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# Ecology and Management of Eastern Oregon Forests



## A COMPREHENSIVE MANUAL FOR FOREST MANAGERS

Oregon State UNIVERSITY | Extension Service

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Online preview version

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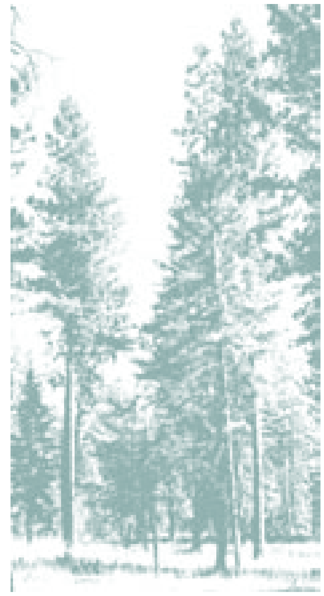
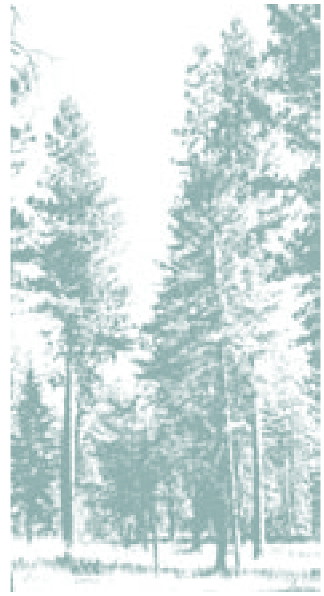


# Introduction



The forests of eastern Oregon are diverse—varying from pure stands of ponderosa or lodgepole pine to mixtures of the pines with Douglas-fir, larch, and grand and subalpine fir—and they have many values including clean water, recreation, wildlife habitat, livestock range, and timber.

Due to the forests' complexity and the great diversity of owner objectives, these forests are managed with a variety of strategies. Determining the potential of any particular forest area is not easy, and choosing management options to accomplish your objectives may be difficult. If you are interested in solving this puzzle of complexity and successfully managing your forestland, this manual is for you.

Chapter 1 is an overview of the ecology and management of eastern Oregon forest types. It will help you understand which forest type(s) you have and give you some ideas about their management. Chapter 2 is about the long-term strategies and tools you need to plan and carry out the management of your forest. Chapters 3 through 5 focus on the ecology and management of four major forest types: ponderosa pine, lodgepole pine, and warm and cool mixed-conifer. Chapters 6 covers reforestation and vegetation control. Chapter 7 focuses on important insects, diseases, and parasites that affect forests and landscapes. Chapters 8 and 9 deal with management for range and wildlife values. A glossary, Appendix 1, defines many of the specialized terms used throughout the publication.

William H. Emmingham
May 2005

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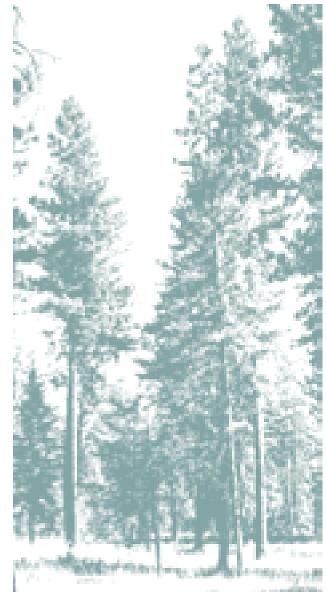
These selected pages, from Chapter 2, are a sample of the range and depth of information in Manual 12 as a whole.

CHAPTER 2

# Silvicultural systems for eastside forests

Stephen A. Fitzgerald, William H. Emmingham, Paul T. Oester

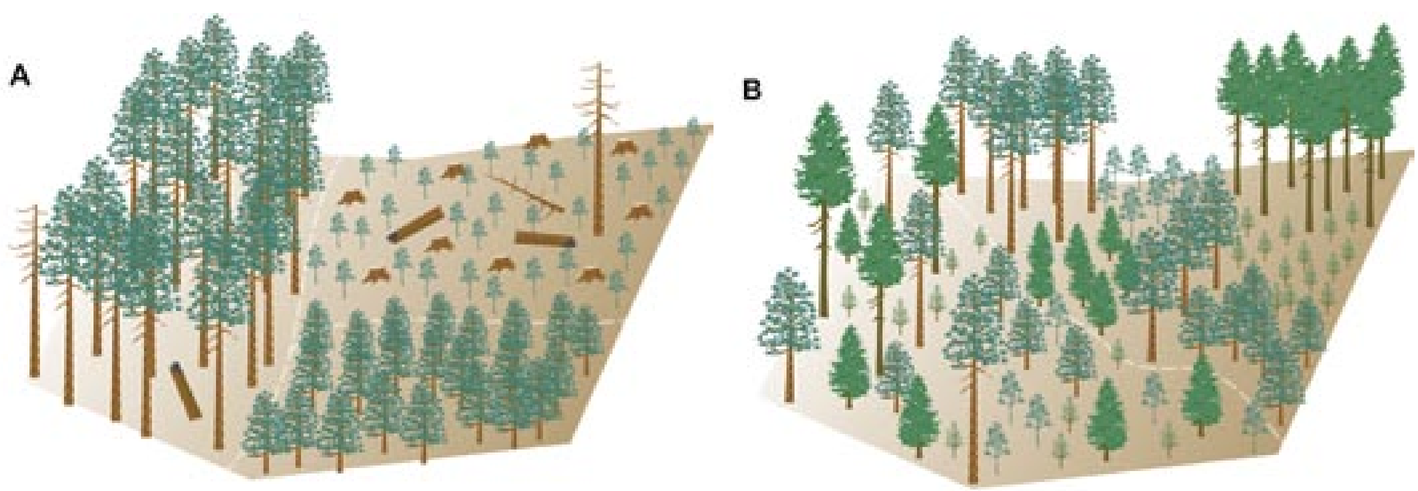


You have many choices for "designing" your forest—how it looks and what it produces—using a variety of long-term management strategies called silvicultural systems. You'll carry out your long-term strategies in operations such as planting and vegetation management, thinning, pruning, fertilizing, and prescribed burning.

It is critically important to choose your long-term strategy before you begin any management in your forest. If you act without a strategy, you run the risk that what you do today will make it difficult or impossible at some later time to achieve your long-term goals.

Lack of timely management action over thousands of acres and many decades has significantly reduced both the commercial and amenity value of eastern Oregon forests. Active management can restore many of those values. Passive "management" is risky because natural trends in stand development and succession often lead to forests at high risk of insect attack or wildfire.

In choosing a management strategy, you first need to decide whether you want relatively simple even-aged, single-story stands or more complex uneven-aged, multistory stands (Figures 2.1a–b). A critical element of the plan is how you will bring young trees into the forest; i.e., how you will regenerate the forest. The three methods of regenerating even-aged




*Figures 2.1a–b. Even-aged stands (A) are composed of trees that regenerated within a decade or so, but they vary in height and diameter, depending on their competitive position. Still, the tree crowns form a single overstory canopy. Dominant trees grow larger than suppressed trees. Uneven-aged stands (B) are composed of trees of a few or many sizes and ages (lower left). Tree crowns form an open, multilayer canopy. Or, they may be composed of small groups of trees that are more or less even-aged (upper right).*

stands are clearcut, shelterwood cutting, and seed tree cutting. Regenerating uneven-aged stands uses individual tree selection (ITS) and group selection harvest methods. Both these approaches require active monitoring and management to guide stand structure, stand density, and forest health.

Which silvicultural system you choose depends on:

- Your long- and short-term objectives
- Current stand conditions; e.g., is the stand already even- or uneven-aged?
- Site factors; e.g., is it a dry, ponderosa pine type of site or a cool, moist, mixed-conifer type?
- Insect and disease problems
- Competing vegetation
- Slope and terrain
- Timing of harvest and access for harvesting equipment

This chapter describes some of the long-term strategies (silviculture systems) and how site and stand conditions influence the management operations needed to achieve your objectives.

## Even-aged regeneration methods

### Clearcutting

Clearcutting has been used very successfully to produce young, even-aged stands on mixed-conifer, lodgepole, and some ponderosa pine sites. A typical reason to clearcut is to convert lodgepole or ponderosa pine stands that have been heavily damaged by insects, disease, mistletoe, or wind or that have had all the good or high-value trees removed in a high-grade harvest. The value of remaining trees may be marginal, and the dead and dying trees will continue to deteriorate and lose value. Clearcutting captures as much value as possible and helps make the operation economically feasible. In these situations, your main goal is to start over and establish a young, productive stand that is relatively resistant to forest pests. Clearcutting also is used to harvest forest stands that are mature; i.e., they have reached their highest long-term growth rate and top commercial value.

Once you clearcut, you are required by law to reforest the site within 6 years. Reforestation (see Chapter 6) can be by planting seedlings or by allowing seed from surrounding stands to naturally regenerate the site. Where natural regeneration is uncertain or slow, planting helps you meet the 6-year requirement. If you want to use natural regeneration, you need a special plan approved by the Oregon Department of Forestry. Be forewarned that establishing a plantation after natural regeneration has failed is much more expensive than planting in the first place, because competing vegetation has re-established.

Avoid clearcutting on dry, climax ponderosa pine or lodgepole sites or on hot, south-facing slopes with shallow soils. These are areas where soil surface temperatures are high and soil moisture is low. Planted seedlings are likely to die under these harsh conditions. In contrast, on more moist clearcut sites, planted seedlings of site-adapted species work well if competing vegetation is kept in check.

Soften the harsh look of a clearcut by using irregular boundaries and, as required by the Oregon Forest Practices Act, by leaving snags and a few green trees in the interior of the clearcut for future snags (Figure 2.2). The idea is to break up the opening in a more natural looking way and to provide important feeding areas for deer, elk, and other wildlife. Snags and large, down logs within a clearcut provide valuable habitat for cavity-nesting birds and mammals.

*Figure 2.2. A clearcut with irregular boundaries, snags, and scattered green trees.*

## Shelterwood and seed tree cuttings

A shelterwood cutting leaves enough trees per acre to provide shelter and/or a seed source to regenerate the site. Shelterwoods leave 10 to 25 trees per acre of the larger trees present. Be aware that reducing a stand below 40 to 50 square feet of basal area per acre triggers the legal requirement to reforest the area. Shelterwood cutting is used to encourage regeneration on harsh, south-facing slopes and in frost pockets. Residual overstory trees provide shade, helping seedlings survive summer drought (Figure 2.3). In frost pockets, an overstory canopy reduces the severity of frosts that can kill germinating or planted seedlings. Summer frost also can severely restrict growth or kill most of the new needles each year. If the shelterwood is on a harsh site, planting vigorous seedlings of a drought- or frost-tolerant species is a good idea.

A seed tree cutting provides a source for natural seeding where sheltering is not important. Seed tree cuts leave two to nine trees per acre, which can satisfactorily regenerate relatively moist sites where shade is not needed. However, seed tree cutting is rarely used in eastern Oregon because site conditions are likely to keep regeneration below legal requirements.

Since part or all of a new stand may come from natural regeneration, it is very important to leave healthy, well-formed trees of the species you want to manage on the site. Leave trees should be large, dominant and co-dominant trees that are vigorous and have full, dense crowns (Figure 2.3). Also, they should be free of mistletoe and other health problems. Typically, trees with these attributes are windfirm, resistant to insects, and capable of producing shade and abundant seed for natural regeneration.

*Figure 2.3. Shelterwood in a mixed-conifer stand. Note that healthy, well-formed trees with long live crowns are left to provide the best possible seed source. This photo was taken just after most of the stand was cut to leave shelter/seed trees.*

Overstory shelter or seed trees may be harvested to release the understory seedlings or may be left to create a two-story stand. If you harvest the overstory, do so after planted or natural regeneration is well established (3 to 6 years) but before seedlings are 2 to 3 feet high. This timing will minimize damage to regeneration. Remove any overstory trees of the regenerated species that are infected with mistletoe to prevent infecting understory trees. Leaving some overstory trees can provide:

- Vertical stand structure (i.e., layers of vegetation in the understory, midstory, and overstory layers) and wildlife habitat
- Increase in leave-tree value for harvest later
- Opportunity to convert to an uneven-aged stand over time

During overstory removal, protect seedlings and saplings from damage by using directional felling—felling trees toward skid trails—and using designated skid trails for harvesting equipment. Or, harvest during winter when a snow pack can protect seedlings.

*Figure 2.4. Windthrow in a shelterwood.*

Windthrow of leave trees can be a problem (Figure 2.4). In areas that get high winds (e.g., ridge tops and saddle gaps) or have shallow or wet soils, seed trees are more likely to blow over. Avoid shelterwood and seed tree cutting in these areas. Massive blowdown is likely in stands that had been growing very densely and then were opened up in one operation. The better approach is first to thin dense stands to improve windfirmness and cone production, then make a shelterwood cutting a decade or more later. A systematic thinning program throughout the life of a stand helps grow good shelter trees.

## Uneven-aged regeneration methods

### Individual tree selection

*Figure 2.5. A hypothetical stand maintained by the ITS method, in which trees in all size/age classes are thinned periodically.*

The individual tree selection (ITS) harvesting method is used to create and maintain uneven-aged stands having trees of three or more sizes mixed together with more small and medium-size trees and fewer large trees (Figure 2.5) The mix of tree sizes includes both merchantable and nonmerchantable trees. It's important to inventory uneven-aged stands so that periodic thinning can be used to adjust the balance between large and small trees (Figures 2.6 and 2.7). Using ITS may avoid the costs of tree planting by maintaining a continuous forest canopy on the site and relying on natural regeneration. ITS is considered an intensive approach because you need to thin the stand every decade or two, and you have to be careful to preserve understory trees. Stands that already have three or more size classes as a result of past harvesting, windthrow, insects, or other disturbances are good candidates for ITS. Stands that have two size classes can be converted to uneven-aged stands in a relatively short time (e.g., 10 to 20 years) with thinning and reforestation. It takes much longer to convert single-story, even-aged stands using ITS.

ITS is applied by lightly thinning every decade or two in the various size classes across each acre (see "Managing stocking in ITS," opposite). With each thinning, growing space for residual trees or new regeneration is created. The upper diameter limit for ITS typically is 18 to 25 inches. When individual trees grow to this limit, they are harvested. Trees or groups of trees less than this diameter are thinned to a specified spacing based on species, site productivity, and time until the next thinning (Figure 2.6) to keep overall stand densities, including small trees, relatively low. For example, densities of uneven-aged stands are managed at only 50 to 75 percent of the full stocking level targets for even-aged stands (see pages 28–29) in order to promote the growth of understory trees. These lower densities reduce the risk of bark beetle attack and encourage good growth on all trees in all size classes. It is equally important to have new seedlings establish after most harvests to ensure continued recruitment of trees into larger age classes over time.

A common mistake is to maintain uneven-aged stands at too high a density or to delay needed thinning. Overstocked stands especially suppress the growth of smaller trees. Often, an overstocked stand has too many large trees. For example, a 30-inch dbh tree has almost 5 square feet of basal area, so four 30-inch trees will occupy 50 percent of the lower stocking limit for ITS on many sites. The goal here is to find a good balance between overstory stocking and understory tree growth.

It is important to remember that ITS is not "take the best trees and leave the rest" or what is referred to as high grading. All size/age classes should be thinned, even trees not of commercial size, leaving the best formed and most vigorous trees to grow. Thus, during each cutting cycle, thinning may be both commercial and precommercial. Although the two types of thinning can be done at the same time, they usually are separate operations for work efficiency or contract reasons.

Most tree species regenerate well from seed on a mineral soil. However, if cone and seed production are poor (typical of larch) or competion from herbs, grasses, and shrubs is a significant problem, vegetation control and hand planting may be needed to establish a new size/age class or to secure the desired mix of species.

## MANAGING STOCKING IN ITS

Management of ITS stands involves periodic thinning in all age/size classes to achieve a balance between smaller understory trees and bigger overstory trees. Inventory of stands is necessary before partial cutting or thinning, to estimate the number of trees per acre (tpa) in each size class. Figure 2.6 depicts an uneven-aged stand with more tpa in the 4- and 8-inch diameter classes than in the 12- to 24-inch classes. Figure 2.7 superimposes a logical target number of trees for each diameter class (dotted lines on the estimates of current stocking (bars). This simple tool illustrates the need to thin in the 8- and 16-inch classes while leaving trees in the 4- and 12-inch classes.


*Figure 2.6*

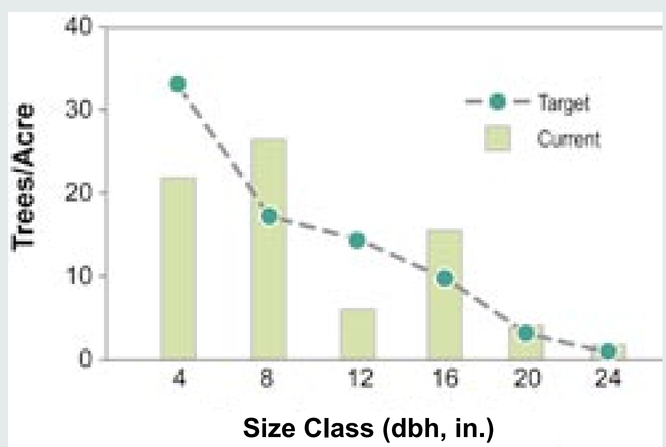
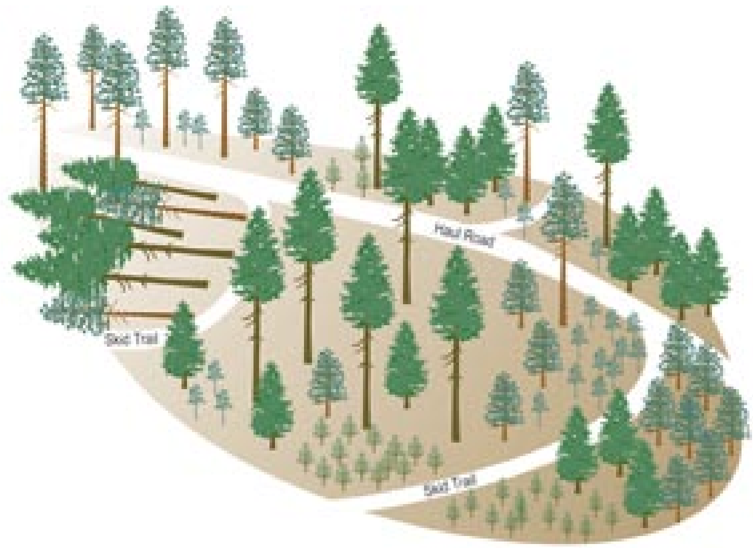



*Figure 2.7*

To prevent injuring seedlings, saplings, and commercial-size trees during harvest, carefully design the logging system (Figure 2.8). It is important to plan and establish a permanent skid trail system that reuses skid trails, controls soil disturbance, and reduces soil compaction and damage to trees. Use directional tree felling to minimize damage to residual trees, which in turn reduces risk of certain insects, disease, and decay.

*Figure 2.8. Harvesting a mature group of trees in the group-selection harvest method (as in other methods) depends on having a well-designed skid trail and haul road layout.*




## Group selection

Group selection harvests and thins trees in small groups, from about 0.25 to 4 acres. Group selection creates many small, even-aged stands of several different age or size classes within the larger stand of 30 to 100 acres or more (see the upper right of Figure 2.1b, page 21). Group selection cuts are made so that 10 to 25 percent of the stand area is harvested and regenerated in mini-clearcuts every decade or two until the entire area has been harvested and regenerated over a period of many decades. Natural seeding or planting can regenerate group selection cuts. A permanent skid trail system is important in managing stands with the group selection method.

The forests of central and eastern Oregon, particularly ponderosa pine forests, are often "clumpy" or "groupy" by nature and so are ideal for the group selection method. These forests often are a mosaic of even-aged stands of various ages and sizes as a result of regeneration in areas disturbed by fire, wind, insects, disease, livestock grazing, and past timber harvest. Many pine forests, for example, have patches of extremely dense, small-diameter trees where tree growth has stagnated (Figure 2.9). Such patches urgently need thinning to improve tree growth, vigor, and resistance to bark beetles. If trees within these groups have mistletoe infections, the trees should be removed.

On moist sites, it might be necessary to help the less shade tolerant ponderosa pine and larch by reducing the amount of shade-tolerant Douglas-fir and grand fir. Older, mature patches can be thinned to maintain an age/size class, or an entire mature group can be harvested to establish a new age class. On moist sites, it is important to make the group openings large enough (1 to 4 acres) to allow ponderosa pine and larch to establish and grow without competition from other species.

## Free selection

In many areas, forests vary in density, species composition, and tree age. Free selection combines ITS and group selection methods in such an area. Current stand conditions dictate what to do on any particular acre. For example, ITS methods are suited to the part of the stand that contains a mixture of three size classes. In other parts of the stand, trees may be clumpy; group selection either would thin some clumps to promote tree growth or would harvest all trees in mature groups to initiate regeneration. Group openings also can be created by making a miniclearcut in parts of the stand with poorly formed, insect- or disease-infected trees. Poorly stocked areas can be planted. Free selection is flexible and takes advantage of existing stand conditions to produce a very diverse forest over time.

*Figure 2.9. In a stagnated stand, pole-size lodgepole pines grow slowly or not at all. Thinning should release the trees with the best crown ratios for healthy growth.*

## Tree health and stand stability depend on stand stocking

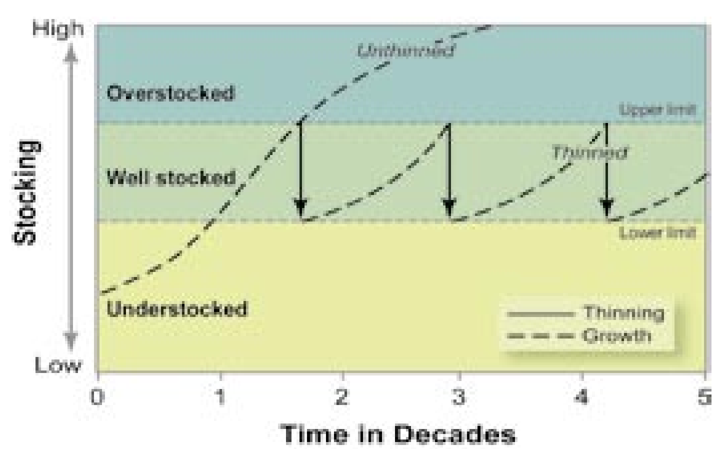
Maintaining proper stand density and stocking are the keys to maintaining healthy, stable forests that reliably produce the forest values you set in your objectives.

As mentioned in Chapter 1, stands change over time, developing from open to closed as trees grow. As trees grow, they consume more and more site resources such as sunlight, water, nutrients, and space. Each site has limited resources. As trees grow larger, the site eventually reaches its carrying capacity, and some trees lose out, becoming less vigorous. Eventually all the trees in a stand may become less vigorous and therefore less healthy. Removing some trees is necessary to maintain stable, healthy stand conditions.

Research has shown that fast-growing trees can resist bark beetle attack, some diseases, and mistletoe infection. Therefore, maintaining forest health boils down to keeping individual trees growing well. How many trees per acre you can keep vigorous depends on the site's basic ability to support trees (i.e., site productivity) and on tree size.

Site productivity varies from place to place, often over short distances. For any given site productivity there are stocking limits, which can be defined in terms of trees per acre and tree size or by basal area. Above the upper stocking limit, the stand is said to be overstocked, and many trees in the stand will become vulnerable to attack by beetles or root disease (Figure 2.10). It is important to keep stands below that level so that most individual trees remain healthy and vigorous. We establish a lower stocking limit based on how often we wish to thin or on the volume needed to make a thinning profitable. If stands are thinned below the lower stocking limit, volume growth per acre over time will be diminished. The period between thinnings depends on site productivity, how many trees are removed, and the target stocking level. For best results, you will need to determine the site productivity of your stands *before* you begin thinning; see "Measuring site index," page 28.

*Figure 2.10. The stocking levels (dashed lines) of forest stands change over time. As trees grow, stocking levels progress from low, or understocked, to well stocked and, eventually, to overstocked. By periodic thinning, stocking levels can be maintained within the "well stocked" zone, where the trees and stands are resistant to beetle attack.*



## MEASURING SITE INDEX

A site's productive potential is expressed as a site index. Site index is based on how tall certain dominant trees will grow over a given time—50 years for lodgepole pine and 100 years for ponderosa pine and other eastern Oregon tree species. A site index of 70 means dominant trees grow, on average, to 70 feet in 100 years; a site index of 140 means dominant trees grow to 140 feet in 100 years.

To determine the site index of a stand for each species, you need to systematically measure trees whose height growth has not been significantly suppressed from excessive stand density or top breakage during their development. Typically, these are dominant trees. Measure total height and age at breast height. Age is determined by boring to the center of the tree at breast height with an increment borer and counting the number of annual rings from the center to the outermost ring. Height is measured using a clinometer or other instrument See *Tools for Measuring Your Forest,* EC 1129, for more details on measuring tree heights.

As an example, you measure six dominant trees in a 10-acre stand of ponderosa pine:

| Tree | Height | Age | Tree | Height | Age |
|---|---|---|---|---|---|
| 1 | 75 | 98 | 4 | 63 | 70 |
| 2 | 82 | 95 | 5 | 63 | 65 |
| 3 | 70 | 80 | 6 | 60 | 60 |

Next, plot the height and age data points on the ponderosa pine site index curves in Figure 2.11. Because site productivity can vary in a stand, you might get a "shotgun" pattern of data points. Use your judgment as to which site index curve best represents your tree sample points. In Figure 2.11, site index curve 80 best fits the data points. Now, you can use 80 to find the maximum and minimum trees per acre in thinning operations (see example in Chapter 3, pages 56–57). **Note:** If your data points fall across several site index classes on the graph, you may need to measure more trees throughout the stand and divide the stand into areas of similar height growth or site index.

### Establishing stocking level targets

Site index is the most common way to quantify the capacity of the site to grow trees. More productive sites can support more trees of a given diameter or basal area than sites of lower productivity because more resources are available to trees. Therefore, you need to determine the site index for each stand (see "Measuring site index," at left).

### Stocking level control for even-aged stands

In relatively pure even-aged stands, each species has its own stocking limits which depend on tree spacing and site indexes. For example, Table 4.4 (page 72), provides stocking guidelines for lodgepole pine stands with an average diameter of 6 to 18 inches. Each diameter class (e.g., 6, 8, and 10 inches) has a recommended spacing and a minimum and maximum number of trees per acre recommended for each site index. Basal area guidelines also are provided. The guidelines consider efficient use of site resources, susceptibility to bark beetle attack, and tree vigor and growth. The tables apply only to even-aged stands or even-aged groups within uneven-aged stands.

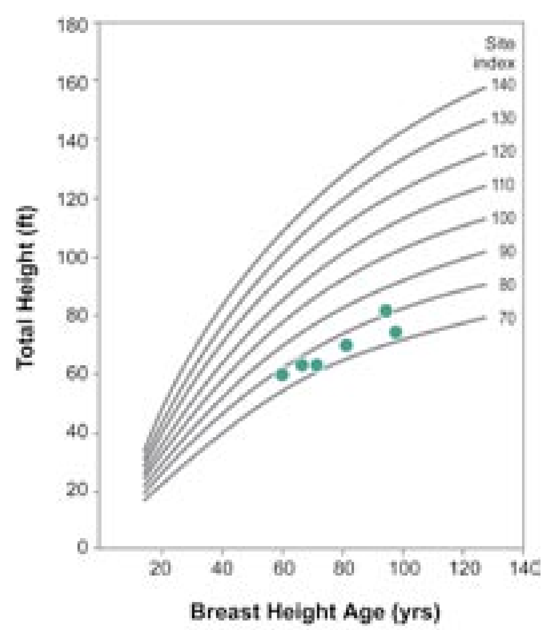



*Figure 2.11. Site index curves (100-year basis) for managed, even-aged ponderosa pine stands in central and eastern Oregon. Heights are for the tallest trees in the stand (from Barrett 1978).*

For each species, density management tables are provided in the appropriate chapter. Keeping your stand within stocking limits for a given diameter and site index maintains good growth and tree vigor. See the thinning example on pages 56–57 in Chapter 3.

If you manage your stand close to the upper stocking level, residual ("leave") trees grow more slowly and take longer to reach a given size because there is more competition. The advantage is that you come closer to capturing the full potential of the site to grow wood (that is, volume/acre/year). If you manage your stand close to the lower stocking level, there is less competition and individual trees grow faster in diameter, taking less time to grow to a target size. This approach leaves more site resources to grow understory trees or other vegetation.

### Stocking level control in uneven-aged stands

Achieving proper stocking levels is more complex in uneven-aged stands than in even-aged stands. In group-selection thinning, within the even-aged groups you can follow the guidelines above for even-aged stands. However, you might want higher stocking at the edges, where older groups adjoin younger groups, to foster windfirm edges.

In individual tree selection (ITS) thinning, where trees of many sizes are thoroughly mixed within the stand, stocking control is essential but more complex. The goal of thinning through ITS is to maintain a balance among larger, older trees and younger, smaller trees so that all sizes are growing well. Target stocking levels vary by site productivity: more productive sites can support higher

## RADIAL GROWTH AND BASAL AREA

In many Eastern Oregon sites, site quality and tree height growth are not well correlated; therefore, site index is not always a useful measure of productivity. Stands may be overstocked even if they are thinned to levels specified in tables based on site index. In such cases, you can better judge site quality by comparing radial growth with stand basal area. First, some background.

Basal area, expressed in square feet per acre, is a good measure of stand stocking, and it is easy to measure with a basal area angle gauge. The gauge measures the cross sectional area of living trees at breast height. See *Stand Volume and Growth: Getting the Numbers*, EC 1190, to learn how to measure basal area. Each species has different basic rules for stocking based on basal area.

**Radial growth** is good way to judge stand vigor and site quality in order to set stocking levels. Measure radial growth at breast height by taking an increment core and counting the rings in the outermost inch. A tree with good vigor will grow five to ten rings per inch. Trees with poor vigor will have 20, 30, or more rings per inch.

Three factors are important in determining current radial growth rates: site quality, current stocking, and historic stocking. Poorer sites may not support good rates of radial growth at the basal areas specified in the tables. You should suspect poor site conditions if the most vigorous trees (trees with more than 40 percent *live crown ratio*) on your site are very widely spaced *and* their rate of radial growth is far less than expected for the stocking level. If the radial growth of residual trees remains at 15 to 20 or more rings per inch when your stand is at or below the upper stocking level (as in the basal area table), you need to thin to lower residual basal areas. In stands where high grading has removed the vigorous dominant and co-dominant trees and left poorly growing trees, the radial growth rates on residual trees can remain low for a decade or more, even if properly spaced.

To learn more about the Growth Basal Area System that was designed to handle this situation, see Hall (1987).

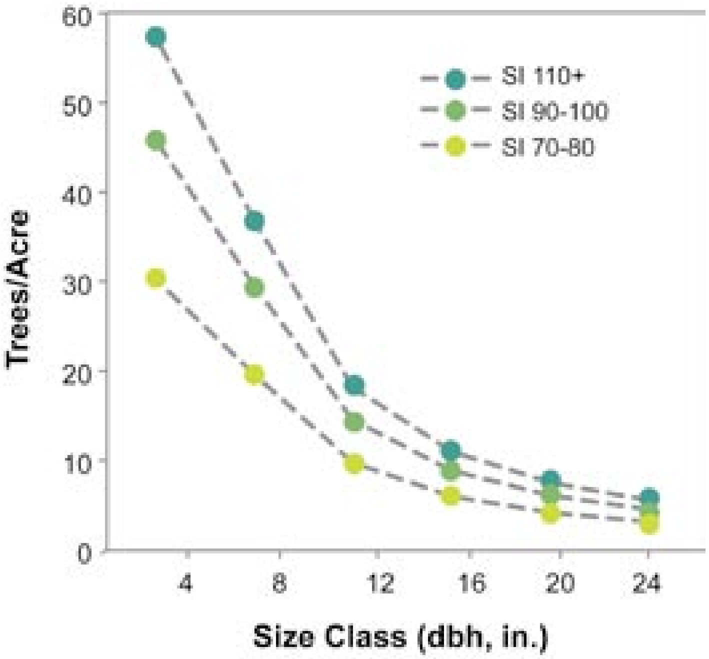



*Figure 2.12. Stocking level targets in trees per acre (tpa) by diameter class for ponderosa pine stands on sites of low (SI 70–80), medium (SI 90–100), and high (SI 110 and above) productive potential.*

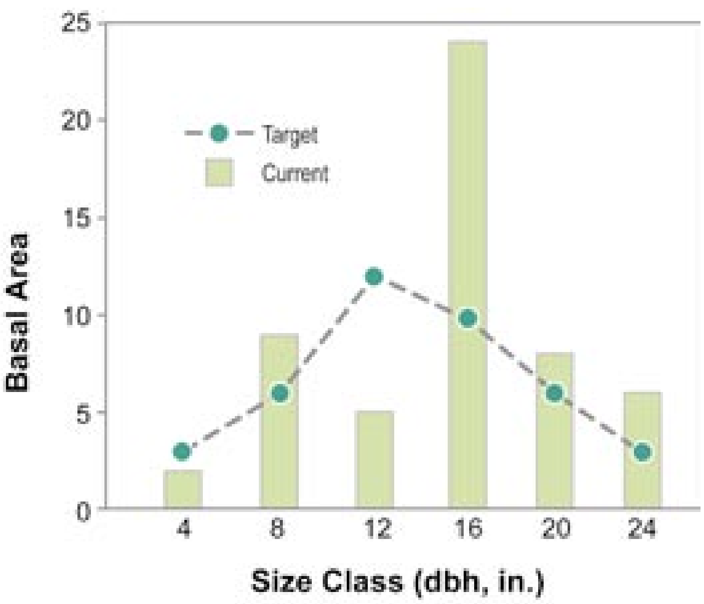



*Figure 2.13. Stocking levels in basal area (bars) and target basal area by diameter class (dotted line) for an ITS stand. Thinning should remove trees in diameter classes whose basal area exceeds target levels.*

stocking levels. Figure 2.12 shows the theoretical stocking levels by diameter class for ponderosa pine sites of low, medium, and high productive potential. A good rule of thumb is to maintain overall stocking level—measured in basal area —at 50 to 75 percent of the full stocking target level for the stand's site quality. In practice, this means you will need to measure basal area in many places to determine how much to cut during periodic thinnings.

For example, Figure 2.13 shows the amount of basal area (bars) in an ITS stand. Also shown is a target basal area (BA) level (dots) for each diame-ter class. The site index and stocking level tables (or radial growth measurements) for this stand indicate full stocking is 80 square feet of BA. Upper stocking level for ITS would be 70 percent of 80, or 54 square feet —which, by coincidence, is the current stocking. The target lower stocking level is 50 percent of 80, or 40 square feet.

Growing stock can be distributed in the different age/size classes in a variety of ways, but we chose to put about 85 percent of the growing stock in the 8- to 20-inch size classes (see Figure 2.13). This distribution provides ample numbers of trees to grow into each larger age/size class. We decide to leave the 8-inch diameter class to fill in the 12-inch class, and we decide to remove 14 square feet in the 16-inch class, 2 square feet in the 20-inch class, and 3 square feet in the 24-inch diameter class, bringing overall stocking down to the desired level. Note that the 12-inch diameter class did not have enough stocking to warrant thinning any trees in that size class. Also, over time it is important to keep young trees growing into the 4-inch diameter class; 50 to 100 seed-lings and saplings less than 2 inches in diameter would be adequate.

How often you harvest in the ITS system depends on stand density, tree vigor, the current number of age classes in the stand and, most important, the site's productive capacity. For example, on ponderosa pine sites capable of growing 200 board feet or more per acre per year, you could thin the stand every 10 to 15 years and remove on average 2,000 to 3,000 board feet per acre. The cycle for harvest on less pro-ductive sites might be as long as 20 years.