Developing Quality Christmas Trees in the Pacific Northwest

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Contents

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Introduction

Christmas trees are a major horticultural crop in the Pacific Northwest (PNW). As with any crop, success in growing Christmas trees requires hard work, timely attention to detail, extensive knowledge of cultural practices, and an understanding of your intended market.

This publication outlines how trees grow and the culturing practices necessary to develop their size, shape, and density so that they are marketable. The first section of the publication gives an overview of four culturing practices that producers use (side shearing, leader pruning, basal pruning, and seed source selection), and the second section discusses these practices as they relate to specific tree species commonly grown in the PNW.

The successful sale of your Christmas tree crop depends on your ability to develop top quality trees and effectively market them. While it may seem a bit strange to think about tree markets that are 5 to 12 years in the future, many of the culturing and tree spacing decisions you make about your young trees are based on the type of trees you eventually want to sell. For example, if you are growing noble fir, do you want to end up with dense 7-foot trees or open 6-foot ones? Your answer will affect your culturing practices in the years leading up to harvest.

This publication explains intermediate-level techniques for culturing trees commonly grown in the PNW. It is one in a series of publications, videos, and websites to assist prospective, new, and longtime Christmas tree growers. See Additional Resources (page 30) for topics not covered here, such as diseases, pests, and disorders; best management practices (BMPs); and nutrient and weed management. It is important to understand the interactions of all of these factors to grasp the complexity of growing Christmas trees. Newer growers interested in a broad overview of Christmas tree production should first read *Growing Christmas Trees in the Pacific Northwest* (PNW 6).

Tree culturing: an overview

Culturing refers to the practices growers use to guide the shape, height, and density of their trees. These practices include cutting and trimming side branches (often described as "shearing"), top or leader trimming, basal pruning, and seed source selection. Before discussing how to perform these tasks, it is important define some terms and to understand a bit of tree physiology (Figure 1).

Images and illustrations of noble and Douglas-fir are used throughout this publication because these species make up the bulk of the PNW harvest.

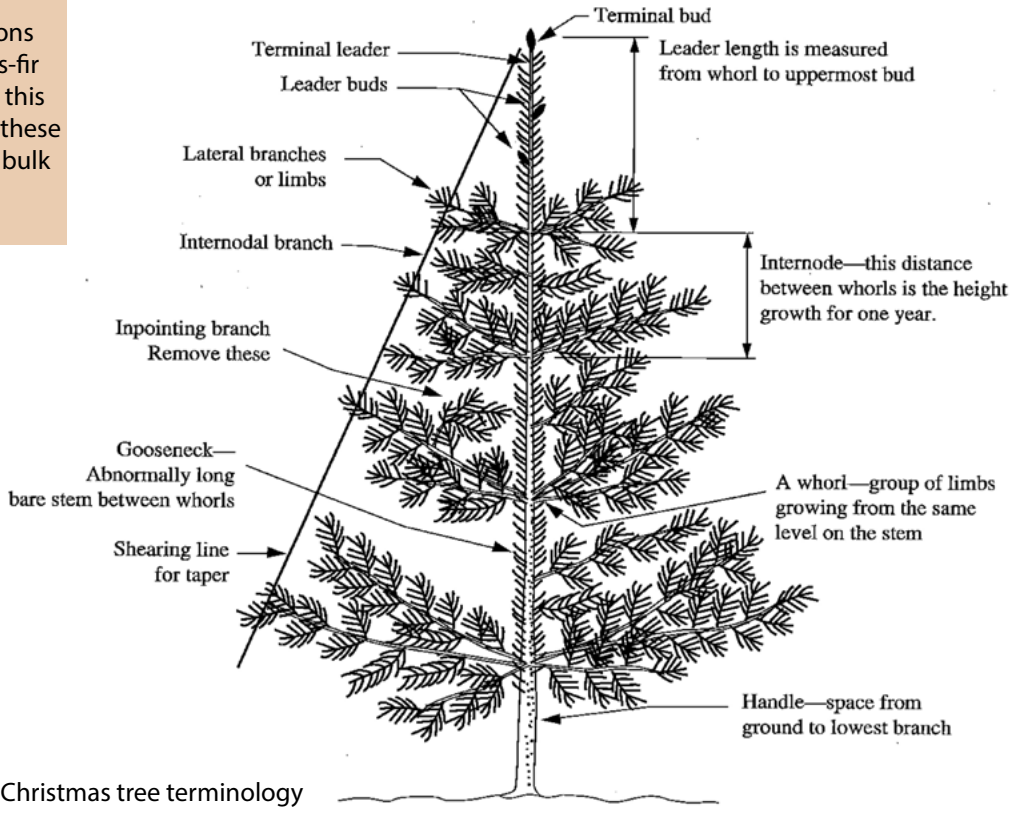

Figure 1. Christmas tree terminology

Each year a tree will initiate growth from buds developed the prior season. By examining the growth patterns of leaders and branches, you can determine the age of that portion of the tree. These patterns may be easy to see on noble fir and less distinct on Douglas-fir. Each year of growth produces a new age-class of needles and branches, new leaders, and a ring of wood on the outside of the stem. Understanding these aspects of tree growth is critical to successful culturing and effective evaluation of diseases, disorders, and other types of damage.

The growth year for a tree (Figure 2) can best be understood by starting at bud break.

- Bud break (late April to June): Bud break varies with each tree, site, and species. Changes in yearly weather patterns will influence timing, but bud break typically occurs between late April and early June.
- Branch and leader growth (June to August): Early branch and leader growth is very tender and limp. Growth progresses outward and upward, and becomes more firm and woody with time. Buds are difficult to see at first but become well defined and differentiated later in the season. Bud picking and plucking should happen while new growth is still elongating and is easily "snapped."
- Culturing work (July to September): This is the "shearing season," when leader control and side trimming are typically performed. On some species and in some years, buds may break and produce a second flush of growth mid- to late summer. This is called lammas growth; it is like two growth years in one. It is important to recognize and manage this extra growth, as it tends to be more vigorous than non-lammas growth.
- Maturation and dormancy (October to February): Branches become progressively stiffer and woody. Buds also become stiffer and tighter as winter progresses. Shearing may be ongoing, but it is a bit more difficult.
- Bud swell (March to April): Buds begin to enlarge with the warming weather, and sap starts to flow. Bud break will occur soon. This is the last chance to finish cultural work before the tree begins another growth year.

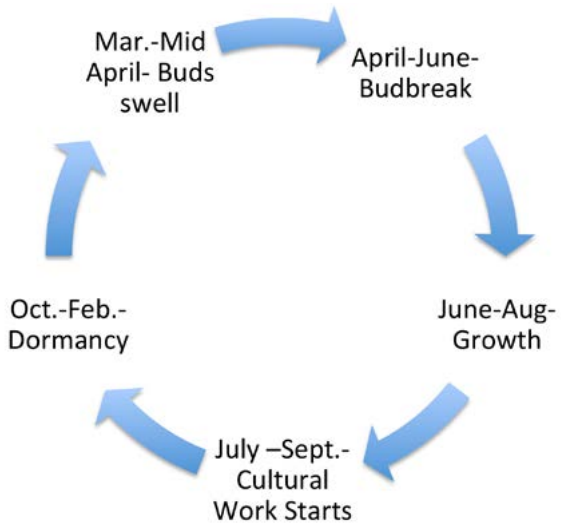

Figure 2. Yearly growth cycle

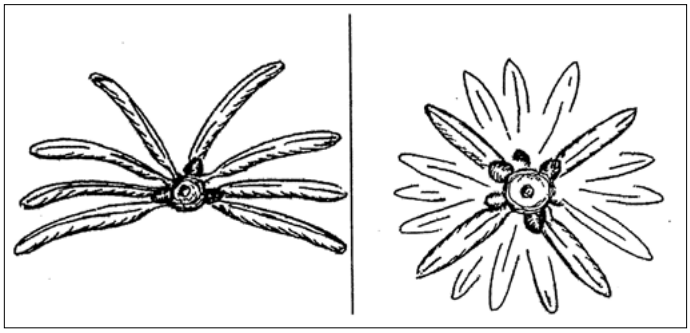

Image: Jeff Owen

Figure 3. Branch structure (L); leader structure (R)

It is important to know the difference between branches and leaders, especially as this relates to growth habit (Figure 3). Branches grow outward in a horizontal plane and buds develop along the branch. Leaders, on the other hand, grow upward and buds surround the leaders in circle. The buds between the prior year's terminal node and the current year's terminal bud(s) are called internodal buds. The internodal buds will become next season's branches, and the terminal bud will become next year's leader, if all goes well. An array of hormones and plant growth regulators determine how and where buds develop in different parts of a tree. In culturing a tree, these distinctions become important when leaders die or are trimmed. Keep in mind: Branches make poor tops and leaders make poor branches, especially on true firs.

The best culturing system combines an understanding of tree growth and culturing techniques

with clear knowledge of the final product your buyers want. Your culturing system can create trees that are dense or open, wide or narrow, short or tall. The final value of a tree typically is based on the tree's height and its quality assessment (often called grade). Understanding how your culturing practices influence both are key considerations.

Tree culturing: the basics

Tree culturing is difficult work; it is both art and science. Although many growers hire skilled contractors to do tree culturing, it is still important to know what is involved.

Each tree in a row can be as different as individuals in a family—they are different but have similar characteristics. If you cultured one hundred trees in the exact same way, you would end up with a range of trees of different grades and heights. The art of culturing comes from knowing how to evaluate each tree and develop it into a saleable product. Before beginning your cultural work, determine the type of tree you eventually want to harvest. The culturing methods used to produce a dense 7-foot noble are different from those needed to develop an open noble of the same height, and each tree may react differently to your culturing methods.

Culturing tips and tools of the trade

Protection and safety

- Wear leg and shoe guards for protection from the shearing knife (Figure 4).
- Keep first aid kits handy; include wasp and bee sting care, bandages, and wraps.
- Wear proper clothes for working in fields.
- Know where and how to get help, if needed.

Figure 4. Leg guards

Clippers and saws

- Use a quality pair of clippers that fit your grip (Figure 5).
- Keep clippers sharp and lubricated.
- Keep extra blades, springs, and other parts on hand.
- Have a sharp pruning saw; it is useful in branch removal.

Figure 5. Hand clippers (L); shearing knife (R)

Shearing knife

- Get a shearing knife with a quality blade; keep it sharp and clean. Note: Shearing knives come in many shapes and makes (Figure 5).
- Keep rivets secure.

Cleaners and disinfectants

- Use pitch cleaner on saws, knives, and clippers; tools will need frequent cleaning to remove sap.
- Disinfect tools frequently to avoid spreading diseases. Commonly used disinfectants are quaternary ammonium (e.g., Green shield, Physan), hydrogen dioxide (e.g., OxiDate, ZeroTol) and Clorox bleach (10%). For a review of products see: http://www.ct.gov/caes/lib/caes/documents/special_features/boxwood_blight/list_of_sanitizers_for_cps_02-03-14.pdf

Sharpening

- Learn how to sharpen your tools or take them to a professional. Remember: A sharp tool will make any job easier.

Pullers and straighteners

- Have enough long straight sticks (e.g., bamboo or split cedar) on hand to use as top straighteners. Make sure they are sturdy enough to tie up stiff, bent leaders without bending themselves (Figure 6).

Figure 6. Sturdy top-straightening sticks

- A variety of homemade or purchased pullers can help move branches to fill in blank spots that might otherwise make a tree unsaleable (Figure 7).

Figure 7. Plastic tape (top) and plastic pullers (bottom) can help train branches to fill holes.

Stilts and ladders

- Use stilts (Figure 8), ladders, or some other type of lift once the trees are taller than you can reach.

Figure 8. Worker on stilts

Power equipment

- For shearing, there are various handheld machines, and a even a few tractor-based types (Figure 9).

Figure 9. Tree shearing with machines

Basal pruning

Basal pruning is often the first cultural practice needed during a rotation. Basal pruning removes branches between the ground line and a set height on the stem. It is a similar process for all species. The pruned stem or "handle" provides a straight, branchless area of at least 1.25 inches per foot of tree height, per United States Department of Agriculture (USDA) Guidelines (1992). Most buyers require this amount of clear stem so consumers can insert trees into their water stands.

The best time during a rotation to start basal pruning is when a leader develops about 12 inches in length above two good lower whorls. This stage

of development frequently occurs after two to four growing seasons, depending on the species. Be aware that removing more than 30 percent of the foliage at one time may hinder next year's growth. Basal pruning can be conducted over multiple growing years.

If you basal prune when the tree is too small, the pruning may shock the tree and stunt leader growth for another year. If you postpone it too long, the thicker bottom branches are time-consuming and difficult to remove.

You can basal prune at any time of year, but be extra careful to avoid breaking tender new growth on branches above the base during the early stages of tree growth (May to June). Some growers basal prune in October and November to take advantage of bough markets or downtime for harvest labor crews. Be sure to check with bough market buyers before cutting and shipping. Most markets will not accept branches that have been sheared, and juvenile foliage may not have traits desired in boughs.

Basal prune the stem high enough to avoid serious defects, such as incomplete bottom whorls and crooked stems. Most growers try to keep about 10 inches between the bottom whorl and the ground for a typical 6- to 7-foot tree (Figure 10). This allows enough space to prevent the shearing knife from hitting the ground during trimming and an open area for the chain saw when you fell the trees at harvest. Consumers also appreciate a sufficient handle to easily fit the tree base into a water stand.

Figure 10. Basal pruning removes all lower branches

Trim branches flush with the stem to avoid stubs and heavy scars. Avoid trimming into the main stem as this may attract boring insects or diseases. Use hand pruners or short saws for basal pruning. Attempt to remove all live buds and branches.

Basal pruning provides several benefits besides conforming to USDA grade requirements. It defines the usable portion of the crown and helps facilitate mowing, cultivating, spraying, fertilizing, and harvesting. Additionally, the practice increases air circulation around the trees, which may help reduce some foliar diseases. Adequate handle length also improves tree shaking at harvest by allowing the tree base to slip into the shaker cone.

When evaluating the early growth of your trees, another key decision is determining if an individual will ever become a marketable tree, or should you cut your losses and remove it. Poorly formed, slow growing trees rarely improve with age, and you need to assess the worth of trying to correct deficiencies year after year.

Leader control

The leader or terminal of a tree is physiologically different than a branch. Leader trimming is used to manage tree height and density. The leader trimming practices outlined in this section apply to most Christmas tree species; species-specific leader trimming is covered later.

There is no one formula for trimming leaders. General suggestions for leader control are to:

- Maintain one dominant leader.
- Pay close attention to the number and distribution of buds along the leader; they determine future branch position and tree quality.
- Remove competing leaders when they develop.
- Delay top trimming as long as possible into a rotation. Once you begin trimming leaders, it will become a yearly and often time-consuming task.

The goal for your final product and the growth habits of individual trees will influence where and how you trim the leader. For example, growers looking for a more open tree might be content to leave leaders in the 16- to 18-inch range when the trees are small. Growers looking for a very dense tree may never allow a leader to grow longer than 12 inches.

Bud spacing and density along the leader is also variable and will influence where you trim a tree. What is the take-home message? It is important to develop your technique for your site, your seed source, and your market. Experiment with a few trees and record progress as you try different leader trimming techniques—this way, you can learn what works best for your site and market.

Generally, July through September is the time of year for trimming leaders. This is the early succulent period, when the new top growth is finishing and you can clearly see the buds on the leaders. Trimming during this window of time produces a higher percentage of erect leader growth the following season. Species-specific exceptions to this rule are discussed later.

The answer to the question "When to start?" will depend on the goal for your final product. If you are growing compact tabletop trees (3 to 5 feet), you might begin leader trimming when leaders first exceed 8 to 12 inches. With more typical 6- to 7-foot trees, you might start leader control when trees reach around 4.5 feet. For taller or more open trees, leader trimming will depend on the bud distribution along the leader and the height of the marketable tree.

Top tying

Top tying is required when leaders die or fail to develop vertically. Side branches are trained to become leaders. Top tying is one of the most time-consuming (and therefore, expensive) practices of leader control. The most common method is to affix a sturdy stick to the tree with flagging tape, twist or cables ties, and then carefully pull up the leader and train it to remain straight (Figure 11). Alternative

Figure 11. Top tying

methods for individual species are discussed later. The sticks and fasteners need to be removed by March of the following season to prevent fasteners from cutting the stem and damaging the tree.

Shearing

Shearing establishes the tree's taper (ratio of tree height to width) by trimming branches to limit their outward expansion (Figure 12). Most shearing in the PNW is done by hand using a shearing knife. A few growers use mechanical, hedge-type pruners or rotary trimming heads. Some also pick buds or succulent growth, particularly on noble and Nordmann

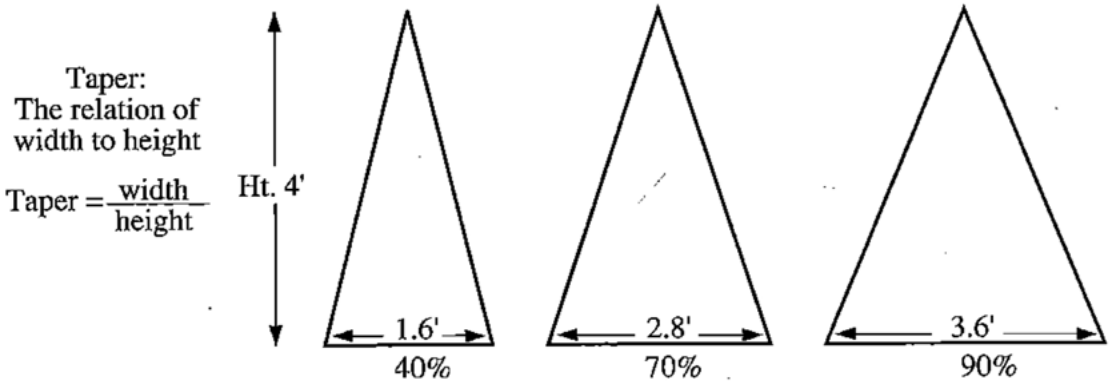

Figure 12. Taper establishes the width-to-height ratio (Image: USDA)

fir. All of these methods have the same purpose: controlling width and taper. Generally, shearing is best limited to trimming the branches that grew that season. Trimming branches from the second- or third-year growing season may be necessary, but it severely slows future branch expansion.

There are many tools and techniques growers use to shear trees. Some of the advantages and disadvantages of these tools and methods are described below.

1. **Hand snipping,** or bud or branch picking (Figure 13)—When growth is succulent (late June to early July), new growth can be broken off by hand or with a small carving knife. Some skill is needed to know how long or short to leave the remaining branch because it is still elongating.

   Advantages: Produces the most natural look without the shearing lines produced by knife cutting.

   If performed early in branch elongation, additional buds may form at the cut ends in some species.

   Disadvantages: Time-consuming; the succulent season when it works best is short (2 to 3 weeks). Because of the time involved, some growers will use this technique only in harvest years.

Figure 13. Bud picking on Nordmann fir

2. **Hand pruning**—After new growth has elongated (July), prune with hand clippers to desired taper.

   Advantages: A more natural looking tree and a longer shearing window compared to bud or branch picking.

   Disadvantages: As with bud picking, it is time-consuming, and workers may be too close to trees to visualize overall taper.

3. **Knife shearing**—The shearing knife is the most common shearing tool and is used after new growth has elongated. Side shearing is best done before new growth becomes "woody" and harder to shear.

   Advantages: Less expensive than other hand techniques. A knife-sheared tree can appear uniformly cut in-line or the knife can be used more selectively to cut individual branches that project outside the desired taper.

   Disadvantages: Aesthetics; some buyers dislike the cut lines on needles that are produced by the knife.

4. **Machine shearing**—More common on Douglas-fir than with the true firs. Hedge-type trimmers, rotary trimming blades, and tractor-based units are available.

   Advantages: Fast and fairly easy to establish the tree taper.

   Disadvantage: May leave some "chattering" where branches are not cleanly cut by the blade. High initial equipment cost. Noise.

Some trees will develop blank sections, or "goosenecks," no matter how good your shearing skills or the tool used. Lack of buds, bud mortality, and deer rubbing are common causes of open sections. Large holes become defects in grade. A number of inventive options may help fill these areas. For example, branches near a blank section can be coaxed to move up, down, or sideways. Care is needed to avoid creating another hole elsewhere. In many situations, holes may appear more pronounced if tree density is not uniform throughout the tree.

Lammas growth

Lammas growth is a late summer regrowth that occurs on some species (Douglas-fir and noble, in particular). Lammas growth is especially common

with summer rains. In essence, the buds rebreak and grow a shortened version of next year's growth (Figure 14). It is sometimes accentuated on lower-elevation plantings.

Figure 14. One whorl bud shows lammas growth (R); multiple buds show lammas growth (L).

Lammas growth has advantages and disadvantages, which arise from the fact that this growth tends to be more vigorous than non-lammas growth the following growth season. If the lammas growth is not symmetrical, it may produce a lopsided tree. Species-specific solutions for dealing with lammas growth are discussed later.

Frequently, only a few of the buds will break and produce lammas growth. In this case, try to maintain the symmetry of the tree and prevent competing tops. Your options may involve using this vigorous growth (e.g., to become a new top or trimming it back to fill blank areas).

Tree grades and standards

Height class and grade typically determine tree value. Both measures are open to misinterpretation and can become points of disagreement between a buyer and seller. The *USDA Christmas Trees Market and Shipping Point Inspection Instructions* (1992) outlines a number of height and grade definitions with illustrations that growers and buyers can review; however, this document is somewhat dated and not used by everyone. It is important that buyers and growers agree on how height and grade are measured, and that they include this information in a written understanding. For example, how

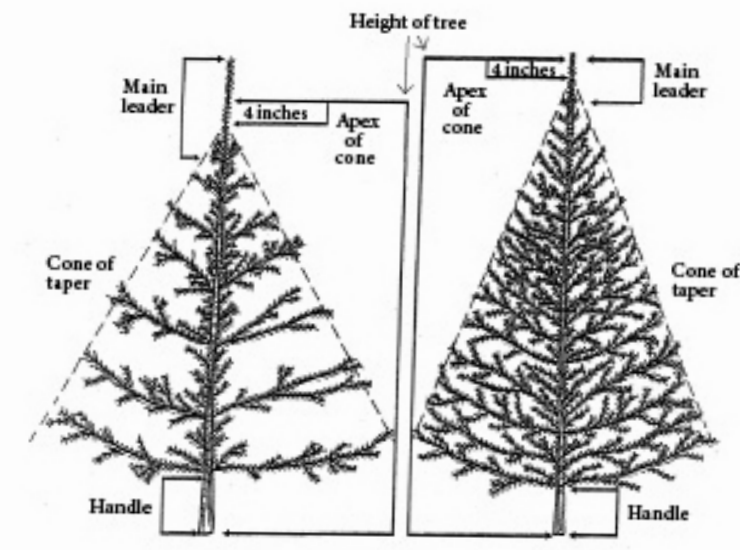

Figure 15. USDA Guidelines to measure tree height (Image: USDA)

do you determine tree height? It seems like a simple question, but there are many methods. The USDA guidelines (Figure 15) say that tree heights should be stated in 1-foot increments, but that actual heights should be recorded in ½-foot increments. So, trees from 6 feet to 6 feet 2 inches are listed as 6-foot; trees from 6 feet 3 inches to 6 feet 8 inches are listed as 6.5 foot; and trees from 6 feet 9 inches to 7 feet are recorded as 7-foot. In reality, most growers will sell trees in 1-foot increments. The tree height is frequently measured from the cut base to the point where the top whorls intersect the leader if held vertically, often called the "fold." Some growers measure the tree height from the base to the top of a properly cut leader, while others measure the height to the fold plus 4 inches. Thus, it is important that everyone understands how height is measured prior to trimming, shipping, and billing.

Tree grade is another area where buyers and sellers need to have a clear understanding of terms. The USDA guide lists the grades as Premium, #1, and #2. To determine the tree grade, each tree is divided into vertical quarter sections called "faces." Each face is examined for foliage density, uniformity, condition, and quality. In practice, growers will sell trees in various grade combinations; they will also develop new grades. For example, some growers add a Utility Grade between a #2 and a cull (no value). Other growers will combine Premiums and #1s into one price grouping or have a mix of #1s and #2s with a price. Still others may simply sell a particular field "as is."

Culturing techniques have a direct impact on grade. Below are descriptions of common (but not universal) grade classes for noble fir.

- **Premium:** These are the perfect, prize-winning trees. Foliage is dark green and healthy. The tree density is usually heavy and uniform all the way to the top. None of the faces have any holes. Even in the best fields, Premium trees are rare.
- **#1:** You can have one hole (larger than a grapefruit) on one face and slightly lighter density on the top. Otherwise the tree looks like a Premium.
- **#2:** You can have two holes on two faces. Otherwise the tree is healthy, with nice color and a straight top.
- **Utility** (not a USDA Grade): A tree you would not mind in your house, if the price were low enough.
- **Cull** (no value): May actually have a cost for removal.

Seed sources: the basics

Given a choice, it is far easier to develop a quality tree with suitable genetic traits than to spend time and money correcting inherited problems. Good prospects for Christmas trees generally show dark green color, plentiful buds, upright branching, ample but not excessive growth, good form, and resistance to diseases and insects. All of these characteristics are based on traits that are at least partially inherited. That, in a nutshell, is why seed source considerations are so important. Keep in mind that seed source refers to where the seed originally was collected, not the nursery where the seedlings are grown.

The look of your final product will depend on the interaction of genetic and environmental factors that influence growth. First, select the species that will be the best fit for your site. Next, consider seed sources within that species that may have traits that best fit your needs. Genetic traits such as color, growth rate, upright branching, and bud count each have a range of heritability. These traits, the characteristics of your site, and your cultural and management practices will help determine the development of your trees.

The identification of the better seed sources within a species typically involves testing the seed sources on multiple fields for a rotation and evaluating their performance. Outside groups (such as university researchers, Christmas tree association members, or seed orchard or nursery owners) typically do this work rather than individual growers. As a grower, your options usually will rely on someone else collecting the seed, and growing and selling the seedling. With that in mind, the list below outlines some possible options for seed and seedling selection:

- **Clones** (exact copies of the parent) are produced by grafting, planting rooted cuttings from the parent source, or replicating seed embryos. Clones are more common in the horticulture industry than in Christmas tree production, although a few Christmas tree growers plant grafted sources.
- **Full-sib cross** are controlled crosses, where both the female (cone) and male (pollen source) are known. This may be occasionally available for noble and Douglas-fir; typically, a seed orchard is part of the system.
- **Half-sib cross** are when a grower knows the source of the cones but not the pollen. This seed source can be an option with noble and Douglas-fir, but rarely with other species (Figure 16).

Figure 16. Harvesting noble fir cones at a seed orchard

- **A collection area or provenance** is the most common method for identifying, collecting, and selling seed and seedlings to growers. The size of a collection area can range from a

small stand of trees to a seed zone to a national forest, state, or country. With some collections, the elevation of the collection may also be noted.

- **Species** is when all you know is the species and nothing about where the seed was collected.

With native trees in the PNW, the most common collection designations are seed zones. These are set areas established in 1966 by foresters and other individuals in Oregon, Washington, and California. Seed zones are usually many thousands of acres in size and were established for forest seed collections as a guide for seed transfer and adaptability under forest conditions. They were replaced with species-specific collection areas for Oregon (Randall 1996) and Washington (Randall and Berrang 2002). Seed zone maps for both systems can be viewed at http://www.forestseedlingnetwork.com/resources/seed-zone-maps.aspx.

In Idaho, the most common designations for collections are national forests or specific collection areas, often with additional information on elevations. Grand fir and some pine species may have other breeding zones used by the U.S. Forest Service (USFS).

Christmas tree seed may come from around the globe, and different countries or regions will have their own ways of identifying collection sites. Denmark has a well-established protocol for identification and registration of collected seed. Turkey has a seed zone map similar to Oregon and Washington. Other countries or collectors often rely on naming the seed sources after a nearby city or region, and within those areas they may add a collection unit number.

Why is this important for growers? It is about determining what seed source will perform well on your farm and identifying ways to repeat success (or avoid a second failure). Consider, for example, growers west of the Cascades Mountains who wanted to try Douglas-fir seed sources imported from the east side of the Cascades. Although the trees looked fine at first, as they grew larger it was apparent that many sources were prone to a needle cast disease (*Rhobdocline*) and needed repeated fungicide applications before being sold. West side sources, however, did not show these problems. The fact that these same east-side sources performed well in Idaho and eastern Oregon highlights the importance of understanding the interactions of site and seed source.

As a general rule, the more specifically you can describe the seed collection area, the more repeatable and consistent the growth characteristics of your future trees. Because trees will exchange most of their pollen over a small area, important inherited growth characteristics may be found only in seed collected from trees in that area.

One advantage of membership in a Christmas tree grower association is the opportunity to purchase seed or seedlings of improved sources from special group collections or orchards. Also, by talking with other growers and looking at their trees and sites, you can get an idea about what may work best for you.

When considering your seedling options from various nurseries, carefully read any description provided. For example, you may find a nursery listing "Improved or Superior Douglas-fir." If the source was improved for timber growth, it may not be a good Christmas tree option without further testing (or asking the right questions). For example, the rapid growth valued for Douglas-fir used for timber might be too fast for Christmas trees, and a source improved for timber might lack internodal buds. Investigate each source before purchase. Many nursery catalogs will also list a USDA Plant Hardiness Zone to assist in matching species with planting regions. These are broadly useful in planning.

In conclusion:

- The species you select is critically important. If you do not match the site to an appropriate species you may be fighting diseases and other problems throughout a long rotation. Do your homework and spend time getting to know your planting site (e.g., wet areas, poor soils) and how your species selection matches with the site.
- Once you have selected the species, order early. Many nurseries are reluctant to plant trees based on the speculation that Christmas tree growers will buy them years in the future. The better sources and stock types are the first to be sold, so you should plan years ahead.

Culturing true fir

True firs are defined botanically as all species of the genus *Abies*. Douglas-fir is not a true fir, which is why its name is hyphenated. About 50 true fir species are scattered around the world. Six are native to the Pacific Northwest, and one, noble fir, comprises the bulk of the commercial true fir Christmas tree harvest in the region.

True firs comprise over half of the Christmas tree harvest in Oregon, Washington, and Idaho. Among these, noble, grand, Nordmann, and Turkish fir are the most common and are discussed in detail below. Fraser, subalpine, corkbark, Shasta, Trojan, Caanan, white, and Korean are also briefly considered.

Noble fir

Noble firs (*Abies procera*) have excellent needle retention and attractive foliage; they account for over half of the Christmas tree production in the PNW (Figure 17). Noble fir is a native of high-elevation sites in the Oregon and Washington Cascade Mountains and the coast range, from Oregon through southwest Washington. Its northern range limit is near Stevens Pass in the north-central Washington Cascades. Its southern range limit is around latitude 44° north, in southern Oregon, where noble fir hybridizes with Shasta and red fir.

Figure 17. Top examples of noble fir

Branch and needle structure are stiff and strong enough to withstand heavy snows in their natural habitat. They have characteristic, well-branched whorls with short internodal branches. Without culturing, there are open internodal spaces between whorls.

Sites where noble fir can be successfully grown are scarce. Ample rainfall (more than 45 inches annually), excellent drainage, and cooler summer temperatures are key site characteristics but are hardly a guarantee of success.

Seed sources

This important species has a long history of progeny and provenance testing, and growers continue to test new sources. There are five broad collection areas for noble fir:

- Coastal mountains in Oregon
- Willapa Hills in southwest Washington
- Cascade Mountains in Oregon
- Cascade Mountains in Washington
- Southern Oregon Cascades

Generally, the Oregon Cascade sources tend to be slower growing, bluer in color, and more layered, which sometimes translates into fewer internodal buds. The coastal sources from the mid-Oregon coast to the Willapa Hills in southwest Washington tend to grow more vigorously, have more internodal buds, and appear greener. The faster-growing coastal sources are the preferred option for most Christmas tree growers. Sources from the Washington Cascades can be fast growing but may lack internodal buds. Sources from the southern Oregon Cascades can be slow-growing and share traits with Shasta fir.

Growers have seed source options that range from individual families, orchards, stands, seed zones, or countries. Names of collection areas such as Siletz, Riley-Fanno, 053, 251, Mary's Peak, and Baw Faw Peak are well known. Growers with a long history of growing noble fir will have favorites. To review more specific progeny and provenance test results, visit the website for the Christmas tree program at the North Willamette Research and Extension Center (http://oregonstate.edu/dept/NWREC/programs/christmas-trees). The website includes information on testing and rankings of commonly grown PNW species.

Locating specific seed sources can be difficult, so knowing where to look is important. Nursery catalogs are obvious options. Some nurseries cater to Christmas tree growers, others to timber producers, and some to both. Another source is the PNW Christmas Tree Growers Association, which maintains seed orchards, and sells seed and seedlings as

a service to members. In nursery catalogs, noble fir will typically be listed by seed zone and elevation (in Oregon and Washington), by country where collected (in Denmark), or by referencing some of the tested source names such as RF10 (Riley Fanno tree #10). If buying seedlings, you might also encounter a reference such as "PNWCTA Orchard Run." This simply refers to a general collection of mixed families from a seed orchard run by the PNW Christmas Tree Association.

When purchasing seed or seedlings from nurseries, ask what makes the selections "improved," "beautiful," or "selected." For example, noble fir seed from Danish seed stands and orchards is often available. Keep in mind that these collections were developed from seed collected in the Cascade Mountains and transported to Denmark where landraces were developed and selected for bough production, not Christmas trees. These trees typically are quite blue, layered, and slow-growing. Bough growers might like these options, but Christmas tree producers might not.

Leader control

The correctly trimmed noble fir leader length is often age-, site-, market-, and tree-specific. The proper length will depend on your answers to these questions and the options the leader itself provides:

- What tree density and height do you or your buyers desire?
- What is the bud arrangement on the leader?
- How full is the existing tree?
- Are there any defects you need to fix or fill?
- What is the current tree height and how long until harvest?

A first task with leader control is to make sure the tree has one dominant leader. During the first years after planting, double tops or suckering branches are common. Remove these, leaving only one leader. Do this as early as possible on young trees by cutting out the competing tops flush with the stem. Considerations for selecting the best leader are length, vigor, erectness, central position, and completeness of terminal bud set. For example, if one leader has six terminal branch buds and another has only four, save the six-budded leader to ensure a balanced, six-branched top whorl the following

Figure 18. Six whorl buds on a leader

year (Figure 18). Removing multiple leaders is usually the only type of leader control required during the first 2 or 3 years after you establish a plantation. Postponing this job may cause crowding, suppression of lateral branches, and development of crooked stems because multiple leaders tend to lean away from each other.

Before describing when to begin leader control, we need to first review the common types of buds that occur along a noble fir leader. There are two general types and many shapes and sizes in between. The first type is the bubble bud (Figure 19) and the second is a standing, or petioled, bud (Figure 20). The bubble bud is smaller and usually does not have needles surrounding it. The standing bud typically has needles that surround it and can be relatively large.

Remember, the current year's buds become next year's branches and leaders. Unlike pines and some spruces, additional buds do not develop when

Figure 19. Bubble bud beneath clipper on noble fir

Figure 20. A standing or petioled bud on noble fir

trimming noble fir leaders. So you need to visualize the tree's development as you consider where and how to trim. The ideal situation for leader pruning is to locate a uniformly spaced internodal bud cluster (these buds will be next year's "false whorl" branches) just below a single bubble bud at 12 to 16 inches above last year's top (Figure 21). Cut just above the bud (Figure 22).

This textbook approach, however, will not always be available, so you may need to find the next best solution. It is important to keep in mind your goal in leader trimming: to create a natural looking top. A natural top is one with a single erect leader surrounded below by a symmetrical whorl of four to six branches. In leader pruning, you are also trying to increase tree density by slowing the tree's upward growth.

Growers have various opinions about the proper length to cut leaders, partly because of differences in the type of final product desired and partly because of the wide range of sites where trees are grown. For example, growers looking for a more open tree might be content to leave leaders in the 16- to 18-inch range when the trees are small. Growers looking for a very dense tree may never allow a leader longer than 12 inches. Likewise, growers targeting an 8- to 12-foot final tree can allow for longer leaders during this early development period.

What is the take-home message? It is important to develop your technique for your site and market. Experiment with a few trees and record progress as you try different shearing techniques; this way you can learn during the first rotation. Also, keep in mind that each tree will have a different distribution of buds along a leader, which will influence the final leader length for cutting. Poorly budded leaders will need to be kept shorter. Leaders with ample, well-distributed buds give growers more trimming options.

Method and time of year

A number of trials with noble fir have reviewed the ideal time for trimming leaders. Timing can vary by site, but trimming generally works consistently well from July to August, when new leader growth has just completed and you can clearly see the buds. Trimming during these summer months produces a higher percentage of erect leaders the following year. The longer you delay leader pruning, the more

Figure 21. A nice set up for next year's top

Figure 22. The proper trimming method

leaders you will have to tie up the following growing season—and the more branchlike they will appear. It is still critical to perform leader trimming even if you miss this window, but expect to tie up more of the leaders. Make the cut above the selected bud with the trimming angle leading away from the bud (Figure 22). This keeps the pitch from covering the bud. At the same time, remove any additional buds within 1 to 2 inches of the bud you select as the new top. This reduces the number of potential competing leaders the following growth season. Keep in mind what is happening from the tree's perspective: You have just trimmed off the intended terminal bud set. Like all conifer trees, noble fir has rapid height growth, and a terminal bud set assists that process. By isolating a single bud early in the growing season, the tree can make the physiological and hormonal changes needed to create a new terminal from the selected bud. In using this method and timing, you are increasing the likelihood that the bud you selected will be the new top. It may not be perfectly straight, but it has a good chance.

Often, buds are not in a perfect position or well distributed. Trimming options generally occur within a 4-inch space along a leader; you make decisions on bud selection within that space.

Replacing lost leaders

Abortion of the center bud on the tip of the leader is a frequent and troublesome problem on noble fir. Also, during the succulent growth stage (May to July), birds or equipment can break off existing leaders. Whenever a leader is broken off near its base

or fails to develop, serious deformity problems result unless you take prompt remedial action. There are several solutions, depending on tree age and other situations.

Nonharvest year. There are two methods for replacing lost leaders on younger trees: bud forcing or encouraging a branch to become the leader. No solution is perfect, but timely remedial action can mean the difference between a saleable tree and a cull.

Bud forcing develops the most natural top but is the slowest method of reforming a top, and sometimes new tops do not develop. Bud forcing works well if small buds or sprouts are beginning to show where the top leader bud aborted or broke off. To force a new leader, trim back each branch on the top whorl to about 50 percent of its length. When trimming, make sure at least one or two buds remain on each branch stub to keep it alive and balanced. This trimming will stimulate the growth of the leader buds; often multiple leaders will sprout. Retain the best leader and trim out all others at the base (Figure 23).

Figure 23. Forcing a terminal bud

Tying up a branch to become the leader is a second method of reforming a top. If one branch has moved into a more vertical position and appears to be forming a terminal bud cluster, you can select it as the new top and secure it with a splint to force the branch into the new upright position (Figure 24). Trimming the outermost buds on the branches that do not turn up further promotes the branch to act like a new leader. When none of the branches seem

Figure 24. Reposition the leader to be straight

Figure 25. Creating a new leader

to "want" to form a new leader, you can force a branch into the leader position. One method is to select two branches that are directly opposite each other. Draw them together into the vertical position. Bind them tightly together near their bases and their tops with wraps of plastic flagging (Figure 25). After several months, when they have set in a vertical position, remove the flagging, select the best leader, and remove the other. The leader formed by an upturned branch tends to produce a two-sided, branchlike internode the following year, so keep the new leader a bit shorter than you might otherwise. Encouraging a nodal or internodal branch to become the leader often produces an asymmetrical top.

Harvest year. Most buyers will demand a single erect leader cut to a proper length. In the harvest year, there is no time to force a new leader from a latent bud, as you would with younger trees. Also, it is not important that the new leader have good bud set since the tree is being harvested. Therefore, in the harvest year, a branch from the top whorl can be turned up and forced to replace a missing leader. Select the whorl branch that would cause the least disruption to the shape of the tree. This will become the new top. Next, turn up and secure the branch. It is important to use a firm splint to force the new leader into place. Accomplishing this task while the branches are pliable (June to mid-September) will minimize the difficulty in achieving a straight leader.

Secure the new leader at three places along the splint: bottom, middle, and top. Unless you do this,

Table 1. Yearly noble fir cultural guide

Tree age (years)	Tree height (average)	Leader length (average)	Taper (%)	Culturing goals/activities
1–2	10″–1.5′	uncut	50	Establish single leader
3	1.5–2.5′	uncut	50	Side shear/basal prune
4	2.5–3.5′	14″	50–60	Build structure/basal prune
5	3.5–4.5′	14″	60	Build density
6	4–5.5′	12″	60	Build density
7	6.5′	10–12″	60	Market shear/harvest
8	7.5′	10–12″	60	Market shear/harvest
9	8′	10–12″	60	Market shear/harvest

the branch will continue to behave like a branch. Occasionally, you may need to move this top branch in two steps to avoid breaking it. The splint should remain in place for about 2 months.

For yearly cultural targets for a typical 6- to 7-foot noble fir, see Table 1.

Shearing

Shearing is often conducted a year or two before most leaders needs trimming. This will keep noble fir from becoming overly wide.

As trees reach about 3 feet in height, strive for 50 to 55 percent taper. In some trees shearing can begin 2 years following planting. Once a tree has been sheared, it will likely need it each year. As a general consideration, it is much easier to allow a narrow tree to widen out than to take an overly wide tree and try and reduce the taper.

In nonharvest years, most growers shear trees with a knife. The shearing angle and taper will be determined from the top of the leader to the base. Some growers like to set the terminal length first and then shear following the taper. Others will make an informed guess about where the top of the tree will be and trim accordingly. A shearing knife is not the only tool. Growers looking for a more "natural" tree will use bud picking or plucking techniques, or use hand-trimming tools. Be aware that bud picking has a narrow time window of perhaps only 2 weeks when the growth is quite succulent. In progressive shearing years, the tree taper can gradually widen to resemble the one desired at harvest.

During the harvest year, shearing and leader trimming should be conducted differently. For example, in leader pruning, only straightness and length are important. So if the existing leader is straight but too long, cut the leader to provide proportion for the desired taper.

Here is a rough rule of thumb: Cut the top slightly above the apex of the cone formed by the crown of the tree. Before you cut, ask your buyers what leader length and taper they might prefer.

Shearing or bud picking is also best done early to allow branch ends time to heal and darken. Some growers are careful in the harvest year to produce a more natural looking branch structure. Bud picking or very light knife shearing can be used to produce this lighter touch.

Lammas growth

Lammas growth is common on noble fir. Buds on the top, sides, or both can regrow. How you deal with lammas growth depends on the situation.

A common situation is when two to three of the five terminal branch buds break and elongate. If these branches grow strongly vertical and appear to form competing leaders, one solution is to nip back these lammas branches by removing their outer bud(s). If left untrimmed, the lammas buds likely will overtake the terminal bud during the next growing season, creating an unbalanced, multi-topped tree. If the lammas branches do not grow vertically, they likely will remain branches next season and can remain untrimmed.

Another situation is when all the nodal buds and the terminal bud become lammas. In this case, you can leave these to grow next season, as long as the tree still looks in proportion. Some growers have found it best to work with lammas growth in the dormant season (January to March). Since

lammas growth is so vigorous, it becomes a predictable option in reestablishing a leader. Leaving the lammas bud uncut and gently tying it into a vertical position (Figure 26) will predictably form your new leader. In cutting lammas growth, try to identify the small buds on the lammas branch. Try to leave at least two buds along the growth, otherwise you may

Figure 26. Lammas growth positioned to become a new leader

end up with a branch without any buds to form new branches.

Grand fir

Grand fir (*Abies grandis*) grows naturally in western and eastern Oregon and Washington, and northern Idaho. It is also found in southern British Columbia, northwestern California, and western Montana.

Grand fir, like Douglas-fir, has many racial variations over its wide geographic range. Heritable differences include growth rate, disease resistance, needle retention, needle form, needle color, and other characteristics important to Christmas tree growers. Some experts divide the species into a coastal variety (var. *grandis*) west of the Cascades Mountains and an interior variety (var. *idahoensis*) east of the Cascade Mountains. In the southern portion of the coastal variety's range, grand fir also hybridizes with concolor (white) fir; the resulting progeny is called grandicolor. The westside varieties usually have needles arranged in two single, flat rows on the twig. Some interior varieties have two double rows on each twig, and the needles spread upward slightly, like a noble fir.

Figure 27. Grand fir

Although grand firs from suitable seed origins make beautiful Christmas trees (Figure 27), broad market demand has declined in western Oregon and Washington. For many Idaho and eastern Oregon producers, it is the most commonly grown tree.

Seed sources

Despite many decades of growing grand fir, there are very few provenance tests to guide selection of seed sources. The last detailed test from 1979 evaluated 22 seed collection areas on four sites. Those tests (Douglas 1984) developed the following rankings based on equally ranked scores for vigor, branch form, disease resistance, color, needle form, aphid damage, and late flushing:

1. Seed sources from the Clearwater River drainage east of Grangerville, Idaho
2. Seed sources from western Montana, near Missoula and Hamilton
3. Seed sources from north of the Blue Mountains in southeast Washington, near Pomeray
4. Seed sources from the Mid-Columbia area, near White Salmon Washington and Mosier in Oregon

There are no Christmas tree seed orchards of tested grand fir, though the Inland Empire Christmas Tree Association (see Additional Resources, page 30) will occasionally offer seedlings from a seed stand in Sand Point, Idaho. Many nursery listings will show the seed zone number or a collection region such as Clearwater, Idaho.

Leader control

Grand fir is a vigorous grower and often will produce multiple leaders once you begin to cut tops. Grand fir is better than noble in replacing missing leaders and frequently develops many new tops on its own. Buds along the leaders tend to be ample and not as differentiated as noble. Because of this growth habit, some growers prefer to delay trimming grand fir tops until the fall following side shearing. Here the process is to shear trees while leaving the leaders intact. This delay avoids creating multiple tops that develop with earlier leader cutting. In either system, it is useful to remove the tips of competing leaders early to avoid trimming out competing leaders later.

To develop the typical-sized harvest trees, growers begin leader pruning as trees exceed 4 feet in height, cutting the leader to around 14 inches. Consider this a maximum length. If the tree is sparsely budded or has holes without branches, a shorter leader is preferred. In successive years, trim the leader to 11 to 14 inches. Grand fir can be cultured like noble (Table 1, page 15) or Douglas-fir (Table 5, page 24), depending on the desired "look." Grand develops approximately 2 years sooner than noble.

When you cut tops, cut the top so that a specific bud is isolated to become a new top, as with noble fir. With grand fir, it usually is not necessary to pick a bud cluster to form a top whorl; ample buds are usually present along leaders.

There are additional techniques to help improve tree quality. One is to reduce the leader length to 7 to 10 inches in the year before harvest. This reduces the amount of open area near the top of the tree. In the harvest year, cut the leader to a length conforming to the general taper of the tree.

Shearing

Side shearing grand fir often begins early in the yearly growing season, as it tends to harden off before noble and is not prone to a second flush of lammas growth. The first part of July is generally when shearing starts in the Willamette Valley. In eastern Washington and Idaho, shearing typically begins in late July and the first part of August. Later or dormant shearing is also acceptable with grand fir, but the job is slightly more difficult after the new wood begins to harden. Many producers find that grand fir can easily become too wide. One solution is to maintain the tree in a narrow profile early in a rotation and gradually let it widen. It is difficult to slim down an overly wide grand fir late in a rotation, so it is best to keep the taper narrow from the beginning.

Grand fir can look like Douglas-fir or noble, depending on how it is cultured. The important difference will be determined by how much branch definition is allowed and how long the leader remains. Typically, growers try for some sort of intermediate appearance, with a density similar to Douglas-fir.

Grand fir side shearing often begins in the second year after planting, and it may precede leader pruning by a year or two. Many growers begin side shearing after the trees width exceeds a 50 percent taper. Once you begin side shearing, continue it every year. Maintain a taper of around 50 percent until a year or two before harvest. At that point, you can allow the tree to fill out toward the final 60 to 70 percent taper that most consumers prefer. Consult potential buyers before shearing, if possible.

Turkish fir

Turkish fir (*Abies bornmuelleriana*) grows in native stands in Turkey (Figure 28, page 18). Other common names used for Turkish fir include Bornmullers or Uludag fir. Turkish fir seed for Christmas tree production has been imported into Oregon since 1966. Landscape and specimen trees in arboretum sites have been in the U.S. for much longer. It is a newer species in the marketplace, and acceptance of it is increasing.

Among botanists, there is some debate regarding the botanical relationship of Turkish, Nordmann, and Trojan fir. For purposes of this publication they are treated as separate species.

Generally, Turkish fir grows at about the same rate as noble fir, but there can be large differences in growth rates among the range of sites where the two might be grown. The needle form of Turkish fir tends to be finer and more like a bottlebrush relative to Nordmann. Turkish fir also has a small waxy stripe on the upward tip of the needle. Despite these differences, it can still be difficult to tell Turkish and Nordmann fir apart. Both deer and rabbits will seek out Turkish and Nordmann fir to browse and rub (deer), and chew and cut off stems and branches

Figure 28. Natural distribution of *Abies* sp.—Trojan fir (purple), Turkish fir (green), and Nordmann fir (blue)

(rabbits). Keepability is excellent if the tree is displayed in water-filled stands, though a few individual trees have shown rapid needle drop.

Seed sources

Seed is primarily imported from wild stands in Turkey. Currently there is one small seed orchard in Springfield, Oregon, a producing orchard in Denmark (Kongsore FP 267), along with a few seed collection sites scattered around the U.S. Testing of seed sources is ongoing. Turkish provenances or collection regions that have performed well in the PNW include Bolu and Adapazari. The Turkish Forest Service has numbered collection areas for wild stands, similar to our seed zones in the PNW. Stands that have been included in provenance tests include 216, 218, 219, 221, and 225. (For more information, see http://oregonstate.edu/dept/NWREC/programs/christmas-trees.) Studies of these collections suggest that stands 218, 219, and 221 perform well. Remember that this testing is just beginning and not all stands have been part of a test. Provenance and progeny tests suggest the species generally breaks bud earlier than noble fir and Nordmann, so beware of planting in frost-prone sites.

Leader control and shearing

See Nordmann fir.

Nordmann fir

The natural distribution of Nordmann fir (*Abies nordmanniana*) is shown in Figure 28. This species is the common Christmas tree of Europe, where Denmark and Germany are the major producing countries and have a long history of testing and seed production. Some nursery catalogs will use the common name as Caucasian fir. Producers often lump Nordmann and Turkish fir together (usually as Nordmann) because the two species can be difficult to tell apart. As a general rule, the foliage on Nordmann fir is held a bit flatter on the branch; its needle tips are also flatter compared to Turkish fir. In the PNW, Nordmann grows more slowly than noble, by a year or two. Its growth rate is notably slow for the first two years following planting. As with Turkish fir, deer and rabbits seem to be attracted to Nordmann fir. Tree keepability after harvest is high overall with some poor individual trees. It is a newer species in the U.S. marketplace, and acceptance for it is increasing (Figure 29, page 19).

Photo: Judy Kowalski

Figure 29. Nordmann fir is the common Christmas tree of Europe and its acceptance in the U.S. is increasing.

Seed sources

The wild stands for this species run along the Caucasus Mountains on the east side of the Black Sea, from Turkey to southern Russia and through Georgia. Denmark has been growing the species for many decades and now has some landrace seed stands and seed orchards where collections are made. The best-known provenance sources are from Georgia in the Borshomi and Ambrolauri/Tlugi regions. Provenance and progeny testing is ongoing. Sources from the Savsat region of Turkey have performed poorly in two PNW trials.

Seed orchards are just beginning in the PNW, with a small site in Dallas, Oregon and others just established in the Willamette Valley.

Leader control

Both Turkish and Nordmann fir are good at developing new or replacing damaged tops with little help from the grower (Figure 30, right; Figure 31, page 20); many growers simply wait for the tree to produce new tops on its own. Given the tendency of both species to provide a leader, many of the upper whorl branches turn up if a leader is damaged, resulting in competing leaders and upturned branches. In some cases, these whorl branches will turn up even without trimming the top. Some growers will lightly nip the end buds to minimize these upturning branches. New leaders often form near the old terminal or from lower branches. On occasion, sticks are used to straighten crooked tops or tie up new leaders.

Both Turkish and Nordmann fir tend to grow slowly for the first few years and then begin rapid leader growth. This makes it challenging to achieve uniform density from top to bottom, especially in the area of the top two or three whorls. One solution for filling in this crown area is to trim the top leader very short (approximately 8 inches) a year ahead of harvest. This allows more time for the top to fill in.

When growers start leader pruning, they generally follow the strategy for leader control for noble fir. That is, they cut the leader at an isolated bud at the proper height. Buds on Turkish and Nordmann are seldom as differentiated as with noble, and lammas growth is quite rare.

Over the past decade, many trials using plant growth regulators applied to elongating leaders have

Figure 30. Arrows indicate two competing leaders on a Nordmann fir

Figure 31. Keeping the best leader on a Nordmann fir

been conducted on both Nordmann and Turkish fir. At the proper rates and timing, growth regulators can reduce leader growth by 30 percent and forestall trimming of leaders that become too long. NAA (Ethyl 1-naphthaleneacetate) has been the preferred product for this purpose, but product registration has been slow to develop.

Shearing

Since Turkish and Nordmann fir tend to grow slowly the first few years following planting, trees can appear overly dense and wide in the lower portion of the tree. Growers have experimented with side shearing with a knife as soon the tree starts vigorous growth (years 2 to 3) and keeping the young trees at a 50 percent taper (or less) during the preharvest years, with gradual widening closer to harvest. Thus, side shearing often precedes leader control by 1 to 2 years. In-pointing branches frequently develop and need hand trimming (Figure 32). Unlike grand and noble fir, Nordmann and Turkish fir have a high percentage of buds that form on the

Figure 32. Removing in-pointing branches

outer 50 percent of the branch rather than being equally distributed along the branch. Given this trait, it is important to begin side shearing early in a rotation and not allow trees to become too wide too early. If shearing involves trimming into older branches, it will take time for these areas to fill from existing interior buds. Turkish and Nordmann fir may also be sheared early in the shearing season, even before grand fir.

In Denmark, and with some PNW growers, bud picking is the preferred cultural practice. A typical strategy is to allow the trees to grow freely until they reach 3 to 4 feet tall. Then, the year they reach that height, bud pick all the center buds and growth tips in the whorl braches from the top to the base when the new growth is still elongating. In subsequent growth years, bud pick the top whorls only (unless others become too wide).

Fraser fir

Fraser fir (*Abies fraseri*) from the southern Appalachian Mountains is a popular and attractive Christmas tree of the eastern United States. It grows well in the Appalachian Mountains and is accustomed to summer rainfall. In the PNW it is frequently prone to damage by the balsam woolly adelgid, and (for better production) it often requires summer irrigation or cultivation on sites with mild summer temperatures and high rainfall.

Seed sources

No progeny test of sources have been conducted in the PNW to determine which sources may (or

may not) be better adapted to local conditions. Extensive testing in North Carolina has shown large family differences, yet there is little to suggest that any of these families would perform well in the PNW. Interestingly, in North Carolina, the Roan Mountain source is the provenance most commonly collected, yet other provenances (e.g., Balsam Mountain and Black Mountain) have better height growth and bud set. Collection areas and opportunities for wild collections are limited.

Leader control

Fraser fir, like grand fir, tends to have good bud development along the leaders. Extensive culturing trials in North Carolina have identified conventional and accelerated culturing options. In the conventional approach, leaders typically remain uncut until the third growth season (unless they exceed 12 inches). In the third growth year, leader height is maintained between 8 to 12 inches. In a more tree-specific, accelerated program, leader length starts out longer but progressively declines as harvest approaches (Table 2).

Table 2. Accelerated leader control program for Fraser fir (Owen, 2009)

Tree age (in years)	Leader length (in inches)
3–4	14–18
5–6	12–14
7 to harvest	10–12

As with other true firs, you should delay leader trimming as long as possible in the rotation. Once you start, you likely will need to cut tops annually as well as remove competing leaders.

Delaying leader trimming until late August reduces the incidence of upturned branches and multiple leader formation. In bud selection, isolating an individual bud in summer works well. As with noble fir, removing buds within an inch or so below the selected bud will help minimize competing leaders. If bud selection is delayed into fall, the larger buds develop better leaders the next season than the smaller buds. Bud response is also improved with irrigation or adequate rainfall.

Shearing

Following the conventional culturing option described above, lateral shearing maintains the growth between 4 to 6 inches yearly through harvest. Under the accelerated approach, laterals are cut progressively shorter as harvest approaches (Table 3). The preferred shearing times are summer and spring (prior to bud break). Try to avoid fall and winter shearing as this causes reduced growth the following season.

Table 3. Accelerated lateral shearing program for Fraser fir

Tree age (in years)	Lateral length (in inches)
1–2	laterals are not cut
3–4	7–9
5–6 to harvest	6–7
7 to harvest	5–6

PNW Fraser fir growers have found it harder to adjust the width of the trees, so growers tend to let them maintain a wider taper throughout the rotation.

Subalpine and corkbark

Subalpine fir (*Abies lasiocarpa*) have been grown for years in small quantities. These are generally considered the same species, with corkbark listed as a variety. Subalpine is widely distributed, ranging from Arizona and New Mexico to the Yukon, Alaska, and the higher elevations of the Cascades and Olympic Mountains. Corkbark is native to southern Colorado, New Mexico, and Arizona. Norway is likely the largest current producer of subalpine and corkbark Christmas trees, and both are gaining in popularity with Idaho producers. Irrigation may be needed to increase growth if growing on dryer sites.

The corkbark variety (var. *arizonica*) often has a unique gray-blue color (Figure 33, page 22). Both subalpine and corkbark are prone to frost damage and multiple top formation, especially if grown in the Willamette Valley. Growers in colder areas in northern Idaho and northeast Oregon have better success with this species.

Seed sources

Subalpine from the Kaibab, Uncompahgre, Dixie, and Cibola National Forests are a suggested source for Idaho. Recommended sources of corkbark are from the Apache, Coconino, and Gila National Forests. For more information see *Growing Corkbark*

Figure 33. Small corkbark fir

fir and Subalpine Fir for Nursery Production (PNW 645).

Leader control

A common issue with both subalpine and corkbark are multiple or absent tops. Most plantation sites tend to be much warmer than native, high-elevation locations. When temperatures turn warm, this species may start leader growth, but trees are then damaged when low temperatures return. With multiple tops, hand prune and select the best leader while removing others. If the terminal fails to grow, select a branch that appears to want to become a new leader and tie it upright using a splint, or force new buds to develop.

Shearing

This species seems to grow narrow naturally, so bud picking or light hand-clipper pruning is often preferred over knife shearing. Fungal damage to new shoots possibly caused by *Delphinella sp.* has been a problem in some locations.

Shasta fir

Shasta fir (*Abies magnifica* and var. *shastensis*) is a native of high elevation sites in the Cascades and Siskiyou Mountains of southern Oregon and northern California. It is a transition species between noble fir and California red fir. Shasta fir hybridizes with noble fir and California red fir where their ranges overlap near the McKenzie River in Oregon. Needles of noble fir are generally considered more durable than those of Shasta fir. Shasta fir develops a narrower, more self-shaping crown than noble fir, often with distinct whorls.

Seed sources

There has been limited testing of Shasta fir. In one test, the best Shasta fir seed origin among those tested were from the Siskiyou Mountains south and west of Grants Pass, Oregon (Douglass 1983). Shasta is resistant to current season needle necrosis but prone to needle loss if fumigated prior to shipping.

Culturing

Leader control and shearing follow noble fir strategies.

Trojan fir

Trojan fir (*Abies equi-trojani*) is native to Turkey (Figure 28, page 18) in dryer lower elevation sites near the Aegean Sea. It is sometimes referred to as Kazdagi fir. Little is known about Trojan fir prospects in the PNW. The foliage is quite densely layered, and in a few trials the species grew faster than Turkish fir. In a progeny test established in 2013, some Trojan fir families tended to break bud prior to Turkish fir.

Canaan fir

There are debates about the taxonomy of Fraser, balsam, and Canaan fir (*Abies balsamea* var. *phanerolepis*). Suffice it to say that this variety has traits of both the Fraser and balsam, and grows naturally in isolated pockets in Virginia and West Virginia. The tree takes its common name from the Canaan Valley of West Virginia and is also referred to as West Virginia balsam.

Seed sources

While there are seed orchards with improved sources for post harvest quality, production of this species in the PNW has been spotty due to low demand and concerns over needle shedding in early production trials. The attraction of this species for some growers has been the trees' ability to tolerate wetter soils than other true firs.

Culturing

Typically, growers follow the model for Fraser fir when growing this variety. However, individual trees may exhibit traits of Fraser or balsam fir. Fraser fir tends to have short needles and horizontal branches. Balsam has longer needles and near-vertical branching near the top. With the Fraser-like trees, vertical branches near the top are removed. In the balsam types, only the most vigorous and vertical branches are completely removed, while most will have their terminal buds trimmed.

White fir

White fir (*Abies concolor*) has a wide distribution, and variation between locations can be large. For that reason the species is subdivided into two geographic varieties that separate the California and PNW types (var. *lowinana*) and Rocky Mountain (var. *concolor*) types. The species generally has a lovely gray-blue color, long needles, and a pleasant citrus smell. Grower experience in the Willamette Valley suggests the species tends to be a magnet for disease problems such as branch cankers. The species is popular in Idaho and in eastern Oregon and Washington.

Seed sources

There has been limited testing of White fir, but provenance tests in Idaho (White) provide a broad ranking of collections from national forests in New Mexico and Arizona (Table 4).

Table 4. Seed source ranking for white fir (White)

Most recommended	Rio Grande (NM)
	Sante Fe (NM)
	Cibola (NM)
	Kaibab (AZ)
Least recommended	Lincoln (NM)

In separate needle retention trials in Pennsylvania (Bates 2004), the Sante Fe and Rio Grande were best, Lincoln was intermediate, and Apache was poor. There are also a number of horticultural varieties of white fir used in landscape plantings.

Culturing

The challenge on many sites is frost injury to leaders causing either dead leader buds or multiple short replacement leaders. Shearing and leader control is similar to that described for grand fir, its close relative.

Korean fir

Korean fir *(Abies koreana)*, as the name suggests, is native to the Korean peninsula. It is a minor species in the PNW, with attractive, short-needled foliage. It tends to grow wide early and may have premature cones. There are a number of horticultural varieties, and interest in hybrid crosses with species like Fraser and subalpine fir is growing, but the establishment of this species is far from operational (Cregg, 2013).

Seed sources and culturing

Little is known about specific seed source or cultural techniques.

Other true fir species

A number of other fir species have been grown in the PNW in addition to the ones described above. There is a certain attraction to being the first to grow a new species, but proceed cautiously. Most new introductions are unsuccessful, and it is likely someone has tried it before. Keep in mind that even if you successfully grow a new species, you also need to sell them. Growing the trees and finding a market for them are both challenging steps. If you try a new species, be sure to collect as much information as possible about the seed source (e.g., collection area and elevation) and the common and scientific names of everything you plant so you can repeat success (or avoid a second failure).

Culturing Douglas-fir

Douglas-fir (*Pseudotsuga manziesii*) accounts for about half of the Christmas tree production in the PNW. Before 1960, virtually the entire harvest of Douglas-fir was from unsheared stands on sites where trees grew slowly. This slow growth resulted in generally well-proportioned "natural" trees.

During the 1960s and 1970s, growers learned how to culture Douglas-fir, and production began in plantations across the PNW. By trimming back the leaders and lateral branch tips, growers controlled and directed tree growth to improve tree shape, taper, and density.

Table 5. Yearly Douglas-fir cultural guide

Tree age (years)	Tree height (average)	Leader length (average)	Taper (%)	Culturing goals/activities
1–2	1–2 ft	uncut	50	Establish single leader
3	3–5 ft	cut at 4.5 ft	50	Build structure/basal prune
4	5.5 ft	12 in	50–60	Build density
5	6.5 ft	8–12 in	60	Build density
6	7.5 ft	8–12 in	60	Market shear/harvest
7	7.5–8 ft	8–12 in	60	Market shear/harvest

In native stands, the species is widely distributed and often broken into two varieties: coastal (var. *menziesii*) and Rocky Mountain (var. *glauca*). The Cascades and the Rocky Mountains generally separate the two varieties. Douglas-fir is grown in many locations in the United States and accounts for about 20 percent of the national harvest.

Seed sources

Tests have been ongoing over many years on this important Christmas tree (and timber) species. Seed and seedling purchasers often have a wide variety of options.

One seed collection consideration suggests that PNW growers on the westside of the Cascades should only purchase seed originating from west of the Cascades (var. *menziesii*). Many of the sources from east of the Cascades have shown high susceptibility to foliage disease problems such as Rhabdocline needle cast. Growers in Idaho and eastern Oregon generally can select either variety.

There are two Douglas-fir seed orchards in the PNW that have a Christmas tree focus. As with noble, growers have a wide range of preferences about seed source selection. Christmas tree growers have options ranging from individual families, orchards, and collection areas. Collection areas that have been popular with Christmas tree growers include sites in the Willamette Valley (coastal foothills), Washington (Lake Cushman), and British Columbia (Texada Island and Powell River).

As with noble fir, progeny testing is ongoing. The latest selections and can be found on the North Willamette Research and Extension Center website (http://oregonstate.edu/dept/NWREC/programs/christmas-trees) or by talking with nursery owners.

When ordering trees through nursery catalogs, be careful to note that in many cases Douglas-fir may be listed as improved for timber growing (i.e., rapid growth). Rapid growth often (but not always) will not be a good choice for Christmas tree purposes. Important traits for Christmas trees include high branch and bud numbers, dark green color, moderate growth, and upright branching. Prior to ordering, carefully investigate your options. Nursery catalogs typically list seed zones and elevations (in Oregon and Washington) or collections areas in British Columbia (e.g., Powell River, Texada Island). If the seed originates from a Christmas tree seed orchard, it may have a family name such as Ramsby, Val 3, Texada 138, 135, or Orchard Run (Figure 34). Orchard Run typically indicates a seed mix of all cone-producing families in the collection year mixed together. Christmas tree orchards for the Rocky Mountain varieties are in the establishment stages.

Figure 34. Progeny test examples Val 3 (center) and Texada 138 (right)

Leader control

Unlike true firs, one of the challenges with Douglas-fir is minimizing the formation of multiple leaders. Douglas-fir is the fastest growing of the species commonly grown in the PNW, and leader control and shearing often are done concurrently. Side shearing typically begins a year or two before leaders are trimmed. The proper year to begin either leader control or shearing is determined by tree growth, not tree age. Some trees are likely to be ready to start leader pruning the same year that you begin side shearing. However, most trees will not be ready for leader control until the following year.

Growers have devised numerous techniques for developing sheared trees. The standard method (Table 5, page 24) and the progressive method will be discussed here.

In the standard method, trim the leader back to around 4.5 feet in the year when growth exceeds this height. Where you cut will depend on where buds are located on the leader. Generally, trim back to a single bud on a single leader. Exactly where you trim the leader will depend on your site and the density and position of buds along the leader. With ample buds, leaders can remain longer.

If you want trees either taller or shorter than the 6.5- to 7.5-foot average, plan a corresponding increase or decrease in sheared tree height after the first year's shearing. After the first year's leader pruning, maintain an annual pruned leader length of about 12 inches each year until harvest.

Another shearing method, called progressive shearing, shortens the leader progressively in the following way:

1. Defer leader pruning until leader length first exceeds 20 inches.
2. Prune the leader back to about 20 inches.
3. Every year thereafter, shorten the leader by about 4 inches to a minimum leader length of 12 inches.

Thus, the leader is progressively shortened each year from 20 inches the first year, to 16 inches the third year, and to 12 inches every year thereafter, until the tree is ready to harvest.

The principle of both the progressive and standard method of leader shearing is to maintain relatively wide internodal spacing near the base of the tree, where you can anticipate several years of growth to fill in the open spaces. At the same time, maintain progressively shorter spacing toward the top to develop uniform density from top to bottom.

Photo: Barney Douglas

Figure 35. Multiple leaders on Douglas-fir

Multiple leaders

Multiple leaders develop as the tree becomes larger and more vigorous (Figure 35). Typically, the first and second leader pruning is a simple operation because it merely shortens a single, natural leader. The third and fourth leader pruning, however, often involves problems and difficult choices where multiple leaders and possibly some heavy suckers have developed. When selecting the leader to keep, the best one to save is normally the lowest one on the stem. Completely removing its competitors higher on the stem prevents short, heavy, upright stubs. It also gives the top of the tree a more natural appearance.

You can minimize multiple leaders in one of three ways:

Photo: Barney Douglas

Figure 36. The gap between buds minimizes multiple leaders.

1. Leave a gap of an inch or two between a lone bud on the leader and the next bud below it. This will encourage a single upright leader to form the next season, or at least minimize the number of competing tops (Figure 36).
2. Trim the leader during its late succulent stage, about mid-July. The retained bud near the top of the leader stub will gradually develop a more upright position during the course of the growing season. This encourages more upright growth of the new leader and improves its resistance to bird and wind breakage while succulent.
3. Shear the top portion of the tree, except the desired leader, during the late succulent stage in July. This encourages dominance and upright growth of the single retained leader. Shorten the leader to the desired length once it has assumed a normal vertical form later in the summer.

Suckers sometimes form from unsheared, internodal branches below the main leader, and they may be more vigorous than the leader you select. Merely shortening their tips, instead of completely removing them, forms a heavy unattractive stub. Solutions will depend on the situation. Often, these suckers should be removed completely. In some instances, a sucker may be more upright and centrally located than the true leader. In this case, you can trim off the true leader and use the sucker as the new top.

Leader straightening

Next year's leader, arising from the top bud of a pruned leader, does not always grow erect at first. It may have a noticeable offset, called a dogleg, where the top bud turns upward to form a new leader. This condition should not cause alarm before the harvest year. Bent or crooked leaders usually either straighten themselves or are hidden by new growth.

Doglegs, however, may cause noticeable top defects on trees ready for harvest, unless you take corrective action when the trees receive their final shearing. You can often deal with doglegs by tying them tightly with plastic ribbon against a splint to straighten the leader. Sometimes a doglegged leader is too rigid to straighten. In this case, cut it off and tie a flexible internodal branch below it to a vertical position by the same method. You can also use this procedure to replace a leader too high on the tree for good proportion and density, or to replace a leader broken by birds or wind.

Replacing undesirable leaders

Some Douglas-fir trees develop unusually coarse and vigorous leaders a year or two before they attain harvest size. These are sometimes abnormally large in diameter and very sparsely budded for a foot or more above their bases. Trimming them back in the usual manner to a 12-inch leader results in too few buds to fill in the top of the tree with branches. This scarcity of buds causes an open hole in the upper crown of the tree.

Another serious problem is that the few buds that do occur on this heavy leader stub grow too much and develop, in turn, into large, coarse, doglegged multiple leaders. This problem, once it starts, tends to continue until you correct it.

Correct the problem by removing the large leaders. Then, bend upward a flexible internodal branch and, using a splint, bind it firmly with plastic ribbon. Finally, trim the upturned internodal branch back to proper length (about 12 inches) to form a new leader. Unlike the leader that you removed, this new leader is usually well-budded and small enough not to grow excessively the following growing season. Trimming back the large natural leader actually enhances the tree's development by directing growth into the lower portion of the crown. Do not forget to remove the stub and plastic ribbon after the tied leader has become set in a vertical position.

Shearing

Douglas-fir has a long shearing season. It begins in the middle of July when the branches are fully elongated and buds on the new growth become fully visible, and extends until the buds start to open the following spring. With passing time, branches become more woody and stiff, and shearing takes more effort. With this in mind, many growers prefer shearing between late July and September, especially in harvest years.

Douglas-fir is prone to lammas growth, especially when summer rains occur. The resulting irregular, excessively long branch tips may require a touch-up shearing to restore good proportion. Alternatively, shearing can be postponed until after this growth has occurred.

Lammas growth on the leader tends be more vigorous than non-lammas growth. If lammas growth develops within 4 inches of the top, it likely will overtake the leader in the next growth year. To correct this, remove the tip bud(s) on the lammas growth within 3 to 4 inches of the top. Or if a new top is desired, tie the lammas growth in an upright direction, prior to next year's growth. This can utilize the lammas growth to your advantage.

Adjusting tree density

There is a wide range of preferences in tree density. Producing a denser tree requires earlier leader shortening and, therefore, more years to grow to a given height. Douglas-fir growers will tend to keep the tree taper narrow (40 to 50 percent) on younger trees. For a typical 6- to 7-foot harvest tree, taper will gradually increase until the harvest year, when the final taper is around 60 percent. Again, know the type of tree (density, taper, and height) your market desires and adjust your practices accordingly.

Bare or blank spots in a tree

Dealing with Douglas-fir bare or blank spots requires considerable judgment. First, it is important to determine if there are enough buds and branches to fill the hole from the side. If there are, it may be possible to slow height growth so that bare spots can fill with time. It is also possible to pull adjacent branches from either side to assist with filling. Flagging tape is often used to hold the branches in place until they stay put. Be careful to avoid creating additional holes with this remedy. Again, you may need to keep the leader shorter so the hole has time to fill. If the bare area is pronounced, you may need to cut off the top of the tree above the bare area and tie up a lower branch to form a new top. Or, you can evaluate the time and expense needed to create a marketable tree and make a decision about removing the tree as a cull.

Culturing pine

Many consumers refer to all conifer trees or all Christmas trees as "pines." They are partly correct. All the true firs, spruces, and Douglas-firs are in the pine family. For our more specific interests here, we will discuss the genus *Pinus*. Though not grown in large numbers, there are a wide number of species grown for Christmas trees. Some common species are Western and Eastern white, ponderosa, bristlecone, Scotch, and lodgepole/shore pines. All pines have needles held together in a fascicle bundle at their base. The white pines have four to five individual needles per bundle; lodgepole and Scotch pine usually have two. The market for pine in the PNW has declined. Prior to growing pine, be sure you have a market to sell them. Become familiar with many of the needle diseases common to pine. A few growers have decided not to grow pine due to foliage disease problems. Because of insect pests such as European pine shoot moth and cereal leaf beetle, you may need additional phytosanitary certifications, depending on where the trees are shipped to or pass through. Before planting, investigate export regulations with your state agricultural department (see Additional Resources, page 30).

Scotch pine seed sources

There has been little seed source testing for Scotch pine Christmas trees in the PNW. The species has a wide distribution where it grows naturally, and seed has been imported for many years. Scotch pine has had a number of progeny testing programs in the Midwest. Some of the most widely utilized sources are those from central Spain (Guadarrama and Gedros), French sources (D'Auvergne), Scottish Highlands, and crosses (PennSpanish). If you are interested in growing any of these pine species, follow these guidelines:

- Start small. Only plant a few trees and try, if possible, to utilize multiple seed sources for each new species. This limits your losses and also helps determine whether a species has possibilities from a particular seed source. If one source is poor, maybe another is good.
- Keep careful records and mark the trees well. Our memories fade during the rotation. If a source does well (or poorly), you need to know what the source was and where it came from (both the nursery and seed source) if you hope to grow it again.
- Ask around. Perhaps someone in the area has experience with the species you are interested in.

Seed sources for other pine species

Little effort has been devoted to testing various pine sources in the PNW region. With that in mind, recall the three cautions mentioned above.

Culturing pines

These species have a growth habit different from fir and spruce, and this influences the culturing process. Pines tend to have few internodal buds (Figure 37), and branch buds are clustered at the ends of branches. The new growth on pines will emerge from the buds at the ends of branches and leaders and develop "candles," which are the new leaders and branches. As the candles elongate, the new needles can be seen developing along the length of the candle. The shearing period for most pines is limited. For the common species mentioned above, the effective shearing window occurs at the growth point where the candles have elongated and the emerging needles are about 50 percent as long as their final length. If you wait much past this growth stage, dormant buds have less time to develop, and fewer and weaker branches will emerge the following season. White pine in particular will show little bud development if leader and branch trimming is delayed. A few pine species like Virginia and Monterey can have multiple growth periods in a season, and have a wider and more frequent window for shearing.

Photo: Cathy Blumig

Figure 37. Pine internodal spacing

Many growers will let pines begin with a wide (60 to 70 percent) taper and let the top growth begin to balance the bottom so that the final taper ends up in the 50 to 60 percent range. This is the opposite strategy used in fir and spruce culture. The reason for this is that the lower pine branches, once sheared, tend to be less vigorous than, for example, grand fir. Shearing pine species too tightly early in a rotation may create trees that are too narrow at harvest.

Leader trimming follows the same progressive trimming as with fir. Leave the tree alone as long as possible, then begin to shorten the leaders each year.

Many pine growers suggest trimming the leader at a 45 degree angle. This may encourage a terminal bud to form, rather than having multiple leader buds beginning at the top of a flat straight cut.

Culturing spruce

A wide range of spruce species are grown in the PNW, though total production of spruce is quite small. Spruce can broadly be defined as any species falling into the *Picea* genus. Common variety names are blue, Colorado blue, green, black, white, Black Hills, Myers, Serbian, Siberian, Sitka, Norway, and Engelmann spruce. Common traits include needles that are on raised wooden "pegs" and tend to be stout and pointed. Selected spruce species will often be used for potted and living Christmas trees, as they tend to grow in pots better than other species. One detriment to growing spruce can be attacks from the white pine weevil. The weevil will damage tops on Christmas trees, causing dead tops and multiple leaders. On the positive side, a number of spruce species tolerate wetter soils and colder climates better than many other species. Spruce may be found on many tree farms in eastern Washington and Oregon, and northern Idaho.

Seed Sources

Spruce is commonly grown in the horticulture industry, and hundreds of unique varieties with names such as "Fat Albert" or "Hoopsi" are sold as grafted plants. Colorado blue spruce (*Picea pungens* var. *glauca*) is prized for its blue foliage color (Figure 38). Seed sources for Christmas trees may list a national forest collection area, specific collection locations, or unique specimen sources. In many wild collections of Colorado blue spruce expect that only some fraction of the trees will exhibit the prized blue-gray coloration.

Culturing

Growth form and development are similar to noble fir. Some spruce species will have latent buds that emerge after trimming to help fill the tree.

Consumer needs and concluding ideas

Always be mindful that growing your trees is only a step in a process; continued consumer satisfaction is also critical. The postharvest quality of trees varies among the commonly grown PNW species (Table 6, page 30). It is important that consumers know that the trees too have a "shelf-life" and will exhibit differing postharvest characteristics even when displayed properly in water-filled stands. Growers, buyers, shippers, recyclers, and end-consumers each have important tasks after trees are harvested. Many of the references and web sites at the end of this publication lead to sources that can help make the Christmas tree experience satisfying for all involved in the process.

Photo: Barney Douglas

Figure 38. Blue spruce

Successful Christmas tree growing is a constant learning process. It starts with being selective about your growing site. Next in importance are your species and seed source selections. As your trees move through a rotation, expenses and the complexity of your cultural choices rapidly increase. The idea that you simply plant trees and come back in 7 years to harvest beautiful trees is a fairytale. And while it may sound backwards, growers always need to be

Table 6. Postharvest quality ratings for PNW species in water display

Species	Rating[1]
California red fir	E
Canaan fir	G/E
Corkbark fir	E
Fraser fir	P/E[2]
Grand fir	G/E
Korean fir	G/E
Noble fir	E
Nordmann fir	E
Turkish fir	E
Shasta fir	F/G
Douglas-fir (var. coastal)	G
Douglas-fir (var. interior)	G/E
Scotch pine	G
W. White pine	G/E
Colorado blue spruce	G
White spruce	G

[1] (E) Excellent potential to last for 4-6 weeks under typical household conditions, (G) Good can last 3-4 weeks, (F) Fair can last 10 days to 3 weeks. All trees assumed to be cold hardened at testing.

[2] Results are variable among seed sources

Adapted from: Hinesley, E., Chastagner, G. 2004. Christmas trees in Agricultural Handbook 66 The Commercial Storage of Fruits, Vegetables, and Florist and Nursery Stocks.

mindful about the type of tree they want to grow and sell. Within certain limits, trees can be cultured to produce a variety of shapes—from narrow, dense, wide, or layered—but your program of leader trimming and shearing needs to be tailored to meet the demands of the intended customers. Successful operations are both capable of producing quality trees and skilled in marketing.

On the following pages, a number of additional resources are listed to assist in growing Christmas trees. These resources will fill in some of the gaps not covered in this publication. Website addresses for the various PNW Christmas tree grower associations are listed to provide more opportunities for learning and meeting with other growers.

Additional resources

Many of the publications and links listed below can be found on the North Willamette Research and Extension Center website (http://oregonstate.edu/dept/NWREC/programs/christmas-trees). Check this website for regularly updated information.

OSU Extension publications

The following publications are available in the Oregon State University Extension catalog at https://catalog.extension.oregonstate.edu

Culturing

- *Growing Christmas Trees in the Pacific Northwest* (PNW 6) https://catalog.extension.oregonstate.edu/pnw6
- *Growing Corkbark fir and Subalpine Fir for Nursery Production* (PNW 645) https://catalog.extension.oregonstate.edu/pnw645

Insects/diseases/disorders

- *Pacific Northwest Insect Management Handbook* https://catalog.extension.oregonstate.edu/insect
- *Pacific Northwest Plant Disease Management Handbook* https://catalog.extension.oregonstate.edu/plant
- *Identifying and Managing Christmas Tree Diseases, Pests and Other Problems—in English and Spanish* (PNW 659) https://catalog.extension.oregonstate.edu/pnw659
- *Best Management Practices for Christmas Tree Export* (EM 9093)—in English and Spanish https://catalog.extension.oregonstate.edu/em9093

Weed management

- *Pacific Northwest Weed Management Handbook* https://catalog.extension.oregonstate.edu/weed
- *Weed and Vegetation Management in Christmas Trees* (PNW 625) https://catalog.extension.oregonstate.edu/pnw625

Videos

- *Shearing and Culturing Christmas Trees* (EM9044) https://catalog.extension.oregonstate.edu/em9044
- *Esquilar y Cultivar Arboles de Navidad* (EM9044-S) https://catalog.extension.oregonstate.edu/em9044s

Nutrient management

- *Christmas Tree Nutrient Management Guide for Western Oregon and Washington* (EM8856) https://catalog.extension.oregonstate.edu/em8856

Other publications and resources

Culturing

- Hilliker, D. 1993. *Basics of Growing Christmas Trees.* Treehaven Evergreen Nursery
- *USDA Christmas Tree Market and Shipping Point Inspection Instructions* https://www.ams.usda.gov/sites/default/files/media/Christmas_Tree_Inspection_Instructions%5B1%5D.pdf

Insects/diseases/disorders

- *Christmas Tree Diseases, Insects, and Disorders In The Pacific Northwest: Identification and Management* 1997. WSU Extension Publication MISC0186. http://ppo.puyallup.wsu.edu/ct/publications
- *Pest Management Strategic Plan for Christmas Trees. Oregon, Washington and Idaho* http://www.ipmcenters.org/pmsp/pdf/or-wa-idchristmas-treespmsp.pdf

Economics

- *Christmas Tree Economics: Establishing and Producing Noble Fir Christmas Trees in Western Oregon* (AEB 002) http://arec.oregonstate.edu/oaeb/files/pdf/AEB0002.pdf
- *Christmas Tree Economics: Establishing and Producing Douglas-fir Christmas Trees in Western Oregon* (AEB001) http://arec.oregonstate.edu/oaeb/files/pdf/AEB0001.pdf

PNW associations and Co-ops

- Inland Empire Christmas Tree Association http://www.iecta.org/
- National Christmas Tree Association http://www.realchristmastrees.org/dnn/Home.aspx
- Pacific Northwest Christmas Tree Growers Association http://www.pnwcta.org/
- Puget Sound Christmas Tree Association http://www.pscta.org/
- Oregon Christmas Tree Growers Association http://www.christmastrees-or.com

PNW State Departments of Agriculture

- Idaho Department of Agriculture http://www.agri.state.id.us/
- Oregon Department of Agriculture http://www.oregon.gov/ODA/PLANT/NURSERY
- Washinton State Department of Agriculture http://agr.wa.gov/PlantsInsects/ChristmasTreeLicense/ChristmasTree.aspx

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