Guide to Reforestation in Oregon

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OSU Oregon State University
Oregon Forest Resources Institute
Rediscover Oregon's Forests
Oregon Department of Forestry

About this Guide

Welcome to the *Guide to Reforestation in Oregon.* This guide provides step–by–step directions for you, the forest landowner, to convert bare or recently logged lands to stands of healthy, "free to grow" trees.

Why Reforestation Makes Sense

Forests provide many benefits to landowners, ranging from income to the satisfaction of having trees and wildlife around them. In addition, the lives of all Oregonians are enriched by the jobs, raw materials, wildlife habitat, and clean water that come from forests. Whether it involves establishing a new stand on old pasture or brush lands, or reforesting after logging, reforestation is the key to restarting forests and sustaining a continued flow of these benefits.

This Guide Will Help Ensure Successful Reforestation

What often stands in the way of successful reforestation is not a lack of effort, but simply a lack of information. Some landowners may not realize that "reforestation" means more than planting trees and watching them grow. The effort is seldom successful without careful planning before planting, good treatment of seedlings before and during planting, and careful tending of the young forest for several years after planting.

What You'll Find in this Guide

With the conflicting demands for time and effort we all face, it can be difficult for you to gather specialized reforestation information. The difficulty increases for landowners who are new to forestry. The purpose of the *Guide to Reforestation in Oregon* is to bridge this information gap. The guide is written as a comprehensive outline for Oregon landowners who are not experienced in reforestation; however, it also contains information valuable to seasoned forest landowners and foresters, and also to forest stewards in other places.

Where to Get Additional Answers

Of course, there are some questions that can't be answered in a book. For help with those questions, contact your local office of the Oregon State University Extension Service or the Oregon Department of Forestry. There is contact information near the end of this book.

We congratulate you for seeking the information you need for successful reforestation and hope this *Guide to Reforestation in Oregon* will help you reach your forestland objectives.

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This manual describes the rules for reforesting after harvest of small woodlands, gives guidance for the decisions the landowner must make, and gives step-by-step instructions for planting and taking care of seedlings.

OSU Oregon State University

OREGON FOREST RESOURCES INSTITUTE Rediscover Oregon's Forests

OREGON DEPARTMENT OF FORESTRY "STEWARDSHIP IN FORESTRY"

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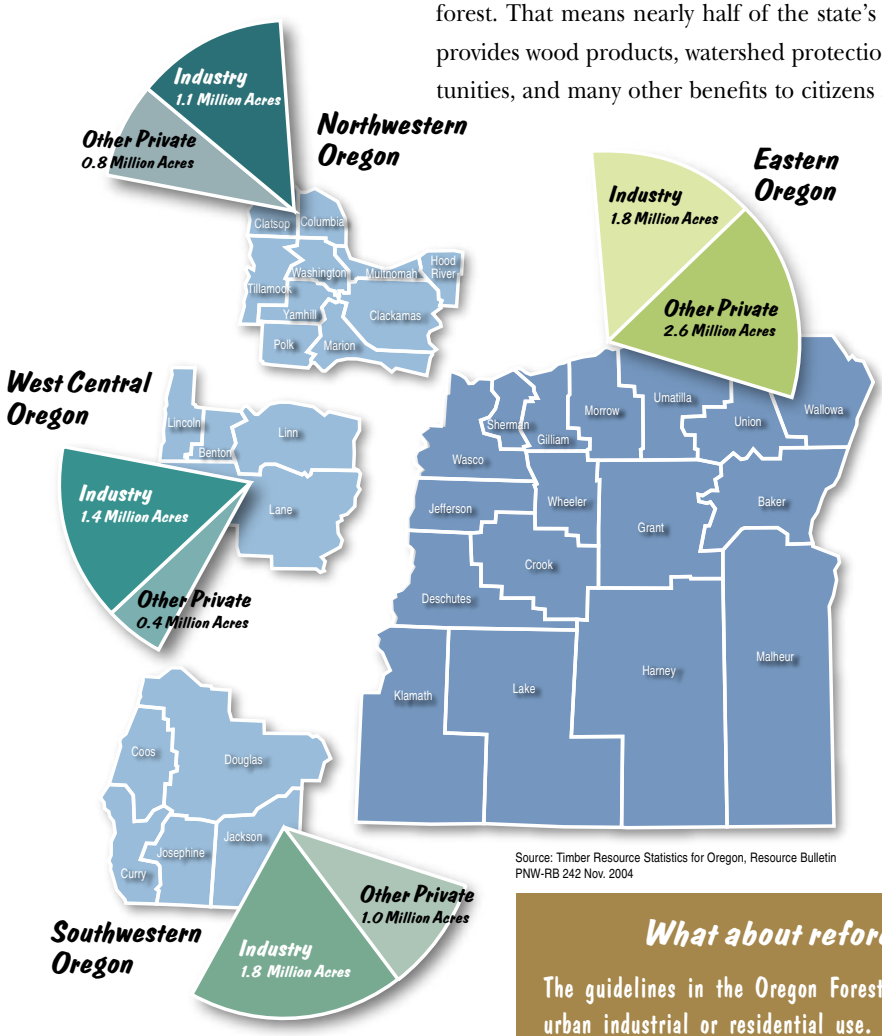
Why Reforest?

It is good for Oregon's economy and environment. Oregon has nearly 28 million acres of forest. That means nearly half of the state's land area grows trees. This vast area of green provides wood products, watershed protection, fish and wildlife habitat, recreational opportunities, and many other benefits to citizens and visitors alike.



Source: Timber Resource Statistics for Oregon, Resource Bulletin PNW-RB 242 Nov. 2004

More than 10 million acres of Oregon's forestland is held privately (industry and family owned). About 4.5 million acres are owned by about 166,000 non-industrial private woodland owners. In Western Oregon there are approximately 6.3 million acres of privately held forest land as compared to Eastern Oregon's approximate 2.7 million acres.

Another important reason for reforesting is it's the law. Oregon was the first state in the nation to have rules to ensure continuous harvest of timber on private lands while safeguarding soil, air, fish, and wildlife resources. In 1971, Oregon enacted the Oregon Forest Practices Act, which regulates many activities conducted on forestland (e.g., timber harvest, road construction, site preparation, and reforestation).

What about reforestation in urban areas?

The guidelines in the Oregon Forest Practice laws do not include lands zoned for urban industrial or residential use. However, there are landowners with small lots who may wish to create a forest setting within an urban boundary. Aspects of this manual might prove useful since many of the same reforestation concepts will apply. While most homeowners get their landscaping plants from horticultural nurseries, the landowner looking for a modest order of 100+ seedlings might want to call one of the state's many forest or horticultural nurseries. Depending on the urban planting site, it is a good idea to check with neighbors, get advice from a Master Gardener or Master Woodland Manager, check on local ordinances, and find out what your local Oregon Extension Office recommends. You might also check with industrial neighbors who might provide advice and may have surplus seedlings available.

What Does the Law Require?

The purpose of the reforestation rules is to ensure that forest tree cover is maintained or re-established after forest trees are harvested. The regulations are embodied in the Oregon Department of Forestry Forest Practice Administrative Rules (OAR) and Forest Practices Act, Chapter 629, Forest Practices Administration. The Oregon Board of Forestry recognizes that optimum tree stocking levels are desirable. The rules are designed to require reforestation that ensures that stands of trees continue to occupy forest sites, but at somewhat less than optimum levels. Most landowners should easily be able to comply with these rules by using sound harvesting and reforestation practices.

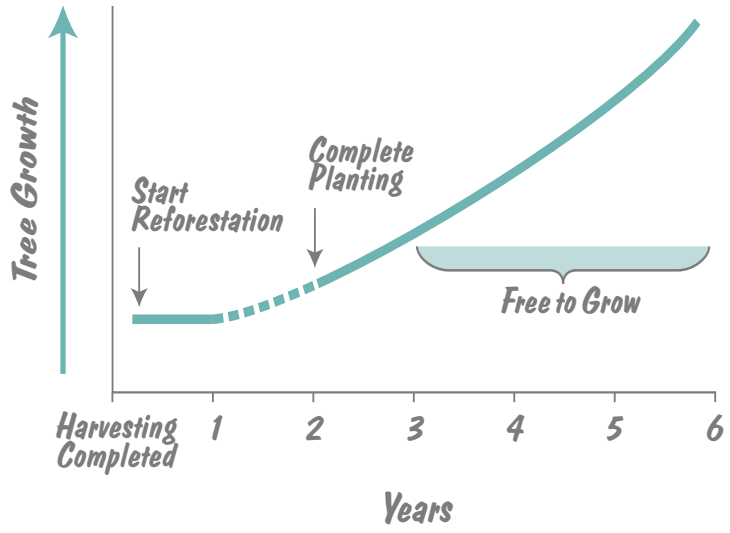
Reforestation is required on areas where harvest operations have taken place and post-operation tree stocking is below specified levels. These required stocking levels vary by site productivity. The reforestation rules allow either artificial (usually tree planting) or natural (seeding from mature trees on site) methods to be used. The rules also describe time limits within which reforestation must be accomplished. Reforestation requirements apply any time that post-operation stocking is below the levels specified in the rules, even if stocking was already below those levels before the operation. In other words, landowners often must reforest following salvage harvests and conversions of under-producing stands. The rules also specify procedures for operations involving forest incentive programs and developing forestlands to non-forest uses. Check Oregon's Forest Protection Laws: An Illustrated Manual (2002) with a Stewardship Forester for specifics, or see Forest Practice Notes Number 2: Reforestation (December 1994).

The reforestation rules hold landowners, not loggers, responsible for reforesting their lands after forest operations. Landowners are expected to understand and apply the forest practice reforestation rules. Landowners should be aware that planning for reforestation before harvesting operations begin will make compliance with the rules easier. In addition, landowners need to know that if the Oregon Department of Forestry (ODF) identifies a reforestation rule violation, the landowner will be ordered to comply with the rules and may be assessed a civil penalty of up to $5,000. If the land is sold, any uncompleted

obligation to reforest transfers to the buyer. Therefore, by law, the seller must inform the buyer, in writing, of the pending reforestation obligation (Oregon Revised Statutes (ORS) 527.665).

When reforestation is required, it means more than simply planting seedlings or saving seedlings, saplings, or trees already on the site. The landowner must see to it that the trees are in "free-to-grow" condition after six years. Being "free to grow" means that a tree has a good chance of outgrowing undesired competing grass and brush to become part of a vigorous, healthy forest. For example, trees surrounded by taller vegetation are not free to grow, and may be stunted or killed by competition for sunlight, water, and soil nutrients. The free-to-grow requirement makes it very important for landowners to plan for reforestation before harvesting begins. Planning will minimize the costs of reforestation and ensure its success.

A harvest unit may be exempted from the reforestation requirements if the landowner is developing the land for a bona fide non-forest use. The landowner must obtain documentation from the county that authorizes the new land use under local ordinances and states that all necessary permits have been obtained. The land use change must be completed within 24 months of harvest completion and must be maintained for at least 6 years.



How Long After Harvesting Do I Have to Reforest?

The reforestation compliance clock starts running when the harvest operation is completed or 12 months after felling begins, whichever comes first. Once the clock starts, landowners have:

- 12 months to start reforestation tasks such as site preparation and ordering seedlings
- 24 months to complete planting; and
- 6 years to establish an adequately stocked free-to-grow stand

Approved written plans are required if natural reforestation methods will be used. Plans for natural regeneration must be submitted no later than 12 months after the completion of the operation.

How Many Trees Do I Have to Plant After Harvest?

Generally, the more productive the site, the more seedlings or residual seed trees are required for successful reforestation. At least 100 to 200 well-distributed tree seedlings per acre (see Forest Practice Notes Number 2, December 1994, for detailed standards) must be established after a harvest operation (including salvage harvest) if the remaining tree stocking is below minimum levels. See *How many trees should I plant?* in this publication for more guidance.

Do I Have Choices in What Tree Species I Can Plant?

Yes. Any tree species, conifer or hardwood, suited to the growing site and with commercial value, may be used for reforestation. Natural reforestation plans proposing that hardwoods be allowed to grow untended from seed or sprouts will generally not be approved. Active management of hardwoods, such as inter-planting of unstocked areas or thinning, is needed to gain plan approval. An approved written plan is also required if non-native tree species are to be used.

How Can I Make Sure Trees Are Free to Grow?

Ensuring that trees are free-to-grow usually means controlling competing vegetation. A common control method is the use of herbicides. The Oregon Forest Practices Act requires that ODF be notified before herbicides are applied to forestland. The notification must include a map of the parcel being treated and the name of the chemical. Forms may be obtained from ODF offices. If chemicals are to be used within 100 feet of a fish-bearing stream, a written plan is required. Rules also require protection of vegetation in riparian management areas. Individuals doing their own herbicide applications need to have the proper equipment, as well as an applicator license for use of chemicals as required by state law and product label. See OAR 629-620-0600 for additional requirements, and check labels of any product you are considering using. If a spill occurs, it must be reported to ODF and the national response center (1-800-424-8802)

Where Can I Get More Information About the Requirements?

Copies of the December 1994 *Forest Practice Notes Number 2: Reforestation*, *Forest Practice Field Guides* and *Oregon's Forest Protection Laws: An Illustrated Manual* are available from any ODF office. They provide more detailed information on:

- reforestation stocking requirements
- determining the site's productivity class
- free-to-grow requirements
- written plans
- suspension of reforestation rules in forest incentive program cases
- re-vegetation required for bare soil
- changing land use

For information about vegetation management requirements, see *Forest Practice Notes Number 3: Chemicals and Other Petroleum Products* (January 1997).

Landowners needing further help should contact qualified consulting foresters or other professional foresters, including ODF Stewardship Foresters or OSU Extension Foresters, for advice. Contact information is included at the back of this publication.

Decisions! Decisions!

There are a great many decisions to make when planting a new forest. Many of these decisions or choices must be made very early in the process of reforestation. Preparation is the key to success.

Select an Appropriate Goal for Your Land

Your reforestation choices will be a result of your goal selection. Consider these common choices:

- Timber production
- Wildlife or native woodland
- Multiple use – balance of timber and other revenue commodities with non-revenue commodities
- Conversion – converting from grass or brush fields to forest
- Legacy forest – long-term plan with indeterminate final outcome
- A combination - part of the property for timber, part for wildlife, etc.

Timber production is growing commercially valued trees for sale to wood products companies. Choosing this goal has to be closely matched with the characteristics of your land or growing site. Growing trees to sell requires the proper soil, climate, and zoning. It also requires knowledge of future wood product markets and how your trees will be grown for these markets. You may need assistance to see if your site is well matched with this goal. Timber production, like any business venture, requires careful planning and investment for future returns. Growing trees can be both profitable and enjoyable. It also offers many investment choices. You must select from a wide array of financial choices as you prepare the site, select and plant seedlings, and provide post-planting care. You may wish to consider these choices as investment options, each with inherent risk but with various yield potentials. The decision to make a low initial investment may be more risky and offer lower yields than other choices. Expert assistance may clarify your options based on your site and resources.

Your site may be better suited for certain types of wildlife or native plant habitat. Investment choices related to this goal offer differing outcomes. Sometimes this goal incorporates the use of natural or artificial seeding as a method of tree establishment. Many free or low-cost publications about managing forestlands for wildlife are available from the Woodland Fish

and Wildlife Project of the Western Forestry and Conservation Association. See *To Learn More* in this publication for a listing of available publications and webpage links.

A multiple use goal for your land seeks to balance income with other non-revenue values, like enhancing riparian zones, wetlands, or developing habitat for wildlife. Choosing this goal may make your management choices more complex and can increase costs. However, cost-sharing programs may help with partial reimbursement for riparian enhancement and planting.

Conversion to forest from non-forest land use can be expensive, due to the high costs of preparing the site, obtaining seedlings, planting, and caring for trees. However, cost-sharing, grant programs, or tax credits may help reduce this high start-up cost. Vegetation management and careful selection and care of seedlings are essential to accomplishing this goal. Technical assistance from an ODF Stewardship Forester or an OSU Extension Forester can help you develop a plan to increase planting success. Under certain conditions, such conversions can qualify for a future one-time exemption from most of the tree retention requirements normally imposed by the Forest Practices Rules (OAR 629-611-0000).

A legacy forest is a long-term project to grow forests for some future use, like handing down a forest to future generations or to a conservation organization. This goal entails very long-term choices with a broad range of possible outcomes. Choices are made not to get quick cash returns but to enhance the forest growth and maturity, watershed, and wildlife values into the future for subsequent generations.

Give goal selection considerable attention to determine what is best for you and your land. It will make the many subsequent choices of preparing, planting, and caring for the trees much easier and more successful. Ultimately, you will need to know what your land is best suited to grow and consider what you want to accomplish and are willing to invest. Each choice, if carefully undertaken, can be a work of stewardship helping Oregon's environment and way of life for its citizens. Financial assistance programs for afforestation, and in some cases reforestation, are available from the U.S. Department of Agriculture to share some costs to eligible landowners. These programs are administered by ODF and/or USDA. At the back of this publication there is information on how to contact a Stewardship Forester in your area. The OSU Extension Service has publications about landowner assistance. See *To Learn More* in this publication for ordering publications.

Decide How to Prepare the Site

Site preparation is nothing more than creating the best growing environment for your seedlings at the time of planting. Logging slash, weeds, and compacted areas can create unfavorable conditions and prevent the site from meeting the reforestation standards described in Oregon's Forest Practices Act. Typically, timber harvesting leaves residual logging debris (slash) lying on your harvest site, as well as creating openings in your forest canopy (clearcuts or small patch cuts). The slash can restrict access for planting and other activities and can pose a fire hazard. The new openings encourage rapid growth of many herbaceous plants and shrubs that will compete with tree seedlings for moisture, nutrients, and light. The best time to prepare your site to enhance the survival and vigorous growth of the new forest is immediately after harvest and before planting.

What are the most common choices for site preparation?

Depending on your goals, finances, and site conditions, you may wish to:

1. Clear the land with machinery (mechanical), placing debris in piles
2. Clear the land by hand (manual), piling debris or cutting it and leaving it lie (slashing)
3. Clear the land with aerial or ground-based herbicide applications (chemical)
4. Clear the land with fire (slash or pile burning)

There are also many combinations of choices, and it is wise to seek professional advice, especially if the land is steep or riparian areas might be impacted. Some choices, such as use of heavy equipment like bulldozers, will be expensive. Steep slopes may preclude operation of heavy equipment, or the presence of tall trees may make aerial operations difficult. Conversion of grass or pasturelands to a forest may require disking or ripping with a subsoiling tool. Heavy grass or sod mats may require burning beforehand to ease the tilling process.

In developing your site preparation plan, consider the following:

- Before harvesting, identify who is responsible (the logger or landowner) for site preparation, seedling purchase, and planting. Include this information in your logging agreement.
- Before harvesting, consider what type of vegetation is likely to appear after the land is cleared.
- Do only the minimum amount of site preparation necessary for replanting to reduce fire hazards, save money, and reduce disturbance to the site.
- After harvest, identify the competing vegetation on the site and determine the correct vegetation control method if one is required.

Mechanical site preparation

Before using mechanized equipment, you must fill out a Notification of Operation at an ODF Office. Minimize soil disturbance and compaction, for instance by using an excavator, if possible. If you use a bulldozer, be sure to use a brush blade. To reduce compaction and displacement, pile brush when soils are frozen or soil moisture is low. Avoid creating ruts down slopes.

Do not use heavy equipment:

- When soils are saturated or damp enough to be compacted easily
- In wetlands within 50 feet of water (the distance may vary depending on water type)

Care must be taken to protect water and riparian areas when applying chemicals

Chemical site preparation

If you plan to use herbicides for site preparation, refer to ODF's rules for application of chemicals.

Determine whether the terrain is suitable for aerial or ground equipment. If there are unwanted scattered hardwoods present, treat them individually by injection (hack and squirt) or backpack sprayer (basal or thin-line).

Prevent Soil Compaction

Soil compaction is caused by the use of heavy equipment. As soil becomes compacted, it has less and less pore space for air and water. The loss of pore space can halt root growth in that soil. Compaction along skid trails and tractor paths can inhibit seedling growth for decades. Avoid using heavy equipment when you can.

Site preparation by burning

If you plan to use controlled burning as a site preparation technique, contact the local ODF office for forest practice rules and fire permit requirements.

In any kind of site preparation, minimize slash and debris in riparian areas. Keep slash piles above the 50-year floodplain of all waters. Minimize slash within 100 feet of public roads and 500 feet of structures to minimize fire hazard. As you develop a detailed plan, consult a forester for additional information.

Decide What to Grow

Oregon has millions of acres suitable for growing trees. Your land has specific properties that will influence or limit what will grow well (or grow at all). You may have to modify your original goals after carefully analyzing your site and the species best suited to it.

The following questions can help you identify the best species choices for your site:

- What is the soil type and what are the soil's properties?

  Most important are the physical properties: water-holding capacity, rate of drainage, presence of restrictive layers or "pans", high water table, depth to bedrock, etc. Consult local soil survey maps, which are found at Natural Resource Conservation Service offices to find out about your area.

- What species of trees grow on this land or in the area?

  Carefully observe what tree species are growing on your site before you harvest. Are those species growing well on your land? Trees native to your area should be well adapted to your site. However, unique properties of your site may make it difficult even for some natives of your region. These micro-sites may require unique species selection. To find out more about how to identify trees or shrubs that are or were growing on your land, consult OSU's Extension Service circular EC 1450, *Trees to Know in Oregon.*

- What are the site's slope and aspect?

  Steep south-facing slopes offer very different challenges to growing trees than flat or north-facing slopes. Generally, steep south-facing slopes are warm and dry and require more care in reforesting than other slopes and aspects. North-facing slopes may favor competing vegetation that will require the planting of large seedlings and vigorous vegetation management.

- What is the climate (rainfall, periods of drought, temperature extremes)?

  Trying to grow trees that are not well adapted to your land's climate may limit their growth or vigor or increase their susceptibility to pests and diseases. Instead, choose species well adapted to the site conditions. Avoid species known to be susceptible to common diseases or insects.

Should I replant with species different from those being harvested?

Not usually, but the answer may be "Yes", if another species

- is better adapted to site conditions
- is less susceptible to forest health problems
- has greater economic potential

Commonly planted tree species for western and eastern Oregon

Eastern Oregon		Western Oregon	
Common name	**Scientific Name**	**Common name**	**Scientific Name**
Douglas-fir	*Pseudotsuga menziesii*	Douglas-fir	*Pseudotsuga menziesii*
ponderosa pine	*Pinus ponderosa*	grand fir	*Abies grandis*
Engelmann spruce	*Picea engelmannii*	incense-cedar	*Calocedrus decurrens*
grand fir	*Abies grandis*	Jeffrey pine	*Pinus jeffreyi*
lodgepole pine	*Pinus contorta*	lodgepole pine	*Pinus contorta*
mountain hemlock	*Tsuga mertensiana*	ponderosa pine	*Pinus ponderosa*
subalpine fir	*Abies lasiocarpa*	Port-Orford-cedar	*Chamaecyparis lawsoniana*
sugar pine	*Pinus lambertiana*	California red fir	*Abies magnifica*
western larch	*Larix occidentalis*	Sitka spruce	*Picea sitchensis*
western white pine	*Pinus monticola*	sugar pine	*Pinus lambertiana*
		western hemlock	*Tsuga heterophylla*
		western redcedar	*Thuja plicata*
		western white pine	*Pinus monticola*
		white fir	*Abies concolor*
		Hardwoods	
		red alder	*Alnus rubra*

If root rot or other diseases are found prior to or during harvest, replanting hardwoods or more resistant conifers may be an excellent way to avoid future problems. Similarly, planting hemlock, cedar, or spruce seedlings rather than Douglas-fir may be a good choice in areas affected by Swiss needle cast.

What about growing exotic or non-native trees?

It would be nice to find a tree species that would grow better, faster, and taller than the local varieties, but in most cases the exotics prove to be inferior to trees from local sources. Should you want to try an exotic species, carefully research what is known about its performance in your area. You may need to consult with forestry professionals, who can help you with species selection, growth characteristics, and potential wood markets. You will need ODF's approval of your plan.

Should I plant more than one species?

Planting diverse species of conifers or a mix of hardwoods and conifers is gaining wide acceptance. More landowners are planting several species to suit different conditions on a site, such as pines or cedar in wetter spots and Douglas-fir in the remainder. This practice does require careful attention to the special needs of each species (i.e., different site requirements, special handling and planting, and different vegetation management strategies).

Decide Between Seeding and Planting

Seeding

Landowners who choose seeding use either artificial (also called "direct") seeding or natural seeding. This depends on the silvicultural management regime being employed. Artificial seeding employs seed collected from or near the planting site or from a suitable seed zone. Natural seeding uses seed from nearby mature trees. The advantage of artificial seeding is that seed can be applied immediately after harvest without waiting for a year with good cone or seed production for natural seeding. Natural seeding may prove impractical at some sites since for some species the period between cone crops is 7 to 10 years, longer than the time required for the forest to be free-to-grow. You may need to prepare the site to expose adequate soil for both artificial and natural seeding and to remove existing undesirable species. When harvesting, be sure to leave seed trees of a desirable species or mix of species.

Eastern Oregon landowners have used natural seeding as a viable reforestation method for many years. However, unpredictable cone cropping, unfavorable weather, and competing vegetation can result in over or under stocking as well as poor forest health. The potential benefits (e.g., lower cost) can be quickly offset by unreliability. Therefore most landowners choose to plant rather than rely on natural regeneration.

If you select either artificial or natural seeding, you are required to submit a pre-approved plan; check with the local ODF office about what it should include. For more about seeding and silviculture in Eastern Oregon obtain a copy of *Ecology and Management of Eastern Oregon Forests* (Manual 12) through the OSU Extension Service. Seed zone information can be obtained through ODF.

Planting

If you choose to plant trees, you have several more decisions to make. The first is whether you will hire a contractor or plant the seedlings yourself.

If you want to hire a reforestation contractor, consider the following in your selection:

- Does the contractor have adequate general liability and auto insurance?
- Will the contractor sign a planting contract specifying prices for services, planting techniques, and a guarantee of workmanship?
- How long has the contractor been planting trees?
- Does the contractor have references from other customers?

If you want to plant the trees yourself, ask yourself the following questions:

- Do I have the knowledge, strength, and skills necessary to plant my trees?
- Do I have the time?
- Do I have the right tools?
- Do I have a suitable place to store my seedlings while I plant them?
- Do I have a way to transport my seedlings to the planting site?

Arrange to Get Trees

When should I order my trees?

Order trees as soon as possible. If you know well in advance when your harvest or conversion will occur, place your order for trees with a nursery ahead of time. It is generally best to seek a source of seedlings between one and two years before you plan to plant because it takes that long to grow quality seedlings. Ordering early will ensure the best selection of seedling species and sizes. Last-minute ordering may leave you with unacceptable choices that could mean costly delays.

Where can I order trees?

ODF's Forestry Assistance program publishes an annual guide to finding seedlings, called *Sources of Native Forest Nursery Seedlings*. This free guide is a listing of local nurseries in Oregon and surrounding states with the species, sizes, and cost of seedlings they offer for sale to landowners. You can get it from your local ODF, on the web, or from an OSU Extension office.

Make on-site visits to nurseries to compare seedlings first-hand. If you have planned ahead for your seedling needs, you may be able to visit several nurseries. This effort will make seedling shopping much easier, since you will be able to compare what you are buying first-hand. You can get a sense of the overall seedling culture and care that catalogs don't reveal. Differences in stock-types and species will be very apparent. You can get a sense of root mass by asking to dig some samples. A personal visit will let you meet the nursery staff and ask questions about sorting and packing, size ranges, and other issues that will help in your seedling

buying decision. Although this step will take some time, it will pay big dividends in that you will have a clear idea of what you are buying when you get your trees.

What seed source should the seedlings come from?

There are specific geographic ranges within which seed can be transferred from collection sites to planting sites without problems. These areas are called "seed zones." The publication *Forest Tree Zones for Western Oregon* (1996, Oregon Department of Forestry, Salem OR) has a series of seed zone maps for each tree species commonly planted in western Oregon. For eastern Oregon, seed zones maps can be found in *Sources of Native Forest Nursery Seedlings.* In general, seed collected from within a zone should be planted in the same zone, so that the trees and the climatic conditions are compatible. The seed zone concept was developed because planting incompatible seed can lead to forest stand failures years and even decades after planting. Seedlings planted outside their zone can be highly susceptible to frost damage, disease, insects, and wind, whereas seedlings from the local source are adapted to local conditions and are barely impacted.

The seed zones are subdivided into topographic areas or elevation bands with even more similar environmental conditions. Elevation bands within seed zones differ for each species. Most bands represent 1,000 feet of elevation, but some are only 500 feet, and others may be 2,500 feet. Whenever possible, obtain seedlings from both the same seed zone and the same elevation band as the area you are reforesting.

What about genetically improved seedlings?

Genetically improved seedlings are raised from seed produced in orchards with carefully selected and arranged parent trees. The parents are selected for growth, form, and other desirable traits. Only a few species (e.g., Douglas-fir and western hemlock) are currently available. Genetically improved seedlings are available from several nurseries at a slightly higher cost than seedlings grown from natural or wild stands of trees. The higher cost of the seedlings is considered to be offset by the faster growth and better form of the young trees.

Similar to seed zones, genetically improved seedlings have "breeding zones." The Douglas-fir breeding zones are similar to the revised seed zones described in *Forest Tree Zones for Western Oregon* (1996, Oregon Department of Forestry, Salem OR). Because general demand is small, you cannot expect nurseries to have the genetically improved seedlings for your particular area. There are quite a few sources in northwestern Oregon and the Cascade foothills. There are currently few sources in southwestern Oregon, the southern Cascades or Siskiyou Mountains, or eastern Oregon.

What is an appropriate seedling type?

Bareroot

In Oregon this is the most common seedling production type. Seeds are sown and grown outdoors in nursery beds, lifted, and provided to you without soil on the roots (hence the name). Trees of this type are frequently classified by the number of years grown in a nursery and transplant bed. For example, the 1+1 stocktype is grown for one year from seed, lifted, sorted for culls, transplanted, and grown in a nursery bed for one more year. The 1+1 has proven to be a large and reliable seedling for years. Bareroot seedlings can also be offered by size subclasses within a type, such as 2+0 small or large.

Container

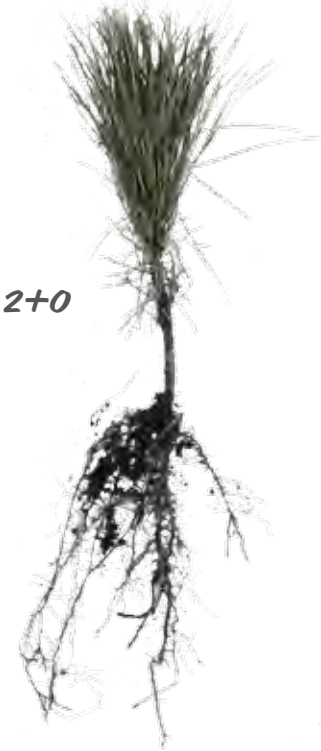
Container seedlings are also called "plug" seedlings. They are normally grown in a greenhouse or a shelter-house, which is a modified greenhouse. The container cavities are filled with growing medium (e.g., peat and perlite) and the seed is sown on top. The term "plug" comes from the fact that the seedling, once grown, looks like a plug stopping up a hole. There is a wide array of container sizes and shapes. One of the most common container seedling sizes is the 'styro-8', which is grown and extracted after one year. A styro-8 is a seedling grown in a styroblock container

What is a stock-type?

Generally, stock-type is given as a code that denotes both how the seedling was grown and how long it was grown in the nursery. The stock-type number designations can seem a bit strange at first, but actually the system is simple. A 2+0 seedling is one that was sown in a bareroot nursery and grown without disturbance for 2 years. In contrast, a 1+1 seedling was grown from seed for 1 year, lifted at the end of the first growing season, then transplanted back into nursery beds and grown for one more year. The 1+1 Douglas-fir stock-type has become increasingly popular among foresters because it has a large stem diameter and a large root volume (or mass), and it tends to perform well over a range of site characteristics.

Douglas-fir

ponderosa pine



2+0

p+1

Styro-8

Styro-15

western larch

p+1

western hemlock

p+1

western redcedar

p+1

having an arrangement of 80 cells with a cavity size of 8 cubic inches. Larger stock sizes such as styro-10 and styro-15 (10 and 15 cubic inch cavity sizes) container seedlings are available as well.

Combination

A typical combination of the two seedling types is the plug+1. These seedlings are grown in a greenhouse or shelter-house for 9–12 months and then transplanted into a bareroot nursery for a year. Plug seedlings for transplanting are often grown in styroblocks with 1-, 2-, and 4-cubic-inch cavity sizes. Plug+1 seedlings can be very large, and similar to 1+1 seedlings. Some harder-to-grow species such as western hemlock are available more often as plug+1s than as 1+1s.

What is an appropriate seedling size?

Your planting site conditions will provide clues as to the most appropriate size of seedlings to use. Evaluate your site for rapid growth of competing vegetation, limiting moisture, shallow soil depth, rocky soils, or animal browsing potential. Depending on the limiting factors at your site, you may need to obtain more than one size of seedling.

If you have a high potential for severe brush competition and do not have a moisture limitation, then large seedlings are a good choice. Although the larger seedlings may be more expensive and harder to plant, they are more able to survive and grow when competing with brushy species. If your planting site is droughty or has shallow soil, consider shorter trees with large root systems. Small seedlings should be used only on well-prepared sites (like those prepared by burning) and where there is little or no potential browsing problem. In general, you should plant the largest size tree that your site can support. Many nurseries have limited supplies of large trees, so place your order as soon as possible.

A few bareroot nurseries also offer seedlings by size class rather than a coded (e.g. 2+0) stock-type. The seedlings may be called by size names like "large" or "extra large." As a careful seedling shopper, ask about packing and grading sizes (e.g., heights and stem calipers) to compare stock-types offered at different nurseries. You may also ask about typical ranges of sizes or percentages of seedlings at the minimum and various larger sizes. It would be a mistake to assume that all 2+0s or 1+1s or 2+1s are the same size or have the same distribution of roots or branches or foliage. Also, you can't

Comparison of Common Stock-types

Stock-type	Nursery type	Typical minimum Height (in.)	Typical minimum Caliper (mm)	Advantages	Disadvantages
1+0	bareroot	6–8	4–5 (hardwoods)	Typical for hardwoods like alder, maple, oak, ash	
		5–8	3–5 (conifers)	Cheaper than 2+0	Must have excellent site prep Requires careful handling
2+0	bareroot	10–15	4-5	Common minimum size for Douglas-fir Much cheaper than 1+1 or plug+1s	
		12–16	4-6	Larger size 2+0 Cheaper than transplants	Less root mass than transplants

Stock-type	Nursery type	Typical minimum Height (in.)	Typical minimum Caliper (mm)	Advantages	Disadvantage
Styro-5	container	6–8	2-3	Slightly cheaper than 2+0	Must have excellent care and site prep Less common type for outplanting Costs slightly more than 1+0
Styro-8	container	9–12	3-5	Desired for ease of handling and planting	Not readily available without a contract Costs more than a 2+0
Styro-15	container	10-16	4–6	Large seedling produced in one year	Costly May require browse protection
Styro-20	container	14-20	4–6	Very large container seedlings	Costly
1+1	bareroot	12–16	5–7	A transplant that can be large with a large caliper and root mass Able to compete well on a brushy site and overcome animal damage	Costs more than 2+0
		14–20	6–9	Larger 1+1s grown at lower bed density to have larger caliper and root mass Cheaper than 2+1	Costly
Plug +1	container + bareroot	12–20	5–9	Combination of a small plug and a bareroot transplant Has advantages of a large caliper tree Wider selection of species than 1+1 transplants	Difficult to obtain without a contract Costly
2+1	bareroot	16–20	6–9	Large trees for brushy sites	Older stock-type not commonly grown

assume that next year's seedlings will look just like those grown last year or the year before. Growing conditions and nursery conditions may change, so that trees could be taller, shorter, thinner, or stouter from one year to the next.

How do I choose seedling sizes (stock-types) suitable for my site?

Three characteristics of size or stock-type must be considered when selecting a seedling for a site:

- stem diameter (caliper in millimeters)
- shoot height (in centimeters or inches)
- root mass (volume in cubic centimeters).

The rule that many reforestation specialists go by in picking seedlings is that the stem diameter and root mass need to be large enough to support the top of the seedling. In general, the ratio of shoot to root (on a weight or volume basis) should be no more than 3:1; with 2:1 being the target. While there has always been a strong emphasis placed on shoot characteristics (height and diameter), it is critically important that the seedling also have a root system that can provide the top with a good anchor in the soil and with an adequate water supply soon after planting. Rapid root growth is essential in harsh or droughty sites.

Large stem diameter seedlings offer several advantages:

- They resist damage caused by movement of soil, rocks, or debris
- They resist attack by pests and are more likely to survive and grow after deer browsing
- They may be more resistant to heat stress or sunscald
- They generally have a large amount of foliage and a corresponding large root system

Tall, well-branched seedlings offer advantages and disadvantages, depending on your site:

- They reach above competing vegetation
- They may better overcome the ill effects of deer browse due to their many branches and buds
- They may be more likely to topple if the site is windy or droughty or has shallow soils

Short seedlings may offer advantages on sites without vegetation competition that are droughty or very windy. However, deer or elk browsing can be a problem, if stems have few branches or buds. Be cautious of short seedlings that do not have a healthy foliage color. This may signal a problem.

Large root systems offer both advantages and disadvantages:

- They will help anchor seedlings in windy sites
- They offer better growth in moist or dry sites
- They can be difficult to plant if the site is rocky; for such sites, container seedlings are recommended

Generally, large stem caliper, moderate shoot height (except in brushy areas), and large root systems make for the most desirable tree. Look for well-balanced seedlings with root systems big enough to support the shoots. Also look for seedlings with numerous large well-developed buds and dark healthy foliage color. Be wary of seedlings with dry or moldy foliage, which can result from storage problems. Also watch out for seedlings with dry roots caused by long storage.

Planting Spacing Guide for Commercial Timber Production

Number of trees per acre	Spacing (feet)	Species for which spacing is optimal (at 10-15 years)
200	15 x 15	—
260	13 x 13	ponderosa pine
300	12 x 12	grand fir, western larch
360	11 x 11	Douglas-fir
430	10 x 10	western hemlock
540	9 x 9	—
680	8 x 8	—

Source: *Using Precommercial Thinning to Enhance Woodland Productivity.*

Seedling Cost Comparison Table*

Elevation (ft)	Species common name	Age	Stock type	Minimum size			Price	
				Height (in)	Diameter (mm)	Container size	($/1,000)	($/100)
1,000	big leaf maple	1-0	Bareroot	8	3.0		329	82
1,000	black cottonwood	Rooted	Bareroot	8	3.0		554	139
1,500	Douglas-fir	2-0	Bareroot	12	4.5		210	
2,000	Douglas-fir	1-1	Bareroot	10	4.0		464	117
1,000	Douglas-fir	1-0	Container	—	—	Supercell	300	55
1,000	Douglas-fir	1-0	Container	—	—	Styro-10	395	55
1,500	Douglas-fir	1-0	Container	8	3-0	Styro-8	314	63
4,000	Engelmann spruce	2-0	Bareroot	8	5.0		190	50
1,000	grand fir	2-0	Bareroot	6	—		210	60
1,000	Jeffrey pine	2-0	Bareroot	4	4.0		303	76
4,500	lodgepole pine	2-0	Bareroot	6	5.5		235	35
4,000	mountain hemlock	2-0	Bareroot	4-8	—		225	33
3,000	noble fir	2-0	Bareroot	6	—		250	65
1,000	Oregon white oak	1-0	Bareroot	4	3.0		329	82
4,000	ponderosa pine	2-0	Bareroot	3	4.0		303	76
1,000	ponderosa pine	1-0	Container	—	—	Supercell	345	55
5,000	ponderosa pine	1-1	Bareroot	4	5.0		443	111
1,000	ponderosa pine		Container	8	2-4	Styro-5	202	40
1,500	Port Orford cedar	2-0	Bareroot	8	3.0		442	110
500	red alder	1-0	Bareroot	16	4.0		250	
1,000	Sitka spruce	2-0	Bareroot	8	4.0		365	91
4,000	sugar pine	2-0	Bareroot	5	3.0		303	76
1,500	western hemlock	P-1	Bareroot	10	5.0		496	124
3,500	western larch	2-0	Bareroot	8	4.0		332	83
1,500	western red alder	1-1	Bareroot	12	4.0		547	137
500	western redcedar	P-1	Bareroot	12	5.0		380	50
5,000	western white pine	2-0	Bareroot	3	3.0		403	101
5,000	white fir	2-0	Bareroot	4	3.0		337	84

Taken from: *Sources of Native Forest Nursery Seedlings*, ODF

*Varies by nursery, stocktype, species, and seed source

A Primer on Seedling Physiology for Reforestation

The seedling that is purchased for reforestation comes from growers with considerable professional experience. Whether container or bareroot, seedlings have gone through a lengthy management process. The morphological characteristics such as height, stem diameter, root mass, bud shape, needle length, and numerous other factors all result from timing of irrigation, fertilization, top clipping/root pruning (if bareroot), hardening, and other nursery cultural practices.

While the morphological characteristics are important and easy to see, the internal physiological characteristics are very important as well. Some of the more important physiological factors to the landowner are (1) plant moisture stress (PMS) at the time of planting, (2) cold hardiness and, (3) dormancy. Seedlings need to be below 5 bars plant moisture stress at the time of planting as measured by a pressure chamber. Seedlings capable of surviving a freeze test below -15°C (5°F) will handle stress well, be in a dormant state, and be more likely to grow after planting. Understanding moisture stress and cold hardiness can help to better understand the physiological condition of the seedling.

PMS: Moisture stress in seedlings is measured using an instrument called a pressure chamber, which most nurseries have. A short stem with needles or leaves is placed into a chamber with the cut surface of the stem sticking out. Pressure is applied to the stem and needles in the chamber. Due to the pressure, the water in the sample moves up and out through the cut stem surface. Plant moisture stress is determined by the amount of pressure it takes to get the first bit of water to appear at the cut surface. The pressure is measured in bars with 1 bar roughly equal to 1 atmosphere or 14.7 lbs/in^2. If it takes only 1-2 bars to get the water to appear, the seedling is well hydrated. If the seedling is at 15 bars, then there is a water deficit. Moisture stress is an important physiological factor because water limits photosynthesis, which in turn limits seedling growth.

Freezing Tolerance: The cold hardiness test is also a very good test of how well a seedling is physiologically prepared for handling and outplanting. This test is not available at most nurseries, but can be done by some testing services. Seedlings are potted up in media, placed in a temperature-controlled freezer, taken through a subfreezing cycle, and then returned to room temperature. At least three temperatures are used in order to bracket the most likely temperature at which 50% of the seedlings will die (LT50). Seedlings start out in the fall with a low tolerance to cold, but by late fall can withstand temperatures of -15°C (5°F) or lower, depending on seed source.

Dormancy: In addition to moisture stress and cold hardiness it is important to keep in mind dormancy. Seedlings that are cold hardy and have gone through a dormancy cycle resist handling stresses better, are less prone to mortality, and are better able to withstand environmental stresses before they start growing in the spring. The classical definition of dormancy states that a plant or seed is dormant when placed in a favorable environment and does not grow. There are two kinds of dormancy that are good for landowners to understand. The first is 'quiescence' and the second is 'rest.' Seedlings actively grow into the summer months in Oregon and go into quiescence in late summer or early fall as they are "hardened off." The common term "hardening" is used to reflect stem lignification and budset and is induced by water stress. Quiescence refers to a form of dormancy whereby the seedlings stop terminal growth due to environmental factors, such as moisture stress. However, if given water they will likely start to grow again. As day length gets shorter and temperatures decrease, seedlings move into a stage called rest. Rest is a dormant state whereby cold is necessary to satisfy various biochemical reactions in order for seedlings to break bud and grow. The rest state for Douglas-fir and ponderosa pine is October-November. Once the dormant state of rest is satisfied the seedlings go back into quiescence. Since quiescence is environment driven, favorable growing conditions will cause the seedling to start to grow.

So, why does seedling physiology matter? Seedlings that make it to the planting site in January or February

or later (eastern Oregon) may still face another month or two of inclement weather. Trees that are cold hardy to low temperatures and safely quiescent have the ability to withstand fluctuations in temperature and sustain a high rate of survival and growth.

Whether seedlings are planted in Western Oregon or Eastern Oregon, low elevation or high elevation, different aspects, and slopes all require attention to moisture stress, cold hardiness, and dormancy. In fact, in Eastern Oregon or at high elevation where seedlings are often in storage for a long time, the physiology of the seedlings at the time of planting strongly impacts reforestation success. Seedlings left in storage for several months should be frozen at around -2°C (29°F), which means they have to be cold hardy to some extent when they go into storage. Seedlings in storage must have low PMS prior to being stored because they remain fixed in time until brought out. A seedling coming out of storage with high moisture stress will lack the ability to hydrate quickly after planting. Seedlings coming out of a planting bag need to be quiescent and ready to grow.

This short primer on seedling physiology is to get you acquainted with the idea that there is a lot more to seedling quality than morphology (e.g. height and stem diameter). Good planting success is often traced back to adequate levels of moisture stress, cold hardiness, and dormancy. Keeping your trees within the bounds of nature's growth cycle will make you a much better grower of forests.

How much do seedlings cost?

Costs vary according to the nursery, species, seed source, cost of seed, size or stock-type, the quantity ordered, buyer specifications, and availability. In general, the larger the seedlings, the higher the price. For species with special growing requirements or that are grown in limited numbers, the price may be higher than for standards like Douglas-fir or ponderosa pine.

ODF's *Sources of Native Forest Nursery Seedlings* lists the unit cost of seedlings from many Northwest nurseries, for both bareroot and container stock. Nurseries generally sell seedlings to woodland owners in units of 100 or 1,000. Some nurseries offer discounts for purchases of large amounts of seedlings. If you and neighbors have similar growing conditions and require the same species, then it makes sense to pool your seedling needs into orders of 1000 seedling lots. Seedlings selling for $250 per 1000, for example, are much less expensive than those selling for as much as $1 apiece at some horticultural nurseries.

When you are comparing seedling prices, look not only at the cost per unit number of trees but also at services that the nursery may provide free or at low cost. These include simple services like tying seedlings in easy to count and carry bundles, or providing cold storage, which otherwise can be expensive.

How many trees should I plant?

The number depends on the size of the area and on the species you choose. Start by determining the size of the area to plant. If the land has a variety of soil conditions and aspects, you may wish to categorize your planting areas. Refer to *Decide What to Grow* in this publication to choose the species best suited to your site. Be careful to recognize and identify problem sites, such as boggy or swampy areas, as well as regions of very shallow rocky soils, when you calculate your acreage. These areas require careful consideration to identify appropriate species or a mixture of species to plant; some areas may not be plantable. Once you know the sizes of the areas, you can determine the number of trees to order for each species.

Be sure to plant enough trees – typically no less than 300 evenly spaced trees per acre for western Oregon sites. For Douglas-fir, planting 350-400 trees per acre is reasonable. For eastern Oregon sites, typical planting densities per acre are 150-300 ponderosa pine, 150-400 lodgepole pine, or 300-450 of mixed conifers. Adhering to specific spacings is less important than planting all sites that are favorable for the species that you have selected. It is usual to add 10 to 20% more trees per acre to ensure adequate stocking.

By planting more than the minimal numbers of trees required per acre by law, you hedge against unforeseen losses and still achieve a well-stocked and well-spaced young stand. Higher planting densities may give you more options if thinning is a part of your long-range plan. The extra trees will also minimize the need to interplant later (at higher cost) to fill gaps left by losses or poor growth.

When should I plant my trees?

Reforest during the first planting season after harvest. If this is not possible, wait no longer than the second planting season after harvest:

- In northwestern Oregon and sites not limited by moisture, plant between December and mid-March.
- In southern Oregon and on droughty sites, plant between December and late February.
- On eastern sites, plant when soils reach approximately 40°F; usually mid-March to mid-April depending on elevation, aspect, and weather conditions.
- Fall planting (September to November) may be used with container stock on western sites where moisture is adequate; it is not recommended for eastern sites because soils are too dry for seedling establishment.

When should I arrange to get my seedlings for planting?

Most nurseries will give you a delivery date based on your request for pick up. These dates are always tentative and can be affected by weather or harvesting processes. Check with the nursery a week or two before you expect your trees, to be sure that your order is on schedule. Plan for delays and talk frequently with your planting contractor, giving updates of schedule changes. Seedlings must be planted as soon as possible after they leave the nursery, or their chances of thriving drop drastically.

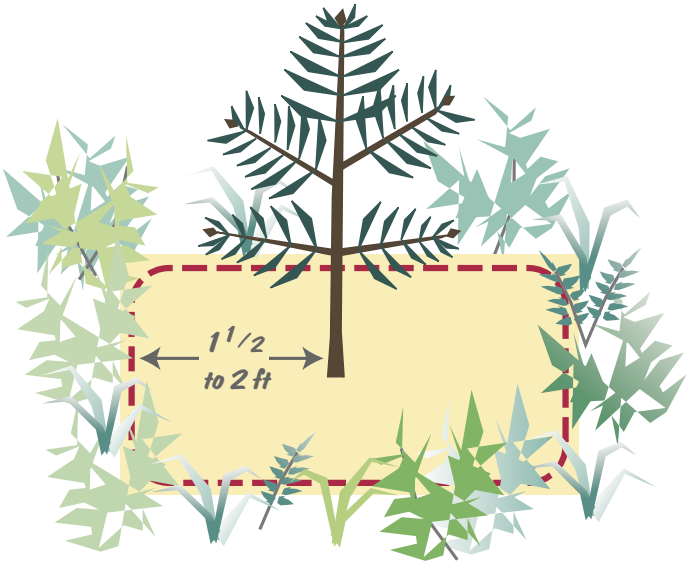
How, when, and where will the seedlings be picked up from the nursery? How do I care for them while they are being planted?

Delivery is one of the points to negotiate with the nursery or planting contractor. Getting seedlings from the nursery to your planting site is not a trivial matter. Do you have a suitable vehicle to haul your seedlings, or do you need to get a trailer, rental truck, or refrigerated van? Can the planting contractor pick up your trees? You may want to find a nursery that has cold storage available to hold your trees while you make final arrangements to get them picked up and planted. If you live a long way from the nursery, check whether they can ship your trees to your house or to a nearby cooler. Having a local cooler for your seedlings is a bonus if you are planting the trees yourself or if the planting crew can work only a few days at a time. If your trees are shipped to your house, they should be planted within a few days of receipt; the same day is best. Seedlings are perishable and should be kept cool at all times prior to planting.

Decide How to Control Competing Vegetation

Successful reforestation depends on weed control or vegetation management. Brush, grass, and other vegetation compete with seedlings for moisture and nutrients. Without some form of weed control, the effort and money you put into planting seedlings may be wasted.

Weed control measures should be well thought out and ready to implement before you plant the seedlings. Often some weed control or site preparation is done before the seedlings are planted (See EC 1188 *Site Preparation: An*



Control Competing Vegetation

Method	Advantages	Disadvantages
Manual	Low knowledge need Low weather dependence Low risk to nearby areas Low controversy	High cost Low number of acres treated High capital cost High soil disturbance Many access problems
Chemical	Low cost High number of acres treated Low capital cost Low soil disturbance Few access problems	High knowledge need High weather dependence High risk to nearby areas High controversy

Introduction for the Woodland Owner). If weeds become a problem after planting, an action to control vegetation is called a "release treatment" (See EC 1388 *Introduction to Conifer Release*).

The objective of weed control is to increase survival and growth of the trees you have planted. Manual or chemical methods are often used for weed control. Each has advantages and disadvantages.

Manual or Non-chemical methods

Burning

Check with the experts before considering burning for controlling competing vegetation. Burning can kill existing herbaceous vegetation, but it is difficult to implement a good burn on a small acreage, and burning may be unacceptable to neighbors. It may also have the unintended effect of preparing a good seedbed for future weed invasion.

Manual scalping

Manual scalping (clearing of vegetation at a planting spot) can be done at the time of planting. The area scalped must extend 1.5 to 2 feet out from the seedling. For scalping to be effective in the absence of herbicides, the competitor roots must be removed or the area must be re-scalped one or more times per year. The manual clearing of unwanted vegetation is very hard work that can lead to injuries. It is also expensive, Landowners should consider weeding around their trees several times a season in order to increase water uptake and keep the trees from being overtopped by competing vegetation.

Mulching

Mulch mats made of reinforced Kraft paper with an asphalt core, heavy black plastic, or meshed black plastic have shown success comparable to use of herbicides for controlling vegetation. However, costs are significantly higher for mats. The mulch mats must be adequately pinned to the ground; in windy areas, the corners must be weighted down. Scalping may be necessary before the matting is laid. Landowners with small parcels may want to mow the grass around seedlings and then install the more expensive water-permeable black netting that weeds cannot grow through for even greater effectiveness. Newspaper has been tried for years, but generally fails because it disintegrates much too quickly.

Mechanical

The mechanical removal of vegetation is done before the seedlings are planted. It is commonly done with a crawler

tractor equipped with a toothed blade (brush blade). Depending on conditions, the brush can first be sprayed with herbicides and then crushed with a tractor. Tractors are also used to move the slash and brush into piles or windrows to give better access for planting and to remove cover for wildlife that will damage seedlings.

Grazing

Grazing, if managed carefully, can be an effective tool for reducing competing vegetation. However, unmanaged cows and sheep are known to damage seedlings when grazing among newly planted seedlings. Sheep grazing as a vegetation management tool has other problems: (1) contrary to myth, sheep will not always eat what they are expected to, (2) sheep require supervision and protection from predators, and (3) sheep may introduce disease that can be transmitted to deer or elk. Goats eat almost anything, including seedlings.

Mowing

Unfortunately, although mowing around seedlings may reduce mouse damage, it does not actually reduce competition from grass. Landowners with the time and energy can use mowing successfully if they also keep the grass at least 1.5 to 2 feet from the seedling. This will mean regular weedings throughout the first two growing seasons.

Chemical methods

To achieve vigorous tree growth with minimum impact on the soil, the use of herbicides according to their label has proven to be safe and effective. Herbicides sometimes are used in the forest to

- Prepare sites for tree planting by controlling competing vegetation
- Release trees fom weed competition to improve growth
- Help minimize wildlife damage to seedlings
- Maintain forest road rights-of-way

Chemicals can be used in site preparation or as a release treatment, depending on weed species, tree species, and stock-type. The chemicals can be applied broadcast by helicopter or ground equipment, or spot applied around each seedling. Two or more applications of herbicide may be necessary for seedlings to become established. The herbicides must be applied early, not when brush has already overcome the seedlings.

Most herbicides used in forestry are relatively low in toxicity but all chemicals must be handled carefully. Properly applied forest chemicals can help you achieve the desired benefit without putting water, soil, fish, wildlife, or human health at risk. Before deciding what you need to use, it is best to consult a weed control specialist.

For more information, see *Vegetation Management* in this publication.

Decide How to Protect Seedlings from Insect Pests or Animal Damage

Damage to seedlings by animals such as rodents, gophers, and deer is a constant and on-going problem for new forests in the Pacific Northwest. The smaller animals eat the cambium around the base of the seedlings while larger animals eat the foliage and buds and can even uproot the seedlings. Various control strategies may be employed, depending on the species and number of animals. The primary objective of animal damage control is to control damage, but this does not always mean controlling the animals. Mostly, what is necessary is to use a combination of methods to prevent, eliminate, or reduce the animal damage to within economically acceptable limits.

Prevention simply keeps the damage from occurring. In most cases it is a good idea to simply wait to see if there is a damage problem and then address it according to its seriousness. If there is a high probability of damage, preventive steps need to be taken. Corrective action stops or reduces damage after it begins. It may be necessary to

Control Animal Damage

Animal Species	Control Strategy
Mice	eliminate or change habitat (food and cover) bait trap
Mountain beavers (boomers)	eliminate or change habitat (food and cover) bait trap
Gophers	eliminate or change habitat bait trap
Deer	install physical barriers (Vexar, fencing) leave forage
Elk	install physical barriers (Vexar, fencing) leave forage
Porcupines	no standard method
Black bears	no standard method
Rabbits	no standard method

combine prevention and corrective action, if more than one pest species is causing the damage or the damage occurs during more than one season.

Most tree species are susceptible to particular insect pests, which can damage young or mature trees. Some insects can be tolerated, but others may have to be controlled by various methods (e.g., chemical or biological). A certain amount of damage is inevitable, and if healthy stock of good size has been planted, the overall stocking of your stand will be fine. Deer may nip branch tips, but the seedlings will pull through if they are encased in plastic mesh tubing or if they can rapidly grow above browsing height.

Know which animals are likely to damage your seedlings. Check with your local extension agent or forester for more information on animal damage risk in your area Make preparations to do something if necessary. Then keep a close eye on your newly planted seedlings. In many instances, animal control is not necessary. When the predator population is strong and healthy, with hawks and the like feeding on mice and gophers, the seedlings are likely to do well. The most damage seems to occur in areas where the predator/prey ratio is out of balance. Hawks and cougars don't eat seedlings – mice and deer do. If you manage accordingly, the predator/prey ratio may operate in your favor.

There are many control/protection methods:

Lethal methods include eliminating the population or reducing population numbers before damage occurs. Poisons, trapping, hunting, and predators can be used to eliminate or reduce the population. For burrowing animals, trapping is the most successful, but controlling weeds with herbicides to remove cover has also worked quite well.

Non-lethal methods include the use of physical barriers like plastic mesh tubing, netting, bud caps, and fencing (electrified or not). Repellents create an unattractive environment for the pest, but especially in western Oregon's rainy environment, the positive effects may not last very long without re-application.

Scaring the pests away is a tactic that is probably more suited to a personal garden or nursery than a field planting. However, deer can be frightened away by gas cannons that go off randomly and light-reflecting tape. Unfortunately, the deer and elk get accustomed to these things over time and learn to ignore them.

Other methods for minimizing animal damage include planting resistant tree species, planting a mixture of tree species, habitat alteration, and planting larger trees. Promoting vigorous growth of seedlings by vegetation management can reduce the impact of browsing. A fast-growing tree can outgrow the browse and reach a height that precludes animal damage to its terminal shoot.

Newly planted seedlings can taste especially good to animals for one simple reason: the seedlings come loaded with nitrogen in the form of amino acids, proteins, and sugars. In areas where the food supply is limiting, animals will graze on the high-nutrient seedlings first. To prevent that, consider leaving more brush. Even though that forage may

provide cover for mice and gophers that feed on seedlings, it can also provide an alternative food source for deer and elk. In some instances the deer and elk will graze the area and never touch a single seedling!

Wildlife impacts on seedlings can be difficult to predict without prior experience in a particular area. For more information, refer to the following publications from Extension Service Communications:

- *An Introduction to Forest Protection*, EC 1253 (part of the Woodland Workbook)
- *Understanding and Controlling Deer Damage in Young Plantations*, EC 1201
- *Controlling Pocket Gopher Damage to Conifer Seedlings*, EC 1255
- *Controlling Vole Damage to Conifer Seedlings*, EC 1256
- *Controlling Mountain Beaver Damage in Forest Plantations*, EC 1144

What follow-up do I need to do?

Check your plantation annually. You may need to

- Replant
- Protect against animal damage
- Control competing vegetation

Consult a forester for more information.

How to Plant and Take Care of Seedlings

Correct handling and care of planting stock from the time it leaves the nursery until it is planted is essential for successful reforestation. The seedlings should be kept cool, but not allowed to freeze after you pick them up. Ideally, they should be stored at 33–35°F. Minimize the length of time that boxes or bags of trees are out of cold storage. On the planting site, place the boxes or bags in a cool, shady place, and keep root systems moist. Dip them in water if necessary to prevent drying after they are removed from the storage boxes or bags.

Proper planting is necessary for plantation success. To make sure that the tree is planted in mineral soil, you may have to cut a scalp with the planting tool to clear away weeds or debris at the planting spot. The planting hole should be deep enough and wide enough to allow the seedling root system to hang down naturally. You can plant seedlings using a planting hoe, shovel, or auger. The hole should go straight down and be broken on three sides for the full depth.

Make sure the roots in the planting hole are not deformed into L-roots or J-roots. Pack mineral soil firmly around the root system, leaving no air pockets. Don't let duff, grass, snow, or debris fall in around the root system. Plant the trees at least as deep as they were in the nursery beds. It may be easier to gauge planting trees slightly deeper, e.g., to the first branch, and that is acceptable. However, don't bury green branches. Shallow planting is not acceptable and no roots should ever stick up out of the hole. When properly planted, the seedling will be able to withstand a firm tug on the stem and should stand straight.

Transportation from the Nursery to Local Storage

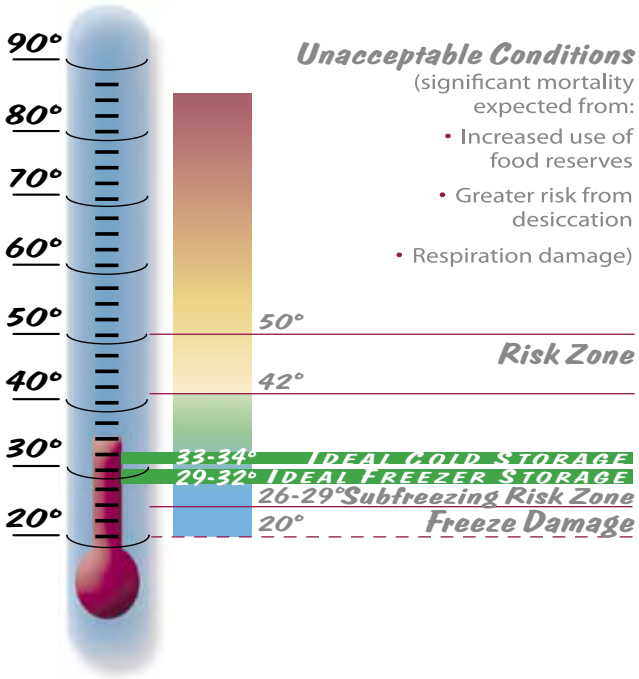
Several types of vehicles may be used for seedling transport; the most common, in order of preference, are

- a refrigerated van (best)
- a truck with canopy (OK)
- a truck with no canopy (avoid); however, a special heat-reflective tarp can be used with this type of vehicle

No matter which type of vehicle you use, monitor the temperature of the bags or boxes to ensure that seedlings remain cool.

Temperature Guidelines for Dormant Seedlings (°F)

Long-Term Storage
Refrigerated unit guidelines (1-6 months)



1. Maintain seedling temperature at 35°F in refrigerated vans. If the vehicle is used regularly for seedling transport, install a temperature-monitoring system in the cargo space and an alarm or meter in the cab.
2. Use racks or loading pallets for good air circulation.
3. Make sure at least one side of every box or bag is exposed to circulating air.
4. Allow air space between all interior surfaces of the cargo space and the bags or boxes.
5. If the cargo space is unrefrigerated, install styrofoam insulation on all interior sides, including the cargo bed.
6. Paint the canopy bright white on the exterior surface and metallic silver on the interior surface; use a tarp of the same colors if there is no canopy.
7. Park the vehicle in shaded areas.
8. If ice is used, place it on a platform above the seedlings to optimize mixing of cool and warm air and to avoid crushing bags or boxes.
9. If using an unrefrigerated (but insulated) vehicle and travelling longer than 6 hours, be sure to travel only during damp and cool days or in the evening (overnight).
10. Secure the bags or boxes in the cargo space to prevent their shifting or bouncing on bumpy roads. Handle them carefully at all times; mishandling can cause a decline in seedling vigor.
11. Do not stack seedling boxes or bags more than two high to avoid crushing.

Local Storage

1. Unload the vehicle quickly and carefully.
2. Plant the seedlings as soon as possible. Keep temporary storage time at a minimum.
3. Use a cooler, if available. Cooler space (possibly for lease) might be found at an industrial or governmental facility, landscape nursery, florist shop, or meat-packing house. Avoid storing seedlings in coolers used for fruit storage. The fruit-ripening process produces large amounts of ethylene, a gaseous plant hormone that can jeopardize seedlings' later development.

    a. Keep seedling temperature as close to 33°F as possible and monitor it continuously.

    b. Avoid using facilities without devices that warn of high and low temperatures.

    c. Make sure seedlings are moist and bags or boxes are well-sealed before storage, especially if humidifiers are unavailable.

    d. Store bags or boxes on pallets so that each container has at least one surface exposed to circulating air.

4. If no cooler is available, go directly to the field from the nursery and plant the seedlings as soon as possible!

    a. Place bags or boxes on north side of a large structure that receives no direct radiation, or under the canopy of a very dense grove of evergreen trees (you should see no ground vegetation).

    b. Keep surface of boxes damp by spraying with water during the day.

c. Cover bags or boxes with a reflective tarp set up as a lean-to. Such a tarp will protect against radiant heat, provide shade, and allow air to circulate. Do not use a canvas tarp since this can trap heat underneath and damage seedlings.

d. Check bags or boxes for rodent damage frequently and repair any rips or tears immediately. Check seedlings to make sure they are still moist and reseal bags or boxes tightly.

e. Monitor temperature (leave a dial thermometer in place) and check frequently. Spray bags or boxes with water if they start to warm above 40°F.

Transportation to the Planting Site

1. Don't transport seedlings to the site until it has been prepared to favor survival and maximize growth.
2. Double-check that you received the correct seedlings and their physical specifications.
3. Take only as many seedlings to the field as you intend to plant that day and leave the rest in cold storage.
4. Handle bags or boxes gently and take precautions to minimize bouncing and sliding around on the bed.
5. Never place anything heavy on bags or boxes. (For example, never use spare tires to keep the protective tarp secure while driving.)
6. Check the load's temperature before you start your trip and leave the dial thermometer in place so you can monitor temperature throughout the day.
7. If weather is sunny, windy, dry, or warm, make sure you have everything you need to protect seedlings (water, reflective tarp, damp moss). Monitor temperature, winds, and humidity if you can, to avoid planting during unfavorable conditions.

Seedling Protection at the Planting Site

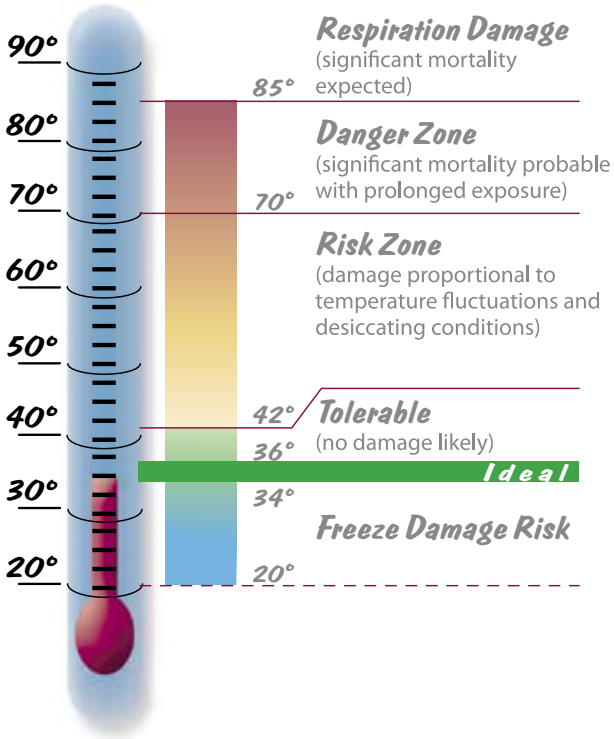
1. If possible, park in the shade, regardless of the type of vehicle being driven.
2. If a pickup with a protective tarp is used and no shade is available, remove the bags or boxes of seedlings from the bed, place them in the shade of the pickup, and cover them with the protective tarp.
3. Never allow planting crews to sit on bags or boxes.
4. Keep seedling containers tightly sealed in the refrigerated van or under the insulated pickup canopy until a planter returns for another load.
5. Open only one seedling container at a time, and close the partially filled container tightly to prevent moisture loss.
6. Make sure you carefully separate roots in seedling bundles so that root damage (breakage and stripping) is minimized during planting.
7. Keep partially empty bags or boxes in a cool, damp location until a planter returns for a new batch of seedlings.
8. Monitor seedling temperature (maintain below 40°F) and moisture status (pressure chamber readings should be below -5 bars) every time seedlings are taken out.

Planting

1. Assign inspectors to planting crews and check that there is consistency among inspectors with regard to planting criteria.
2. Place seedlings in planting bags so roots are well-protected from dry, circulating air. Once roots dry out, they cannot rehydrate and become functional again. NEVER let roots dry out.
3. Use insulated planting bags that are white on the outside and silver on the inside, if possible, particularly if planting is to be done on days when it is sunny, warm, windy, or dry.
4. If roots appear to be drying out, dip them in water or a vermiculite slurry for one minute before placing them in the planting bag.
5. If conditions are warm, dry, windy, or sunny, gently place dampened sphagnum moss over seedling roots. Be prepared to stop planting if conditions become

Temperature Guidelines for Dormant Seedlings (°F)

Field Application Guidelines (1-5 days)



unfavorable. The best air temperatures for planting are between 35 and 42°F.

6. Do not pack seedlings too tightly in the planting bags; keep the seedlings loose for easy removal and minimal damage to stems and small roots.

7. Use good judgment in distributing seedlings to planters depending on weather conditions. Unless they have a way to keep seedling roots moist (water dip, jelly rolls, water-absorbent slurry, wet moss, etc.) and temperatures inside bags cool (insulated bags), do not provide planters with more seedlings than can be planted in 1 hour (warm, windy, dry day) to 2 hours (cool, calm, humid day).

8. Jelly-rolling can help minimize potential stresses of the environment when planting must be done in warm conditions.

9. Keep planting bag collapsed at the top to minimize drying.

10. If roots appear flooded, pour excess water from the bottom of the planting bag to prevent asphyxiation (low oxygen) damage to roots.

11. Use a planting tool that is best suited to the seedling size and the site.

12. Seedlings should be pulled gently from planting bags to avoid root stripping.

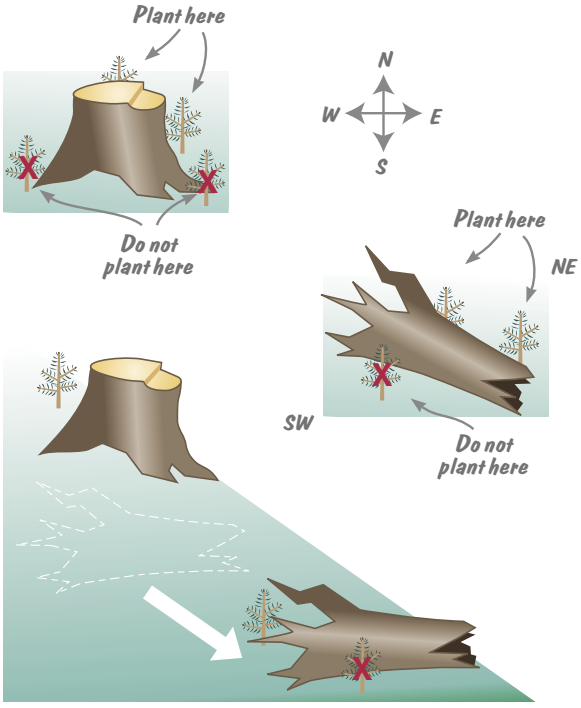
13. Do not allow planters to field-prune roots.

14. Do not allow planters to hit or vigorously shake seedlings in an effort to dislodge excess soil.

15. Plant in favorable microsites as much as possible (no vegetation, moist mineral soil, free of duff or debris in the planting hole, and in partial shade of stumps, logs, debris, or dead brush).

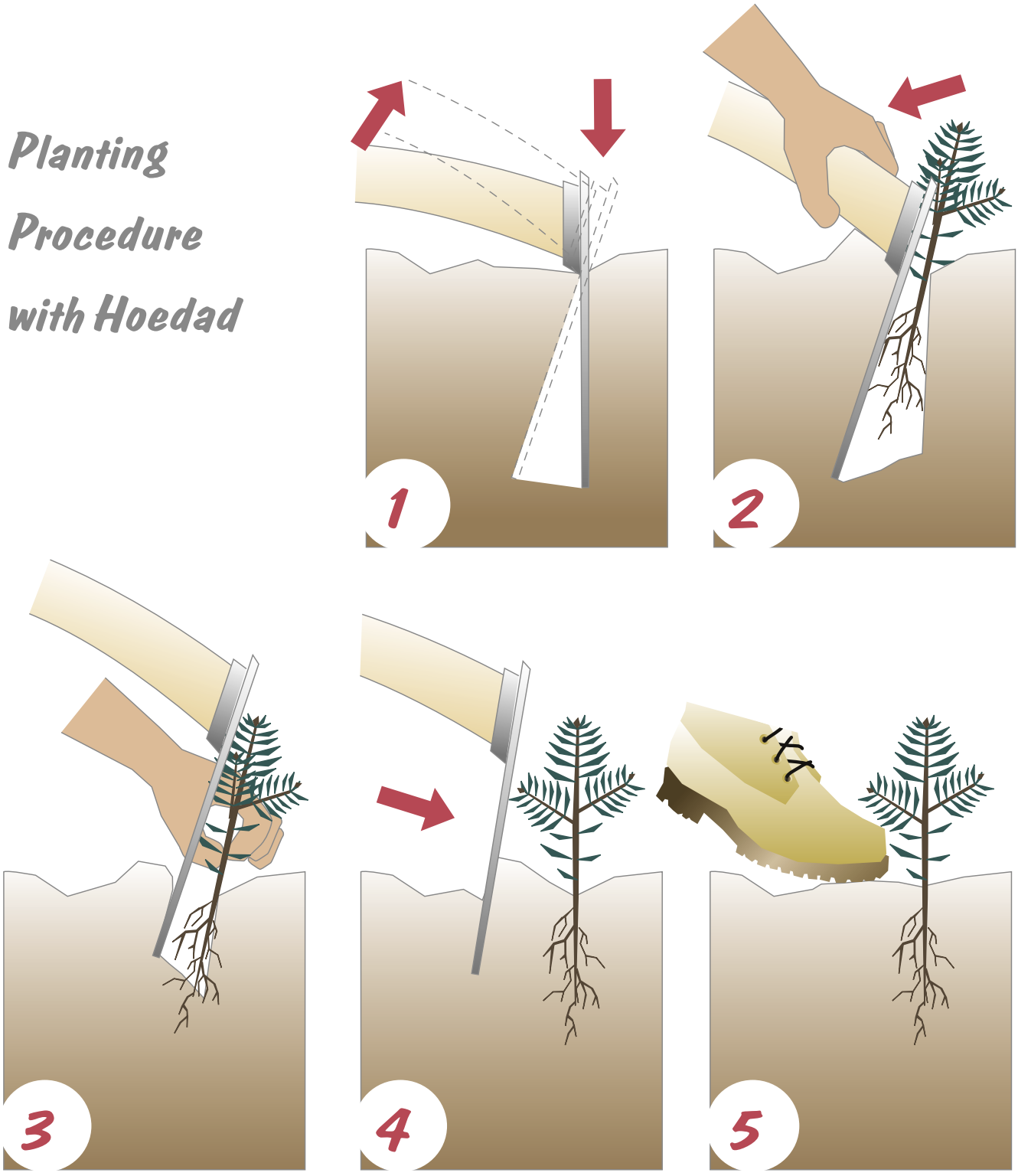
16. Remove trees from the planting bag one at a time and only after hole is prepared.

17. Make sure roots fall straight down in the planting hole. Do not allow J- or L-rooting.



Seek good microsites for planting. Aviod south-facing slopes and mobile debris or logs.

Planting Procedure with Hoedad



1. Insert blade deeply and pull back to open hole. 2. Insert seedling. 3. Backfill gently around roots. 4. Firm soil with planting tool. 5. Pack soil firmly around seedling.

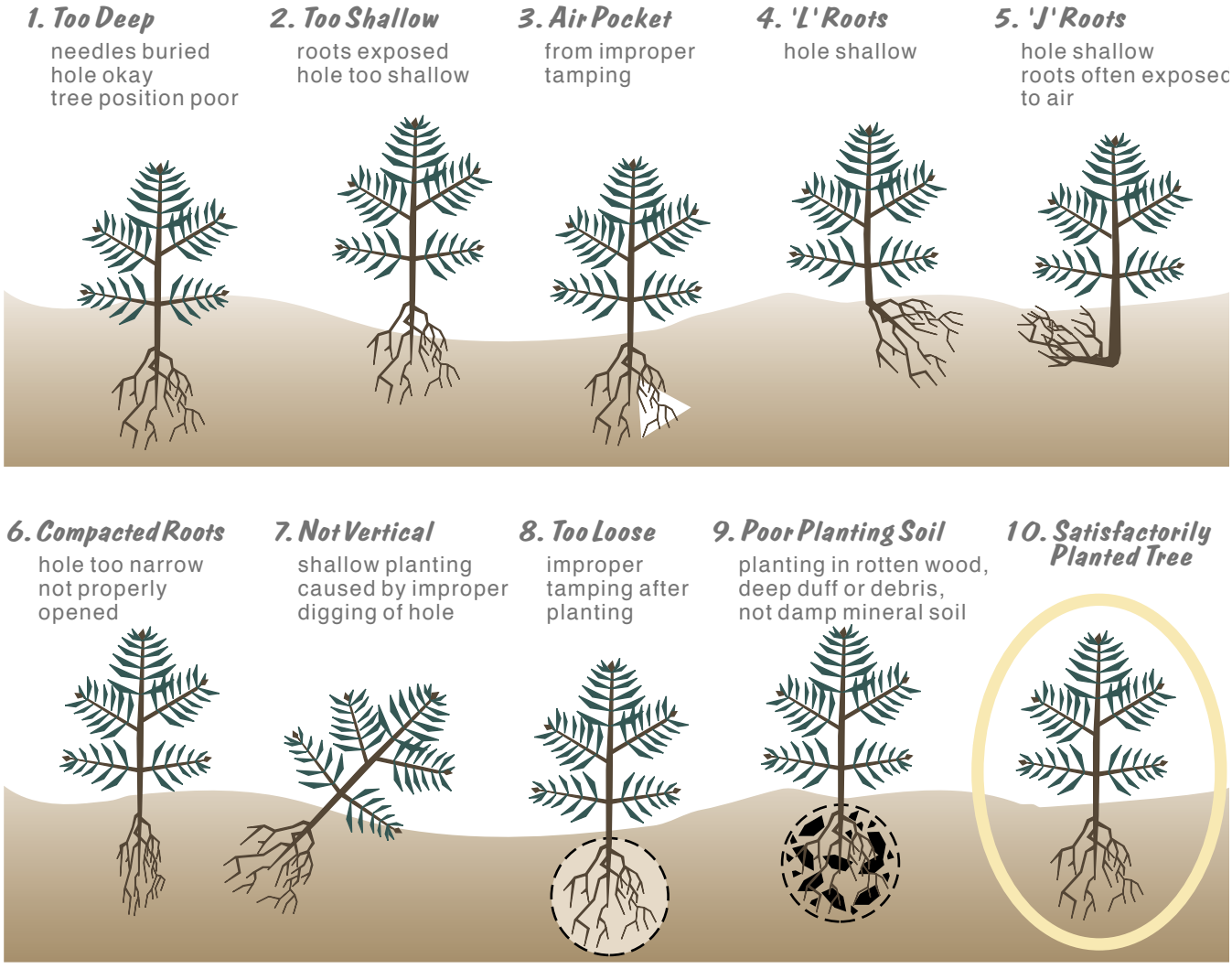
18. Make sure that soil is gently packed around the root system as the hole is filled. Planters must not stomp the ground at the base of the seedling with their boot heels; rather, they should tap firmly with their toes (that way their aim is better).
19. Keep the root collar level with or slightly below the packed soil surface, but no deeper than the lowest living branch junction.
20. Plant all seedlings from a planting bag before taking coffee or lunch breaks.
21. If you expect moderate to high browse damage, install protective devices as soon after planting as possible.

After Planting

Perform a late-spring survey after the seedlings have undergone mild stresses. Early mortality strongly suggests that stock was dead or low in vigor at planting. Also assess animal or vegetation problems early.

Mid-summer surveys may provide further information on stock quality, particularly if seedlings have not encountered severe heat or moisture stress. Development of short, stubby "stress needles" indicates root damage at or before planting. If trees are dying in the absence of environmental extremes (and despite good site preparation), then stock quality is a

Common Planting Problems



factor and may need to be addressed with the nursery.

Keep vegetative competition at a minimum during establishment (first 3 to 5 years). Recent research has suggested the following guidelines:

1. Two to 4 years of continuous vegetation control (more than 80% of competing vegetation killed) can more than double volume production of seedlings on good sites (Sites I and II) and more than triple that on fair (Site III) to poorer (Site IV) sites.
2. Four years of continuous vegetation control on Site III land can reduce time to sapling closure by up to 10 years when seedlings are planted at 8- x 8-foot spacing.
3. On moist sites, growth reduction of seedlings is similar with either brush or grass and herb competition. On drier sites, seedling growth is reduced more by competition from grass and herbs
4. Replant openings larger than 12x12 feet to ensure full site occupation.

Vegetation Management

Chemicals are the most common means of vegetation management in Oregon. Although non-chemical methods for vegetation management are available, both cost and effectiveness favor the use of chemicals. The information presented here is not intended to be a complete guide to herbicide use. Before using any chemical, read and follow the label directions. Using a chemical outside of its intended use is against the law. Before you can apply a herbicide to your land for forestry purposes, the label must state that the herbicide can be used for forestry use.

Know the soil upon which the herbicide will be applied since soil characteristics affect chemical bonding. Be cognizant of other factors like wind, rainfall, temperature, and the target species you wish to control. See *Forestry Practice Notes Number 3: Chemicals and Other Petroleum Products* (January 1997) for more information. You might also check the chemical manufacturer's website for additional suggestions as well as brochures and advice from your local extension agent. Become informed concerning any chemicals you use, be they herbicides for forestry use or fungicides to be used for roses around your home. Safety first!

The general public is too often under the impression that there are lots of herbicides for use in forestry when, in fact, there are approximately nine in common use. They are atrazine, clopyralid, glyphosate, hexazinone, imazapyr, metsulfuron, sulfometuron, triclopyr, and 2,4-D. Atrazine controls many young grasses and broadleaf weeds. Clopyralid is good for broadleaf weeds, thistles, knapweed, and use

Herbicides most commonly used by landowners in Oregon

Common Name	Product Name*	Chemical Family
2,4-D	Weedone and others	Phenoxy
Atrazine	Conifer 90 and others	Triazine or chlorotriazine
Metsulfuron	Escort	Sulfonylurea
Glyphosate	Accord	None generally accepted
Hexazinone	Velpar, Pronone	Triazine
Imazapyr	Arsenal, Chopper	Imidazolinone
Sulfometuron	Oust	Sulfonylurea
Triclopyr	Garlon	Pyridinecarboxylic acid
Clopyralid	Transline	Pyridinecarboxylic acid

*There are many product names for the same chemical. Different companies will manufacture the same or similar herbicides under different product names. Read the label carefully and know the chemical you are using.

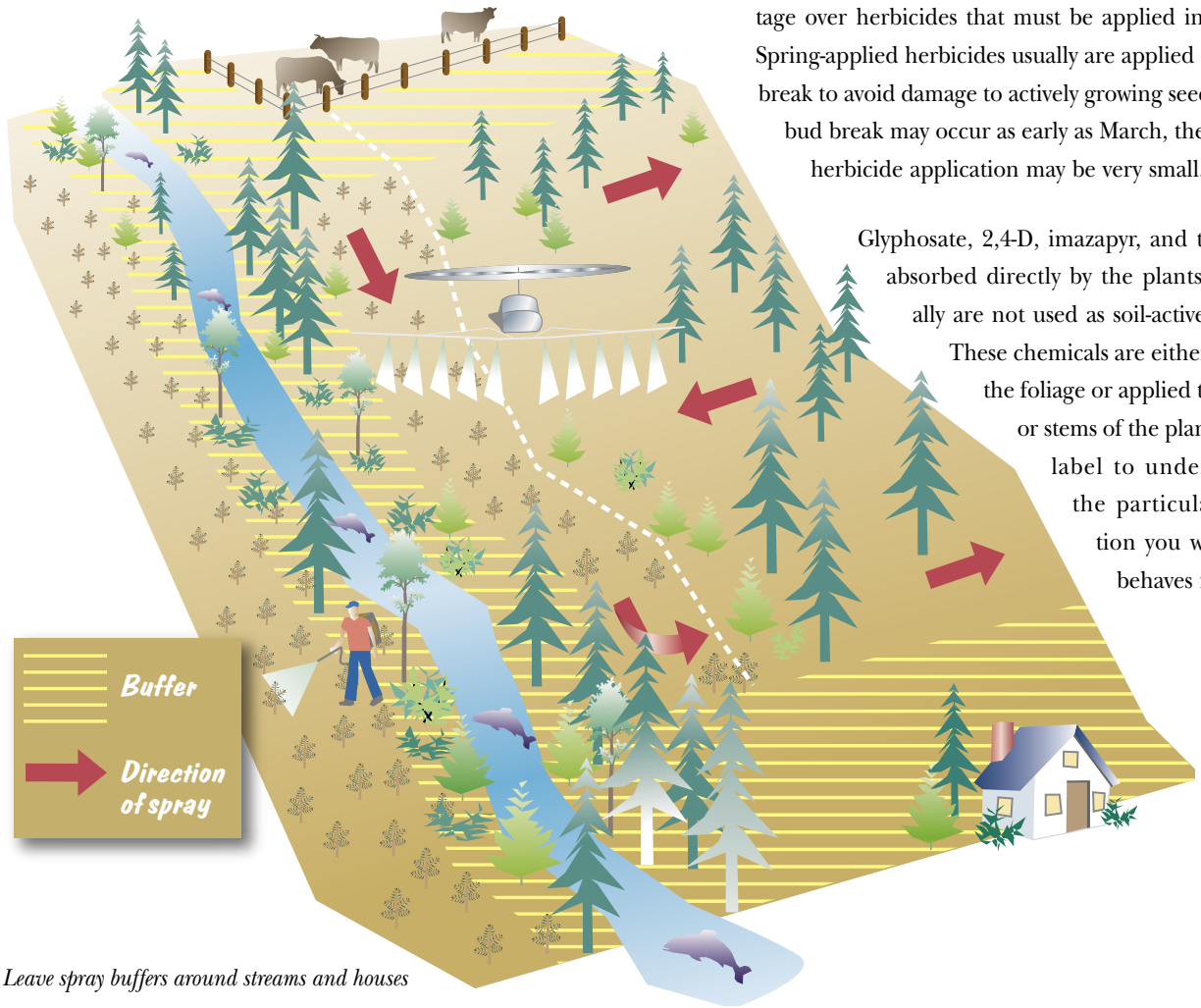
on range land. Glyphosate works on almost all plants and sells in everything from hardware to grocery stores. Hexazinone is mostly used to control grasses, forbs, and young shrubs. Imazapyr also works on forbs, shrubs and young hardwoods. Metsulfuron controls a number of broadleaf weeds and many blackberry species. Sulfometuron works well on grasses and some forbs (will not control thistle and ferns). Tryclopyr works well on shrubs. The herbicide 2,4-D has many uses in agriculture, forestry, and lawn care where it controls many broadleaf weeds with no activity on grasses. Aquatic weeds like milfoil and water hyacinth are also controlled by 2,4-D.

In the United States, the nine common forestry herbicides are packaged for sale singly and in mixtures under varying manufacturers, products, and formulations. Most small landowners are likely to purchase their herbicide products at the garden center or farm supply store. It is important to read the labels of all products before making a purchase. A chemical like 2,4-D has nearly 20 manufacturers with each making various products and formulations. Some manufacturers formulate 2,4-D with tryclopyr or clopyralid. There is no harm in this. It is important to know what you want to control and know the chemicals you are applying.

Atrazine, hexazinone, metsulfuron, and sulfometuron are active in the soil. With the exception of sulfometuron and metsulfuron, these chemicals have little or no direct effect through contact with leaves or stems. Atrazine and hexazinone are usually applied in March or April, either before or after planting.

Sulfometuron may be applied in fall. This gives it an advantage over herbicides that must be applied in the spring. Spring-applied herbicides usually are applied prior to bud break to avoid damage to actively growing seedlings. Since bud break may occur as early as March, the window for herbicide application may be very small.

Glyphosate, 2,4-D, imazapyr, and triclopyr are absorbed directly by the plants and generally are not used as soil-active herbicides. These chemicals are either sprayed on the foliage or applied to the trunks or stems of the plants. Read the label to understand how the particular formulation you will be using behaves in soil.



Leave spray buffers around streams and houses

Checklist for vegetation management

The following checklist combines selected forest practice rules and other suggestions to help you achieve management objectives while protecting long-term investments and public resources. Not all rules are addressed, and these suggestions may exceed the requirements of the forest practice rules. Check the specific rules for exact requirements. You can also get more details from the chemical labels and from *Forest Practices Note Number 3: Chemicals and Other Petroleum Products*, January 1997, which is available from ODF.

1. Contact a licensed pesticide consultant or OSU Extension Agent for advice on
   - Whether you need to use herbicides
   - Alternatives (chemical and non-chemical techniques)
   - Choosing the right herbicide for the desired results
   - Using the right amount of chemicals, at the right time, in the right places
   - Using the appropriate application technique
2. File forest practices notification
3. Read and follow directions on all forest chemical labels
4. Keep herbicides from entering any waters during mixing, loading, or applying
5. Attend pesticide applicator training courses
6. Develop an emergency plan for accidental spills
7. Keep records of all applications for three years, including
   - Who applied the chemicals
   - When, where, and what chemicals were used
   - How much was used (rate of application)
   - Weather conditions (wind speed and direction, humidity, temperature, and time of day)
   - You must be able to produce these records within 7 days of being asked.
8. Make sure people hired to apply chemicals have proper licenses (ask to see a current license)
9. Notify neighbors prior to application; for aerial applications, notify adjacent landowners
10. Make sure applicator knows the locations of
    - Application area boundaries and property lines
    - Streams, springs, wetlands, open water, and domestic water sources (aerial application buffers are 100 feet or 60 feet with a written plan; ground application buffers are 10 feet with a written plan). No spraying is to be done over open water.
    - Riparian management area boundaries and domestic water sources
    - Threatened and endangered species sites
    - Sensitive wildlife habitat sites
    - Structures
    - Agricultural areas, including domestic animals
    - Landing, loading, and mixing areas
    - Power lines
    - Roads and trails entering or adjacent to spray unit
11. Plan chemical applications for the right time and season to protect sensitive wildlife and non-target plants
12. Follow all label requirements
13. Avoid aerial applications of some ester-type herbicides when the temperature is above 70° F or when wind is blowing towards a non-target site needing protection, or during windy conditions
14. Use personal protective equipment and gear appropriate to the application, as specified on the label. All equipment must be in a leak-proof condition.
15. Remove containers from the site, rinse multiple times, and dispose of properly
16. Understand worker re-entry requirements as per each herbicide label

Estimating Wind Speed

Wind Speed	Observable Features
Less than 1 mph	Smoke rises vertically. No foliage movement
1 - 3 mph	Foliage and small twigs sway very gently. Grass and weeds sway and bend
4 -7 mph	Small trees in open sway gently, loose scraps of paper move, small flags flutter, you feel slight breeze on your face

When is it too windy to spray chemicals?

Follow the label recommendations with regard to wind speed and wind direction. Discontinue spray applications when the wind speed is more likely to lead to off–target drift. Use drift control agents as directed. Wind direction is just as important as wind speed! Make sure wind will carry herbicide toward your target, not away. Check with local ODF offices for specific regulations.

Typical chemical site preparation prescriptions

The following recommendations are for illustrative purposes. Seek professional advice if you are not familiar with chemical spray techniques and concepts. Timing of applications relative to weather conditions, the target weeds, and the mode of action of the herbicide can make a crucial difference in effectiveness. Always read and understand the label.

For easy-to-control mixed brush such as salmonberry, bracken fern, ocean spray, blackcap raspberry, and trailing blackberry in Westside forests:

Use 2 to 4 quarts glyphosate per acre along with adding surfactant to improve the overall brush control. This is applied when weeds are actively growing, July through September, as a directed spray or by aerial application. Caution should be used when spraying near existing plantations since such chemicals can be damaging to actively growing tree seedlings.

Sulfometuron and metsulferon can also be used with glyphosate at 2-3 quarts of product per acre. Sulfometuron will control grasses and reduce sprouting of Scotch broom. Metsulferon is partially active on Rubus species and ferns. Since these chemicals are applied at low rates and volumes, accurate calibration is essential. Other common site preparation chemicals are imazypyr and triclopyr.

For spring herbaceous release to control many perennial and annual grasses and broadleaves:

Atrazine provides good weed control at rates of 4.4 lbs of product per acre. Hexazinone provides good weed control at 2-2.66 lbs of product per acre. These chemicals may be applied over Douglas-fir and pines in the spring, either prior to planting or as a directed spray just after planting. These chemicals may be applied over the top of the seedlings before bud break, never after. Take care since other conifer species such as western red-cedar may be damaged. Sulfometuron may also be used to control herbaceous weeds and grasses over many conifer species and Douglas-fir.

For spring release control of Scotch broom, Himilaya blackberry, cottonwood, bigleaf maple, cherry, vinemaple, and alder:

Triclopyr ester at 15% in a basal oil carrier at 85% may be applied as a directed spray to the lower stem of the plant with a backpack sprayer or spray bottle during any season. Best control is obtained when the plants are small. Use on days when the temperature is below 70° F and avoid getting the chemical or volatiles on the nearby conifers.

For spring release control in SW Oregon:

Use 2,4-D or triclopyr on ceanothus and manzanita. For tanoak and madrone use imazypyr as a hack and squirt application.

For spring release control in Eastern Oregon:

Small ocean spray, snowberry, ninebark, ceanothus, coyote brush and other shrubs can be controlled with hexazinone in pine plantings. Herbaceous plants (grasses and forbs) can be controlled by hexazinone and atrazine when used in Douglas-fir and ponderosa pine plantings. Remember don't use hexazinone around larch or western white pine, use sulfometuron instead. Use glyphosate in mid to late summer to control oceanspray, ninebark and snowberry. Clopyralid in spring and summer works well in Eastern Oregon on broadleaf weeds, thistles, knapweed and hawkweed. See *Ecology and Management of Eastern Oregon Forests*, Manual 12, Extension Service, Oregon State University and *Enhancing Reforestation Success in the Inland Northwest*, PNW 520, for more information.

To Learn More

ODF Forestry Assistance

For additional landowner assistance, please contact the ODF office near you. A full list of ODF area and district offices can be found online at:

http://egov.oregon.gov/ODF/offices.shtml

Or, by contacting the main state office at:

Department of Forestry
2600 State Street
Salem, OR 97310
503-945-7200
information@odf.state.or.us

OSU Forestry Extension

Resources in the Forestry Extension Program at OSU can be viewed online at:

http://www.cof.orst.edu/cof/extended/extserv/

Or, by contacting the main office at:

Forestry Extension Program
Oregon State University
109 Richardson Hall
Corvallis, OR 97331-5712
541-737-1727
forestry.extension@oregonstate.edu

Publications

Logan, R. 2002. Oregon's Forest Protection Laws. An Illustrated Manual. Portland, Oregon: Oregon Forest Resources Institute. 160 p.

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Fire Effects Information Database provides detailed species information at http://www.fs.fed.us/database/feis/plants/tree/index.html

Regeneration, Nurseries, and Genetics Resources (USDA Forest Service) provides decades of experience and literature having to do with forest regeneration at http://www.rngr.net

Pacific Northwest Weed Management Handbook – revised annually by the Extension Services of Oregon, State University, Washington State University, and the University of Idaho, available online at http://weeds.ippc.orst.edu/pnw/weeds

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ODF publications are available online at:
http://egov.oregon.gov/ODF/PRIVATE_FORESTS/PCFPubIndex.shtm
(includes Sources of Native Forest Nursery Seedlings)

A full catalog of publications available from the OSU College of Forestry can be found at: http://fcg.cof.orst.edu/structur/pubs_order.php; you can also order publications by writing

Forestry Communications Group
256 Peavy Hall
Oregon State University
Corvallis OR 97331-5704
forestry communications@oregonstate.edu

You can search the full Extension publications catalog online at

http://extension.oregonstate.edu/eesc/

To order publications, write

Publication Orders
Extension & Station Communications
Oregon State University
422 Kerr Administration
Corvallis OR 97331

The OSU Extension Service also offers many helpful publications concerning landowner assistance and related topics. Some publications are free and others can be purchased for a small fee of $1-2.

Title	Order Number
Contracts for Woodland Owners and Christmas Tree Growers	EC 1192
Cost Sharing and Woodland Management	EC 1119
Educational Assistance for Woodland Owners	EC 1154
Enhancing Wildlife on Private Woodlands	EC 1122
Felling and Bucking Techniques for Woodland Owners	EC 1124
Forestry Financial Analysis I: An Introduction for Landowners	EC 1146
Glossary of Woodland Words	EC 1155
Introduction to Conifer Release	EC 1388
An Introduction to Forest Protection	EC 1253
Logging Woodland Properties	EC 956
Management Planning for Woodland Owners: Why and How	EC 1125
Measuring Timber Products Harvested from Your Woodland	EC 1127
Oregon's Forest Practice Rules	EC 1194
Planning Woodland Roads	EC 1118
Seedling Care and Handling	EC 1095
Selecting and Buying Quality Seedlings	EC 1196
Site Preparation: An Introduction for the Woodland Owner	EC 1188
Soil Compaction on Woodland Properties	EC 1109
Stand Volume and Growth: Getting the Numbers	EC 1190
Taxes and Assessments on Oregon Forest Land and Timber	EC 1151
Technical Assistance in Forestry	EC 1120
Thinning: An Important Management Tool	PNW 184
Timber Harvesting Options	EC 858
Trees to Know in Oregon	EC 1450
Tools for Measuring Your Forest	EC 1129
Using Precommercial Thinning to Enhance Woodland Productivity	EC 1189
Understanding and Controlling Deer Damage in Young Plantations	EC 1201

Glossary of Terms

The terms below may be useful. Not all of the terms are used in this publication, but you may come across them in other readings or during discussions with consultants or Extension and Forestry Assistance foresters. For more word definitions, refer folks to: Helms, J.A. 1998. *The Dictionary of Forestry*, Society of American Foresters, 5400 Grosvenor Lane, Bethesda, MD 20814-2198. 210 pages and *Glossary of Woodland Words*, EC 1155.

Acclimation – Phenotypic adaptation to environmental fluctuations; the gradual and reversible adjustment of physiology or morphology as a result of changing environmental conditions

Acid equivalent (ae) – the theoretical yield of parent acid from a pesticide active ingredient, which has been formulated as a derivative. Example: the herbicide imazapyr is applied at 0.5 – 1.5 lb ae/acre.

Acre – A unit of area equaling 43,560 square feet. There are 640 acres in a square mile

Active ingredient (ai) – the chemical in a herbicide formulation primarily responsible for its phytotoxicity and which is identified as the active ingredient on the product label. Example: the herbicide hexazinone is applied at 0.56-1.67 lb ai/acre).

Advance regeneration – Young trees that have become established naturally before timber harvest

Aspect – The direction toward which the slope faces

Auger planting – this method of planting using a small auger to drill planting holes

Autecology – Relationship of individual organism to the environment

"Bottlebrush" –moisture-stressed seedling branches where the needles are tightly spaced together and look like a brush used for cleaning baby bottles.

Breeding zone – A geographical area of defined boundaries and altitudinal limits, from which trees will be selected and bred as a genetically improved strain normally intended for planting in the same area

Caliper – Seedling diameter measured just above the root collar and expressed in millimeters; 25.4 millimeters equals 1 inch

Cambium – A layer of dividing cells that add a layer of woody material during each growing season

Cavity – A depression or cell used for growing container seedlings

Chilling requirement – Time required at low temperatures for a plant or seed to overcome dormancy (rest)

Cold hardiness – The level of a plant's resistance to damage from low temperatures; also called "frost hardiness"

Cone – A specialized reproductive structure that bears seeds or pollen

Conifer – A plant that bears cones; generally referred to as "evergreen" because it retains its foliage year-round

Cotyledon – One of the first leaves developed in the embryo, occurring at the joining point of the epicotyl (shoot) and hypocotyl (root)

Deciduous – A plant that loses its leaves at the end of each growing season

Direct seeding – The process of reforestation by applying seed to the site either by broadcasting it from the air or ground or by placing it in specific spots on the ground

Dormancy – A state in which viable seeds, spores, or buds fail to germinate under conditions favorable for germination or vegetative growth

Doubletop – Two or more shoots at the top of the plant, often resulting from an injury or stem damage

Drought – Moisture imbalance when loss of water through foliage exceeds uptake of water, predominantly by roots

Field capacity – Soil water content after the free water has been allowed to drain from a saturated soil for 1–2 days; expressed as a percentage on a dry-weight basis

Foliar-active – A term used to describe herbicides that enter plants through the foliage

Free-to-grow – The growth stage at which a tree extends above all competing vegetation; the law requires that this stage be achieved in 6 years

Germination – The beginning of growth of a mature dormant seed

Genotype – The genetic composition of an individual

Hardwood – Species that has a dense woody stem, such as oak, maple, or ash; hardwoods are commonly deciduous

Height/diameter ratio – Height of tree divided by its diameter (units need to be the same, such as 75 cm/0.46 cm [or 4.6 mm]). A useful term for understanding the competitive ability of a seedling

Herbaceous – Non-woody; herbaceous plants do not produce a persistent or woody stem

Herbicides – Pesticides used to kill or control the growth of plants

Hoedad – a specialized planting tool that looks like a hoe with an extended blade

Hybrid – An offspring produced by dissimilar parents; hybrids may occur naturally or as a result of human intervention

Hypo hatchet – A hatchet that injects a preset amount of herbicide into tree stems on impact

Intensive survey – A survey effort that requires sampling and data collection according to a predesigned plan for coverage of the area and observations to be made

Jelly-rolling – A packaging process in which seedlings are placed in a rolled, moisture-absorbent material to protect their roots until planting

J-root – A deformation of roots caused by jamming of a seedling roots system into the planting hole, such that the roots twist back up toward the top of the hole; J-rooting most often occurs when the hole is too short for the length of the root system

L-root – A deformation of tap root in the shape of an L, often caused by wrenching in the nursery, such that the roots are dragged to the side and grow 90 degrees to the tap root; L-rooting may also occur if the planting hole is too shallow for the roots to extend downward

Lateral roots – Roots that are at, on, or of the side; the term is usually reserved for main branching roots extending off the taproot

Leader – The terminal or topmost shoot

Lifting – The process of digging or pulling tree seedlings from the nursery seedbeds or planting beds prior to bareroot planting in the field or in a transplant bed

Litter – Dead plant and animal material on the surface of the ground, above the humus layer

Microenvironment – The immediate environment of a specific habitat

Milacre – One thousandth (1/1000) of an acre

Morphology – Form, color, and size of a seedling; in short, its appearance

Mycorrhizae – A symbiotic relationship between beneficial fungi and plant roots

Nitrogen fixation – The reduction of gaseous nitrogen to ammonia or other inorganic or organic compounds by microorganisms or lightning

Nonselective herbicide – An herbicide formulation that destroys or prevents plant life in general, without regard to species. Example: Glyphosate is such an herbicide.

Nutrient – An inorganic substance that plants require for growth (e.g., nitrate and phosphate); nutrients are taken up from the soil by the roots

Overstory – The trees that form the uppermost canopy layer in a forest

Pathogen – An organism that causes disease in another organism; many viruses, fungi, and bacteria are pathogens

Phenology – The study of organisms and their activities in relation to the seasons of the year

Phenotype – The appearance of an individual for one or more traits, produced by the interaction of the individual's genes and its environment

Photoperiod – Duration of light, usually expressed in hours, within a 24-hour day

Photosynthesis – The process by which plants use energy from sunlight to produce carbohydrates from carbon dioxide and water. Sunlight energy is captured by molecules of chlorophyll in the chloroplasts of cells in green leaves

Phloem – One of the conducting tissues in the vascular system. Unlike xylem, phloem is mainly a living tissue, whose cells contain cytoplasm. The phloem can translocate substances in both directions, and its main function is to translocate the products of photosynthesis from leaves to other parts of the plant

Plug – A seedling grown in a container in a greenhouse; the name reflects the shape of the growing cavity

ppm – parts per million

Pressure Chamber – instrument used to measure plant moisture stress. A sampled branch is placed in the chamber and subjected to pressure. The amount of pressure required to push water out of the cut end of the sample corresponds to the level of plant moisture stress in the plants.

Propagation – The process of reproduction by either natural or artificial means

Regeneration – The young trees in an area representing early stages in the renewal of a forest stand

Regeneration goal – The silviculturally prescribed stocking percentage, density, and kind of tree to be established on an area in a specified period of time

Regeneration period – The time required for the establishment of a stand by natural or artificial regeneration, which may include the time required for pre-harvest planning and harvest of the previous stand

Rhizome – An underground stem that produces roots and supports aboveground stems

Root collar – The point of separation between the stem and root of a plant, commonly marked by the cotyledon scar

Root regeneration potential or capacity – The number and/or total length of roots grown by a tree seedling under controlled test conditions

Root:shoot ratio – Root weight divided by shoot weight; can also be root volume/shoot volume. See also "Height/diameter ratio"

Sample – The observed or measured part of a population

Sampling intensity – The number of observations or measurements required to sample a population with a prescribed degree of precision

Scalping – Removal of vegetation and other organic or inorganic material to prepare a planting spot

Scree – Loose rock or gravel on a steep slope

Seedbed – The soil or forest floor on which seed falls

Seedbed density – In nursery practice, the number of seedlings grown per area of seedbed (usually expressed as number of seedlings per linear bed foot; beds are 42 inches wide)

Seed crop – The amount or number of seeds produced by a given species in a given year

Seed lot – Seed source, plus nursery specifics for a given group of seedlings

Seed zone – Area having defined boundaries and altitudinal limits, within which soil and climate are sufficiently uniform that it is expected that seed can be freely moved without problems of maladaptation

Self-shading – Of a seedling, the ability to shade its base with its branches

Seral – An early stage in plant succession that follows natural or human-caused disturbance

Shade-intolerant – Plant species adapted to reproduce and thrive in the open

Shade-tolerant – Plant species adapted to reproduce and thrive in the shade

Shoot:root ratio – See "Top:root ratio"

Softwood – A species that produces wide growth rings, including conifers like fir and pine

Soil compaction – An increase in soil bulk density from an undisturbed state

Soil field capacity – The soil water content after gravitational water drainage has become very slow and the water content becomes relatively stable

Species – A group of genetically related varieties capable of natural reproduction

Stockable plot – A plot on which 50% or more of the area is biologically and physically suitable for seedling establishment

Stocking – A measure of the proportion of the area actually occupied by trees (percentage of an area stocked)

Stocking standard – Agreed-upon classes of stocking with implications for what level is satisfactory; also, the legally prescribed minimum stocking required to comply with conservation laws

Stock-type – A loosely defined term referring to seedling size, age, and production method. The production method can be either bareroot or container or both. Examples: A 2+0 seedling is seed sown in bareroot nursery beds and grown in place for 2 years, then lifted for outplanting. A 1+1 is seed sown in a bareroot nursery beds grown for one year, lifted and culled,

with the remaining seedlings transplanted at wider spacing for one more year, then lifted for outplanting. A plug+1 is a container seedling grown for one year in a greenhouse, then transplanted to a bareroot nursery, grown for one more year, then lifted and outplanted.

Stomata – Openings or pores in the leaf surface through which gas exchange occurs; each stomate is surrounded by two guard cells that regulate the size of the opening

Stratification – The storing of seeds in a moistened medium to maintain viability and overcome dormancy

"Styro-8" – this term describes a styrofoam block container having 80 cavities that are each 8 cubic inches in volume (130 cc). In metric, this might also be referred to as a "415C".

Taproot – A primary root that is markedly larger than others

Target seedling concept – The idea of targeting specific morphological and physiological characteristics that can be quantitatively linked with reforestation success

Tolerance – The ability of an organism to live under a given set of conditions

Top:root ratio – The ratio of the length or weight (fresh or dry) of a tree seedling's stem and foliage to the length or weight (fresh or dry) of its roots

Transplant – A seedling that is grown in one place, removed, and replanted in another place

Transplant shock – An interruption in the normal growth rate of a seedling after it is transplanted; a synonym for Douglas-fir is 'bottle brush' because the needles of the new shoots grow very close together (many needles per unit length of stem)

Traverse line – A straight route of travel across an area for the purposes of locating sample plots at designated intervals

Treatment efficacy – How well a treatment achieves its goal

True fir – A member of the genus Abies, including grand fir, white fir, and noble fir; Douglas-fir is not a true fir

Tubing – The practice of placing a plastic, wire, or paper tube over all or part of a tree seedling to reduce animal damage

Underburning – Prescribed burning conducted within an existing stand of trees to remove slash or manage competing vegetation

Underplanting – Planting trees beneath an existing canopy of larger trees or shrubs

Understory – Plants growing under the canopy formed by other, taller plants in a forest

Ungulates – Deer and elk

Vexar – A type of plastic tubing used to protect seedlings from animal damage

Viability – A relative measure of the number of surviving individuals of any given phenotypic or genotypic class

Water potential – The thermodynamic state of the water within a plant cell, equal to the difference in free energy per unit volume between matrically bound, pressurized, or osmotically constrained water and pure water

Weeds – Plants that are not wanted at a particular place or time

Wrenching – Breaking both larger and finer roots of nursery stock without removing plants from the soil; soil is lifted up, usually by a machine, and then re-firmed around seedlings

Xylem – Cells in woody plants that carry water, dissolved salts, and sometimes previously stored food upward from the roots to the leaves or needles

Conversion Table

when you know	multiply by	to find
Length		
inches (in)	2.54	centimeters (cm)
feet (ft)	30.48	centimeters (cm)
yards (yd)	0.914	meters (m)
miles (mi)	1.609	kilometers (km)
Area		
sq. inches (in^2)	6.452	sq. centimeters (cm^2)
sq. feet (ft^2)	0.93	sq. meters (m^2)
sq. yards (yd^2)	0.836	sq. meters (m^2
sq. miles (mi^2)	2.59	sq. kilometers (km^2)
acre (ac)	43560	sq. feet (ft^2)
acre (ac)	0.405	hectares (ha)
acre (ac)	4047	sq. meters (m^2)
Mass		
ounces (oz)	28.349	grams (g)
pounds (lb)	0.454	kilograms (kg)
Volume		
teaspoons (t)	5	milliliters (ml)
tablespoons (T)	15	milliliters (ml)
cups (c)	0.24	liters (l)
cups (c)	8	ounces (oz)
gallons (gal)	3.785	liters (l)
gallons (gal)	4	quarts (qt)
gallons (gal)	8	pints (pt)
Temperature		
degrees celsius (°C)	9/5(°C) + 32	degrees farenheit (°F)
degrees farenheit (°F)	5/9(°F - 32)	degrees celsius (°C)
Pressure		
bars	0.1	megaPascals (mPa)
bars	14.5	psi
bars	0.987	atmospheres (atm)
Rate		
gallons per acre (g/A)	9.354	liters per hectare (l/ha)
pounds per liquid gallon (lb/gal)	119.8	grams per liter (g/l)

Check Stem Caliper