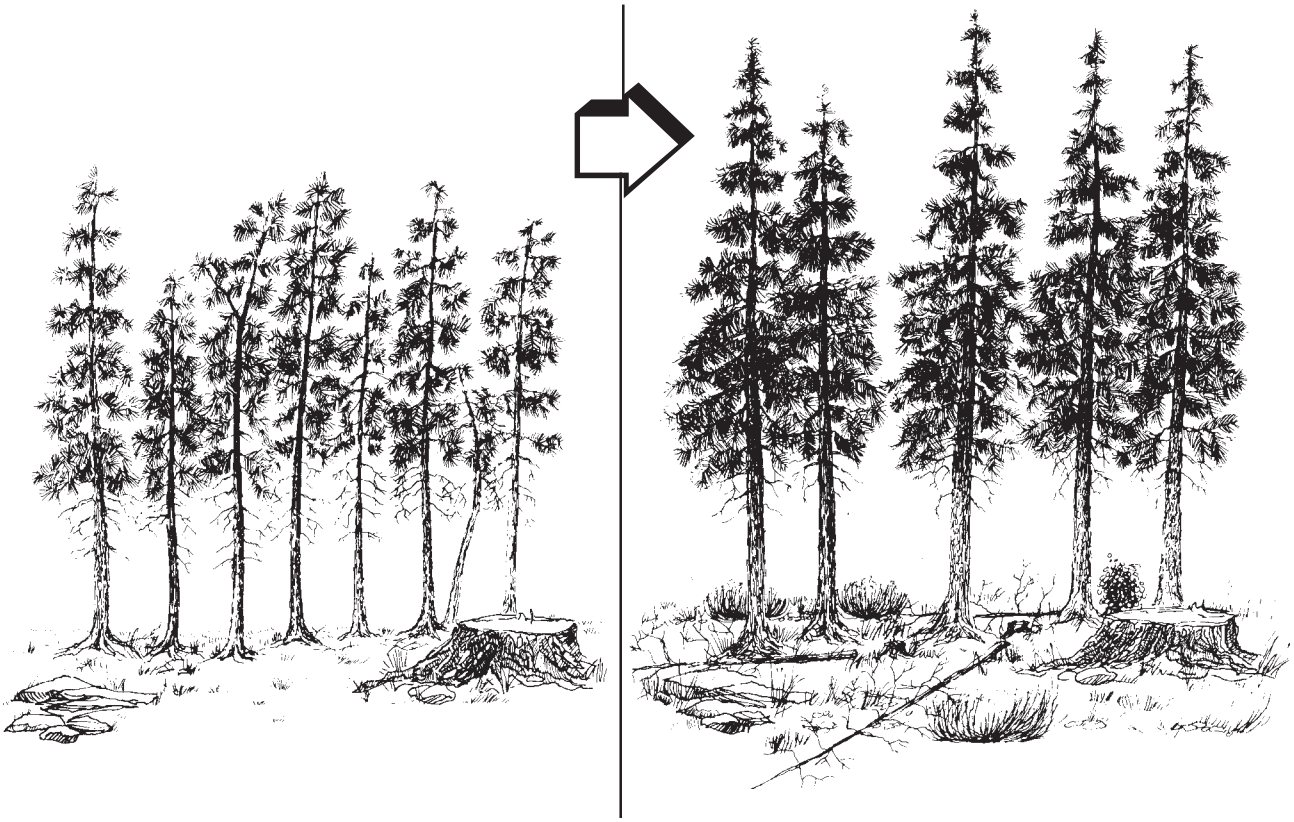
EC 1189
Reprinted April 1997
$2.00

The Woodland Workbook

Stand Management

Using Precommercial Thinning to Enhance Woodland Productivity



Making a good beginning

Precommercial thinning (PCT) is the first of several thinnings you might undertake. PCT takes a stand like the one on the left, reduces the density of crowded trees, and gives the young remaining trees more room to grow.

Ten years later (right), we see a more vigorous stand, with more usable wood production: (1) it's now less susceptible to insect and disease attack; (2) individual trees become larger faster; (3) more forage is produced; and (4) your thinned forest is more pleasant to look at. Turn the page for more information. . . .

OREGON STATE UNIVERSITY EXTENSION SERVICE

Using Precommercial Thinning to Enhance Woodland Productivity

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Contents

References to other publications

When you're referred to another OSU Extension Service publication, you'll find ordering instructions in "For More Information," page 12.

Precommercial thinning (PCT) is an important timber management practice in the Pacific Northwest. You should consider it as soon as a young stand has been established:

- PCT controls stand density by removing trees that will die or crowd crop trees before commercial harvesting can begin.
- PCT opens up young stands so individual trees grow faster.
- PCT leaves more growing space for each tree and usually stimulates forage production for a few years.

Precommercial thinning is just the first of several possible thinnings. Consider it part of your overall management program. You need to understand the basics of thinning to get the most from this publication. First, you should read *Thinning: An Important Timber Management Tool.* It helps you understand how individual trees grow, how stands grow, how stands are classified, what the terms mean, and how stands respond to thinning. A second helpful publication is *Thinning Systems for Western Oregon Douglas-fir Stands: What is Best for You?*

Our goal is to help you understand and carry out precommercial thinning in your young stands. We'll discuss:

l. What stands to precommercially thin
2. How to thin them
3. What techniques and equipment to use
4. How major pests affect PCT
5. How to treat the slash caused by thinning
6. How to set priorities for stands if several need thinning

The methods described here are useful for most even-aged stands in the Pacific Northwest. The table of contents provides an outline of our presentation and will help you refer to specific information.

Too many trees per acre is a common problem in Oregon forests. Foresters consistently find investments in precommercial thinning yield good dollar returns—often better than other forest management investments.

For example, under current economic conditions (1997), investing $110/acre in precommercially thinning a moderate to good site Douglas-fir stand can lead to a $201/acre gain (in present-value terms). Slash disposal following thinning will increase costs and reduce projected gains.

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If you want more forage, then money spent for thinning dense, slow-growing ponderosa pine forests is like purchasing extra acres. After PCT, the land produces more usable wood fiber and more forage.

A major disadvantage is that PCT costs you money or time and labor. The Forestry Incentives Program and Agricultural Conservation Program, managed through the Agricultural Stabilization and Conservation Service, provide financial incentives by sharing the cost of precommercial thinning with landowners.

For more information on cost share assistance programs, read *Cost Sharing and Woodland Management*, or contact a local office of the Oregon Department of Forestry.

Table 1.—*Seven steps to a successful PCT.*

Step	Tasks
1. Identify stands for thinning.	• Walk through stands; use aerial photos and management plan. • Determine boundaries.
2. Collect stand information.	• Systematically take plot data on trees per acre, species, diameter, and slope. Roughly estimate tree age and average height, and note insect and disease problems.
3. Determine objectives.	• Options include timber, range, wildlife, recreation, watershed, esthetics, combinations.
4. Decide on leave tree spacing.	• Plan on a product size—estimate target diameter. • Use spacing guidelines. • Make adjustments for insects, diseases, and objectives.
5. Define leave tree characteristics.	• Consider size, health, form, crown ratio, species.
6. Consider slash disposal.	• Options include pile and burn, prescribed burn, lop and scatter, slash-release purchase, and no treatment.
7. Evaluate results.	• Tree growth and forage response, stand condition. • Did the thinning meet your objectives? • Did the contractor meet performance criteria?

How to Precommercially Thin

Most young forest stands will need precommercial thinning to decrease time to the first commercial thinning and maximize commercial timber production. Both naturally reseeded and planted stands may have clumps or patches that are too dense. Table 1 shows the steps you will need to take for success.

You should plan for PCT at the most beneficial and cost-effective time. The best rule of thumb is to thin early in stand development—when trees are 10 to 20 feet in height and 2 to 4 inches in diameter. At this stage, they're relatively easy and inexpensive to cut, the slash load is low, and the trees left respond quickly with increased growth.

The strategy in PCT is to give trees enough growing room to reach a merchantable or target size. Toward the end of this growth period, trees should be using most of the site resources.

Locate potential thinning areas by a simple walk-through, by looking at aerial photos, or by referring to the section of your management plan that identifies potential PCT areas. Collect information for operational planning on potential thinning sites by taking a series of systematic plots within distinct "stands."

Stands are areas uniform enough in composition (species), age, and arrangement to be distinguishable from adjoining plantations. For an explanation of how to evaluate them, see *Mapping and Managing Poorly Stocked Douglas-fir Stands.*

Table 2.—*Precommercial thinning guidelines for important Pacific Northwest species.*

Species	Conditions for optimum thinning		Tree spacing for optimum wood production[a]		Potential problems	
	Age (yrs)	Height (ft)	Trees/acre	Feet	Ingrowth potential	Sunscald potential
Douglas-fir	10-15	10-15	360	11 x 11	low	moderate
Western hemlock	10-15	15-25	430	10 x 10	high	high
Noble fir	15-20	15-25	360	11 x 11	high	high
Ponderosa pine	10-25	10-20	260	13 x 13	low	low
Western larch	8- 15	10-15	300	12 x 12	low	low
Lodgepole pine	10-25	10-20	135	18 x 18	moderate	high
Grand fir	15-20	15-20	300	12 x 12	moderate	high

[a]Assuming that first commercial thinning occurs when average stand diameter is 10" d.b.h.

Once you've collected this information, set your objectives for the stand. Will you manage the thinning area primarily for timber, or do you wish to combine timber with other values, such as wildlife, livestock, or recreation?

Once you select a stand for precommercial thinning, you need to decide how to space your trees out, which trees to take and leave, how to thin clumps, and how to treat the slash. We'll discuss each of these, and more, in detail below.

Determining how much to thin

Spacing of leave trees depends on the species you are thinning, your harvest or management objectives, and thinning costs. Refer to Table 2 for general spacing guidelines, which are based on thinning at an optimum age or height and a target stand of 10 inches average d.b.h. for first commercial harvest. The numbers given are for maximum wood production and for the maximum number of trees.

Use the table as a general guide for planning PCT operations. If your objective is a larger diameter for a target stand (for example, 12-inch d.b.h.), be aware that you'll need to space trees wider.

Harvest methods and market conditions also influence spacing. Therefore, if maximizing wood yield is your objective and if ground-based logging is economical, you can plan a number of commercial thinnings—and you should begin with a narrow PCT.

Space trees wider if you plan few or no commercial thinnings, if forage production is important, or if markets for small logs are poor. Threat of insect pests, such as mountain pine beetle in east side pine, generally argues for leaving fewer trees per acre—to maintain tree vigor and resistance to beetle attack until trees reach marketable size.

Leaving too many trees is a common problem because we value each tree, it's work to remove trees, and it's not easy to decide which trees to remove if you have many good-looking candidates. Too many trees left will reduce the growth rate of crop trees, and may mean additional delays of up to 20 years before a commercial thinning.

Shade-tolerant species, such as western hemlock and grand fir, can efficiently use lower light intensities. Closer spacings of these trees will mean greater wood production per acre.

Shade-intolerant species such as ponderosa pine need more light (that is, wider spacing) for maximum growth. Furthermore, droughty conditions typical of pine sites warrant wider spacing.

Use target diameters to determine leave tree spacing. Table 3 is a spacing (or stocking) guide for precommercial thinning based on target diameter objectives for a first commercial harvest. Let's try an example with Douglas-fir.

If you plan for a target diameter of 12 inches, leave an average of 260 trees per acre (13-foot spacing) after thinning. When the stand grows to an average diameter of 12 inches, a commercial thinning should take place. If you want a larger target diameter, use wider spacing.

Tree spacing guidelines are not meant as strict rules. Your objective is not an exact spacing between trees, but an overall average.

Table 3 doesn't tell you how long it will take for your stand to reach the target diameter. The time to the first commercial thin depends primarily on the productivity of the site. Stands on good sites will take less time to reach a target diameter than stands on poorer sites.

For example, if leave trees grow at a rate of 5 rings per last inch of growth, it will take 20 years to grow from 4- to 12-inch d.b.h. At 10 rings per inch, 40 years would be required.

Table 3.—*Minimum spacing (in feet) required between leave trees to obtain a stand with selected target diameter.*

Target diameter (inches)	Species				
	Western hemlock (site class 2)	Grand fir[a]	Douglas-fir	Ponderosa pine	Lodgepole pine
6	6	8	6	6	11
8	8	10	9	11	15
10	10	12	11	13	18
12	12	14	13	16	22
14	14	16	15	18	26

[a]These spacings are for grand fir stands east of the summit of the Cascade Mountains.

If you allow stands to grow past their target diameter, tree growth will slow, and mortality from suppression will increase. For ponderosa and lodgepole pine, thinning delays also can mean an increased risk from mountain pine beetle attack.

The target diameters in Table 3 are designed to estimate future average tree size for stands that will be commercially thinned from below. In this system, the trees removed generally are from the lower crown classes.

However, you must adjust the results from the table when you plan to remove trees just from the upper crown classes—for instance, if you plan to cut poles.

Removing larger trees reduces average tree diameter after thinning. Therefore, select a lower target diameter than the one Table 3 recommends when you manage for poles. The detailed methods used to manage for poles are described in *Growing and Harvesting Douglas-fir Poles.*

Wide vs. narrow spacing. If you have a reliable market for 8- to 12-inch saw logs, you may want to thin to a 10-inch target diameter. Plan on a similar or narrower spacing where a good firewood market exists.

Early commercial thinning of small trees has been impractical in areas where:

1. There are poor markets for small logs
2. Steep terrain means you must use expensive cable yarding systems
3. You'll have high road-building costs

So, in the face of high logging costs and poor markets for small logs, a 14- or 16-inch target (fewer trees per acre) is more desirable. If commercial thinning isn't economical, thin even wider to anticipate a larger target diameter at time of final harvest.

Wide initial spacing in small-diameter stands sacrifices early volume growth, but it shortens the time your trees need to reach a larger commercial size.

For landowners interested in forage for livestock or big game, greater space between trees is an advantage because of the increased grass, forbs, and shrubs that will occur before trees reach marketable size. Forage yields often are doubled following PCT, but this is highly variable.

As an example of a wide spacing strategy, suppose you have a dense 20-year-old ponderosa pine stand on a good producing site, and you want a combined income from both livestock and timber from the area. Trees are from 15 to 30 feet high, and forage production is just about shaded out.

Thinning the stand to an 18-foot space between trees (135 trees per acre) will open up the area for forage production and provide for rapid tree growth. In about 40 years, the stand will grow to an average diameter of 14 inches.

A commercial thinning at that time could remove 70 trees per acre and leave 60 to grow. At this spacing (about 27 feet), the stand should grow to a diameter of up to 30 inches without danger of beetle attack.

Selecting leave trees

If production of large, high quality logs is your long-term objective, then select leave trees that:

1. Are in a dominant or codominant position
2. Have at least 30 percent of their total height in crown
3. Have small branches, straight boles, and little taper
4. Lack broken, forked, or damaged tops
5. Have few or no disease problems

Remove trees that are suppressed, poorly formed, sickly, dominant heavy-limbed "wolf" trees, or those competing with selected leave trees. If you're managing stands with several tree species, retain a mix of species that:

1. Have high market value
2. Have good growth potential
3. Are well adapted to the site
4. Are either nonhosts or more resistant to local insect or disease problems

It's better to choose well-formed, healthy trees of a less desirable species than poorly formed, weak trees of the most desirable species. Also, consider your management objectives. For instance, if you plan for natural regeneration, be sure to leave a species adapted to producing seed, germinating, and growing under the prevailing site conditions.

Here's a commonly asked question: "What's more important, strict spacing or leave tree quality?" The answer isn't easy. Quality of leave trees is extremely important because it governs what log values will be in the future. Loose attention to spacing causes less than full site occupancy or overstocking problems. Here's a general rule of thumb: As long as you maintain average spacing at the desired level, minimum and maximum spacing of ½ to 1½ times the desired level is quite acceptable.

PCT factors

Clumps. Many stands contain clumps of trees and "holes" without trees that vary in size and shape. If a clump is over three crown widths, thin the middle of the clump as you would a uniform stand. Don't maintain an area of overdense trees to compensate for a large gap in another part of the stand.

At edges along openings, leave trees at a closer spacing, usually no less than one-half the desired spacing. Try not to create larger openings than already exist.

Topography. Local topography should give you clues for potential weather damage. Stands in areas that experience high winds—sites near the coast or on exposed ridges—can suffer serious damage after thinning. In this case, thinning early in the life of the stand is best, so that trees develop wind-resistant qualities.

Because slope has such an influence on logging costs, stands on steep slopes (40 percent and greater) should be thinned with wider spacings, to grow larger trees that are less expensive to log and more valuable. On very steep slopes (over 60 percent) where expensive cable yarding is required, PCT to final crop-tree spacing because commercial thinning likely will not be feasible.

Distance from roads is a critical factor in cable operations. If a stand is accessible only by long cable spans, precommercially thin to final crop-tree spacing.

Ingrowth occurs when small trees begin to grow between young leave trees soon after a precommercial thinning. They have the potential to compete with leave trees, stealing the benefits of thinning.

Table 2 indicates which species exhibit this trait. If your stand has a lot of vigorous, smaller (nonleave) trees, delay thinning until the stand is a little taller. This gives thinned trees an added "jump" in height over ingrowth. Waiting causes a delay in commercial harvest, but delayed PCT can improve wood quality because it helps in natural pruning.

Prescribed fire can be a tool to take out ingrowth as long as the leave trees have thick bark to resist heat damage.

If you minimize ground disturbance during slash-disposal operations, you'll reduce the seedbed that's suitable for natural reproduction, lessening your ingrowth problem. It's also important to cut PCT trees below the lowest live branch so these branches don't survive to compete with leave trees.

Planting spacing. The number of trees you plant should depend on anticipated mortality and your objectives for future management. Plant fewer trees if you expect low rates of mortality and if you plan no precommercial thinning. If natural seeding is common on your site, plant fewer seedlings.

In western Oregon, plant 300 to 400 trees per acre (10 to 12 feet) if you anticipate little mortality and if you plan to PCT. Thinning will help weed out poorly formed, diseased, or slow-growing trees.

In eastern Oregon, trees normally are planted at wider spacings, say 225 to 300 trees per acre (12 to 14 feet).

If thinning is not desired, plant 250 to 300 trees per acre on the west side (200 east side) unless you expect mortality in the first decade to exceed 20 percent.

Remember: A wider spacing means, first, fewer opportunities to harvest small trees early in the stand rotation and, second, little room for unexpected mortality or stand damage.

Wide spacing early in stand development can result in large limbs and poor log quality unless you plan to prune crop trees. Pruning can be a reasonable option, where crop trees are growing on good sites and trees are pruned early in the rotation.

Avoid overplanting—it will increase your PCT costs or stifle growth.

Mechanical PCT

Standard equipment for PCT is the chain saw. A minimum length of 20 inches for standard bars reduces bending over and fatigue by the cutter. For very small trees (less than l-inch diameter), machetes, axes, or shears are acceptable alternatives to chain saws.

Remember: If a PCT takes place, a permit to operate power-driven machinery on private lands in Oregon is required from the Oregon Department of Forestry. Essential safety equipment includes a hard hat, gloves, leg protection, heavy leather boots, caulk boots for steep or wet slopes, ear plugs, and eye-protecting goggles or glasses.

Chemical PCT

Tree-killing chemicals are alternatives to mechanical PCT. With the "hack and squirt" technique, a hatchet is used to chop around the tree at regular intervals and a small amount of herbicide is squirted into each cut. With this method, the trees die standing, and they gradually decompose and fall apart from the top down. The major advantages include:

1. Slash accumulates slowly as standing dead trees break down
2. Access through the site is still possible
3. Dead standing trees provide some shade and support (during windstorms)
4. Fewer accidents
5. Use of certain chemicals will not enhance bark beetle activity

The major drawbacks include:

1. The difficulty in seeing which trees already have been treated
2. The difficulty of selecting crop trees if others have not been felled near them.

Attention to safety, application timing, and herbicide rates improves the success of your chemical thinning.

Use herbicides safely!

- Wear protective clothing and safety devices as recommended on the label. Bathe or shower after each use.
- Read the herbicide label—even if you've used the herbicide before. Follow closely the instructions on the label (and any other directions you have).
- Be cautious when you apply herbicides. Know your legal responsibility as an herbicide applicator. You may be liable for injury or damage resulting from herbicide use.

Late PCT Problems

When proper spacing is obtained by timely PCT, trees grow efficiently to commercial size. If PCT is delayed or forgotten, stands remain overdense, tree growth slows down, crop trees reach commercial size very slowly—and you'll be delayed many years before a commercial thinning is feasible. Should you do a late PCT? The answer is not easy, so experienced foresters try to avoid it. The three main problems with late PCT are:

1. It's a risky investment and can be expensive (bigger trees are harder to cut).
2. Individual trees take longer to respond and grow.
3. Afterwards, stands sometimes become sunscalded or windthrown.

The following sections should help you decide whether to wait and allow the stand to slowly reach marketable size or to do a late PCT.

Cost

PCT in older stands can be expensive. There are several reasons:

1. Trees generally are larger, yet there are just as many per acre.
2. Thinners have difficulty getting trees down on the ground—they get hung up easily.
3. Slash accumulations are greater, increasing fire hazards and decreasing access.

To justify these costs, you need to know that the time to your first commercial thinning will be significantly shortened. Estimate the costs, returns, and time saved to a first commercial thinning before you thin. If the costs are high and if the time saved is short (say 5 to 6 years), a late PCT probably is not justified.

Do biological benefits justify the cost?

You'll need to consider the biological benefits of a late PCT. The rate and amount of bole-growth response from thinning is largely a function of a tree's crown length in relation to its height (crown ratio).

Trees with crown ratios of less than 30 percent take much longer to respond and may suffer thinning shock or reduced growth for a few years after thinning, especially in shade-tolerant species. Trees with low crown ratios are more common in stands past the optimum PCT stage.

Some species-site combinations may not warrant a late PCT because they typically show poor growth response after thinning. Dense lodgepole pine growing on poor eastern Oregon sites is in this category. Lodgepole pine may exhibit good response, however, if trees are less dense and the stand is growing on a better site.

Ponderosa pine responds favorably to thinning even when trees are 40 to 60 years old and growth has been slow for decades. Douglas-fir on good sites will show a growth response from a late PCT, but not as great as if thinned earlier.

Damage potential

On poor sites, dense stands tend to stagnate. If you don't thin, the stand probably will not produce merchantable saw logs for many years. Furthermore, insect pests such as mountain pine beetle are threats to older, stagnated pine stands. In this case, a late PCT probably is justified. Otherwise, beetles will kill the larger trees about the time they reach harvest size.

Stands with small or poorly developed crowns and long, slender stems are prone to windthrow, permanent bending, or top breakage from ice storms. Such stands may be thinned in two or three stages. Thinning in stages is beneficial because it gives trees time to build stems and root systems before they're fully exposed to weather hazards.

However, reentry into a stand runs your costs up. Normally, stage thinning is considered only when a highly valuable stand is threatened and the added costs are justified by potential returns.

Sunscald also is a potential problem after a late PCT. Species with thin bark are sensitive to sudden increases in sun exposure on the south and southwest sides of their trunks. The heat generated can kill the cambium (growth zone of the tree).

As Table 2 indicates, grand fir and western hemlock (shade-tolerant species) are most susceptible,

especially if they've been growing in very dense stands. Ponderosa pine, western larch, and Douglas-fir have thicker bark, so they're not as severely damaged.

The key to thinning older stands susceptible to sunscald is to open them up slowly (stage thinning). Suppose you have a dense, older stand of susceptible conifers (1,000 trees/acre) with dominant and codominant trees with less than 30 percent crown ratios. A safe approach—but more expensive—would be to remove half the trees now, wait 3 years, and remove 200 more.

As you can see from this discussion, late PCT can be risky business. Avoid it if you can by doing PCT in a timely manner, as shown in Table 2.

Forest Pests and PCT

Insects and diseases that can attack your forest have a big influence on how you thin your stands. Because pests can cause costly damage problems, you'll need to evaluate each stand and direct questions to your Extension forestry agent, service forester, or consultant forester.

The following sections contain recommendations for moderating pest impacts as they relate to a PCT.

Insects

Table 4 is a quick summary of insect problems.

Bark beetles and wood borers are mostly "secondary" pests.

Usually, something else weakens the trees—then these insects move in and cause tree death. Weakening agents include drought, disease, insect defoliators, and competition with other trees. PCT can help by enhancing tree vigor, increasing the trees' ability to resist attack.

Pine engraver beetles are bark beetles that can build high populations in pine PCT slash, then attack and kill standing green trees. To keep these pests from damaging your trees, thin from August through December. Slash created during this time of year becomes too dry for good larval development by the following spring.

If this isn't possible, thin continuously through the summer, so beetles invade newly cut slash instead of green trees.

Mountain pine beetles, major pests of lodgepole and ponderosa pine, are largely a problem in older, overstocked stands. These stands are highly susceptible, particularly on poorer sites. Management systems, like PCT, that space trees out will enhance tree vigor and reduce tree killing.

Thinning acts to "beetle proof" your stands. For further details, see *Thinning to Prevent Mountain Pine Beetles in Lodgepole and Ponderosa Pine.*

Defoliators, such as Douglas-fir tussock moth and western spruce budworm, feed on the foliage of Douglas-fir, grand-fir, and white fir. They can cause decreased radical growth, top kill, and mortality.

Current evidence in Oregon shows no obvious benefits of thinning done before an outbreak in decreasing defoliator damage and preventing attacks. However, knowledge about how cultural practices such as PCT affect trees and their defoliators is still in its infancy.

For now, we encourage the following approach:

1. Refrain from PCT during outbreaks.
2. If you thin mixed conifer stands, try to maintain a good mixture of species that includes nonhost trees.

Diseases

Table 5 summarizes disease problems and recommended PCT practices.

Root rots usually occur as infection "pockets" in stands, slowly spreading from diseased trees to

Table 4.—*PCT guidelines for four major insect pests in Oregon.*

Insect pest	Primary host species	Geographic location	Why problem	How PCT affects pest	PCT management recommendations
Pine engraver beetles (Ips)	Ponderosa and lodgepole pine	Eastern and southwest Oregon	• Builds high populations in slash, then kills green trees.	• Enhances tree vigor, thus increasing tree resistance to beetle attack. • PCT can lead to high populations in slash.	• Create slash from August through December. If you create slash at other times, provide continuous supply of slash through June, July, and August.
Mountain pine beetle	Lodgepole and ponderosa pine	Eastern Oregon	• Kills standing green trees.	• Enhances tree vigor and reduces tree killing. "Beetle proofs" stands.	• PCT recommended to spacing levels as advised by forester. • Thin before trees reach 6" d.b.h.
Western spruce budworm and tussock moth	True firs, Douglas-fir	Eastern Oregon primarily	• Causes decreased growth, top damage, and mortality.	• Unknown—appears to have no positive effect during outbreak in Oregon. • Needs further study.	• Refrain from PCT during outbreak. • In mixed stands, retain good quality nonhost species.

healthy trees through roots. Thinning in root-rot-infested, single-species stands means putting money into trees that probably will die anyway. A PCT in mixed stands offers a chance to change species composition to more resistant species.

You'll need to evaluate separately the effects of PCT for each root disease and situation. In some cases, you can use PCT as a tool to reduce losses; in others, it's a risky investment.

Black stain root disease affects west side Douglas-fir, causing growth loss and mortality in young stands.

Apparently, this disease has always been present at low levels in the forest, but it's been expanding—and it's cause for concern. Increases in the incidence of black stain root disease have largely been associated with young stand management practices such as PCT.

In infected stands, black stain root disease spreads from root contacts and through the soil. Areas free of the disease can become inoculated by several species of bark beetles and weevils that carry the fungus from infected host trees to uninfected stands.

Fresh thinning slash, tree injuries, and cut stumps "attract" and concentrate beetles into new areas. The insects colonize and reproduce in slash and at the root collar of stumps.

Keeping these insects out of your stand is a key strategy for reducing losses. If your stands are within 1 mile of known infection centers, it will be safer to thin in July and early August, after the beetles have completed their spring and early summer flights. This should render the slash from the thinning too dry to act as a host material by the following spring.

Any trees thinned in late winter or spring are prime host material—avoid this timing in areas where black stain has been identified.

Dwarf mistletoes are parasitic green plants that can infect the branches and/or main stem of all conifers east of the Cascades and western hemlock west of the Cascades. Heavy infection reduces tree vigor, lowers productivity per acre, increases susceptibility to other pests, and lowers log quality.

Each tree species is infected by a specific dwarf mistletoe species, and cross infections from one tree species to another are rare. New infections get started when the mistletoe plant "shoots" sticky seeds that land on branches or stems. Use these facts in your management operations.

Convert heavily infected stands to new, disease-free stands. Lightly to moderately infested stands with an infected overstory need the overstory removed before thinning can occur in the understory.

Thin early your young stands without infected overstories. Discriminate against trees with heavier infestations of mistletoe, and encourage nonhost species. Well-formed ponderosa pine trees, with light infection in the lower crown, can outgrow the mistletoe once they're released.

Table 5.—*PCT guidelines for three major forest diseases in Oregon.*

Disease	Primary host species	Geographic location	Mode of infection	How PCT affects pest	PCT management recommendations
Root rots	Most conifers	Eastern and western Oregon	• Healthy root contacts infected root.	• May enhance tree vigor, but tree will die anyway.	• Don't thin within 50' of infection centers in single species stands, or don't thin infected stands at all. • Leave trees that are least susceptible to disease in mixed stands. • You need to evaluate each root rot situation.
Black stain root disease	Douglas-fir	Western Oregon	• Beetles carry fungus and inoculate new stands. Once stand is infected, disease spreads through soil and root contacts.	• Slash, cut stumps, and injured trees "attract" beetles that infest disease-free stands.	• If your stands are within 1 mile of infection center: 1. Thin in July and early August. 2. Minimize tree injury during thinning.
Dwarf mistletoe	Eastern Oregon, all conifers; western Oregon, western hemlock	Eastern and western Oregon	• Parasitic green plant on branches and main stem. • Sticky seed falls on new host and infects. • Each tree species has its own dwarf mistletoe species—cross infections rare.	• Improves vigor in light to moderately infected trees. • PCT offers way to sanitize stand and reduce growth losses.	• Heavily infected stands: convert to disease-free stands. • Lightly to moderately infected stands with infected overstory: remove overstory, then thin. • Lightly to moderately infested stands with no overstory: thin early, discriminate against trees with heavier infestations.

Slash Disposal

Slash is the residue of cut trees left after your thinning. Problems from PCT slash include fire hazard and restricting livestock and wildlife access. Benefits include the slow return of nutrients to the soil and the enhancement of small animal habitat.

Eastern Oregon practices

In eastern Oregon, slash most often treated is in one of the following ways:

1. Pile and burn
2. Underburn
3. Lop and scatter
4. Purchase slash release
5. Do nothing

Pile and burn is most common. Slash is piled by hand or with a small dozer. Piling by hand generally is too labor-intensive. Dozer piling, however, can be a reasonable and desirable alternative as long as you take certain precautions to maintain stand productivity and limit tree damage.

Focus on cleaning up large concentrations, leaving scattered slash to decompose in place. Keep equipment and logs from rubbing the bark off leave trees, so stem rots won't rob your stand of future usable wood. Mechanical piling when soils are frozen or dry helps minimize soil compaction. Use a toothed "brush blade" to keep from moving too much topsoil into piles.

Piles usually are burned in the fall or spring. Keep them small to moderate in size and tightly packed. Place them as far from leave trees as practical, to prevent scorching. Burn when weather conditions are cool and damp—this will minimize heat damage to soil and trees.

Underburning (a prescribed burn of fuel under a residual stand) is becoming more common, but it's risky. It requires considerable expertise. Consider it only under the correct climatic and fuel conditions and with appropriate control and supervision.

Underburning does offer you a good method of seedbed preparation for forage enhancement or conifer reproduction, and it reduces some of the negative aspects of machine piling, such as soil compaction and cost.

Lop and scatter involves:

1. Cutting downed trees (slash) into several sections
2. Cutting the limbs off the top of downed trees
3. Leaving this material spread throughout your stand

Lop and scatter increases your costs over doing nothing, but it gets slash down closer to the ground, which encourages faster decomposition and reduces fire hazards.

Western Oregon practices

In western Oregon, PCT slash usually is left untreated, and the landowner purchases a slash release (see the next section). Here slash typically is allowed to decompose or "melt down" naturally.

Because grazing usually isn't a factor and because the moderate, wet climate hastens decomposition, there's little incentive or need to treat slash. The steeper slopes in western Oregon also limit slash-disposal opportunities. Lopping accelerates slash breakdown rates, but it's more expensive.

Slash-release purchase

The State considers any slash you leave after PCT an additional fire hazard. This is a hazard that's over and above what your fire patrol assessment fee covers. Under Oregon fire laws, you have three choices:

1. Implement one or a combination of acceptable practices to reduce the extra hazard, such as piling and burning.
2. Pay an additional fee (a slash-release purchase; the rate you pay depends on the degree of hazard).
3. Accept the responsibility yourself—but this means you pay the firefighting costs if a fire occurs in the thinning area.

Contact the Oregon Department of Forestry for more information.

Contracting PCT

Thinning contractors are available throughout the Pacific Northwest. It's important to be prepared with information about your stand when you talk to a potential contractor.

Items for each contract bidder include: PCT location, map with thinning boundaries, number of acres, average stand diameter, trees per acre, slope, spacing requirements, stump height, whether cut trees are lopped or not, and how close cut trees should be pushed to the ground.

Be prepared to discuss your requirements and the results you expect. However, be flexible—the more "perfect" you want your stand, the more it's going to cost. Select a contractor only after you have received references from other landowners, and several bids.

You can locate thinning contractors by contacting your Extension forestry agent, consulting foresters, the Oregon Department of Forestry, U.S. Forest Service, Bureau of Land Management, and the Oregon Bureau of Labor.

A written contract agreement between you and your contractor provides a means of communication and helps protect you from poor thinning results or an incomplete job. The box on page 10 shows some of the items to consider (for further details, see *Contracts for Woodland Owners and Christmas Tree Growers)*.

Setting Priorities

If you have several PCT opportunities, establish priorities for your stands. Consider these factors: the site's productive potential, trees per acre, accessibility, the general health of the stand, average tree size, and your objectives. Table 6 reviews these factors.

Examples

We can highlight the principles in Table 6 by using the examples in Table 7.

First, let's examine stand A. Because of its young age and high growth rate, this stand probably offers the greatest return for each dollar invested. It's close to an ideal thinning condition now.

Thinning stand A should be relatively inexpensive because of the small tree size, gentle terrain, and low number of trees to cut. Thin to 300 trees/acre to maximize the saw log production objective.

Stand B is past the optimum size and age for precommercial thinning and probably should be left for a commercial thinning at age 35 to 40. It has high growth potential, so stand stagnation shouldn't be a problem. In 10 to 15 years, the average stand diameter will be about 12 inches, large enough for a commercial thinning.

In stand C, the high number of trees per acre, moderate site, grazing objective, and disease problems make it a good candidate for thinning. Without thinning, it will be decades before trees are large enough for a commercial harvest—and mountain pine beetle soon could begin killing dominant trees.

Thinning, however, may require a conservative approach. You should consider a PCT in two stages, 3 to 5 years apart, to prevent thinning shock and wind or snow damage because of small crowns.

You can expect at least a twofold increase in forage production, gain beetle protection, and still expect good gains in merchantable wood production. Thin this stand to an 18 x 18 foot spacing (135 trees per acre), so that trees will grow to 14 inches before a commercial thinning is needed.

In summary: Thin stand A first, leave stand B alone, and thin stand C gradually.

Things to consider in a precommercial thinning contract

- Legal description of land area
- External boundary designation, map of unit to thin
- Payment schedule and rate per acre
- Work starting date, work completion date
- Criteria for cutting trees: stump height, species priorities for leaving, spacing, minimum tree height to be cut, description of leave and take trees
- Slash disposal: lop and scatter, machine pile, hand pile, do nothing, pile location and size
- Hold-harmless clause (protection against negligent performance by contractor)
- Contractor insurance policies (bodily injury or death, property damage, workers compensation)
- Compliance of contractor with State laws
- Responsibility for licenses and permits
- Oregon Forest Practices Act compliance
- Precaution against fire
- Fire responsibility
- Access, road maintenance
- Suspension-of-activities clause
- Penalty clause for unacceptable performance by contractor

Final Comments

PCT is an essential management practice that will help you get the most from your woodland acres. You can use PCT to accomplish a number of woodland objectives, including timber, grazing, wildlife, and recreation. You should follow the seven steps in Table 1 when you plan and carry out PCT operations.

You can use the information provided here as a guide to precommercial thinning on your property. The success of your operation will depend on your knowledge of thinning and on setting realistic goals. If it's your first experience with thinning, start small, then enlarge the project.

Don't be unrealistic in your expectations. For practical purposes, your stand doesn't have to look "perfect" or "parklike." Expect some damaged trees, imperfect spacing, and "holes." In conclusion, we leave you with the following suggestions for PCT.

Highlights of PCT

1. Precommercial thinning makes dollars and sense—don't delay!
2. Do PCT early rather than late, but beware of ingrowth problems.
3. Don't leave too many trees! Know your target stand.
4. Avoid damaging the soil or crop trees.
5. Thin the most productive stands first.
6. Plan ahead, have realistic expectations, and keep after it.
7. Seek assistance from your Extension forestry agent, service foresters, and consultants.

Operational considerations

1. Cut below live green branches.
2. Have thinners push cut trees to the ground.
3. Closely supervise a PCT project that you hire out.

Table 6.—*Setting PCT priorities for woodlands.*

Factor	Priority	Comments
Site productivity		
Better sites, large crowns	High	Greater gains in board-foot volume.
Less productive sites	Low	Thinning on poorer sites is a low priority because gains are less; however, an exception occurs when stands on low sites won't produce marketable trees for decades.
Trees per acre		
Grossly overstocked	High	The higher the trees/acre, the greater the PCT benefit, especially on lower-quality sites.
Up to 20% above recommended stocking	Low	Gains from PCT are not significant enough to justify costs.
Access/Slope		
Easy access, gentle slopes	High	Less expensive; lower logging cost at commercial harvest.
Poor access, steep slopes	Low	Much higher harvest costs; thin to crop tree spacing.
Stand health		
High risk from insects and disease	High	PCT can sanitize stands and improve health and resistance to pests, lowering future losses.
Most trees poorly formed	Low	Future tree quality doesn't justify treatment.
Tree diameter		
Closest to ideal diameter	High	Best gains from trees closest to ideal PCT condition.
Nearly marketable trees	Low	Allow unthinned stands to grow to marketable size.
Landowner stand objectives		
Maximize wood production	High	Thin stands on productive soils: easy access, gentle to moderate slopes, and young trees.
Encourage forage	High	Thin stands with forage-grazing potential.
Provide for wildlife-hiding cover	Low	Opening stands up through PCT eliminates hiding for a time. Plan PCT around hiding-cover needs.

Table 7.—*Setting priorities for precommercial thinning: three examples.*

	Stand A	Stand B	Stand C
Growth potential	High	High	Moderate
Trees per acre	400	500+	800
Stand age/height	10/14'	25/60'	50/40'
Crown ratio	50%	30%	30% or less
Growth rate: rings/last inch	4	6	25
Slope	Gentle	Gentle	Gentle
Species	Douglas-fir	Douglas-fir	Ponderosa pine
Average stand diameter	3"	7"	6"
Accessibility	Good	Good	Good
Ingrowth	None	None	None
Stand health	Good	Good	Poor-good: mistletoe present; at high risk from mountain pine beetle in future
Objectives	Saw logs	Saw logs	Saw logs/grazing
Market for small logs	Good	Good	Poor

For More Information

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The Woodland Workbook is a collection of publications prepared by the Oregon State University Extension Service specifically for owners and managers of private, nonindustrial woodlands. The Workbook is organized into separate sections, containing information of long-range and day-to-day value for anyone interested in wise management, conservation, and use of woodland properties. It's available in a 3-ring binder with tabbed dividers for each section.

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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.