OREGON STATE UNIVERSITY EXTENSION SERVICE

Selecting and Buying Quality Tree Seedlings

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Introduction

Reforesting your harvested timberland or growing a forest on your nontimber land requires more than just selecting and planting a few trees and hoping they will grow. To ensure success, you first must answer several key questions:

- What species should I plant?
- What types of seedlings are suitable for my site?
- How do I order seedlings?

To help answer these questions, we have divided this publication into three parts:

- Part 1 describes selecting trees that are adapted for good, long-term growth under your local conditions.
- Part 2 discusses choosing nursery-grown stock with the right qualities to survive and show good initial growth.
- Part 3 provides tips on finding and ordering seedlings.

The focus of this publication is on selecting trees suitable for long-term health and productivity. For information on other topics essential to successful reforestation (for example, site preparation, proper planting technique, and follow-up vegetation control), see the list of Extension publications on page 16. For information on short-term (15 years or less) reforestation goals such as fiber production or growing Christmas trees and other crops, please refer to publications focused on those subjects. Your county Extension forester can also answer additional questions that you may have.

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Part 1. Seed zones and selecting adapted species

If you are interested in planting a particular tree species, it is important to determine whether it is adapted to grow on your site, based on the site's soils, climate, and other factors. You can do this using several methods:

- Try to identify tree species that naturally grew on or near your site before the first logging. You can gather this information based on old stumps, historical records, or the knowledge of long-term, local residents.
- Refer to species guides in soil surveys of your area. Soil surveys are a good source of information on site productivity and soil-site-species relationships. See the USDA Natural Resources Conservation Service soil survey at https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm.

Tables 1a-d (pages 3–6) show considerations for selecting species for reforestation in each major region of Oregon, including the coast, Willamette Valley, western Cascades, and southwest and eastern Oregon. For example, on a coastal site with moist soils and shade from standing trees, consider planting a shade-tolerant species such as western hemlock.

Seed zones and elevation

Trees are genetically adapted to the environment in their area of origin. Thus, it is important to plant seedlings grown from seed collected from a location where the environmental conditions closely match those in your area. When ordering trees, geographic seed collection zones and elevation of origin are useful criteria to help match environmental conditions of the seed source with those of your planting area. Seed zones have been established throughout the Pacific Northwest region; they identify areas where growing conditions are similar (Figures 1a–d, page 6–10). Seed zones are often defined by geographic features such as mountain ranges, river drainages, and major valleys. Elevation of origin is an important aspect of your seed source. Elevation is normally noted by 500-foot elevation bands within the seed zone.

The original seed zone map developed in the 1960s (Figure 1a, page 7) is still valid and widely used in the nursery industry. The newer, somewhat larger seed zones developed in the 1990s (Figures 1b-d, pages 7–10) are species-specific and based on more recent genetic research. Research and experience show that the wider seed movement allowed by the new seed zones does not pose a reforestation risk from planting maladapted seedlings. Pacific Northwest tree species have different amounts of genetic variation among populations. For example, Douglas-fir has considerable genetic variation among populations in different locations and has 16 zones in western Oregon under the new system. On the other end of the spectrum, western redcedar has little genetic variation among populations and has only four zones in western Oregon.

When ordering seedlings, specify the seed zone and elevation band for the area of your planting. Nurseries in the Pacific Northwest generally identify the seed zone of origin for planting stock using a code numbering system (Figures 1a-d). It is essential to understand the seed zone system and code numbers when ordering seedlings. The seed zone and elevation should appear on the label of every batch of seedlings. Do not accept unidentified seedlings. The location of the seed source of origin, not the location of the nursery where the seedlings are grown, is the information that is important for ensuring that your trees are locally adapted.

Staying within appropriate seed zones is especially important in areas where conditions change rapidly over a short distance, such as in the Cascade Mountains or in southwest Oregon. The climate in the Pacific Northwest generally becomes warmer and drier moving inland from the coast. Consider this when planting trees east or west of their origin. Never plant trees from one side of the Cascades to the other. Trees from lower elevations or from more southerly latitudes usually start growing earlier in the season compared to trees from higher elevations or more northern latitudes. This may increase their susceptibility to frost damage or fungal disease if they are planted at higher elevations or farther north. Trees from warmer, drier climate zones are likely more resistant to heat and drought.

When seedlings are in short supply, you may face a tradeoff between planting from a source outside your seed zone versus delaying your planting until the right seedlings are available. You should not move seed from more than one seed zone or one elevation band away from your planting area. Also, seed zones are usually narrower from west to east versus from north to south. Moving seed from west to east across seed zone boundaries risks poor adaptation to heat and drought; conversely, moving seed from east to west across boundaries risks poor adaptation to mild and moist conditions. In general, movement north or south is less risky. Often, the most prudent choice is to delay planting until you have the right seedlings. Remember, to maintain forest health over the long term you have to plant seedlings that are genetically adapted to your site. Failure to do so creates stands of poor growth that are chronically hit with insect and disease problems.

(Continues on page 11)

Relative performance for common native tree species in Oregon's major forest/climate regions

Table 1a. Coast Range

Species	Performance category[1]							
	Level of use/ availability	Growth rate	Shade tolerance	Animal damage	Frost/cold tolerance	Drainage/ wet soils	Drought/ heat	Comments
Douglas-fir	5	5	2	2	3	1	3	Good on most sites. Susceptible to Swiss needle cast in coastal fog zone.
Grand fir	2	4	4	4	3	3	2	Moist sites
Noble fir	1	3	3	4	4	1	1	Coast range above 2,000 ft
Red alder	2	4	1	2	2	4	1	Riparian, root rot pockets
Bigleaf maple	1	3	4	1	2	4	3	Most sites
Sitka spruce	1	4	3	5	1	3	2	Fog zone
Shore pine	1	2	1	5	4	4	2	Fog zone
Western hemlock	3	3	5	3	1	2	1	Moist sites (over 60 in. rainfall)
Western redcedar	2	3	5	1	2	4	2	Moist sites, riparian

[1]Perfomance category	Description of rating
Level of reforestation use; availability of nursery seedlings	1=uncommon, infrequently planted; 5 = abundant, frequently planted
Growth rate	1=slow, short, low volume/acre; 5=rapid, sustained, high volume/acre
Shade tolerance	1 = requires full sunlight; 5 = grows well in shade
Animal damage	1=frequently browsed/damaged; 5 = infrequently browsed/damaged
Frost/cold tolerance	1 = easily damaged by frost/cold; 5 = high resistance to low temperatures
Drainage/wet soil	1 = requires well-drained soil; 5 = tolerates poor drainage or standing water
Drought and heat tolerance	1 = damaged or killed by drought and heat; 5 = tolerates drought and heat

Relative performance for common native tree species in Oregon's major forest/climate regions (cont'd.)

Table 1b. Willamette Valley and eastern Cascades

Species	Performance category[1]							
	Level of use/ availability	Growth rate	Shade tolerance	Animal damage	Frost/cold tolerance	Drainage/ wet soils	Drought/ heat	Comments
Douglas-fir	5	5	3	2	3	1	3	Good on most sites
Grand fir	2	4	4	4	3	3	2	Moist sites
Noble fir	2	3	3	4	4	1	1	Moist sites above 2,000 ft
Red alder	2	4	1	2	2	4	1	Moist sites, riparian, root rot pockets
Bigleaf maple	1	3	4	1	2	4	1	Wide range of sites
Oregon white oak	1	1	1	4	5	4	5	Valley margins; droughty sites
Black cottonwood	1	5	1	1	5	5	1	Riparian
Ponderosa pine	2	3	1	4	5	4	5	Poorly drained as well as droughty sites
Western hemlock	3	3	5	3	2	3	1	Moist sites; will tolerate more brush than Douglas-fir
Western redcedar	2	3	5	1	2	4	2	Good on sites with high water table

[1]Perfomance category	Description of rating
Level of reforestation use; availability of nursery seedlings	1=uncommon, infrequently planted; 5 = abundant, frequently planted
Growth rate	1=slow, short, low volume/acre; 5=rapid, sustained, high-volume/acre
Shade tolerance	1 = requires full sunlight; 5 = grows well in shade
Animal damage	1=frequently browsed/damaged; 5 = infrequently browsed/damaged
Frost/cold tolerance	1 = easily damaged by frost/cold; 5 = high resistance to low temperatures
Drainage/wet soil	1 = requires well-drained soil; 5 = tolerates poor drainage or standing water
Drought and heat tolerance	1 = damaged or killed by drought and heat; 5 = tolerates drought and heat

Relative performance for common native tree species in Oregon's major forest/climate regions (cont'd.)

Table 1c. Southwestern Oregon

Species	Performance category[1]							
	Level of use/ availability	Growth rate	Shade tolerance	Animal damage	Frost/cold tolerance	Drainage/ wet soils	Drought/ heat	Comments
Douglas-fir	5	4	3	2	3	1	3	Not suited for hot, dry sites
Ponderosa pine	4	3	1	4	5	4	5	Good for harsh sites (heat/ drought, frost)
Grand fir	2	4	4	4	3	3	2	Moist sites
White fir (mid-upper Cascades)	2	4	5	4	4	2	2	Plant above 3,500 ft on moist, well-drained soils
Incense cedar	2	2	3	3	4	2	4	Suited to a wide range of sites and soils
Sugar pine	1	3	2	4	3	2	3	Plant blister rust-resistant stock
Oregon white oak	1	1	1	4	5	4	5	Valley margins, droughty sites
California black oak	1	1	1	4	4	2	5	Wider range of sites than white oak
Pacific madrone	1	3	2	4	2	2	4	Warm, dry sites

[1]Perfomance category	Description of rating
Level of reforestation use; availability of nursery seedlings	1=uncommon, infrequently planted; 5 = abundant, frequently planted
Growth rate	1=slow, short, low volume/acre; 5=rapid, sustained, high-volume/acre
Shade tolerance	1 = requires full sunlight; 5 = grows well in shade
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Drainage/wet soil	1 = requires well-drained soil; 5 = tolerates poor drainage or standing water
Drought and heat tolerance	1 = damaged or killed by drought and heat; 5 = tolerates drought and heat

Relative performance for common native tree species in Oregon's major forest/climate regions (cont'd.)

Table 1d. Eastern Oregon

Species	Performance category[1]							
	Level of use/ availability	Growth rate	Shade tolerance	Animal damage	Frost/cold tolerance	Drainage/ wet soils	Drought/ heat	Comments
Douglas-fir	3	3	3	3	2	1	3	Poorly suited to south slopes & areas with <20 in annual precipitation
Ponderosa pine	5	4	1	2	4	2	5	Most widely planted eastside species; good survival and early growth
Lodgepole pine	3	4	2	1	5	5	4	Well-suited to frost pockets, poorly drained sites
Western larch	2	5	1	3	4	3	3	Excellent juvenile growth
Grand fir and white fir	2	3	5	2	3	3	2	Susceptible to defoliators
Engelmann spruce	1	3	4	1	5	5	2	Planted above 3,500 ft; good for moist sites and frost pockets

[1]Perfomance category	Description of rating
Level of reforestation use; availability of nursery seedlings	1=uncommon, infrequently planted; 5 = abundant, frequently planted
Growth rate	1=slow, short, low volume/acre; 5=rapid, sustained, high-volume/acre
Shade tolerance	1 = requires full sunlight; 5 = grows well in shade
Animal damage	1=frequently browsed/damaged; 5 = infrequently browsed/damaged
Frost/cold tolerance	1 = easily damaged by frost/cold; 5 = high resistance to low temperatures
Drainage/wet soil	1 = requires well-drained soil; 5 = tolerates poor drainage or standing water
Drought and heat tolerance	1 = damaged or killed by drought and heat; 5 = tolerates drought and heat

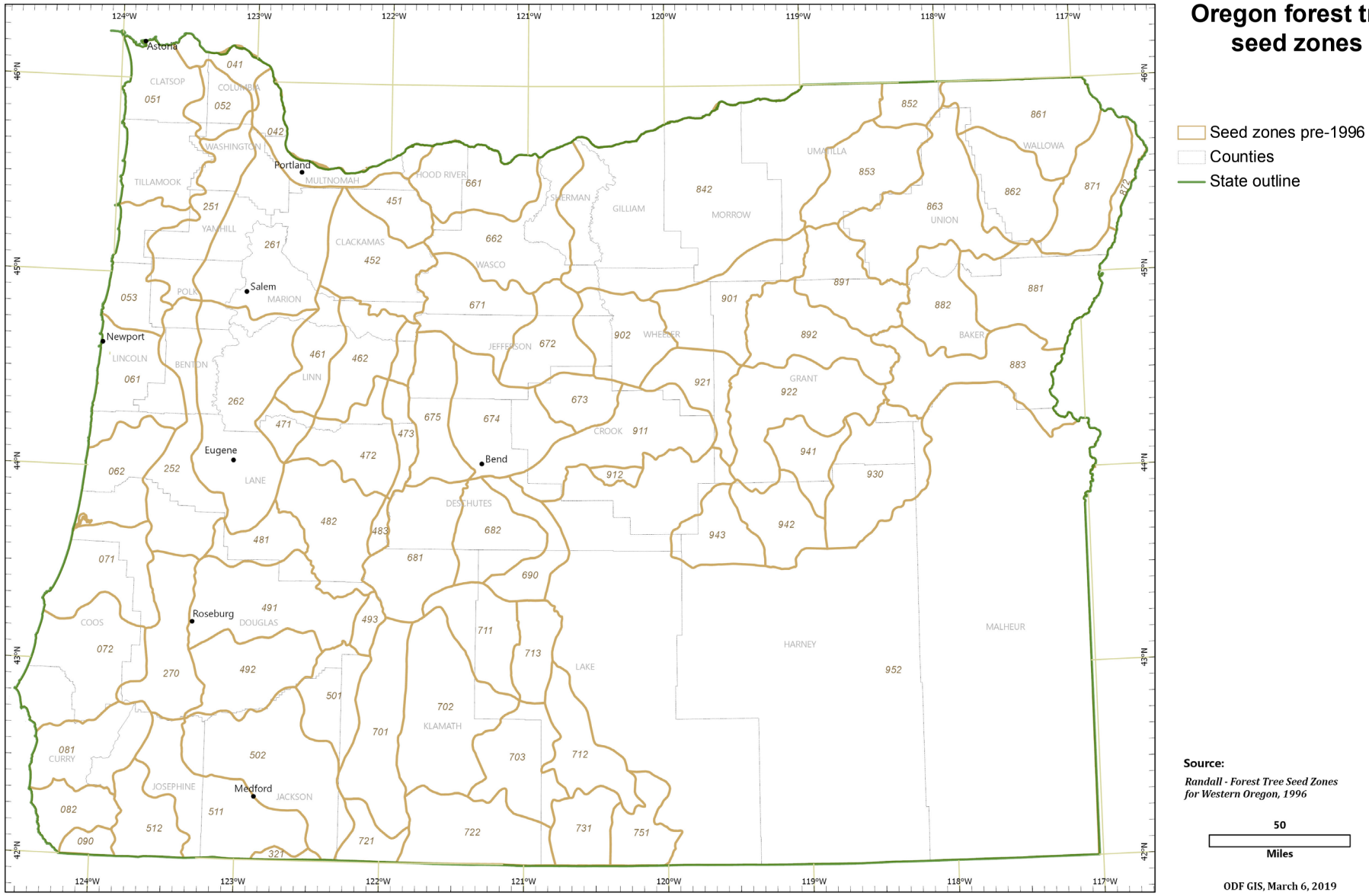

Figure 1a: 1960s seed zone map of Oregon. Zone numbers pertain to all forest tree species. Map produced by Oregon Department of Forestry.

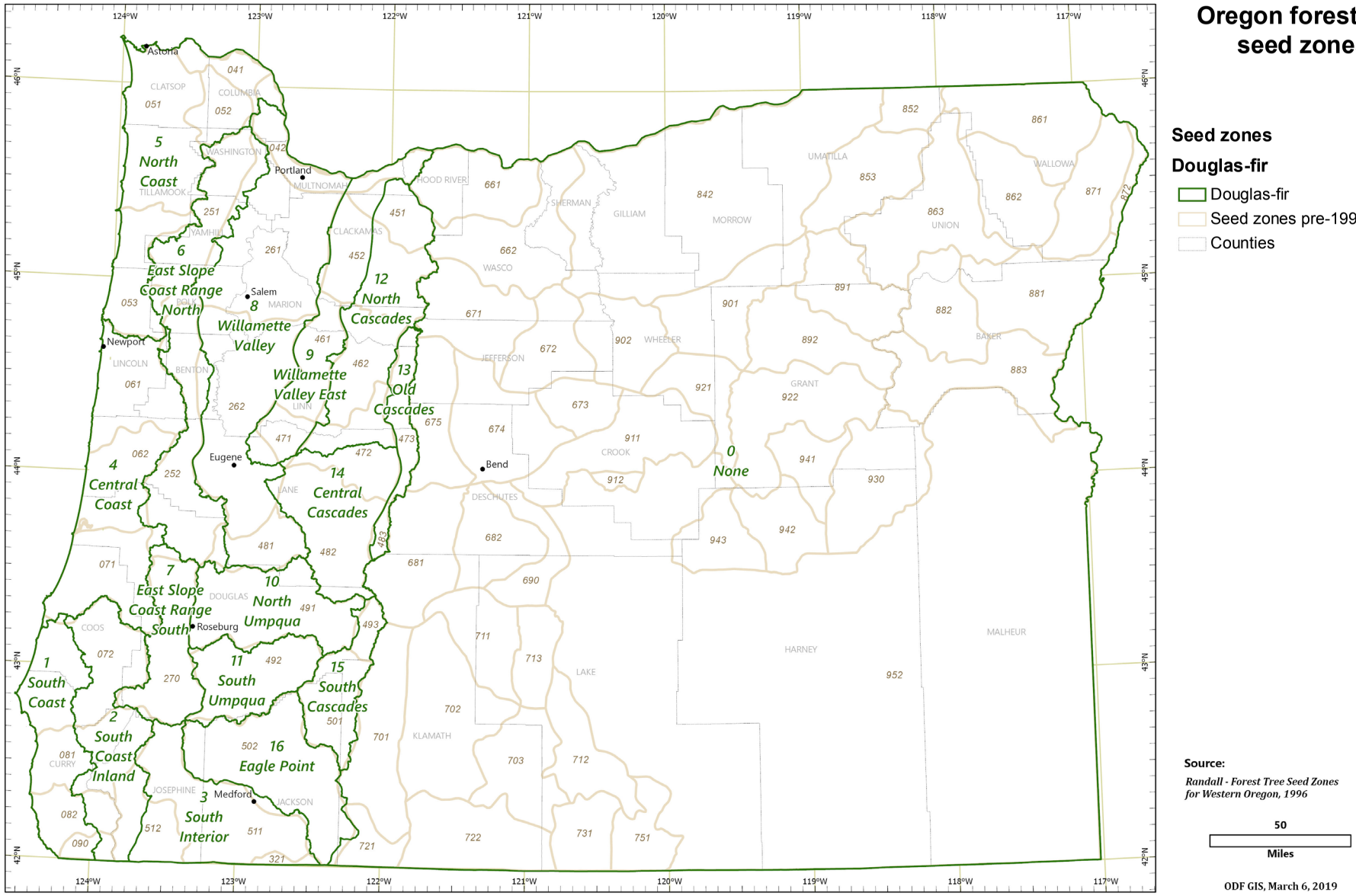

Figure 1b: 1996 Oregon seed zone map for Douglas-fir. Map produced by Oregon Department of Forestry.

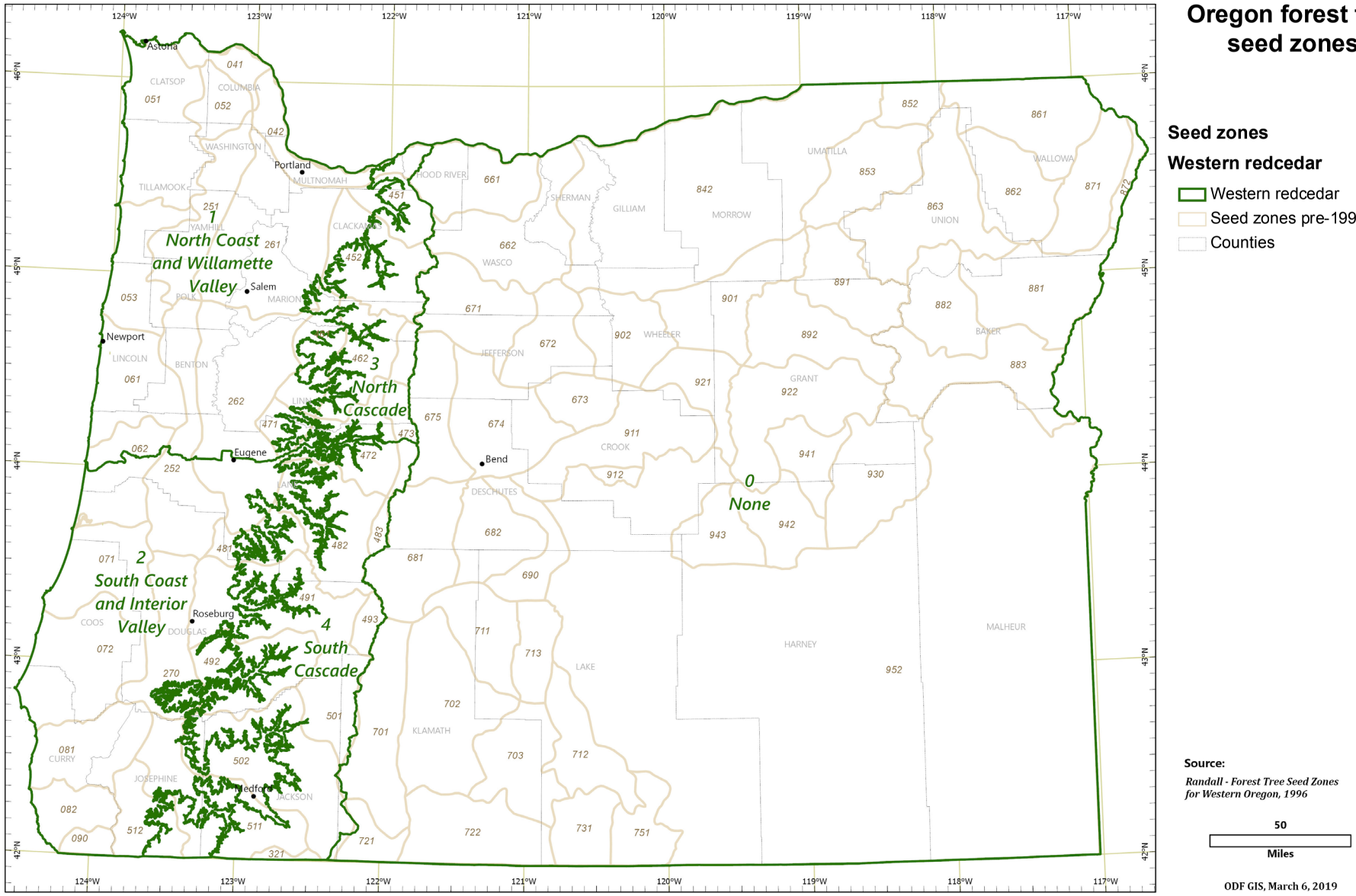

Figure 1c: 1996 Oregon seed zone map for western redcedar. Map produced by Oregon Department of Forestry.

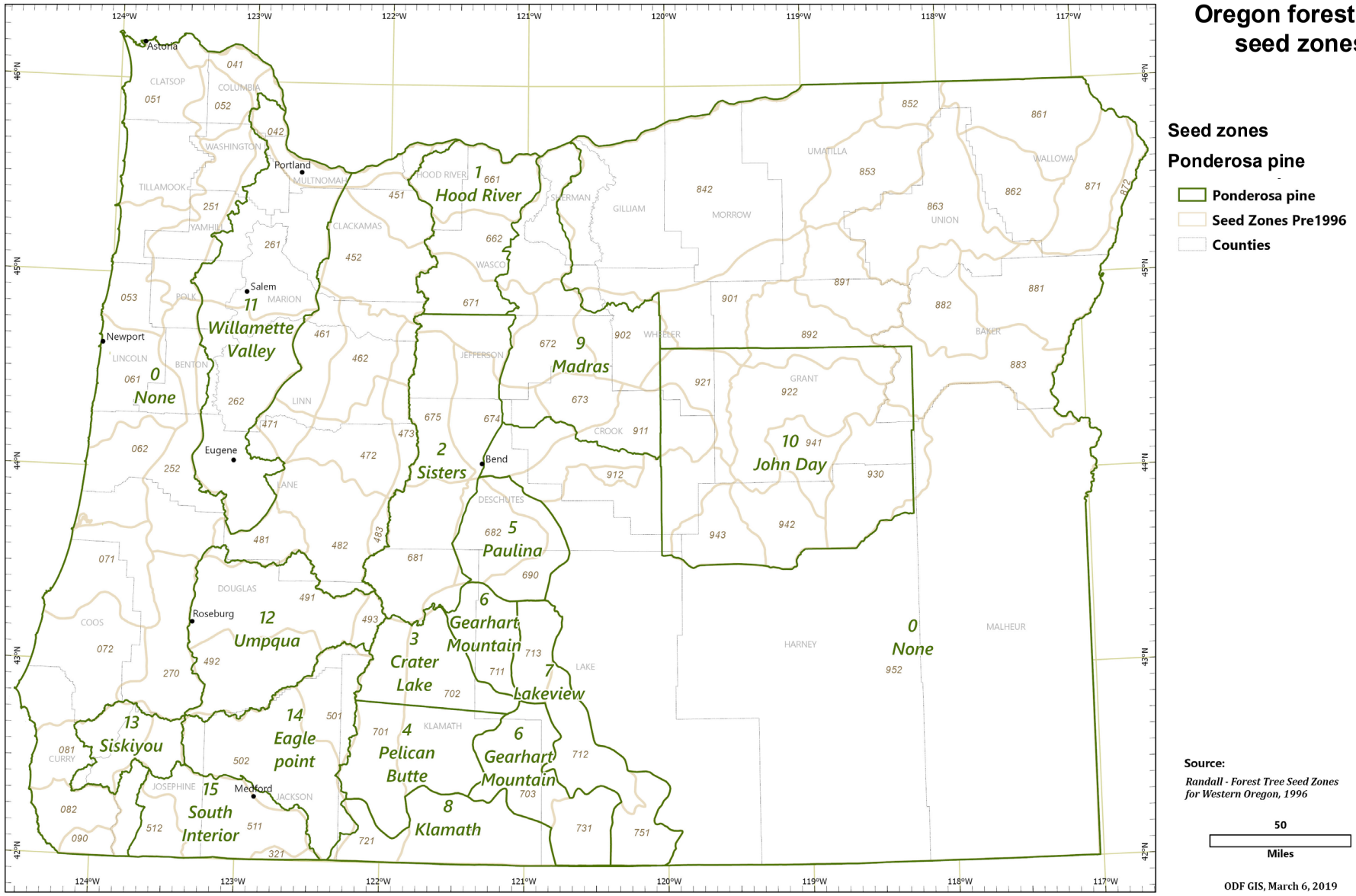

Figure 1d: 1996 Oregon seed zone map for ponderosa pine. Map produced by Oregon Department of Forestry.

(Continued from page 2)

Genetically improved seedlings

Genetically improved seedlings are the result of a long-term genetic selection process of tree breeding over multiple generations. Parent trees are selected for superior characteristics of growth, form, and resistance to disease, insects, and climate stress. Offspring from superior parent trees are tested in controlled plantings called progeny tests. The trees that perform well across a range of conditions are selected and propagated by grafting in seed orchards or by vegetative cloning. The process of selecting superior individuals and crossbreeding with others may continue for generations. Genetically improved seedling stock is more expensive but generally grows faster and is more resistant to disease, insects, and climate stress.

Special considerations regarding introduced diseases

Woodland owners considering Port-Orford-cedar, sugar pine, or western white pine are advised to plant disease-resistant seedlings, which are better able to withstand introduced diseases, such as Port-Orford-cedar root rot and white pine blister rust. Likewise, woodland owners planting trees in or near areas infested with sudden oak death should select species carefully. Contact your county Extension forester for more information.

Growing exotic tree species

Exotic species are trees that are not native to the local area. Some forest owners are interested in exotic species that have potential for fast growth, high value, or better adaptation to a changing climate. Thoroughly testing a new species or variety takes decades. If you plant exotic species, you risk damage from early frosts or extreme drought, susceptibility to diseases, or other problems outside that species' range of adaptability. It may be decades before these issues become apparent. Many tree species from around the world have been tested in the Pacific Northwest, but few have proven successful in wildland forestry applications. Cultivation of exotic species in more intensive agricultural or horticultural systems is more likely to succeed. If you are interested in planting an exotic species, carefully check what is known about its performance in your area. Consult with your Extension forester and other sources.

Risks of climate variability

The future climate in Oregon likely will be warmer than at present, but the magnitude of the temperature increase is uncertain. Although overall precipitation is not predicted to change much, summers are expected to be drier. As a result, trees will probably experience significantly higher levels of heat and drought stress by 2040. Trees planted now based on current seed zone guidelines could be poorly adapted to this future climate. Some forest managers are considering "assisted migration," the deliberate movement of species or seed sources outside their current geographic range in an attempt to anticipate expected warmer conditions.

Assisted migration could improve the long-term adaptation of trees to future climates; however, there is a tradeoff between short- and long-term results. Current populations of species such as Douglas-fir may not be adapted to the predicted future climate, but Douglas-fir trees from warmer climate zones are not adapted to the current climate at higher elevations or farther north. By using assisted migration to move trees from warmer climate zones, you risk planting them in areas where they may experience growth losses, increased incidence of disease, and even mortality in the short term (Figure 2). If you are interested in exploring assisted migration, the Seedlot Selection Tool (see sidebar, page 12) is available to help match seedlots with planting sites based on climatic information.

One approach to dealing with the uncertainty of future climate is using genetically improved seedlings, which is already standard procedure for most timber companies and agencies in Oregon. Tree improvement

Photo: Dave Shaw

Figure 2: A seed source trial site in the Oregon Coast Range illustrates the impact of planting off-site seed stock. The trees on the right came from a seed source in southwest Washington state, which has a similar elevation and annual rainfall total as the planting site. The trees on the left came from southern Oregon, a much drier and higher elevation site. These trees are heavily impacted by Swiss needle cast disease and growing poorly.

The Seedlot Selection Tool is a GIS mapping program designed to help forest managers match seedlots with planting sites based on climatic information. The climates of the planting sites can be chosen to represent current climates or future climates based on selected climate change scenarios. The SST is available at: https://seedlotselectiontool.org/sst/

programs breed trees with superior characteristics in terms of growth rate, disease resistance, and tolerance to weather extremes.

Another approach is to choose species that are adapted to the warmer/drier end of the spectrum within the current range of species or seed sources suitable for a given site. For example, choose ponderosa pine or incense-cedar rather than Douglas-fir on dry sites in southwest Oregon, or favor Douglas-fir over western hemlock or western redcedar on warm/dry sites in the western Cascades. Maintaining mixes of currently adapted tree species while increasing the proportion of drought- and heat-tolerant species is a low-risk strategy for meeting the challenges of future climate change.

A third, more speculative approach is to plant a mixture of local seed sources along with some seed sources from lower elevations and farther south. This could be combined with higher planting density plus thinning to allow for the selection of trees that appear as if they will perform best in the future. Good recordkeeping and monitoring are essential in order to learn from these experiences.

Currently, assisted migration is not widely practiced or recommended in Oregon, but forest managers are implementing it in Canada, where climate warming over the last 40 years has been much more pronounced than in lower latitudes. Long-term studies of assisted migration, including planting trials, are underway across the Pacific Northwest and should lead to more refined recommendations in the future.

Part 2. Selecting stock type

Stock types available

After you have determined the species, seed zones, and elevation for your site, you have to decide on a suitable stock type. Stock type refers both to the age of the seedlings and the method used to grow them. Stock type is an essential factor in determining the size and characteristics of your seedlings.

Seedlings may be grown outdoors in nursery beds, in containers in greenhouses, or by a combination of methods (Figure 3 and Figure 4). Bareroot seedlings are grown outdoors, dug from the nursery beds, and shipped without soil on their roots. Seedlings grown in containers in greenhouses are called plugs because the root mass or growing medium retains a characteristic plug shape.

Container volumes can vary anywhere from 4 to 20 cubic inches, which in turn affects the seedling size (Figure 5a, page 13). Often, seedlings are sown outdoors in a seedbed or indoors as plugs for one season and then outplanted (transplanted to outdoor beds) for another year.

Photo: Amy Grotta, © Oregon State University

Figure 3: Douglas-fir plugs in a greenhouse, ready to be hardened off in preparation for planting or transplanting into a nursery bed.

Photo: Bruce Summers

Figure 4: Douglas-fir Plug+1 seedlings in a transplant bed at the end of their second growing season.

Table 2. Common stock types and their characteristics. Caliper and height measurements are for Douglas-fir; other species may vary

Growing method	Stock type	Total age (years)	Caliper (mm)	Typical shoot height (inches)	Typical root length (inches)
Bare root	2+0	2	5	10–12	10
	1+1	2	6	12–15	10
	2+1	3	8	18–24	10
Greenhouse	Plug	1	2	8–12	6
Combination	Plug + 1	2	6	12–18	10

A two-digit code specifies seedling age. The first number gives the number of years the seedling grew in a seedbed or greenhouse. The second number denotes the years the seedling grew outdoors in a transplant bed. The two numbers added together tell you the seedling's age (Table 2, Figure 5b).

Table 2 shows typical sizes for Douglas-fir seedlings; however, a particular stock type may vary from year to year and from nursery to nursery. Hardwoods typically are grown as 1+0 seedlings. There also is a relatively new stock type, called miniplug-1. The miniplug-1 is started in a greenhouse in very small containers for 3 to 4 months in early spring and then transplanted outdoors for one growing season. These seedlings have plug-1 characteristics and are produced in less time at a lower cost.

Characteristics of quality seedlings

High-quality seedlings should have good stem caliper (diameter), a fibrous root system, healthy foliage, and well-developed buds. Stem caliper is perhaps the single best indicator of seedling quality for all stock types and correlates well with post-planting survival and growth. Stem caliper usually is measured in millimeters at the soil line.

Large-stem seedlings offer many advantages:

- They resist being bent by soil movement, falling debris, and wind.
- They are more resistant to damage by weevils and rodents.
- They have better lateral branch and bud development, which enables them to better withstand big-game browsing.
- They are more resistant to heat.
- They generally have more roots.

A well-developed, fibrous root system (Figure 6, page 14) helps the seedling better access the soil moisture and nutrients it needs to establish quickly. On the other hand, a seedling with a large top compared to

Photos: John Trobaugh, Washington Department of Natural Resources

Figure 5: Examples of different seedling stock types.

(A) Douglas-fir container stock types. From left to right: S-4 (4-cubic-inch root plug, 313A), S-10 (10-cubic-inch root plug, 415D), and S-20 (20-cubic-inch root plug, 615A).

(B) Douglas-fir bare-root stock types. From left to right: 2 + 0 (2 years in a seedbed plus 0 years in a transplant bed), 1 + 1 (1 year in a bare-root seedbed plus 1 year in a transplant bed), and plug + 1 (started as a container ["plug"] seedling plus 1 year in a transplant bed).

its root system may not be able to access enough soil moisture to support its foliage. Shoot-to-root ratio refers to the volume of material contained in a seedling's top compared to its root volume. A good shoot-to-root ratio for Douglas-fir is 1.5 to 1; a poor shoot-to-root ratio can be as much as 3 to 1. Shoot-to-root ratio becomes even more important on droughty sites where the ability to capture soil moisture is critical to seedling survival.

Large timber companies that contract with a nursery to grow their seedlings can specify minimum acceptable caliper, shoot-to-root ratio, or other grading standards. In general, this is not the way that small-acreage woodland owners do business; instead, they order seedlings from a nursery in good faith that the seedlings are good quality. Most reputable nurseries pre-grade their seedlings before filling orders, culling those that do not make the grade. When ordering your seedlings, you can always ask the nursery about their grading standards.

Matching stock to your site

On most sites that have adequate moisture and good soil, it is best to select the largest, most vigorous seedlings available. Large, healthy seedlings will be able to take advantage of abundant resources and need less time to outgrow competing vegetation and browsing deer or elk. Plug+1 or 1+1 seedlings are widely available and are well suited to these productive sites. On well-prepared sites with good soils and minimal competing vegetation, small planting stock such as plugs can do well.

On sites with poor, rocky soil, smaller seedlings are better. It is easier to plant a seedling with a smaller root system correctly on these types of sites because the planting hole or slit can be shallower. Plugs may be the best choice in these situations.

Photos: John Trobaugh, Washington Department of Natural Resources

Figure 6. Douglas-fir 1+1 seedlings showing (left) excellent root system and (right) poor root system. The seedling on the right did not meet grading standards.

Part 3. Buying quality seedlings

Finding a seedling supplier

Woodland owners have several options for buying seedlings:

- Ordering "spec" seedlings from a nursery.
- Contracting with a nursery to grow seedlings.
- Ordering from a locally organized seedling sale.

Plan on buying your seedlings at least one year in advance, or even two years, if possible. Ordering your seedlings well in advance ensures that you will have the best selection possible and avoids a last-minute scramble in years of short supply or high demand. If this is your first time ordering seedlings, it's always a good idea to get references from experienced woodland owners about local options for buying seedlings. Your local Extension forester can also help.

Ordering from a nursery

Many nurseries grow a supply of forest seedlings "on spec" (speculation) each year, meaning they grow the seedlings without a particular buyer ahead of time. Because the seedlings take one to two years to grow, nurseries try to predict the demand for each seedling species, stock type, and seed zone. It is a significant investment for the nurseries, so they are often conservative with their spec production. Popular reforestation species such as Douglas-fir and western redcedar sell out quickly.

The Oregon Department of Forestry maintains a list of forest seedling nurseries on its website (https://www.oregon.gov/ODF/Working/Pages/Replanting.aspx). Before ordering seedlings, you can browse this list and familiarize yourself with which nurseries produce the types of seedlings that you want. If possible, visit the nursery to discuss your needs and observe its operations. In general, bare-root seedlings are sold in bag quantities (typically 100 or more seedlings per bag). In some cases, nurseries will sell smaller quantities.

Contract growing

If you have a very large reforestation project, you may be able to find a nursery that will grow your seedlings on contract. You will need to place your order years before your planting date: two years for 2-year-old seedlings and one year for plugs. The advantage of contract growing is that the seedlings are grown to your exact specifications (for example, specific seed source and stock type). The disadvantage with this arrangement is that it is usually only available to larger seedling orders (20,000 or more seedlings for approximately 60 or more acres). Because most small-acreage woodland owners do not fall into this category, an alternative is to order seedlings from a local entity that has contracted with a nursery to grow seedlings for its buyers/members (see below).

Local seedling programs

You may live in an area where there are locally organized seedling sales. For example, some local chapters of the Oregon Small Woodlands Association contract with a nursery to grow seedlings that they, in turn, sell to their members (Figure 7). The benefit is that small-acreage woodland owners can access high-quality, improved seedlings specific to their seed zone that may otherwise be hard to obtain. The disadvantage is that these programs are entirely volunteer operated and typically are limited to one or two species. Some private companies have also begun using this model to combine individual orders into an order large enough for a nursery to grow on contract. Some soil and water conservation districts also operate sales and will often will have a wider range of species. However, these sales may not include improved seedlings or seedlings from your seed zone; quantities may be more limited.

When to plant

Most reforestation west of the Cascades is done from December through March, when soil moisture is abundant. Seedlings are most dormant and least sensitive to stress from lifting and handling during this period. For western Oregon or western Washington, the vast majority of nurseries organize their production schedules so that seedlings are ready for planting in winter. Fall planting with plugs has recently become an option on the west side, using seedlings that are preconditioned in the greenhouse so that the top is dormant but the roots can produce a flush of growth before the soil becomes too cold.

Eastside and higher elevation sites that are covered with snow must be planted in fall or spring. Take special care with fall planting. At that time, seedlings may have set a terminal bud but are not yet fully dormant. This means they are damaged more easily by handling. Fall planting will fail if the soil is too dry. There also is a risk that seedlings will dry out if they are not covered with snow soon after planting. Spring planting on high-elevation eastside sites should be done as soon as the snow is gone. This often means plowing roads to get to the site.

Photo: Amy Grotta, © Oregon State University

Figure 7: Oregon Small Woodlands Association volunteers at a nursery, loading up a truck with seedlings that were grown on contract for their local chapter's members.

Picking up your seedlings

In the winter months, nurseries will lift bare-root seedlings, which means removing them from the nursery beds and sorting, bagging, and placing them in cold storage. Bad weather and wet or frozen soil can disrupt a nursery's lifting schedule. Contact the nursery four to six weeks before you want your order. One week before you want to pick up your order, contact the nursery again to confirm that your seedlings have been lifted and are ready to be picked up (Figure 8, page 16).

Come prepared to keep your seedlings cool during transit (Figure 9, page 16). A refrigerated trailer, van, or well-insulated pickup canopy is recommended for trips longer than three to four hours. A metal pickup bed transmits exhaust and road heat, which can damage seedlings. You can reduce this problem by placing a piece of ¾-inch plywood on the floor of the pickup bed. Seedlings hauled without a canopy should be covered with a "space blanket" or similar reflective tarp. Don't use dark tarps, which absorb heat. You can use blocks of ice to cool seedlings during transport in warm weather.

Check every bag or box of seedlings to ensure it is identified with the correct seed zone, elevation, and lift date. Don't accept bags with holes or signs of damage. Seedling packages must be handled gently. Throwing or

Photo: Amy Grotta, © Oregon State University

Figure 8: After seedlings have been lifted, they are bagged and kept in cold storage at the nursery until customers pick them up.

Photo: Amy Grotta, © Oregon State University

Figure 9: For a two-hour drive in overcast, 35-degree weather, these seedlings are placed in a pickup bed with a plastic bed liner. The bags will then be covered with a tarp to protect them from rain or dry air.

dropping bags can injure seedlings, reducing their ability to survive and grow.

Ask the nursery or supplier to open a few bags or boxes. Check that the seedlings are adequately moist and that roots do not appear dried out. Excessive water or mud is not desirable. There might be a small amount of white mold on the fine roots. The presence of this type of mold is okay; it probably is mycorrhizal fungi from the nursery soil. Mycorrhizal fungi help the seedling become established in the field. However, excessive gray mold on the needles is a sign of improper storage. Gray, moldy seedlings are suspect, and you should not accept them. It's easier to resolve problems while still at the nursery than when you get back home.

When you return home, keep your seedling bags in a cool, dark place but do not let them freeze. Plant your seedlings as soon as the weather permits. If you need to wait several days before planting, try to find cold storage for your seedlings, such as at a business with a walk-in cooler or your local Oregon Department of Forestry location.

Summary

Obtaining high-quality seedlings is critical to reforestation success. Many decisions need to be made, such as the species to be planted, stock type, seed source, seedling supplier, and timing of seedling pickup and planting. By considering these things ahead of time, your reforestation project will go more smoothly.

For further reading

Refer to these other OSU Extension Catalog publications related to reforestation:

Successful Reforestation: An Overview (EC 1498)
https://catalog.extension.oregonstate.edu/ec1498

The Care and Planting of Tree Seedlings on Your Woodland (EC 1504)
https://catalog.extension.oregonstate.edu/ec1504

Choosing the Right Tree-Planting Contractor for Your Family Forest (EM 9201)
https://catalog.extension.oregonstate.edu/em9201

Introduction to Conifer Release (EC 1388)
https://catalog.extension.oregonstate.edu/ec1388

Enhancing Reforestation Success in the Inland Northwest (PNW 520)
https://catalog.extension.oregonstate.edu/pnw520

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