THE WOODLAND WORKBOOK

REFORESTATION

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Selecting and Buying Quality Seedlings

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Contents

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Successful reforestation of your harvested timberland is more than just 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 kind of seedlings should I select?
- How can I tell whether their quality is good?
- From which nursery should I order?
- How much lead time do I need?
- When is the best time to plant?

We will answer these questions in this publication, which is divided into three parts. Part 1 helps you select trees that are adapted to grow well long-term under your local conditions. Part 2 helps you choose nursery stock that has a high probability of surviving and showing good initial growth. Part 3 provides tips on selecting a nursery, ordering, and purchasing.

Part 1. Seed zones and selecting adapted species

Our focus is on selecting trees suitable for long-term timber production. If you have other objectives, such as short-term fiber production or Christmas trees, read publications that relate directly to those subjects.

To determine whether a particular tree species is adapted to grow on your site, identify the species that grew there naturally before the first logging. This can be done by identifying old stumps on the site or nearby areas. If no stumps are present, you may have to rely on historical records or the knowledge of long-term residents. Species guides also are found in soil surveys of your area made by the USDA Natural Resources Conservation Service (formerly, the USDA Soil Conservation Service). Soil surveys indicate site productivity, soil and environmental conditions, and site–species relationships.

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Table I.—Relative performance ratings for various tree species in climatic regions of western Oregon.

Region and species	Tree performance						Comments
	Level of use[1]	Growth[2]	Shade tolerance[3]	Big game damage[4]	Frost[5]	Drainage[6]	
Coast							
Douglas-fir	5	5	2	3	2	1	Good on most forest sites with good soil and drainage. Control brush before it overtops seedlings.
grand fir	2	5	3	3	4	4	Good on moist sites.
noble fir	1	3	3	4	4	1	For timber planting above 2,000 feet in the Coast Range.
red alder	1	3	1	3	3	3	Used in riparian and root-rot areas.
Sitka spruce	1	5	4	2	5	3	Good only near coast. Spruce tip weevil is a serious pest.
shore pine	1	1	1	5	5	5	Grows on droughty sand or hardpan sites. Good early growth but slower long term.
western hemlock	3	5	5	3	3	2	Will tolerate more brush competition than Douglas-fir.
western redcedar	2	4	4	2	1	4	Good in areas with high water table. Can be browsed heavily.
Willamette Valley and west slopes of Cascades							
cottonwood	1	4	1	3	1	5	Used on river bench alluvial soils.
Douglas-fir	4	5	2	3	2	2	Brush and grass control is important.
grand fir	1	4	3	3	4	3	Good for valley uplands where game damage can be a problem.
noble fir	2	3	3	4	4	2	Used above 1,500 feet elevation; avoid clay soils.
ponderosa pine	1	3	1	5	4	1	Good on sandy soils or clay soils that become droughty in summer.
western hemlock	1	3	5	3	3	2	Used on north-facing sites.
western redcedar	1	3	4	2	1	4	Do not plant on poorly drained clay soils.

[1] Level of reforestation use — 5 = planted on more than 90% of the sites; 1 = infrequently planted

[2] Height and volume growth — 5 = superior; 1 = slow/poor

[3] Shade tolerance — 5 = able to grow well with overstory shade; 1 = requires full sunlight

[4] Big game damage — 5 = infrequently browsed by deer or elk; 1 = frequently browsed

[5] Frost resistance — 5 = high resistance to low temperatures; 1 = easily damaged by frost

[6] Drainage — 5 = tolerates poor drainage or some standing water for short periods; 1 = requires well-drained soils

Table 1 divides western Oregon into coastal and Willamette Valley regions.

Table 2 covers southwest Oregon and eastern Oregon. These tables present considerations in selecting species for reforestation in each region. For example, on a coastal site with moist soils and shade from standing trees, you can consider a shade-tolerant species such as western hemlock.

Table 2.—Relative performance ratings for various native tree species in southwestern and eastern Oregon.

Region and species	Tree performance						Comments
	Level of use [1]	Growth [2]	Shade tolerance [3]	Frost [4]	Heat [5]	Drought [6]	
Southwestern Oregon							
Douglas-fir	4	5	3	3	3	4	Shade cards may be needed on hot, dry sites.
grand fir (mid- to lower coast)	2	4	5	3	2	2	Avoid poorly drained soils.
incense-cedar	1	2	3	4	5	5	Somewhat tolerant of serpentine soils. Pocket rot can be a problem.
ponderosa pine	2	5	2	5	4	5	Gopher control is needed in many areas. Porcupines also can cause damage.
white fir (mid- to upper Cascades)	2	4	5	4	2	3	Plant above 3,000 feet on moist, well-drained soil.
Eastern Oregon							
Douglas-fir	3	3	3	2	3	4	Risky on south slopes with less than 20 inches annual rainfall.
Engelmann spruce	1	3	4	5	2	2	Planted above 3,500 feet. Good on moist sites.
grand and white fir	2	3	5	1	2	3	Tolerates some shade in partial-cut situations. Slow growth first 2 years.
lodgepole pine	3	4	2	5	5	4	Adaptable to a variety of harsh sites.
ponderosa pine	5	4	1	4	5	5	Most widely planted eastside species. Good survival and early growth.
western larch	1	5	1	4	3	3	Excellent juvenile growth.

[1] Level of reforestation use — 5 = planted on more than 90% of the sites; 1 = infrequently planted

[2] Height and volume growth — 5 = superior; 1 = slow/poor

[3] Shade tolerance — 5 = able to grow well with overstory shade; 1 = requires full sunlight

[4] Frost resistance — 5 = high resistance to low temperatures; 1 = easily damaged by frost

[5] Heat resistance — 5 = can stand high temperatures; 1 = sensitive to heat

[6] Drought — 5 = can withstand drought; 1 = dies when drought stressed

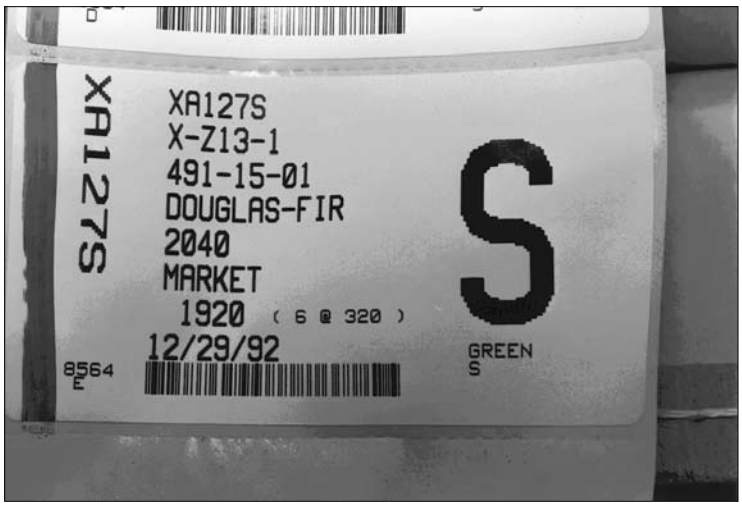

Figure 1.—Tree bag label showing the seedlings' origin.

Growing exotic trees

Exotic species are trees that are not native to the local area. It would be ideal to find one that would grow faster and taller than the native species. Most tree species from around the world have been tested in the Northwest, but few have proved successful. One exception is "KMX" pine. It's a hybrid cross between knobcone pine and Monterey pine. KMX is being grown successfully on dry sites in southwestern Oregon.

It may take years to discover problems when testing a new species. An early frost, a prolonged drought, or some other unusual event may destroy the hard work and money you've invested in the plantation. If you're interested in planting an exotic species, carefully check out what's known about its performance in your area. Discuss the idea with your Extension forestry agent and with other foresters.

Seed zones and elevations

Trees are adapted to the environmental conditions within the area from which they originate. For example, trees from lower elevations or more southerly latitudes tend to start growing earlier than trees from higher elevations or more northerly latitudes. This increases their susceptibility to frost damage if they are planted at higher elevations or in frost pockets. Likewise, trees from warmer, drier climates are likely to be more drought resistant. The Pacific Northwest climates become warmer and generally drier moving inland from the coast. It's important to remember this if you're moving trees from west to east. Never transplant trees from one side of the Cascades to the other. It's important to plant seedlings grown from seed collected in an area where environmental conditions closely match those in your area. This is especially important in areas such as the Cascades or southwest Oregon where conditions can change dramatically in a short distance.

When ordering trees, you will encounter codes such as "DOUGLAS-FIR 491-15-01" (Figure 1). The code gives the zone—for example, 491—where the seed was collected. Seed zones (Figures 2a, page 5, and 2b, page 6) have been established throughout the region; each has a three-digit number. The zones encompass areas within which growing conditions are similar. Zones often are defined by major geographic features such as river drainages, mountain ranges, and major valleys.

Remember that nursery location is not the important factor—it's the seed collection area that is critical. Elevation is given in 500-foot elevation bands within each seed zone. The "15" indicates the elevation band from which the seed was collected—in this case, between 1,000 to 1,500 feet. Other numbers that may appear on the bags or boxes provide added information.

When you order seedlings, specify that they must be grown from seed collected from the same zone and elevation band as your property. This will ensure you're planting trees adapted to grow well in your area. The seed zone and elevation should always appear on every bag or box. Never accept unidentified seedlings.

If you must indicate a substitute for either seed zone or elevation when ordering, you shouldn't move more than one zone or one elevation band away from your property's zone or elevation. Avoid west-to-east movements in zones because drought adaptation can be affected. A good rule of thumb is that it's safest to move seedlings from north to south and from higher elevation to lower.

The term "genetically improved" planting stock refers to seedlings grown from seed produced in a seed orchard. These

seedlings are the result of a long-term genetic selection process. Vigorous parent trees were selected for their superior growth and form. Offspring from these parent trees then were tested in controlled plantings called progeny tests. Once the best growers were identified, grafts or seeds from the parents were placed in an orchard to produce seed of known genetic quality. Genetically improved seedlings are more expensive but make sense. If planted properly and given good plantation care, they should grow 10 to 15 percent faster than average and should mature with good form.

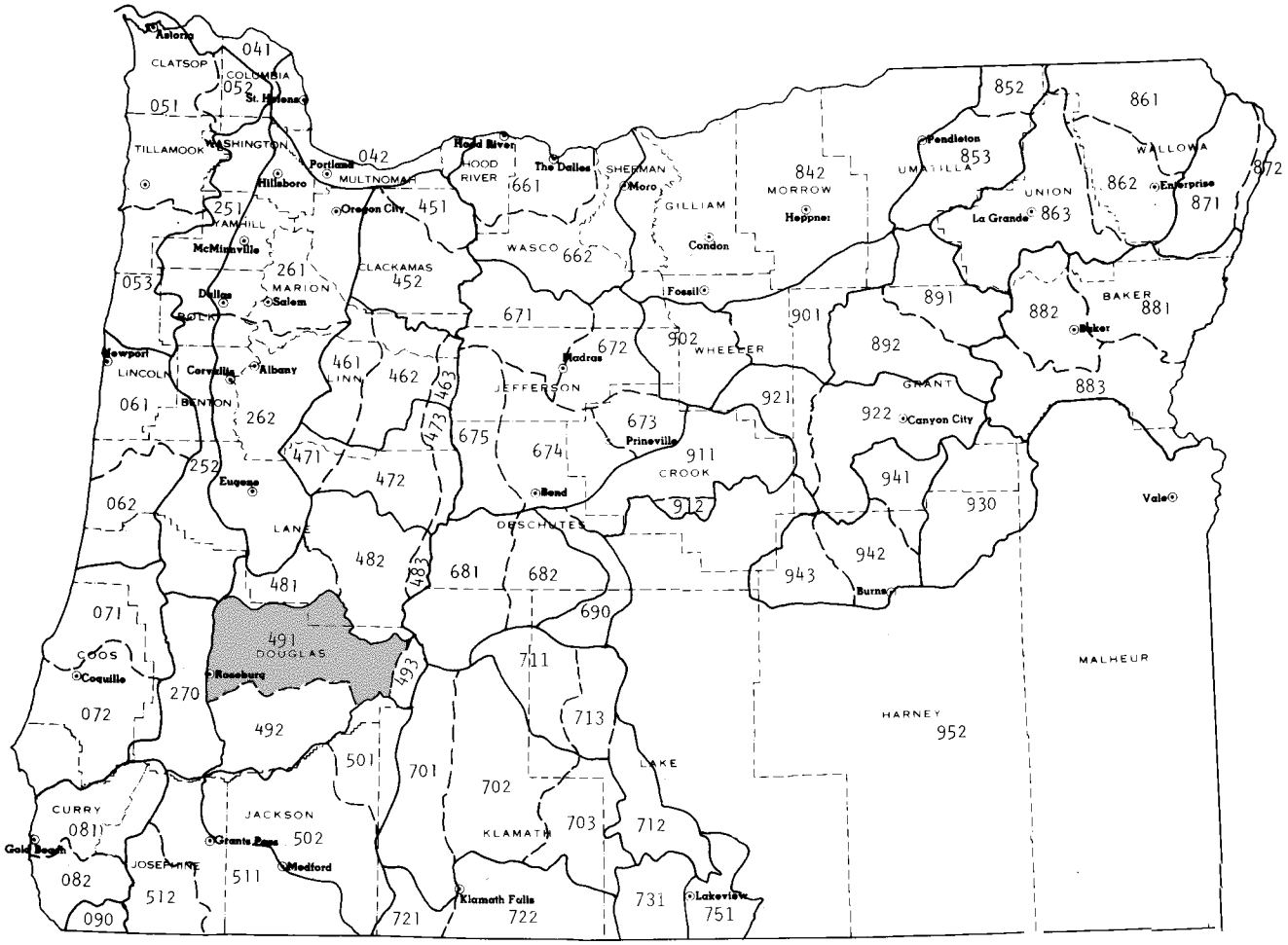

Figure 2a.—Tree-seed zone map of Oregon. (Map courtesy of Western Forest Tree Seed Council.)

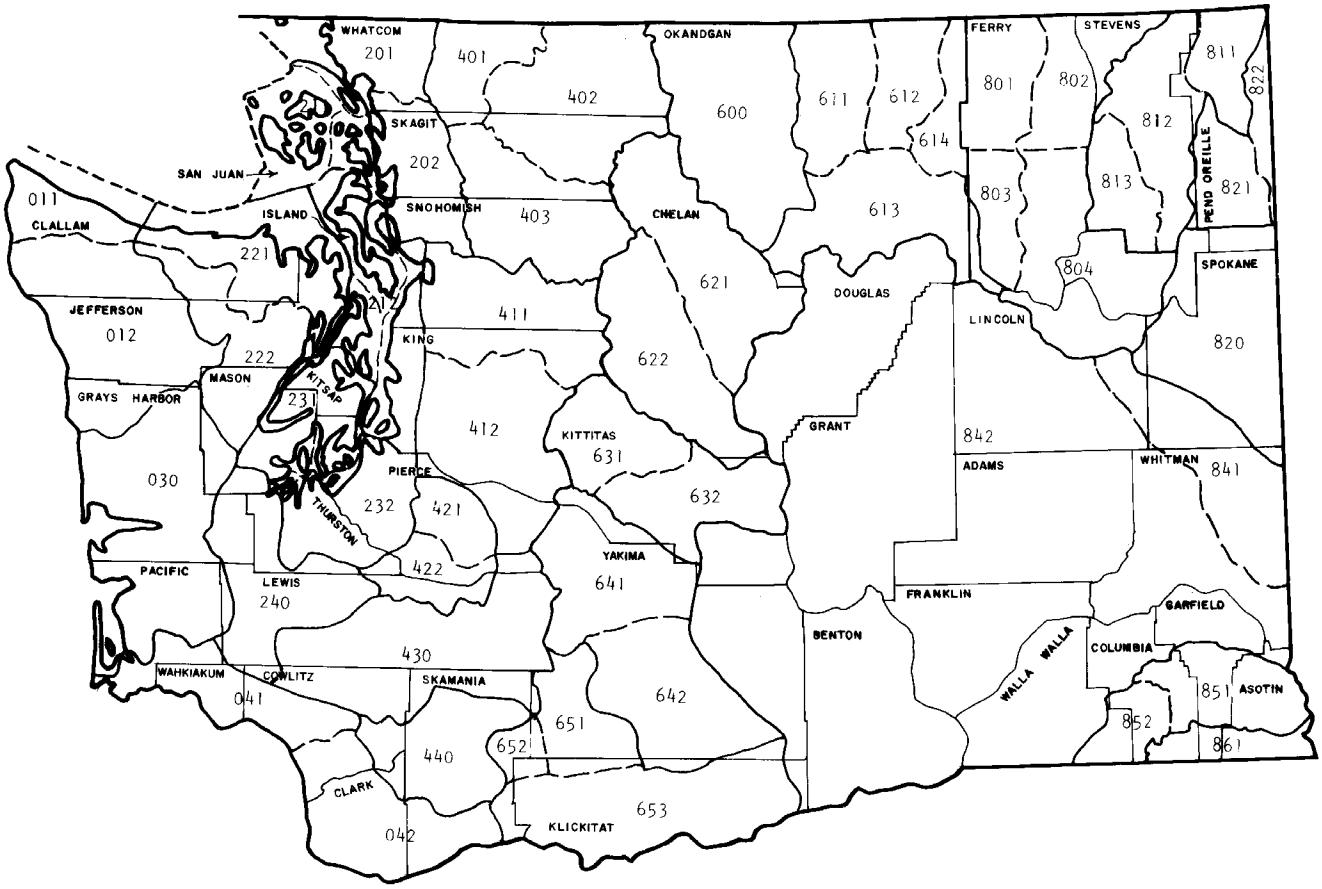

Figure 2b.—Tree-seed zone map of Washington. (Map courtesy of Western Forest Tree Seed Council.)

Part 2. Selecting stock type

Stock types available

After you have determined the species, seed zones, and elevation for your site, you must decide on a suitable stock type. Stock type refers both to the method used to grow the seedlings and to their age. It's an important 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). 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 sizes can be from 1 to 10 cubic inches, but 2 to 4 cubic inches is most common. Specify container size when ordering.

Seedling age is specified by two digits. The first number gives the years grown in a seedbed or greenhouse. The second number denotes years grown outdoors in a transplant bed. The two numbers added together tell you the seedling's age (Figure 4, page 8).

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

Matching stock to your site

On favorable sites that have adequate moisture and good soil, it's best to select the largest, most vigorous seedlings available. Good-quality seedlings should have healthy foliage, well-developed buds, a fibrous root system, and good stem diameter. Stem diameter, or caliper, is perhaps the single best indicator of seedling quality for all stock types. Stem caliper usually is measured in millimeters (mm) at the soil line. It's a good idea to specify a minimum stem caliper when communicating grading standards. Suggested minimums for Douglas-fir stock types are:

Stock type	mm	inches
Plugs	2	0.08
2 + 0	5	0.20
1 + 1	6	0.24
Plug + 1	6	0.24
2 + 1	8	0.31

Large-stem seedlings offer many advantages.

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

You should not, however, buy seedlings based solely on stem caliper. A seedling also should have a well-developed fibrous root system (Figure 5, page 8). Shoot–root ratio refers to the volume of material contained in a seedling's top compared to its root volume. A good shoot–root ratio for Douglas-fir is 1.5 to 1; a poor shoot–root ratio can be as much as 3 to 1. Shoot–root ratio becomes even more important on droughty sites where ability to capture soil moisture is critical to survival (Figure 6, page 9).

Table 3.—Common Douglas-fir stock types.

Growing method	Stock type	Total age (years)	Typical shoot height (inches)
Bareroot	2+0	2	10–12
	1+1	2	12–15
	2+1	3	18–24
Greenhouse	Plug	1	8–12
Combination	Plug + 1	2	12–18

Part 3. Buying quality seedlings

Selecting a nursery

If possible, visit the nursery from which you plan to order seedlings. This is the time to discuss your expectations, grading standards, and minimum specifications. If you're unable to visit the nursery to check it out before placing an order, look into its reputation for performance. Ask the nursery for references. Talk to people who have been major seedling users to see whether they've been satisfied.

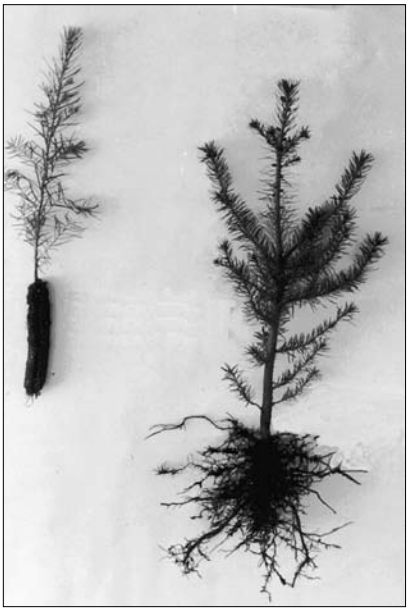

Figure 3.—Examples of container-grown and plug-1 Douglas-fir seedlings.

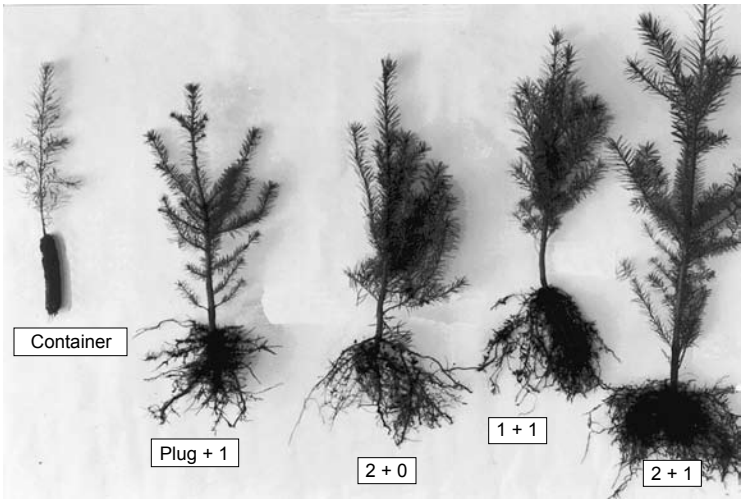

Figure 4.—Examples of different seedling stock types.

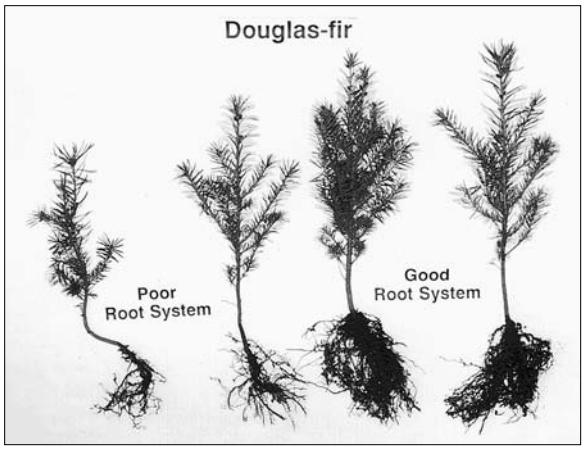

Figure 5.—Examples of good and poor root systems.

August or September is an ideal time for nursery visits (Figure 7). The current season's growth should be nearly completed, and you can get a good idea of what seedlings scheduled for winter lifting will look like. Ask the nursery to dig a few sample trees so you can look at roots as well as tops.

Nursery beds should be neatly laid out and free of weeds. Beds should be tagged or mapped to identify seed zones. Seedlings should appear healthy and be uniformly spaced within beds. Discuss bed densities with the nursery. Usually, lower bed densities produce better quality seedlings.

A nursery visit before ordering your seedlings can improve your confidence and help ensure that you'll get quality seedlings. Lists of forest seedling nurseries are available from OSU Extension foresters and from the Oregon Department of Forestry.

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 lifting and handling stress during this period. 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 they are not yet fully dormant. This means they are damaged more easily by handling. Fall planting will fail if soil moisture is inadequate. There also is a risk that seedlings will dry out if they're not covered soon with snow. Spring planting on high-elevation eastside sites should be done as soon as the snow is gone. Often, this means having to plow roads to get to the site.

Timing and ordering

Good planning is the best way to assure success in finding the right planting stock. Order your seedlings at least 12 months ahead. Most nurseries require a deposit. Seedlings usually are priced and sold in units of 1,000 trees, but often you can order them in units of 100.

If you plan to contract a nursery to grow your seedlings, you probably will need to contract for 5,000 trees or more. Contract growing allows flexibility to grow the type of seedling you want. You can discuss specifications in advance with the nursery manager, and nursery practices can be tailored to achieve your goals.

Picking up at the nursery

Bad weather and wet or frozen soil can disrupt a nursery's lifting schedules. Contact the nursery 4 to 6 weeks before you want your order. One week before you want to pick up your order, contact them again to confirm that your seedlings have been lifted and are in cold storage.

Check every bag or box as it's loaded into your vehicle (Figure 8, page 11). Every package should be identified with the seed zone, elevation, and lift date. Don't accept bags with holes or signs of damage. Seedling packages must be handled gently. Throwing or dropping injures seedlings, reducing their ability to survive and grow.

Ask the nursery to open a few bags or boxes. Check that the seedlings are adequately moist and that roots don't appear to be dried out. Excessive water or mud is not desirable. There might be a small amount of white mold on the fine roots. This 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 should not be accepted.

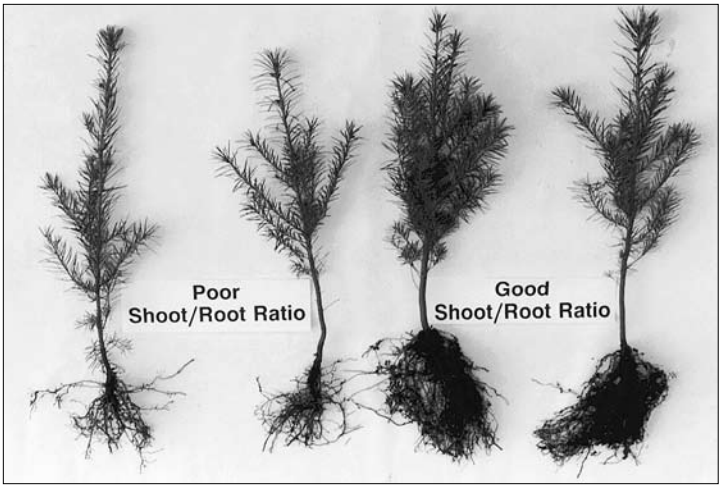

Figure 6.—Examples of poor and good shoot–root ratios.

Figure 7.—Ask the nursery to dig a few sample trees.

Table 4.—Checklist of steps in selecting and buying quality seedlings.

Step 1—Nursery selection

- ❑ Nursery appears well organized and weed free.
- ❑ Check bed densities and seedling size and quality.
- ❑ Beds identified and mapped.
- ❑ Seedlings appear healthy and disease free.
- ❑ Dormant buds set by late summer.
- ❑ Nursery willing to discuss grading specifications.
- ❑ Nursery run in a professional manner. Staff willing to accommodate you as a customer.

Step 2—Ordering seedlings

- ❑ Is advance deposit required? Confirm payment terms.
- ❑ Specify approximate lifting and delivery dates.
- ❑ Size and type of bags or boxes?
- ❑ Number of trees per package?
- ❑ Are quoted prices firm?
- ❑ Do plug seedling prices include containers? Is there a container charge or deposit?
- ❑ Does the nursery have a reputation for dependability and the ability to meet orders?

Step 3—Before you pick up seedlings

- ❑ Tell nursery about your plans to pick up seedlings, in order to minimize storage time.
- ❑ Determine size and type of vehicle you'll need.
- ❑ Ask nursery to keep seedlings in cold storage until ready to load.

Step 4—Checking your order

- ❑ Boxes or bags sealed tightly and not damaged.
- ❑ Seed zone and elevation clearly labeled.
- ❑ Seedling count shown.

Spot check these aspects:

- ❑ Roots should be moist but not excessively wet or muddy.
- ❑ Mold free, except traces of white mold on roots okay.
- ❑ Stem creamy white, not discolored, when bark is scraped off.
- ❑ Buds tight.
- ❑ Seedling grade is uniform and consistent with your specs.
- ❑ No scrapes or mechanical damage.
- ❑ Seedlings look, feel, and smell fresh and cool, not musty.

Step 5—Seedling transport (3- to 4-hour trip)

- ❑ Insulate bottom of truck bed with ¾-inch plywood or similar material.
- ❑ Use tarps if the truck bed is open, or use a vehicle that has a canopy.
- ❑ Allow for some air circulation.
- ❑ Stack to minimize settling and crushing.
- ❑ Unload bags and spread them out in a cool place immediately upon arrival.
- ❑ Use refrigerated transportation for trips longer than 4 hours.

Spread out a sample of seedlings so you can assess their uniformity and grade quality. Look for damaged seedlings or for root systems distorted from improper transplanting. Check to be sure that minimum size, stem diameter, and root grading standards have been met. It's easier to resolve problems while still at the nursery than when you get back home.

Keep seedlings cool during transit. A refrigerated van or well-insulated pickup canopy is recommended for trips longer than 3 to 4 hours. Exhaust and road heat can be transmitted through a metal pickup bed. 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 warm weather. See Table 4 for other suggestions about transporting seedlings.

Figure 8.—Check every bag as it's loaded into your vehicle.

Summary

Your goal throughout the process of selecting and buying seedlings is to end up with a healthy, vigorously growing plantation of trees.

We have provided guidelines and a list of suggestions to follow at all stages of the process. The four overall recommendations:

1. Plan well in advance, and order early.
2. Evaluate your site carefully, and select seedlings that will meet your needs best.
3. Ensure that seedlings have been grown and handled properly so they will be alive and healthy when you plant them.
4. Check with your forestry advisers and neighbors. Learn from successes in your area, and avoid mistakes made by others.

Planting trees is a long-term commitment. You may plant a given area only once in your lifetime, so it's worth doing right.

For more information

Elefritz, Mark, Mary M. Atkinson, and Stephen A. Fitzgerald, *The Care and Planting of Tree Seedlings on Your Woodland,* EC 1504

Emmingham, William H., Brian D. Cleary, and David R. DeYoe, *Seedling Care and Handling*, EC 1095.

Emmingham, William H. and Michael C. Bondi, *Managing Woodlands in the Coastal Fog Belt*, EC 1131.

Hibbs, David E., *Managing Hardwood Stands for Timber Production*, EC 1183.

Hibbs, David E., *Managing Red Alder*, EC 1197.

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