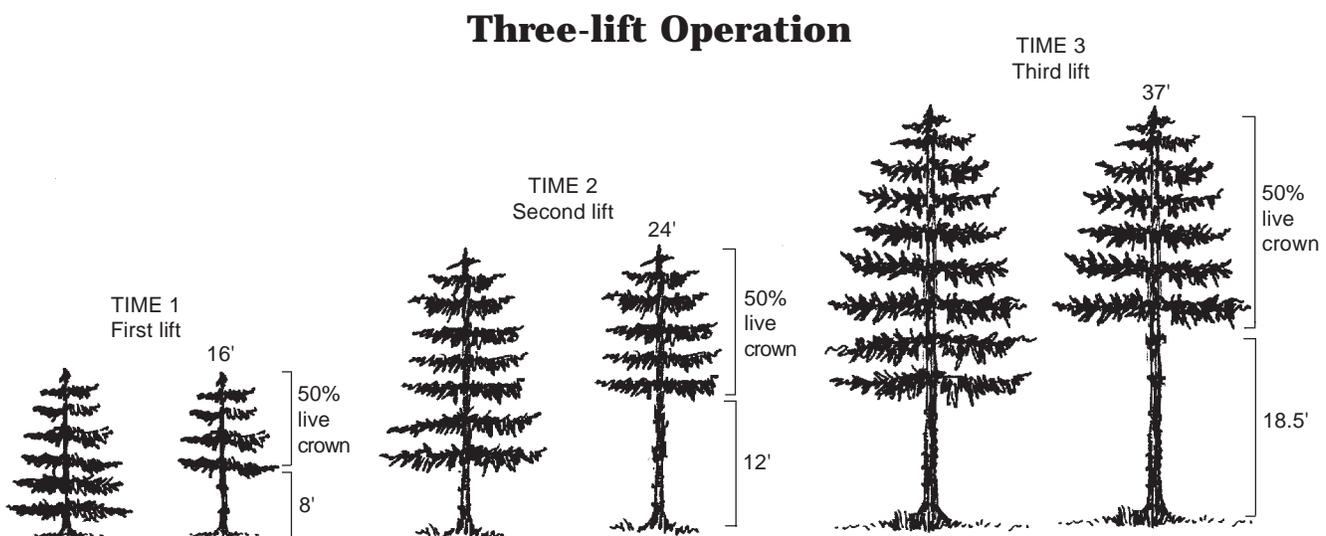
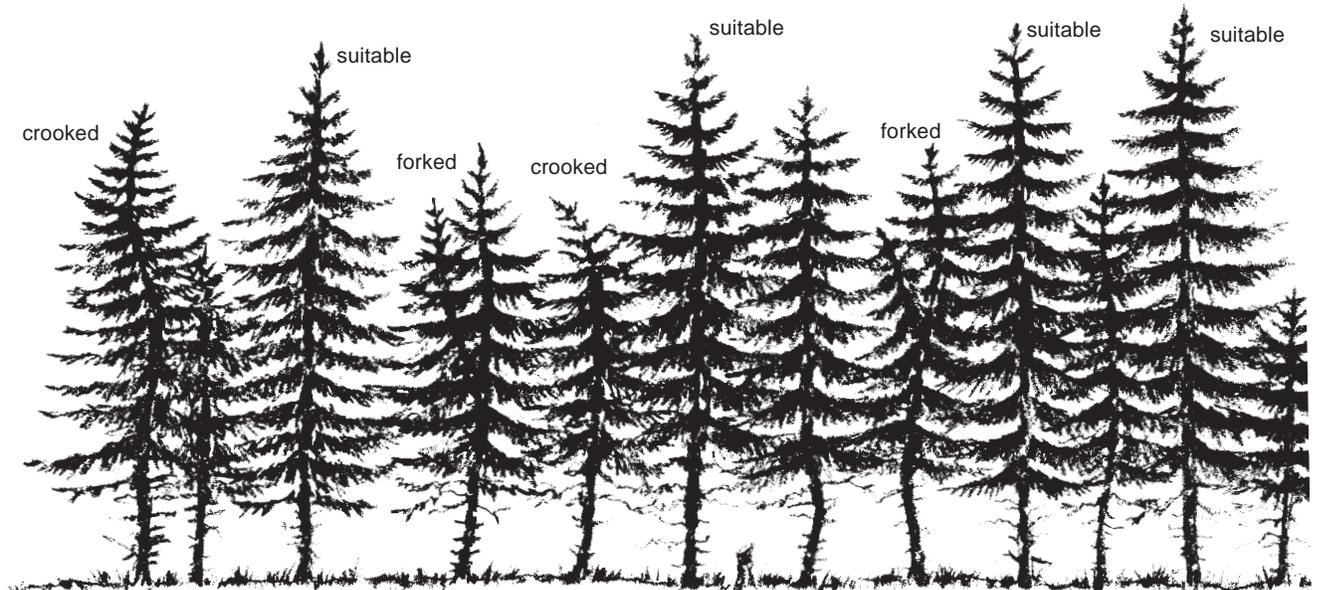


Figure 3.—As the tree grows, each successive lift removes the branches below the 50 percent live crown level.

Stand before thinning and pruning



Stand after thinning and pruning

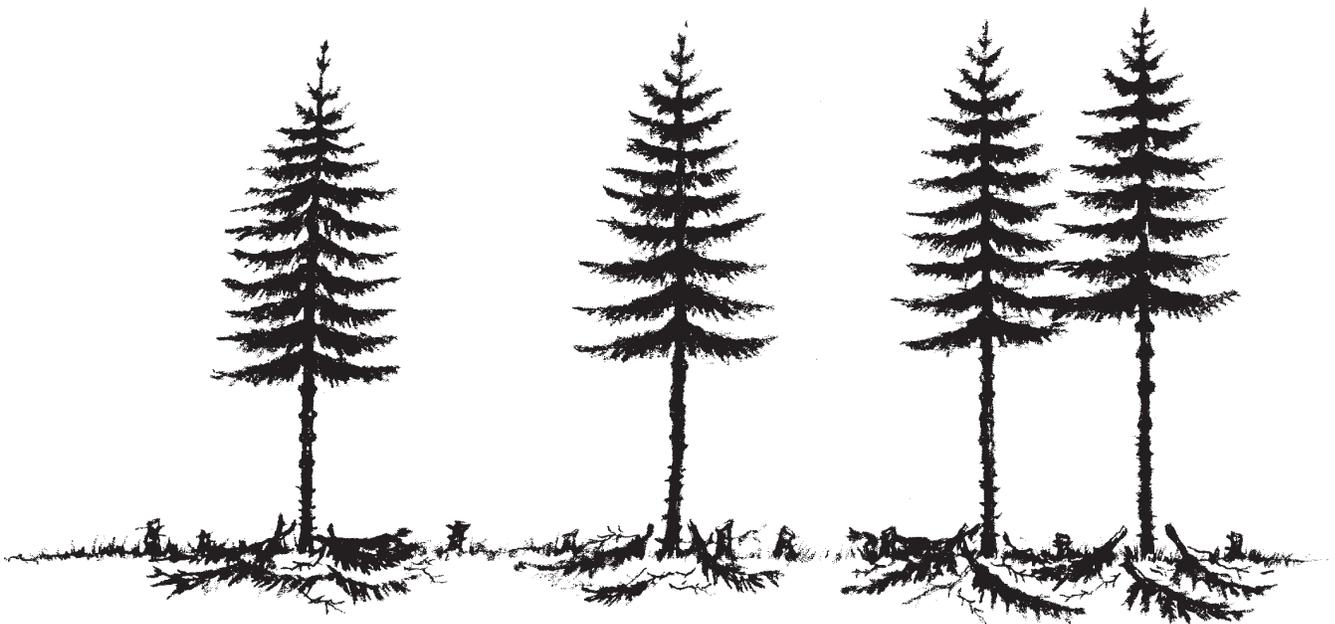


Figure 4.—*Select the best trees in a stand to prune. Avoid pruning trees with forked or crooked tops or those with visible damage. In this case, all trees left in thinning were pruned; however, often only the long-term, “final” crop trees are pruned.*

Commercial thinnings over time will ensure continued growth of the higher value pruned trees and provide periodic income. Commercial thinning 10 to 20 years after early thinning ensures that the pruned trees stay in a competitive crown position and have the best chance of remaining vigorous and healthy until harvest time.

In thinnings, remove unpruned trees that are defective or crowding pruned trees. If you carefully selected the best trees to prune early in the rotation and favor them (to leave) in thinning, they should remain the best trees in the stand.

Fertilization

When trees are well spaced, nitrogen fertilizer often can increase diameter growth beyond that from thinning, producing added clear wood and value. However, before investing in large-scale fertilization, check to see if your site and stand are good candidates. Check with adjacent owners or with the Natural Resources Conservation Service to see if stands on your soil type have responded positively to fertilization.

Generally, thinned stands respond better to nitrogen fertilizer than unthinned stands. Fertilize ponderosa pine and Douglas-fir at a rate of about 200 pounds of nitrogen per acre.

Growth response from fertilization usually lasts 5 to 10 years depending on tree species and site and stand conditions. Therefore, fertilize about 8–12 years before a thinning or final harvest operation. This minimizes the time until dollars invested in fertilizer can be regained in increased timber value. Contact a State Service forester, an Extension forestry agent, or a private consultant about fertilizing and thinning your stands.

Pruning in uneven-aged management systems

Pruning also is compatible with uneven-aged management regimes. In group selection systems, the trees in groups are managed as small even-aged patches. Therefore, the same techniques discussed above are directly applicable.

In single-tree selection systems, where trees of all sizes and ages are mixed together, the same basics apply. Choose the long-term crop

trees and prune them in successive lifts. Since the probability of damaging smaller trees during repeated partial cutting operations is higher in this system, consider pruning extra trees. As with even-aged regimes, give special attention to trees selected for pruning, and favor them (to leave) in all subsequent thinnings. Be sure to control logging operations to minimize damage to pruned trees.

Pruning Mechanics

Identifying trees to prune

Trees to be pruned may be identified ahead of time or at the time of pruning. With proper training, the pruner can select and prune the crop trees. The select-and-prune approach avoids the extra time and/or expense involved in visiting each tree or stand twice. On the other hand, preselection relieves forest workers of that responsibility so they can concentrate on removing limbs.

It is a good idea to permanently mark pruned trees so that you, other forest workers, and potential log buyers can identify them easily—even 20 to 40 years later. Plastic or metal tags or tree marking paint are the most common methods for long-term tree identification. Such efforts do, however, add cost and time.

What's the optimum pruning diameter?

Hardwoods up to 4 inches in diameter and conifers up to 8 inches in diameter are excellent candidates for pruning; smaller trees are even better. The upper limit for pruning depends on how long the stand will be held and how it is managed.

Delaying pruning and/or prematurely harvesting pruned trees decreases clear wood and increases the relative volume of knotty wood in the center core. However, trees over 10 inches can be pruned if allowed to grow to a large size (i.e., greater than 20 inches).

How many trees to prune

Remember the first basic rule of pruning: don't prune too many trees. You will reap little benefit from pruning every tree in a dense young stand, because some will die or be

thinned out before they produce very much clear wood.

For example, a Douglas-fir stand precommercially thinned to 200 trees per acre can grow to only about 14 inches average diameter before it should be thinned again. If not thinned, the growth of individual trees will slow, and, before long, some trees will die from competition.

If these 200 trees per acre had an average diameter of 6 inches when pruned, there would be only a 4-inch layer of clear wood on a 14-inch tree. This may not bring a high premium at the mill.

On the other hand, if this same stand is then commercially thinned to 130 trees per acre when the average tree reaches 14 inches in diameter, the remaining trees can continue to grow to about 19 inches in diameter without serious competition. The largest half of these trees will be 20–26 inches dbh.

A final thinning leaves 85 trees per acre. If these final crop trees had been selected and pruned after the precommercial thinning when the average diameter was only 6 inches, and the dbh at final harvest is 28 inches, this would result in an 11-inch layer of clear wood around a small knotty core. Obviously, the premium paid for such a log would be substantial.

From this example, you can see that pruning too many trees could be a waste of time and money because some will die or be thinned out, unless pruning every tree fulfills some other objective. In summary, depending on the target harvest diameter, only a certain number of trees can be grown to a large size. This depends somewhat on the species and growth potential of the site, but it probably will be 100 trees per acre or fewer.

Sunscauld and epicormic branching

Removal of branches exposes the thin or immature bark on young trees to direct sunlight, which may cause sunscauld. Sunscauld results when the sun heats the bark to lethal temperatures, killing the growing tissue called cambium beneath the thin bark. Often, this occurs on the south and west sides of the tree as the sun shines directly on the bark in late afternoon.

Over a period of years, sunscauld creates a wound, making the tree

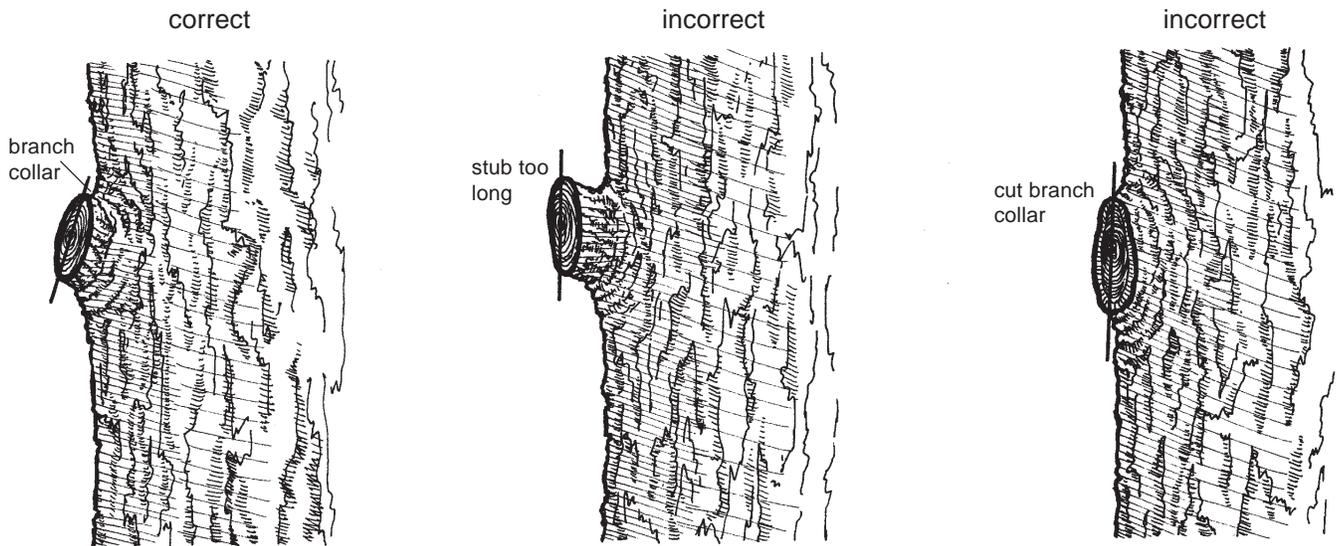


Figure 5.—Remove branches properly to minimize damage to the branch collar.

more susceptible to insects and fungi. Severe sunscald can kill portions of the tree above the wound.

Susceptibility to sunscald varies by species. True firs are very susceptible, Douglas-fir is intermediate, and ponderosa pine is resistant to sunscald.

Exposing the bark of some tree species to sunlight also can stimulate dormant buds within the bark to produce new (epicormic) shoots. These new shoots can produce branches and negate the benefits of pruning if adequate light is available. Douglas-fir, grand fir, and all hardwoods produce epicormic branches. Ponderosa pine and larch do not.

Problems with sunscald and epicormic branching generally occur when dense stands on south slopes suddenly are opened up by thinning. Removing too much crown with excessive or severe pruning also can accentuate sunscald and epicormic branching.

However, pruning in two or more lifts leaves the lower bole shaded, which helps prevent sunscald and minimizes epicormic branching on small-diameter trees. Leaving a few branches on the south and west side of the tree also will help prevent sunscald.

On exposed, hot, south slopes, thin lightly so as to open up the stand slowly, or delay pruning for a few years to let crowns recede and bark to thicken. Finally, don't combine thinning and pruning operations in the same year.

Where to cut the limbs

Cutting off dead limbs has no effect on the tree as long as you do not injure the living bark. Pruning off live branches will not injure the tree seriously if they are from the lower crown. Lower branches having few vigorous needles do not contribute much to the tree's energy and are of little value to the tree.

Remember, when cutting off branches it is important to avoid injury to the bole of the tree *and* the branch collar (Figure 5). The branch collar is the swollen area at the base of the branch. Cut branches outside any enlarged branch collar and never cut flush with the bole. By cutting only the branch, the tree will heal faster, because the wound diameter is smaller.

Another reason for not cutting off the branch collar is that the branch collar is part of the tree bole. If decay enters the wound, it can spread around the bole. If decay enters the branch cut, it generally spreads only within the branch stub. Cutting outside the

branch collar results in less pitching because less live wood is injured.

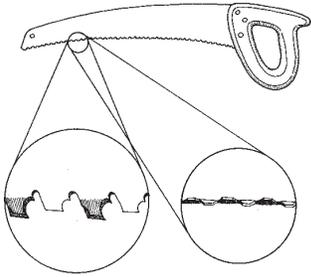
Never treat pruning wounds with a wound dressing or paint. Studies have shown that paints and wound dressings sold in farm and garden stores actually trap moisture behind the dressing and promote the growth of wood-decaying fungi.

Time of year to prune

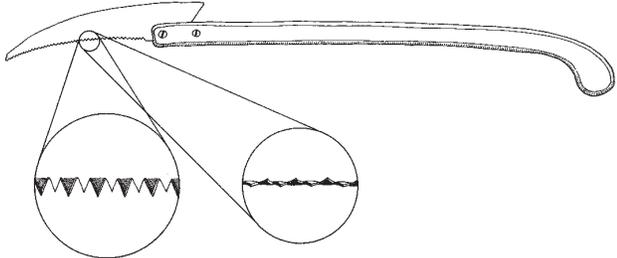
The best time of year to prune is during late summer, fall, and early winter when the tree's cambium is not actively growing. This helps minimize bark injury and pitch flows. In most cases, however, you can prune at any time if you take great care to avoid injury to the main bole of the tree.

In some locations (e.g., Willamette Valley), pruning wounds can attract insects, such as the **sequoia pitch moth**, to ponderosa pine and Douglas-fir. Female moths typically fly from late spring until early August and are attracted to trees pruned at this time. Female moths lay their eggs in the pruning wounds, where the eggs hatch. The larvae burrow under the bark, injuring the tree and creating massive pitch pockets, which degrade the wood quality and weaken the tree. Delaying pruning until fall, after the moths have left, helps avoid attracting these insects to your trees.

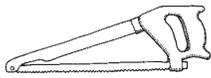
Saws



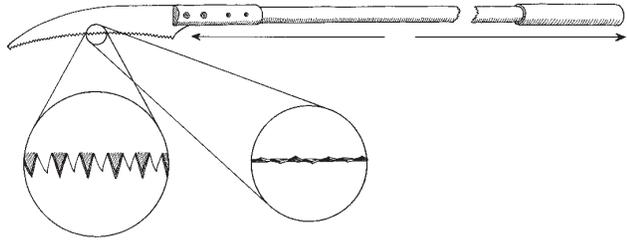
hand saw with chainsaw-type teeth



short-handle pruning saw

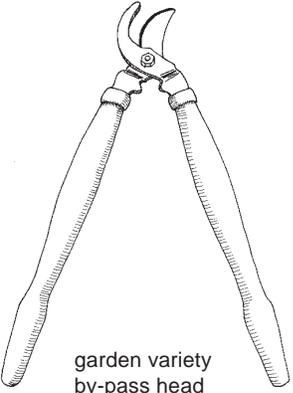


hand saw with changeable blade

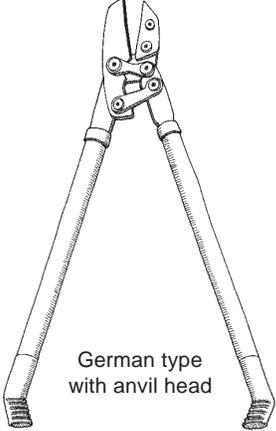


long-handle, telescoping pole pruning saw

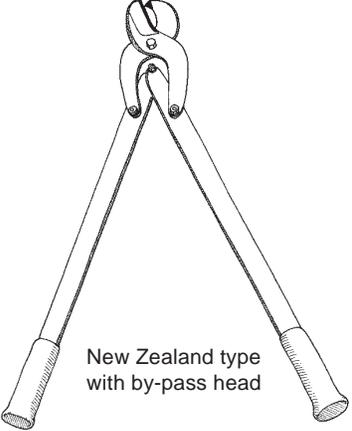
Shears



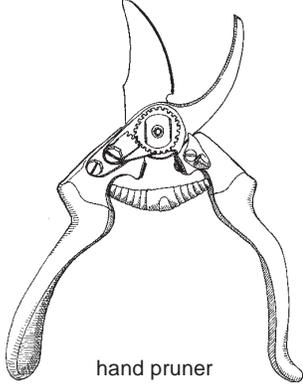
garden variety by-pass head



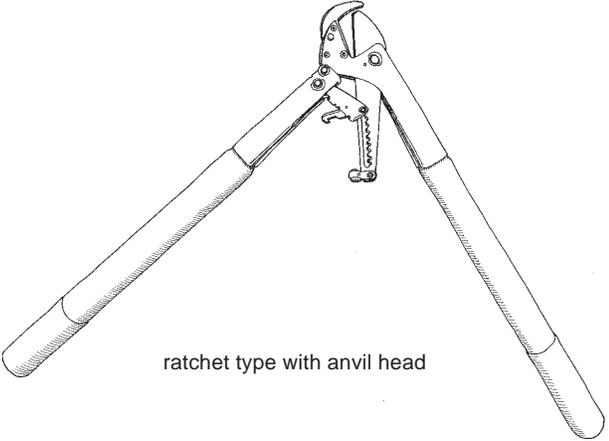
German type with anvil head



New Zealand type with by-pass head



hand pruner



ratchet type with anvil head

Figure 6.—Common pruning equipment.

What about Tools?

Many different tools will work, and different ones work well at different tree heights. Criteria for selecting good pruning tools include the following:

- Cost
- Labor requirements and availability
- Physical ability of operators
- Quality of branch cut
- Likelihood of injury to tree bole/cambium

A chain saw, short-handled pruning saw, or loppers works well near the base of the tree. Safety dictates using the chain saw up to only shoulder height. Using chain saws also requires more safety equipment, including protective chaps, heavy boots, gloves, and hardhat with eye and ear protectors.

Mini-chain saws mounted on long handles also are available. They work well on large branches (over 2 inches) at heights up to 12 or 18 feet, but smaller branches are easier to prune with hand saws.

Never bang *conifer* branches off with a club, because the branches often break off beneath the bark, and massive pitching results or long stubs are left. Dead *hardwood* branches generally break off cleanly.

Short-handled pruning saws work well up to about 8 feet. A long-handled pruning saw works up to about 18 feet.

Hand-powered loppers or shears may be used on branches near the base and up to 8 feet. Be sure to purchase heavy-duty loppers so they are capable of cutting the larger branches at the base of the tree. Hydraulic or pneumatic shears on long, telescoping poles are becoming more readily available.

Mechanical “tree monkeys” capable of climbing up to 35 or 40 feet are available from a few companies, but all have been reported to have significant operational problems. Irregularities in trees such as sucker branches, forks, or large branch collars give tree monkeys problems. It takes large-scale pruning operations to pay for the initial investment.

Climbing trees with ladders also is a common practice for pruning up to 20 feet. In New Zealand, where pruning is done on a very large scale, hand loppers and ladders are used to prune up to 6 meters (20 feet). Loppers are favored because they cut cleanly and closely without injuring the collar or bark. Hand pruners are good for removing small branches low on the tree.

How much equipment you buy depends on your ambition, size of stand, and how much money you are willing to spend. Figure 6 displays some of the more common pruning equipment.

Caution! Be careful with sharp tools to avoid injuring yourself or the tree!

Long-term Considerations

Record keeping is important, especially for pruned stands. Pruning is an investment in the future value of your trees and timber stand. Therefore, carefully document and file the location of all pruned stands (and trees) on maps in your management plan. Permanent tags on pruned trees can help you keep track, or serve as a reminder to your successor.

You should keep the following records:

- Stand location
- Number of trees per acre
- Species
- Dbh of tree at the time of pruning
- Height of pruned log, including all lifts

Selling pruned trees most likely will be different than selling low-quality sawlogs. Because of their value, you will want to separate the pruned logs from others and be able to verify how much clear wood actually exists on each pruned log. This will ensure you get top dollar from log buyers. You can do this if you keep accurate records.

Of course, you should have log buyers examine the pruned trees and provide you with bids *before* you actually cut them. To get the highest

value when selling logs, always get three or more bids and target those that manufacture clear-wood products even if they are located at considerable distance.

Harvest operations in pruned stands demand special attention. Take care to buck trees into pruned and unpruned logs. If you leave unpruned portions attached to pruned portions of the log, the whole log may sell at unpruned value. Careful sorting of pruned and unpruned logs and close supervision of loading will ensure that all pruned logs are sold together for maximum value.

Is there cost-share assistance for pruning?

Cost-share assistance for pruning is available to nonindustrial private landowners through the Stewardship Incentive Program. Cost-share rates are determined by the State SIP committee. Actual cost-share amounts and availability may vary from one county to another and from one state to another. For more information, contact your local State Department of Forestry or Consolidated Farm Service Agency (formerly Agriculture Stabilization and Conservation Service) office.

Summary

Pruning selected trees in your forest stands can be a good investment, assuming future markets reflect present conditions. Many owners like the appearance of a pruned stand, but it really doesn't make good economic sense to prune all trees in a young stand. Instead, prune the final crop trees in stands you plan to manage intensively for several decades.

Prune in one to three lifts so that you can prune the bole before it grows over 4 to 8 inches in diameter. Always leave at least 50 percent of the total height of the tree in live crown. This minimizes height and diameter growth loss. Be careful with sharp tools to avoid injury to yourself and to the bole of the tree. Finally, keep good records so that you and/or your successor can market the value produced with all that hard work.

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Extension Service, Oregon State University, Corvallis, Lyla Houglum, interim director. This publication was produced and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. Extension work is a cooperative program of Oregon State University, the U.S. Department of Agriculture, and Oregon counties.

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