

PLANTING CALIFORNIA



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Division of Agricultural Sciences
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Cover photo: Planting 1-0 pine seedling in hole prepared by an auger-type planting machine.

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NOTE: Effective January 1977, the name of the California Division of Forestry was changed to California *Department* of Forestry.

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REFORESTATION CHECKLIST

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PLANTING CALIFORNIA FOREST LAND

A number of landowners derive satisfaction and a feeling of accomplishment from turning barren and unproductive land to good use. There are many who agree with what John Evelyn wrote in 1664 in the preface to his *Sylva*, "Men seldom plant trees till they begin to be wise . . ."

Other landowners plant trees to improve the beauty and variety of the landscape, provide a means of decreasing noise, improve water quality, provide habitat for a variety of wildlife, protect soil from erosion, or develop desirable wind barriers. The most important consideration is to do what is necessary to achieve what you want from your land.

WHY REFOREST LAND?

Planting or seeding trees is the only sure way to restore to timber production within the next 50 years the 1.2 million acres of idle or partly idle, cutover and burned forest land in California. This acreage is divided almost evenly between private and public ownership. Since only 17 million of California's 100 million acres are suitable or available for growing commercial wood products, the production from these 1.2 million acres of idle land becomes more important every year.

In California, the forest products industry has the sixth largest manufacturing payroll, paying over \$500 million annually for labor alone. Reforestation is urgently needed to ensure multiple uses of forest land and a supply of wood and wood products to meet future needs.

The supplying of future wood needs is only one of the many goods and services derived from reforestation. Other forest products, such as Christmas trees, fresh water, wildlife, opportunities for outdoor recreation, control of runoff and erosion, and modification of local climate, are also of economic and social value to the people of the state.

California's population, now over 21 million, is expected to increase even more and these people require more of the benefits from reforestation and other forest practices.

Long-term Investment

The overhead costs of land taxes, fire and disease protection, and road development are exceptionally high in California. One major way to reduce these costs is to increase the per-acre yield of marketable forest products. For the production of sawlogs, poles, piling, and pulpwood, this means an additional investment in young trees.

Christmas trees. California is the leading Christmas tree marketing area in the world. The sale of Christmas trees represents a way for landowners to realize a short-term return from their tree planting investment.

Increase in land values. In many areas, the selling price of forest land is far greater than the return from the sale of wood products alone. When sold for recreation or homesite purposes, land that has trees growing on it usually brings a higher price than do barren or brush areas.

California and federal government agencies recognize the need for tree planting and, as a consequence, make tree seedlings available, carry on reforestation research, and develop planting demonstrations.

Whatever your reason for reforestation, successful survival of planted or seeded trees depends on closely following the suggestions given in this publication.

SOURCES OF HELP AND ADVICE

The best advice on reforestation problems is from local sources. Because of wide variations in climate, ground conditions, and competing plant



Figure 1. A California Division of Forestry service forester shows a forest landowner the correct planting depth for a tree seedling.

vegetation, it is essential that you contact local foresters, trained plant scientists, or experienced growers who have successfully established a plantation in your area.

California Division of Forestry (CDF) forest advisors, commonly called service foresters, will visit your property and give professional advice on methods for establishing a plantation. They can recommend the kinds of trees to plant and assist you in ordering trees.

Cooperative Extension forest advisors, located in three north coast counties, and farm advisors, located in other counties of the state, can advise you on reforestation techniques and the latest

forestry research. They can refer you to successful tree planters in your area, CDF service foresters for on-the-ground planting advice, and the Agricultural Stabilization and Conservation Service office for cost-sharing help, if applicable. In addition, forest and farm advisors often cooperate with landowners in establishing tree planting demonstration plots.

Soil Conservation Service (SCS) personnel can provide valuable assistance and information, particularly about soil suitability for tree planting. In addition, they can put you in contact with the local Resource Conservation District, another source of help.

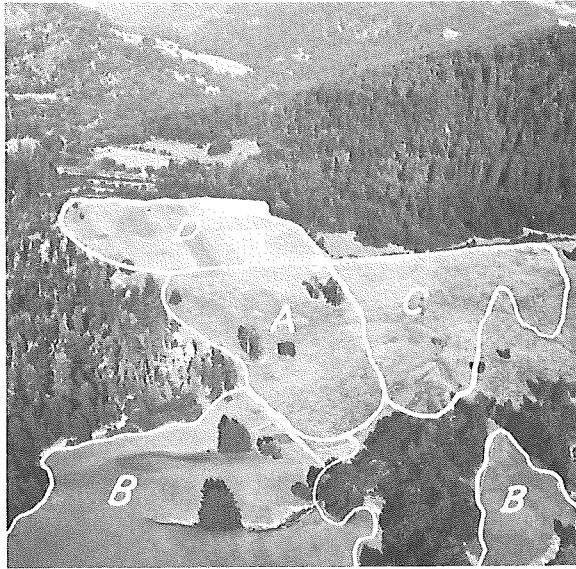


Figure 2. Consideration of soils is important in planning reforestation. Areas outlined in this aerial photo are interpreted as follows.

- A) Originally timbered, as evidence by stumps — good for reforestation
- B) Grassland soils — good for grazing, but will not support trees
- C) Meadows — often poorly drained and probably are not suitable for reforestation
- D) Good quality, irrigated pasture — could be converted to Christmas trees if income would be higher than the return from pasture

Agricultural Stabilization and Conservation Service (ASCS) administers various federal programs of financial assistance (federal cost-sharing) for planting and seeding forest trees. Apply through the local ASCS committee. When your application has been processed, the CDF service forester will visit your property and recommend the reforestation procedure to follow. Once the planting job is approved, you are eligible for reimbursement for a share of the cost of the reforestation work. *Note:* Cost-sharing is not available for Christmas tree production.

Other. You may also wish to talk with experienced tree plantation owners, local forest industry foresters, consulting foresters, and other county, state, and federal foresters in your area. If you are near a national forest, do not hesitate to ask to see some nearby plantation. The suggested reading in the *References* gives information that can also add much to your knowledge.

Resource Conservation Districts often have rental equipment you can use for site preparation and tree planting. If you wish, tree planting and seeding contractors are available to do the complete reforestation job.

WHERE TO LOCATE A PLANTATION

If you plan to grow trees for wood products, select land with deep, medium textured soils. Trees on good forest soils grow more than twice as fast as trees planted on shallow, heavy textured, or rocky soils. However, the productivity of the soil may not be so important if wood products are not your purpose in growing trees.

Before selecting the planting site, make a careful study of competing vegetation, climate, land slope, history of fire, animal damage (wild and domestic), and any past wood production (check growth rings on old stumps in the area).

Soil-vegetation survey maps and SCS maps can help you determine the best planting areas on your property. Check with the CDF service forester or Cooperative Extension forest or farm advisor for information on availability of maps in your county, ways of ordering them, and assistance in interpreting them.

Good places to plant have —

- Deep forest soil that allows 3 feet or more of root penetration

- Average rainfall of at least 20 to 30 inches per year
- Good soil drainage
- No brush and grass, or brush and grass that are easy to clear
- North- and east-facing slopes, especially for growing true firs and Douglas-fir at lower elevations
- Few signs of animal browsing
- History of only limited fire, unless you are sure you can prevent re-burn
- Stumps with eight growth rings or less to the inch during the first 10 to 12 inches of growth; measure rings from the center of the stump outward
- Soil, fire, or climate problems that do not require special and expensive preplanting and planting techniques for success

If an area has 300 to 500 young, well-distributed trees per acre, either natural or from previous planting, there is no need to plant. In general, this number of trees is sufficient to ensure full production of any crop except Christmas trees.

If the area has exposed mineral soil and sufficient seed trees to ensure the likelihood of young trees starting from seed in the next 1 or 2 good seed years — and if you can afford to wait — there is little purpose in planting.

If you intend to grow Christmas trees, ease of access is an important consideration for management and harvesting, especially for "choose-and-cut" sales if you plan to use this method of marketing trees.

REFORESTATION METHODS

Reforestation methods may be classified as follows:

- natural seeding;
- artificial seeding;
- tree planting.

Natural seeding relies on nature to establish seedlings from seed falling from trees. This method gives best results when you prepare the ground to provide a bare mineral soil seedbed (a soil surface that has no organic cover, such as needles or leaves). Seed-eating rodents must be

few in number, either as a result of natural cycles or by intentional control, otherwise the rodents will consume most of the seed crop.

Artificial seeding is usually done by machine or by hand and requires the distribution of a predetermined amount of chemically treated seed on well-prepared ground. Spreading seed uniformly over an area is called broadcast seeding. Putting a few seeds in carefully prepared spots, spaced where you want the trees to grow, is called spot seeding. If you plan to seed artificially, rodent populations must be low so rodents will not eat or damage the seed.

In *tree planting*, seedlings that have been started in the nursery are planted in prepared ground, either by hand or by machine. The planting method you use depends on several factors, some of which are outlined in table 1. Note that the estimated costs are only initial costs. To estimate future costs of and returns from each of the three methods, include such elements as preharvest thinning and fire, disease, and other types of protection. For instance, if natural seeding makes it necessary to thin closely spaced seedlings, final analyses might show costs of natural seeding equal to or higher than the costs of planting.

GROUND PREPARATION

Trees need moisture to survive and grow. Not only must annual rainfall be enough to sustain trees, but the ground must absorb and hold all the moisture that the trees will need through the dry summer season. Forest soils that are at least 3 feet deep usually hold moisture close enough to the surface for the use of roots of newly planted seedlings — if no weeds, brush, grass, or other trees are competing for that moisture.

Grasses and weeds spread quickly and, if uncontrolled, may choke out freshly planted seedlings. Wherever vegetation is competing for soil moisture, ground preparation is usually necessary.

On most successful California plantations, all brush or other vegetation is killed or removed from the site before planting. Merely scalping off the weeds around individual trees or clearing strips just wide enough for a row or two of trees is usually not enough. Plant roots extend beyond stems showing at the surface and soon grow across the strips or patches around cleared trees.

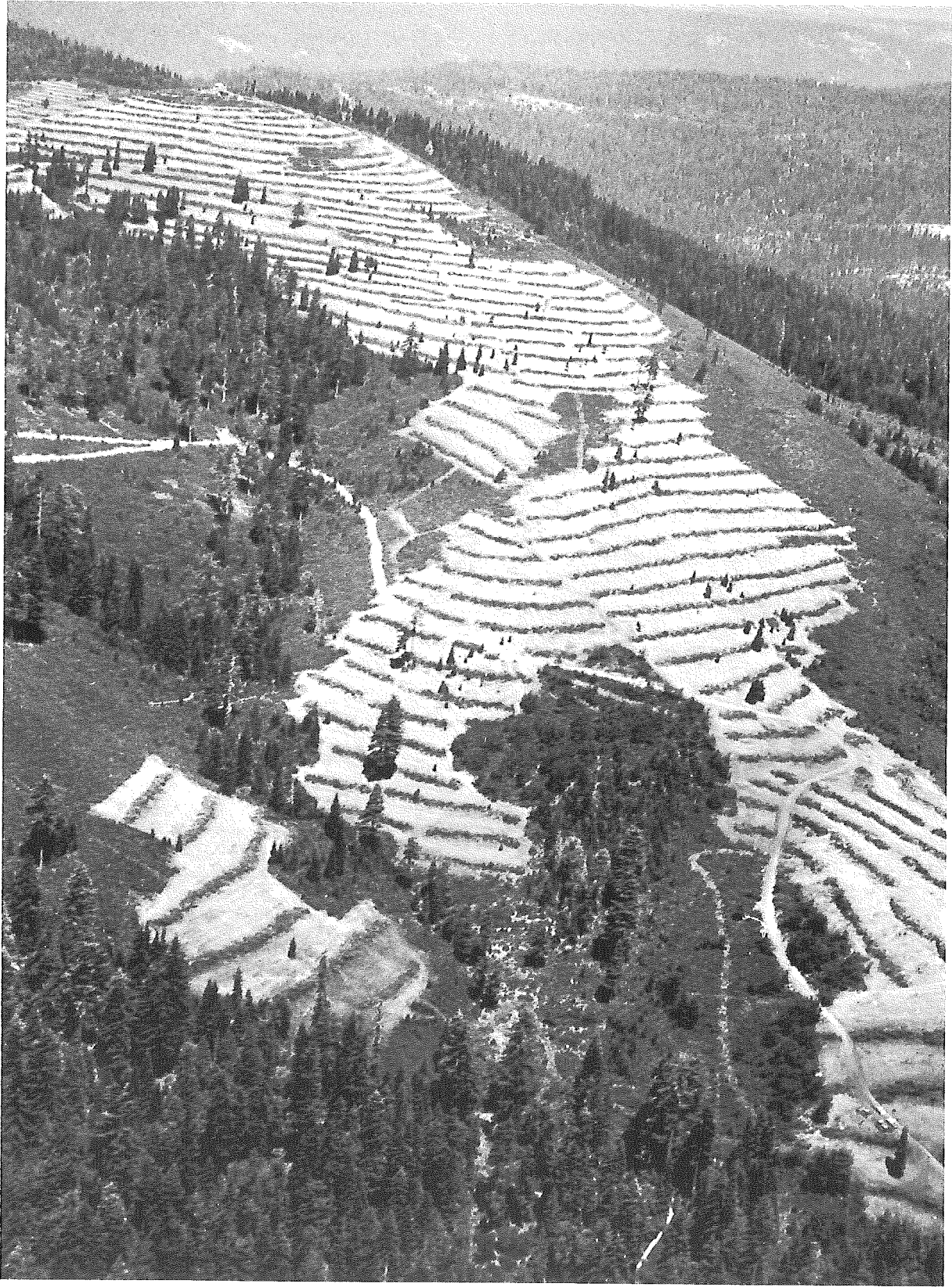


Figure 3. High-producing forest land that has been bulldozer-cleared of brush for planting.



Figure 4. Using a bulldozer with a "root rake" to clear brush from an area to be planted.

In hot climates where trees receive direct sunlight, shade from logs, stumps, or shingles stuck in the ground next to the seedling has helped such species as Douglas-fir and the true firs. Seek advice for correct application and precautions on your plantation.

CONTROL OF COMPETING VEGETATION

You can control competing vegetation by mechanical or chemical methods or by a combination of both.

Mechanical Clearing

You can use a bulldozer to remove all vegetation growing in the area you want to plant. To reduce sprouting, pull out the underground root crowns of brush. The use of a "root rake" bulldozer blade

helps pull out root crowns without removing too much soil. Push logs and debris, together with the brush, into piles or windrows and burn under safe conditions. You can also use fire to clean up heavy brush fields in which the brush has either been cut and flattened or merely crushed to the ground.

If the area has recently been logged, it is usually best to burn heavy slash to prepare for planting or seeding. Be sure to observe local and state fire laws, and obtain a fire permit when required.

On land that has a slope up to 30 percent, the best practice is to push brush and debris into windrows spaced 50 feet or more apart on contours. This makes terraces that help prevent excessive soil erosion, collect water, and level the ground enough so planting machines can be used. The cost of ground preparation may be partly offset by reduced planting costs because machine planting is usually cheaper than hand planting. The U.S.

Forest Service publication *Site Preparation for Forest Regeneration* gives more details about methods of brush control.

If the ground requires deep chiseling or plowing and discing, do this a year ahead of time to permit a season's rain to settle the soil. Otherwise the loose soil may dry out before the roots become established. Such summer fallowing also allows moisture to build up deep in the soil and helps control weed sprouting.

If you intend to direct seed, expose the mineral soil and loosen the top inch or two. If seed is lightly buried in this kind of soil, it has a chance to get enough moisture and oxygen to germinate. Later, the loose surface soil allows new roots to penetrate and develop sufficiently to survive the dry summers.

Chemical Treatment

You can use chemical sprays to kill brush successfully in many areas. Spraying may be the only treatment possible on land too steep for tractors; it may be the only method needed on flat ground if the brush is not too heavy and thick.

Different kinds of brush require different chemicals and times of application. Consult a licensed pest control advisor or your local Cooperative Extension forest or farm advisor about chemicals and application rates.

It is possible to apply chemicals from aircraft, from tanks on trucks or tractors, from backpack pumps, or from portable mist blowers. You can apply some chemicals: by spraying to cover all leaves; by drenching the bases of large brush or trees; by injecting into the tree's circulation system; or by drenching on the stumps of brush or trees to prevent sprouting. The success of a brush control effort depends on using the correct chemical for each species of brush or tree in the correct manner and at the right time. *It is required that you obtain professional advice before using chemicals.*

Combination

Apply a followup chemical treatment to all areas from which you have removed brush. A good practice is to clear the area with a bulldozer, spray sprouts and new brush seedlings during the next growing season, and then plant or seed. This

practice usually eliminates nearly all vegetative competition. *To avoid injuring the young trees, it is better to apply chemicals before planting.*

RODENT CONTROL

Before planting or seeding, it is frequently necessary to control rabbits and other rodents, including mice, porcupines, and gophers. Mice and squirrels eat seed used in direct seeding; gophers cut off roots of seedlings at ground line; rabbits clip off young seedlings; and porcupines girdle small trees, which cuts off the flow of food and water and results in tree death.

To prevent such damage, use traps or bait to reduce rodent populations. Under California law, only duly authorized persons may distribute specific poison baits. Be sure to check the regulations and control methods with your county agricultural commissioner.



Figure 5. Douglas-fir seed damaged by a rodent.

TABLE 1. SUGGESTED METHODS OF REFORESTATION

PLANNING																											
Consider	Planting Seedlings	Artificial Seeding	Natural Seeding																								
Advice and help	Seek professional advice and read suggested literature. You can have a consulting forester or a planting contractor do the complete job.	Seek professional advice and read suggested literature. You can have a consulting forester or an aerial seeding contractor do the complete job.	Seek professional advice and read suggested literature. You can have a consulting forester or a professional contractor do the complete job.																								
Location needs	Deep soils. Rainfall, 20 inches or more. Temperatures less critical for planting than for seeding. Any elevation. Can extend range if plan to irrigate trees.	Deep soils. Rainfall, 30 inches or more, or considerable influence from fog. Low maximum summer temperatures (less than 95° F). Near coast or above 4,000 feet elevation.	Same as for artificial seeding.																								
Preparation	Remove competing vegetation. Grow or purchase seedlings. Rodent control is usually not necessary, except when porcupine and rabbit populations are high.	Purchase or collect seed. Coat seed with repellents. Consider rodent control. Prepare the ground to afford loose, bare, mineral soil.	Seed trees must be available. Be sure there are good cone crops before trying to use this method. Prepare the ground to afford loose, bare, mineral soil. Consider rodent control.																								
Risks	Drought, heat, and freezing may cause losses. Occasionally rodents and other animals may cause some destruction.	Minimize possible seed and seedling destruction by rodents, birds, and insects by controlling rodents and by using treated seed. Drought, heat, and freezing are especially critical during germination period.	Same as for artificial seeding. May be a delay of several years while waiting for cone crop.																								
Species and densities	Select species suited to the area. This method affords maximum control over density of seedlings.	Select species suited to the area. Control of density is less important than when planting seedlings.	Choice of species limited by species of cone-bearing trees in the stand. Little control over density of seedlings.																								
DOING THE JOB																											
Timing	Any time from December to April, depending on geographic location, soil moisture, and condition of planting stock.	Any time in late fall or early winter. Can sow seed in early spring if you stratify* it before sowing.	Most critical of the three methods. Good cone crops are rare. Prepare the ground and control rodents just before the fall opening of cones.																								
Methods	Plant by hand or by machine (see page 22).	Broadcast by hand, by a cyclone-type seeder, or by aircraft. Spot seed by rake, hoe, mattock, or by special seeding gun. Drill holes by special tractor-drawn machines.	Seed is dispersed naturally by wind.																								
Per acre costs	<table border="0" style="width: 100%;"> <tr> <td>Site preparation</td> <td style="text-align: right;">\$20 to \$96</td> </tr> <tr> <td>Trees</td> <td style="text-align: right;">9 to 82</td> </tr> <tr> <td>Planting</td> <td style="text-align: right;">27 to 250</td> </tr> <tr> <td style="border-top: 1px solid black;">TOTAL</td> <td style="text-align: right; border-top: 1px solid black;">\$56 to \$428</td> </tr> </table>	Site preparation	\$20 to \$96	Trees	9 to 82	Planting	27 to 250	TOTAL	\$56 to \$428	<table border="0" style="width: 100%;"> <tr> <td>Site preparation</td> <td style="text-align: right;">\$20 to \$90</td> </tr> <tr> <td>Rodent control</td> <td style="text-align: right;">1 to 5</td> </tr> <tr> <td>Seed</td> <td style="text-align: right;">6 to 30</td> </tr> <tr> <td>Seeding</td> <td style="text-align: right;">8 to 40</td> </tr> <tr> <td style="border-top: 1px solid black;">TOTAL</td> <td style="text-align: right; border-top: 1px solid black;">\$35 to \$165</td> </tr> </table>	Site preparation	\$20 to \$90	Rodent control	1 to 5	Seed	6 to 30	Seeding	8 to 40	TOTAL	\$35 to \$165	<table border="0" style="width: 100%;"> <tr> <td>Site preparation</td> <td style="text-align: right;">\$20 to \$90</td> </tr> <tr> <td>Rodent control</td> <td style="text-align: right;">1 to 5</td> </tr> <tr> <td style="border-top: 1px solid black;">TOTAL</td> <td style="text-align: right; border-top: 1px solid black;">\$21 to \$95</td> </tr> </table>	Site preparation	\$20 to \$90	Rodent control	1 to 5	TOTAL	\$21 to \$95
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FOLLOWUP																											
Care of plantation	Normal care (see page 27).	Followup rodent control is frequently necessary. It may be necessary to thin dense stands.	Same as for artificial seeding. If not successful within first 2 years, followup seeding or planting may be necessary																								

* Pretreat seed by soaking it in water for 24 hours. Then place it in polyethylene bags in refrigeration for several weeks.

COSTS OF SITE PREPARATION

Treatment costs vary with the size of brush, topography, and the size of the treated area. The estimated costs per acre are as follows.

Crush and burn light brush	\$20 to \$40
Clear and windrow heavy brush	45 to 90
Chemical control	12 to 50
Plow or disc	15 to 25
Chemicals for treating tree rows	5 to 15
Baiting for rodents	1 to 5

WHAT TREE SPECIES TO PLANT

The best tree species to plant is usually one that grows or has grown on the area. In addition, what species is best to plant depends on three major factors:

- climate;
- soil;
- the forest product you want or the use you may want to make of the area.

Figure 6 is a general guide that will help you choose a tree species suitable for your climate. When selecting a species, also consider all special conditions, such as degree of slope, or steepness of

land, and exposure. For instance, Douglas-fir and the true firs usually do better on north-facing slopes where it is cooler. On the other hand, while Monterey pine makes a marketable Christmas tree quite quickly, it cannot tolerate extreme cold and so is limited in its range. Irrigation, chemical weed control, weeding, hoeing, or other cultivation techniques make it possible to grow Christmas trees and landscape trees where climates are too severe for normal forest planting.

If the trees in your area have a history of disease problems, that must also affect your choice of a species. For example, only plant sugar pine in areas free of blister rust disease.

Table 2 suggests common uses for species in California. Find out all you can about the tree species before making your final choice.

It is a good practice to plant more than one species if you carefully select each species for your site. By planting more than one species, you can space trees more efficiently, reduce the risk of excessive losses from insects or diseases, and plan for more than one product. For instance, along the north coast, redwood sprouts may come up after cutting or burning so that Douglas-fir planted at wide spacings between the sprouts would make a good forest. Another combination is to plant Christmas trees between wide-spaced rows of trees planted for sawlogs. Take advantage of the topography of your site. In the north Sierra Nevada, for example, you might plant blocks of Douglas-fir and white fir on north-facing slopes and ponderosa pine on south-facing slopes.

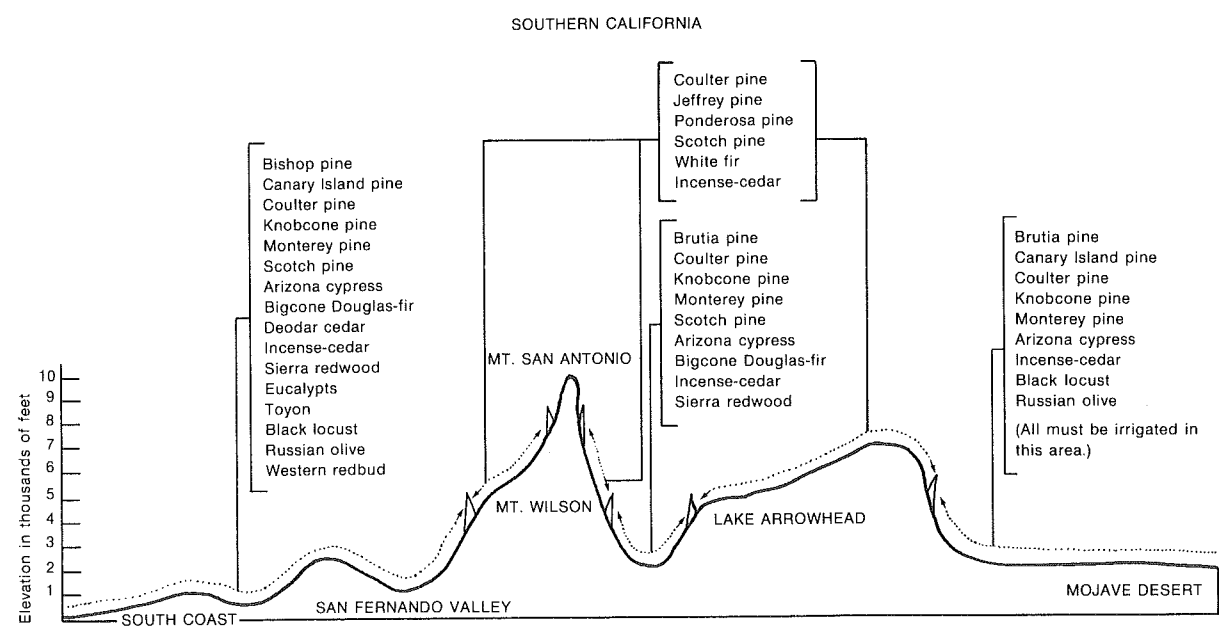
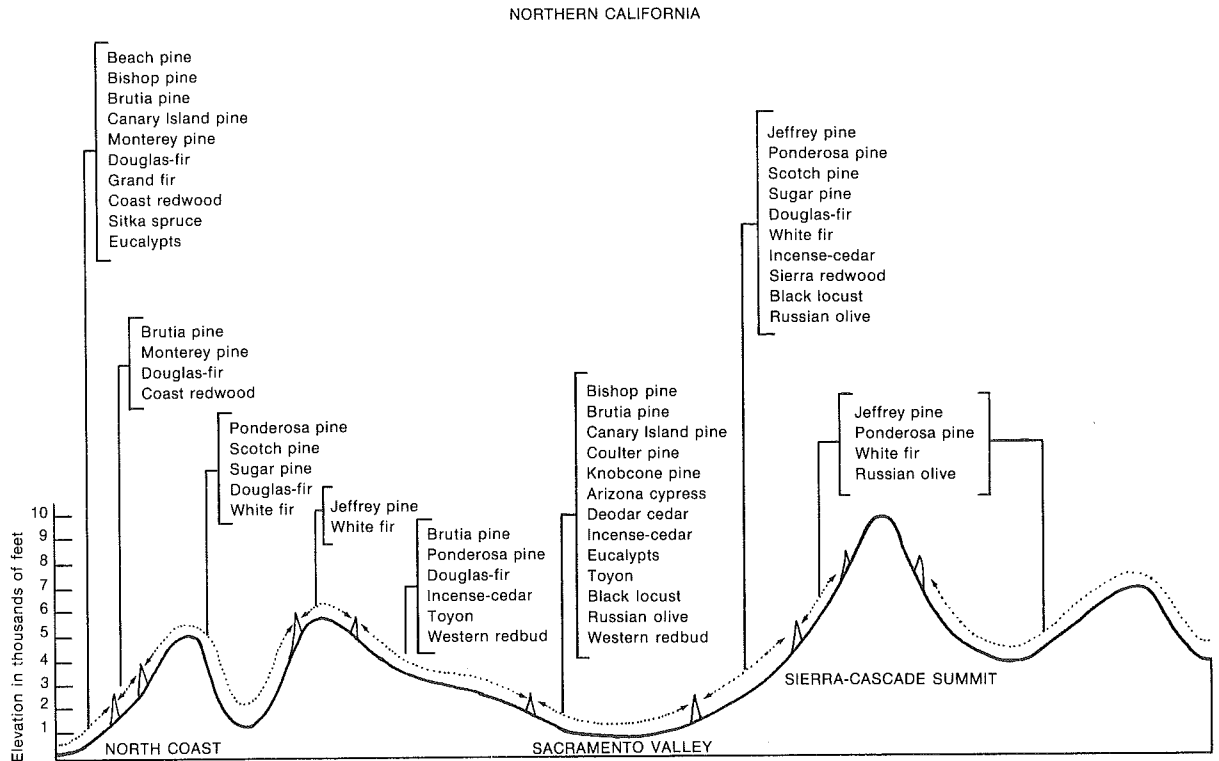


Figure 6. Transects running east and west across northern and southern California to give a general idea of species of trees to plant in different parts of the state.

TABLE 2. LIST OF USES FOR GENERALLY AVAILABLE SPECIES¹

Species	Recommended Uses							Climatic Tolerance				Rate of Growth			Mature size (feet)	Soil Tolerance			
	Street planting	Public grounds	Erosion control	Windbreaks	Wildlife habitat	Christmas trees	Forestation	Coast	Interior valley	Desert	Frost (below 15° F)*	4 feet/year and over	2 to 4 feet/year	0 to 2 feet/year		Good soils	Medium soils	Poor soils	Alkaline soils†
<i>Coniferous evergreens</i>																			
Arizona cypress															30 to 40				
Beach pine															15 to 30				
Bishop pine															45 to 75				
Brutia pine															65 to 100				
Canary Island pine															60 to 80				
Coulter pine															40 to 80				
Jeffrey pine															60 to 150				
Knobcone pine															30 to 50				
Monterey pine															40 to 100				
Ponderosa pine															60 to 200				
Scotch pine															50 to 80				
Sugar pine															70 to 200				
Bigcone Douglas-fir															30 to 60				
Douglas-fir											§				70 to 250				
Grand fir															60 to 200				
Red fir															60 to 200				
White fir															60 to 200				
Deodar cedar															40 to 60				
Incense-cedar															50 to 150				
Coast redwood															100 to 340				
Sierra redwood															150 to 300				
Sitka spruce															80 to 150				
<i>Broadleaved evergreen</i>																			
Eucalypts															50 to 120				
Toyon															10 to 15				
<i>Deciduous</i>																			
Black locust															40 to 80				
Russian olive															15 to 20				
Western redbud															10 to 20				

¹ Shaded squares indicate species adaptability for a specific use.

* High elevation Coast Range, Cascades, and Sierra Nevada.

† Adopted from McMinn, Howard E. and Maino, Evelyn. 1959. *An Illustrated Manual of Pacific Coast Trees*. Berkeley: University of California.

§ Seed source from high elevation only.

If you are planting trees as a windbreak, plant at least two rows and stagger the trees to prevent a continuous opening between the rows. It is often a good idea to mix the species selected for the windbreak with a row or two of evergreens planted on the windward side. If you intend to plant several rows of mixed deciduous species, select some slow-growing species that are shade tolerant so they will not be choked out by the faster growing species.

IMPORTANCE OF SEED SOURCE

Many reforestation difficulties arise because growers disregard the seed source. Trees are not readily adaptable to different environments. If you plant a Douglas-fir seedling from a coast seed source in the Sierra Nevada, it may freeze. A ponderosa pine seedling from a low elevation Sierra Nevada seed source may survive and grow well at high elevations in the Sierra Nevada for a number of years, but, as the tree develops, its branches tend to break from the weight of winter snows. If you plant trees out of their range, they may grow slowly and may be attacked by damaging insects and animals. Trees native to the area are constituted to withstand local conditions.

You can prevent many problems by following this rule of thumb: seed or plant seedlings only from a seed source within 100 miles and 1,000 feet elevation of the planting site. This restriction does not necessarily apply to special, genetically improved stock or to Christmas tree plantations where water and extra care are economically feasible. Seed certified as to origin by a dealer may cost a little more, but it is a wise investment.

In California, there are 85 seed zones based on different timber types and approximately 50-mile latitudinal limitations. The seed zones range from mixed species in southern California to the redwood zone along the north coast. In general, if the planting site is in a particular zone at a particular elevation, seedlings grown from seed collected in that zone at a comparable elevation usually develop satisfactorily.

Most seed dealers and forest nurseries can segregate seed by zone and elevation of origin so that you can be assured of receiving the right seed or planting stock.



Figure 7. A eucalypt windbreak protects buildings and farm crops.

WHERE TO GET SEED OR TREES

Several sources of seed and seedlings of species native to California forests are located within the state; some are in other parts of the country. It is recommended that you try local sources first.

Most forest seed is supplied by commercial sources. You can obtain planting stock from private or public nurseries. You may wish to collect seed and raise seedlings, but this requires considerable skill. Seed quality is also important; a high percentage of the seed must be sound. Cutting tests will show the percentage of sound seed. A good seed is well filled with a material similar to walnut meat. For more accurate determination of how many seeds will germinate, send a sample to a seed testing laboratory. Lists of commercial seed and nursery stock dealers and addresses of seed testing laboratories are available from the U.S. Forest Service, California Division of Forestry, and from U.C. Cooperative Extension offices.

The California Division of Forestry has three forest nurseries that produce seedlings for purchase by the public, except when seedlings are wanted for private land beautification or landscaping. Price lists and order blanks are mailed about November 1. You can obtain these from the State Forester in Sacramento. It is best to order as soon as you receive the nursery order blank so that items in short supply might be reserved for you. Trees are shipped between December 15 and April 1. If you want stock for planting at high elevations later than April 1, you can request the nursery to hold the stock under refrigeration.



Figure 8. Sampling beds of 1-0 ponderosa pine before lifting for shipment.

Trees are sold in rather large quantities; no fewer than 100 containers or 500 bareroot seedlings of each species. If you order large numbers of trees, it is a good idea to ask for partial deliveries so you will not have more trees on hand than you can plant in a few days. CDF nurseries will break large orders into 2,000-tree shipments. (See appendix 2 for information on ordering trees from CDF.)

Los Angeles County has limited numbers of trees available for group or community plantings. You can obtain more information by writing to the Forestry Division, Los Angeles County Department of Forester and Firewarden, 3009 Terminal Annex, Los Angeles 90056.

The Antelope Valley Soil Conservation District, P.O. Box 392, Lancaster 93534, produces planting stock. The District sells either bareroot or potted stock for planting in difficult situations. Trees from this nursery may only be purchased for windbreaks, wildlife protection, and erosion control.

Seedlings from U.S. Forest Service nurseries are distributed for planting only on federal lands and are not for sale to the public.

Since 1972 there has been an increasing interest in raising conifer seedlings in containers under greenhouse conditions. Container designs include a styrofoam block that has a number of cavities; individual tubes of plastic supported in a tray; folding plastic holders that expose the root plug when unfolded; and individual biodegradable pots.

The containerized seedling is grown from seed in approximately 8 months and receives its nutrition from slow-release fertilizers mixed in the growing medium and soluble fertilizers injected into a permanent sprinkler system. At planting time, the seedling and its root medium are extracted from the container and planted with a special planting tool.

Advocates of containerized seedling stock claim many advantages over bareroot stock. These benefits include a reduction in planting time, a capability of extending the planting season, and an overall increased efficiency resulting in less cost per established seedling.

For the present, containerized nursery seedlings are only being raised in production quantities by CDF and a few private timber companies that

require stock for their own reforestation needs. Persons who wish to purchase these seedlings on a contract basis may direct inquiries to representatives of CDF or to the Cooperative Extension offices in Humboldt and Mendocino counties.

For information about buying seedlings from a nursery in another state, write to the appropriate state forester. Remember, out-of-state seed sources may not be compatible with California conditions and such seedlings may suffer due to transportation delays.

Costs

In California, the cost of bareroot seedlings varies from about \$24 to \$75 per 1,000, depending on the age of the stock and the nursery producing it. Container stock varies in cost from about \$70 to \$255 per 1,000. Seed prices are about \$8 to \$30 per pound, depending on the species. For example, ponderosa pine seed may be purchased for about \$6 a pound and Douglas-fir seed for about \$20 a pound.

HOW MANY TREES OR SEEDS TO ORDER

How many trees to order depends on the amount of acreage you intend to plant and the tree spacing you plan to use. A good spacing for most forest plantations is 8 by 8 feet or 10 by 10 feet. However, 6- by 6-foot plantings are better for erosion control projects, since close spacing allows the roots to interweave quickly to hold the soil.

If you plan to use equipment for cultivation or application of chemicals (especially for Christmas trees and windbreaks), space rows according to the width of the equipment. If you do all cultivation by hand and if you use a hand sprayer for applying chemicals for weed control, you can plant trees on a 4- by 4-foot spacing. Plant trees for windbreak rows 10 to 15 feet apart so you can use discs or harrows, which are 8 to 10 feet wide, between the rows.

If you space trees widely, they usually grow to merchantable size earlier than when they are planted close together, such as in an unthinned, 6- by 6-foot plot. However, closer tree spacing has a

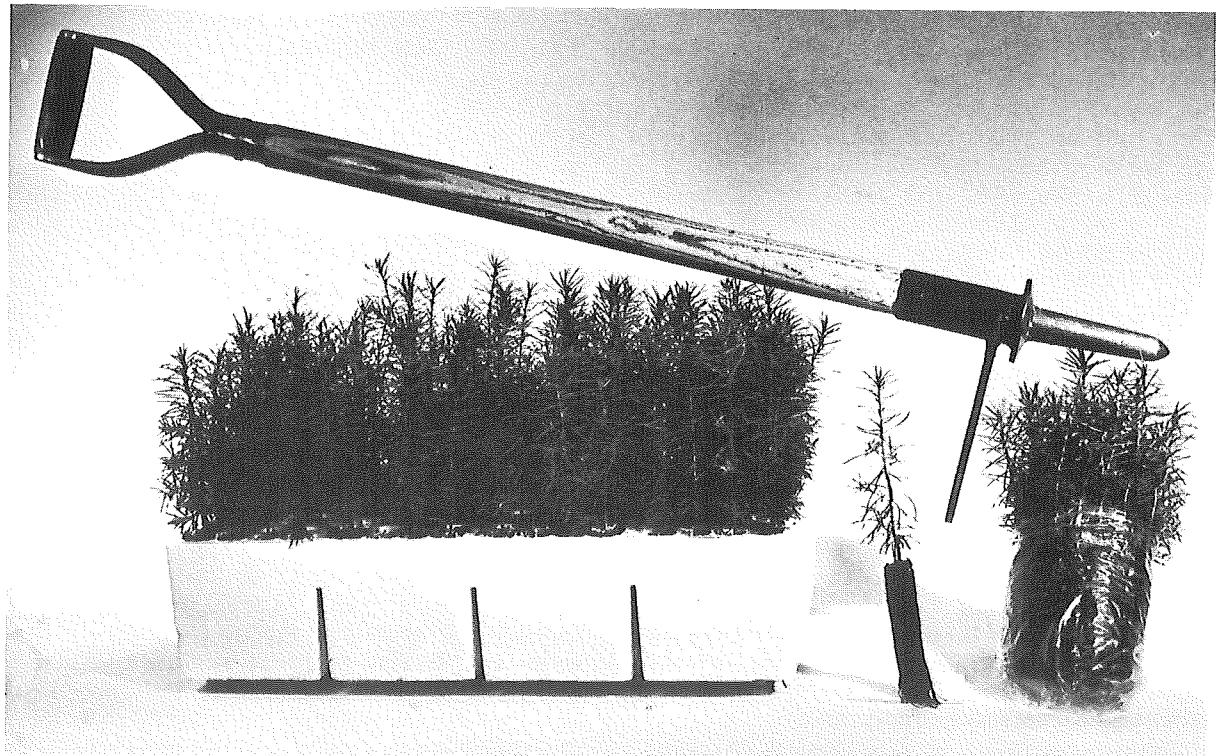


Figure 9. Planting dibble and containerized seedlings.

number of advantages: 1) you can thin early for posts or small poles; 2) it gives you some allowance for loss; 3) the trees close in faster, helping keep out brush; 4) as the trees close in, natural pruning occurs; and 5) it gives you more trees per acre, which is especially important for the production of Christmas trees.

In areas in which past experience has shown that you can get good tree survival and where you do not intend to do any precommercial thinning, a 12-by 12-foot spacing may be best.

Use a closer spacing — 6 by 6 feet or 8 by 8 feet — for seed spots than for tree plantings. The number of seeds to plant varies with seed viability. Here are some suggested rates.

TABLE 3. NUMBER OF TREES REQUIRED FOR DIFFERENT SPACINGS

Spacing in feet	Number of trees/acre
4 x 4	2,722
5 x 5	1,700
6 x 6	1,210
6 x 8	908
6 x 12	605
8 x 8	681
8 x 10	544
8 x 12	454
10 x 10	436
12 x 12	303
14 x 14	222
16 x 16	170

seeds per spot

ponderosa pine	3 to 5
true firs (<i>Abies</i> species)	10 to 15
Douglas-fir	3 to 5
Sitka spruce	4 to 8

If you intend to broadcast seed, the amount of seed you need per acre varies by species and germination capacity. The following rates are recommended for favorable sites.

pound per acre

Douglas-fir	$\frac{3}{4}$ to 1
Sitka spruce	$\frac{1}{2}$ to $\frac{3}{4}$

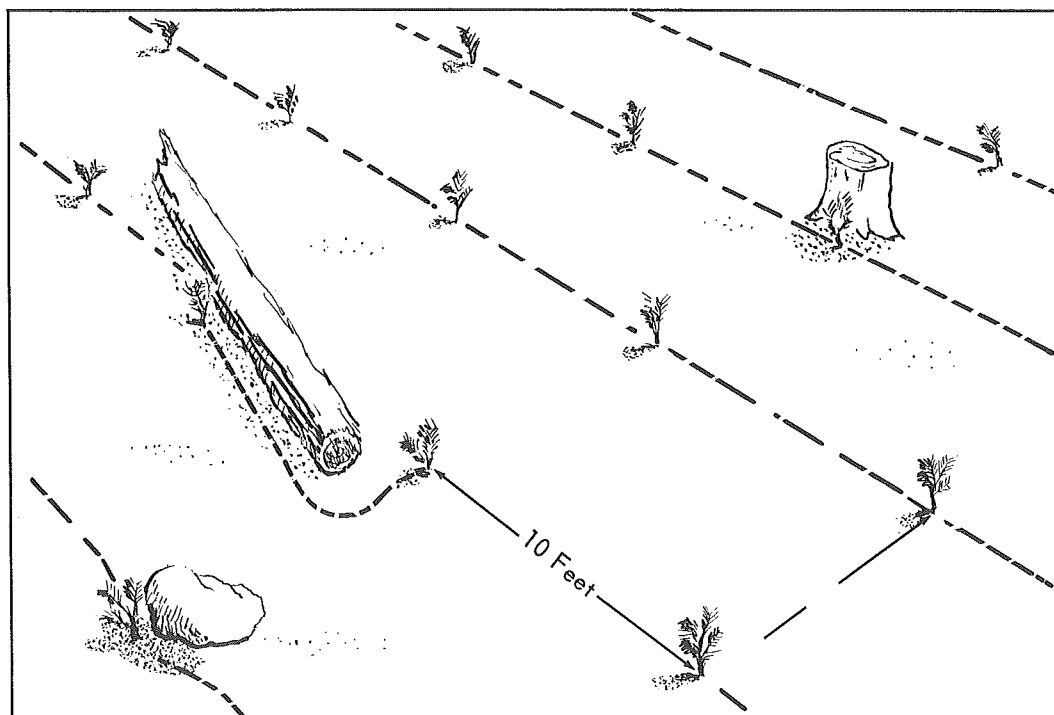


Figure 10. Break the uniform spacing to take advantage of shade or other good planting spots.

HOW BIG A TREE TO PLANT

Small, bareroot planting stock is used for most forest planting. This planting stock is listed by forest nurseries as 1-0, 2-0, 1-1, or 2-1. The first number shows the number of years in the seedbed; the second, the number of years in the transplant bed.

1-0. These trees have grown for 1 year in the nursery seedbed. Stock of this age is usually cheapest and easiest to plant. Ponderosa, Monterey, and Coulter pines, Arizona cypress, and the broadleaved trees are usually big enough at this age to withstand the rigors of planting. Ordinarily, the seedlings should have a 3- to 6-inch-tall top; a well-branched, 8- to 10-inch root; and a minimum stem diameter of 1/16 to 1/8 inch near ground line.

2-0. These trees have grown for 2 years in the nursery seedbed. They have usually been root-pruned between the first and second year. You may desire stock of this age for one of the following reasons.

- Some slow-growing species of trees take 2 years to grow large enough for planting. Jeffrey pine, white fir, red fir, and Douglas-fir are usually in this category.
- Severe conditions require bigger seedlings than those that normally grow in 1 year. Bigger stock usually has a better chance of withstanding a moderate amount of deer browsing; it also competes better with brush that grows up after clearing.

1-1. These 2-year-old trees have grown for 1 year in a seedbed and for 1 year in a transplant bed.

2-1. These 3-year-old trees have grown for 2 years in a seedbed and for 1 year in a transplant bed. True firs often do best when planted at this age or from the 1-2 age class. Christmas tree growers often buy 1-0 or 2-0 trees from the nursery and put them in their own transplant beds for a year or two.

Transplant stock is the most expensive to buy and plant, usually making costs prohibitive for forest planting. However, under extremely severe conditions, the extra cost may be returned by better survival in the field.

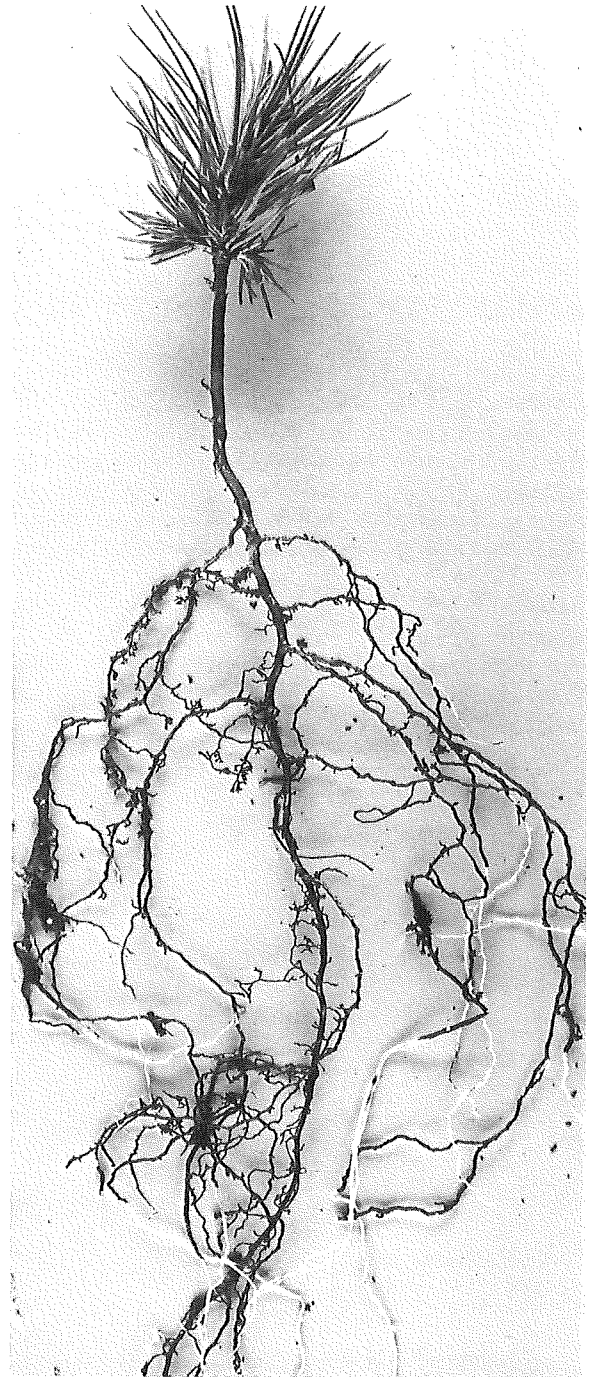


Figure 11. A 1-year-old ponderosa pine seedling that has actively growing white roots.

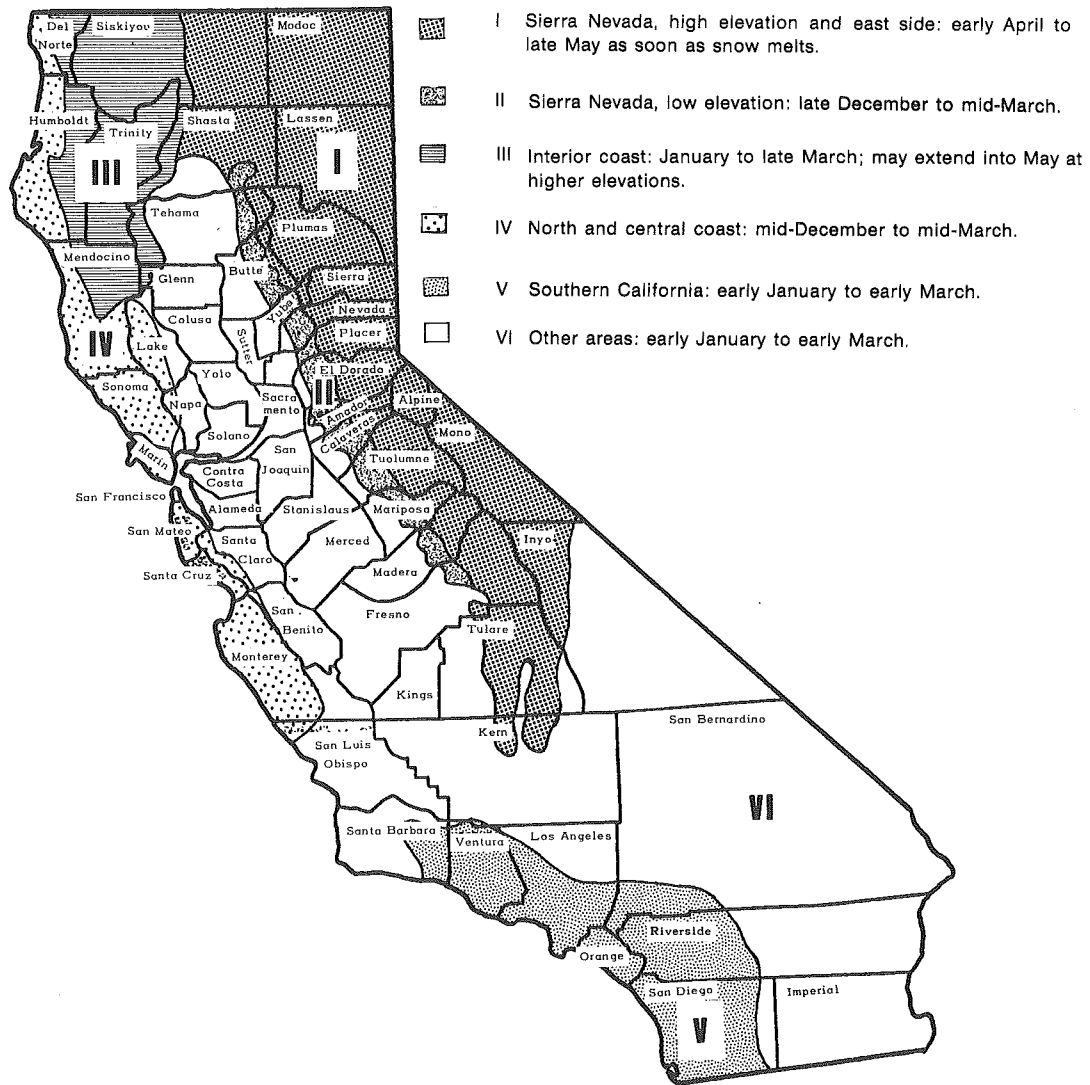


Figure 12. Best planting seasons for different areas of California.

WHEN TO SEED OR PLANT

Several variables make successful reforestation by seeding considerably more difficult than by planting. In general, successful seedings in the north coast area have been made between the first of December and the end of February. In the north and central Sierra Nevada, the few successful seedings were sown between mid-October and the end of December. If weather and soil conditions are good and if rodents have been controlled, early spring sowing is possible soon after snows melt.

For successful direct seeding, the soil must be moist during the 2- to 6-week germination period. Despite the availability of adequate soil moisture at seeding time, some seedings have failed because the top ½ inch or so of soil dried out before seed germination was complete.

When planting seedlings, two important conditions determine the best planting time: the growth stage of the seedlings, and the amount of soil moisture. The tops of the seedlings must not be growing and the root systems must be capable of starting new growth as soon as they are planted. Seedlings are

usually in this stage between late December and mid-March. Be sure the soil is thoroughly moist to a depth of at least 1 foot before planting.

Two other guidelines for deciding the optimal time of planting are: 1) south and west slopes tend to dry out more rapidly in the spring than north and east slopes do, so it is best to plant them earlier in the season than you would north and east slopes; and 2) seedlings planted at high elevations in the fall may be subject to damage if the late fall and early winter seasons have little snow cover to protect the seedlings.

Even though conditions are good for planting, dry winds and heat may kill many seedlings before they have a chance to extend their root systems to pick up the moisture they need from the soil. This is particularly true in southern California during early winter when dry, north winds are common. Nursery-grown Monterey pine is quite susceptible to drying, since this species characteristically has a large top and a limited root system.

Favorable times for planting seedlings in different regions are shown in figure 12.

HOW TO HANDLE TREES

Seedlings are living organisms and must be treated as such. The better the care and the less time that elapses between removal from storage and planting, the higher the survival rate.

Complete all planting arrangements before the trees are delivered. Have the site prepared, the necessary planting tools on hand, and the planting crew standing by. Whenever possible, take delivery of the trees at the nursery. If you request trees to be delivered, avoid schedules that would result in delays due to holidays or weekends.

If it is necessary to delay planting for 3 or 4 days, leave the trees in bundles in a cool, shady place. Make special arrangements for longer periods of storage. If available, refrigerated cold storage is best. Check to be sure that the temperature is not below freezing or above 38° F and that the humidity is 90 percent or above.

Check refrigerator-stored bundles or crates of trees once a week to make sure that the packing material around the roots is moist. If the packing material begins to dry out, place the bundle or crate on end and wet thoroughly; allow any excess water to drain off before replacing on the shelf.

TEMPERATURE, 33° to 38° F

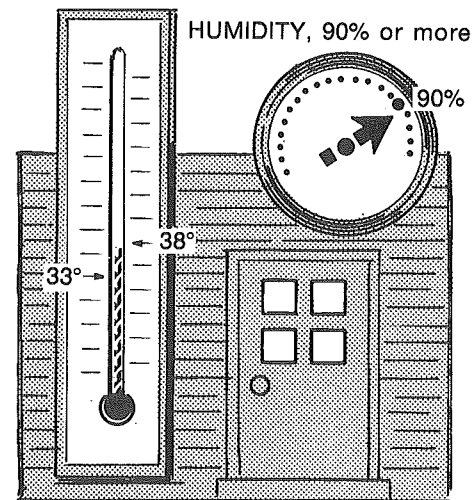


Figure 13. Conditions needed for long-term seedling storage under refrigeration.

Burying trees in snow banks is another cold storage method. However, be careful that the snow does not melt and expose the trees.

If correctly done, heeling-in is a satisfactory method for storing trees for a month. However, heel-in trees only as a last resort, as many things can go wrong. Locate heeling-in trenches in the shade. Remove trees from the packing bundles and plant them in a slanted trench. Make the trench long enough to prevent root bunching and deep enough to prevent curling of roots. Spread the seedlings out along the trench so the stems do not touch one another. Be sure all the root surfaces are covered with soil; do not cover any foliage. Tamp the soil firmly, water thoroughly, and keep it moist.

Prevent exposure of seedling roots to the air; the chances of survival are reduced every minute the roots are exposed. Table 4 indicates the amount of deterioration of seedlings exposed for different lengths of time. Although this study was made with Scotch pine, similar results can be expected for most conifer seedlings. Ideal days for planting are when the weather is cloudy and cool, humidity is high, and there is little wind.

Planting

There are several types of containers available for carrying trees taken from bundles or heel-in beds. The most satisfactory one is a planting bag, which

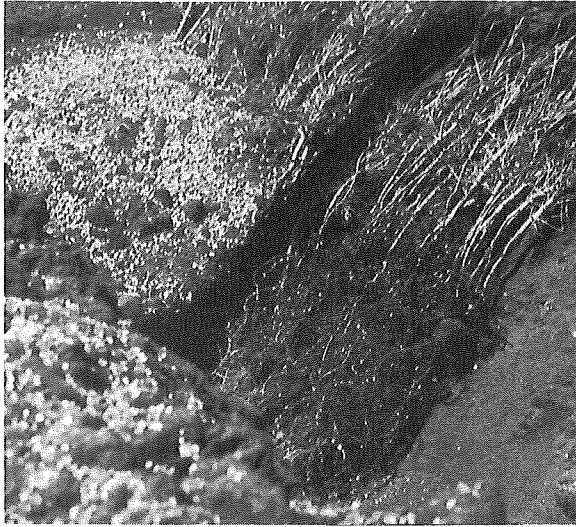


Figure 14. Heeling-in trees for short-term storage.

is similar to a small knapsack, but is carried in the hand or hung on the belt. (See figure 16.) Planting bags may be purchased from vendors of forestry equipment. (Refer to appendix 3.)

An ordinary pail that contains a mud slurry also works well, but weight is a drawback. It is not advisable to keep seedling roots immersed in water, since it reduces the oxygen supply to the roots and washes off beneficial soil. Be sure the planting bag or tray contains sufficient wet sawdust, peat moss, vermiculite, or other moist medium to keep seedling roots damp at all times.

Give the planting crew only enough seedlings to last them about 2 hours. If necessary, remoisten and replenish the medium in the planter's container when more seedlings are added.

Extreme care in planting is more important than speed. If conditions are good, an experienced planter may plant 350 to 700 trees a day.

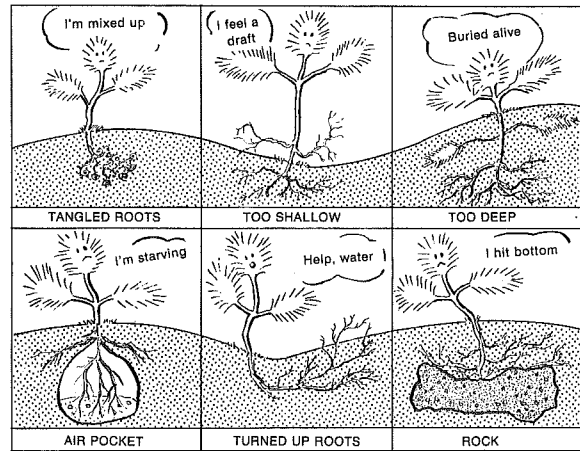


Figure 15. Avoid these tree planting errors.

Careful attention to the details of planting is more important than the tool or method used. Successful planting depends on using good planting stock whose roots are never allowed to become dry. When carrying trees in the field, enclose the roots in a waterproof bag, bucket, or similar container. Always pack moist material around the roots to keep them damp. Plant so the roots:

- only come in contact with damp ground;
- hang down, without bunching or curling;
- have soil firmly packed around them;
- are at the same depth as in the nursery.

Hand planting in California is done with a western planting tool, a planting bar, or a dibble. (See appendix 3 for a list of firms selling these tools.)

The western planting tool is a type of hoe with a long, narrow blade that opens a 10-inch-deep hole

TABLE 4. SEEDLING LOSS DUE TO ATMOSPHERIC INFLUENCE ON THE ROOTS BEFORE PLANTING

Weather	Hour	Air Temperature	Loss due to Exposure (minutes)						
			0	2	5	10	20	40	80
<i>percentages</i>									
Cloudy	9 to 11	48° F	12	50	62	64	69	73	88
Cloudy	12 to 2	50° F	12	49	64	66	69	83	93
Cloudy	3 to 5	54° F	23	54	65	75	83	94	99
Rainy	9 to 11	61° F	8	40	42	46	56	63	66
Hot, clear	11 to 1	73° F	55	80	88	90	94	100	100

in almost any kind of soil. It is also good for working steep ground.

The planting bar opens up a slit 8 to 10 inches deep and wide enough to insert tree roots. It is especially good for loose or prepared soils. A shovel or tile spade can be used like a planting bar

for seedlings that have roots too wide for the slit made by the bar.

The dibble is used for planting containerized stock. It makes a round hole the same size as the root system when the tree is removed from its container. (See figure 9.)

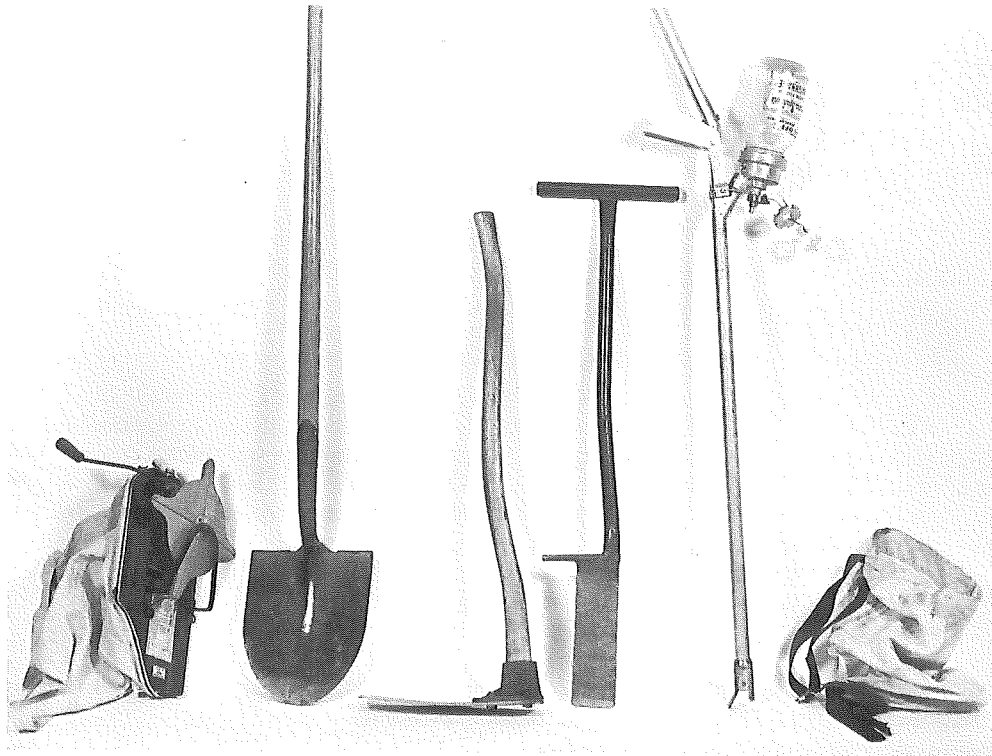


Figure 16. Planting and seeding tools commonly used in California. Left to right: cyclone hand seeder, shovel, western planting tool, planting bar, walking stick seed planter, planting bag for carrying seedlings.

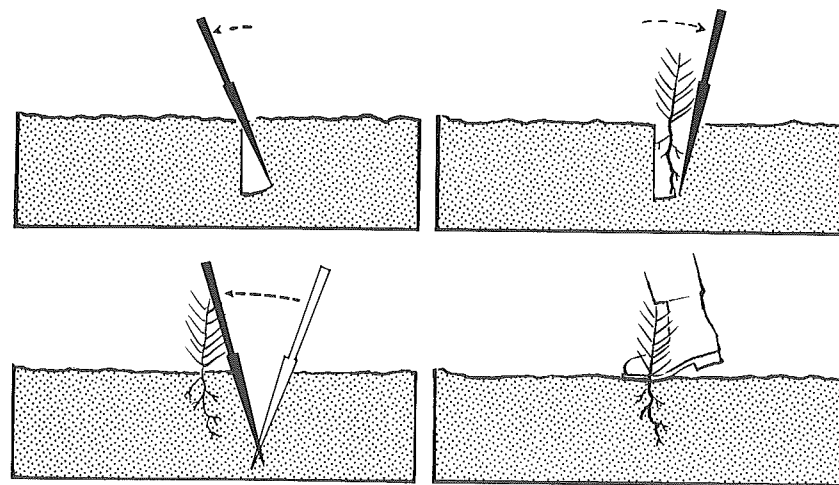


Figure 17. Squared-hole method of planting with a bar.

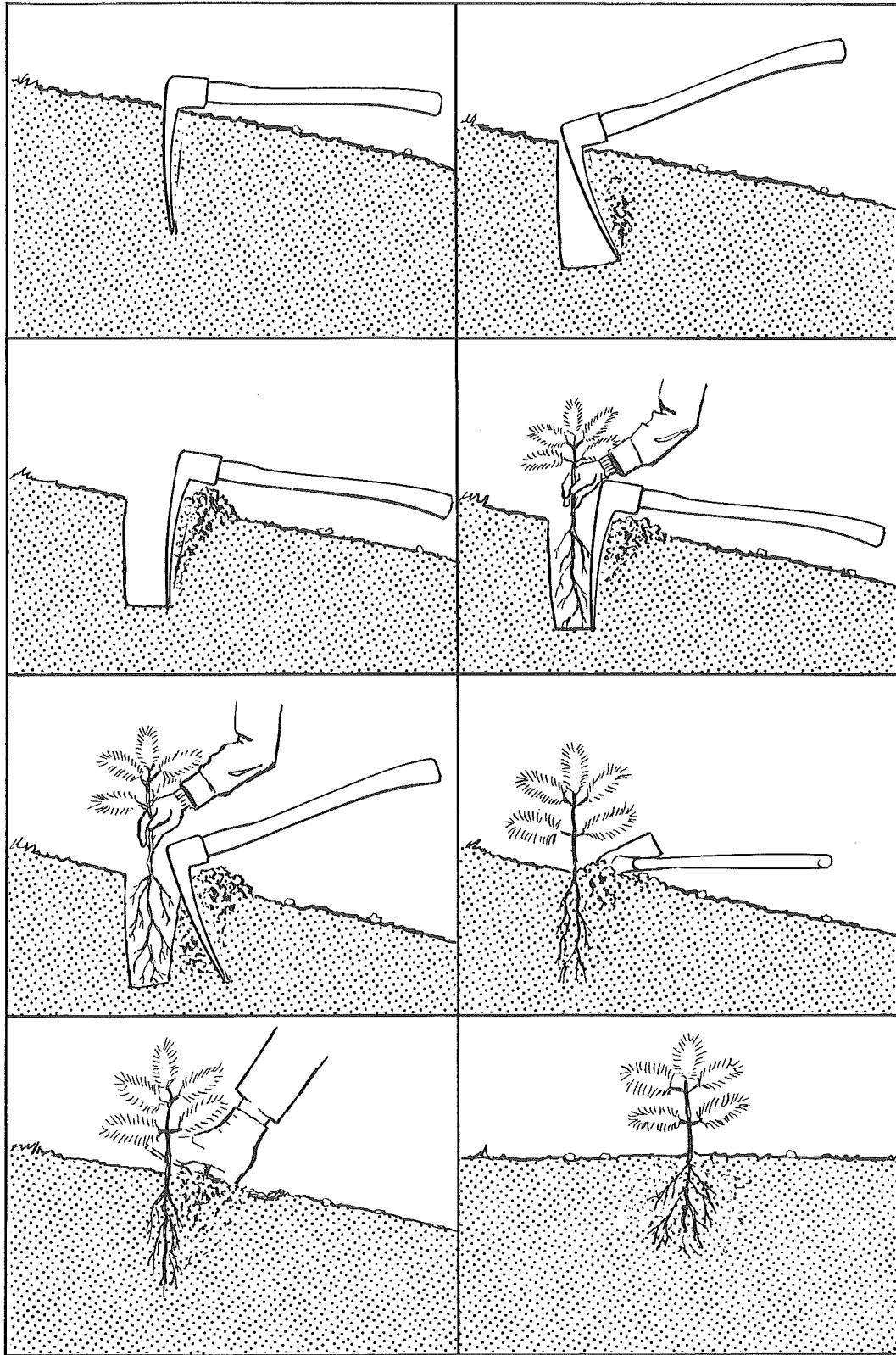


Figure 18. Steps in tree planting, using the western planting tool.



Figure 19. Auger-type machine boring a hole for planting.

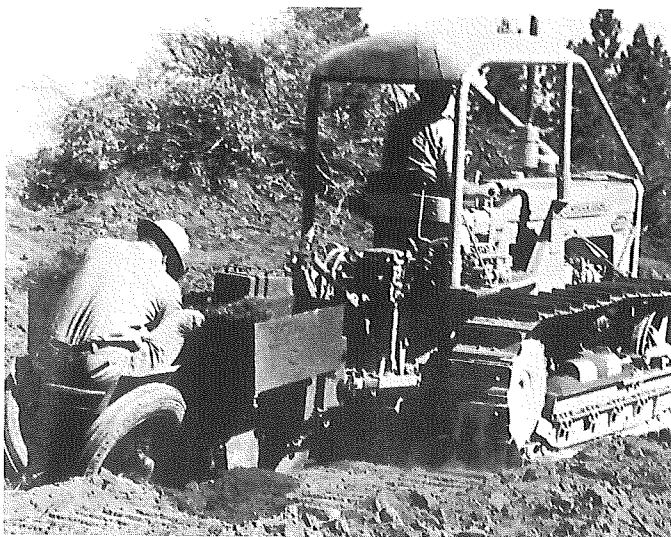


Figure 20. Machine planting on a well-prepared site.

Several kinds of machines have been developed for planting forest trees. There are two general types: the auger-type machine bores *individual holes* for inserting trees; and a tractor-drawn machine opens a *continuous slit* for insertion of trees at any spacing.

Auger-type machines have power furnished by a portable power unit. Some of these units can be used almost anywhere a man can walk. Auger-type machines work well in ground too hard for hand tools. It is usually necessary to have two to four people to plant behind a power auger.

In general, the most satisfactory type of tractor-drawn machine is one that you can firmly attach to a tractor that has a three-point hitch and a hydraulic lift. This permits quick lifts over rocks, logs, or other debris and quick turning at the end of the row. Be sure the machine also has a swivel so it can follow behind the tractor for planting along the contour on slopes.

A tractor-drawn machine is usually limited to use on slopes of less than 30 percent. However, you can use it on steeper ground if you eliminate brush and grass. In areas where the soil is deep, you can use a bulldozer blade to widen out a shelf or terrace on a contour for the machine. Or you can use a reversible disc plow that has large blades to prepare a ditch or contour. You can then flatten the ditch enough so a planting machine can be used.

HOW TO SEED

Seeds are also living organisms and must be handled with care. As soon as you receive seeds, store them in a dry, air-tight container under refrigeration.

Broadcasting large seed, like that of ponderosa pine, has been successful only when the seed was dropped in loose ashes immediately after a burn or on well-prepared sites. It is possible to broadcast seed by aircraft, cyclone hand seeder, or any other method that gives uniform distribution without injuring the seed.

Spot or drill seeding is usually more successful than broadcast seeding for ponderosa pine and other large-seeded species. Spot or drill seeding is also advisable for small seed if seed is in short supply or is unusually expensive. A firm covering of soil, not more than $\frac{1}{4}$ to $\frac{1}{2}$ inch deep, is essential for large seed.

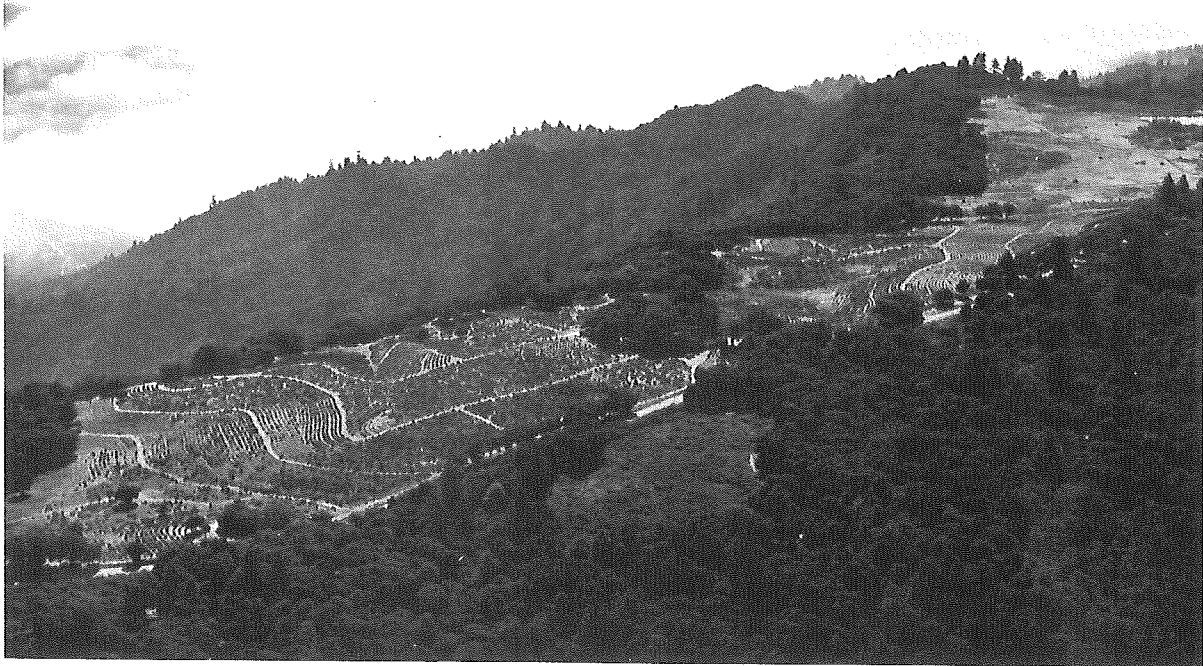


Figure 21. Firebreaks on a Christmas tree plantation.

You can also use modified corn planters or walking stick seed planters for spot seeding. Hand hoe, mattock, or other light hand tools are also satisfactory. Do not step on the seed after planting, especially if it has been soaked or stratified; heavy pressure on the seed may injure it. If soil, particularly clay, is compacted, seedlings may not be able to push through it.

CARE OF TREES AFTER PLANTING

Your plantation needs continuing attention to guard it against losses from fire, insects, diseases, brush competition, and animals.

Fire can wipe out an entire plantation quickly when the trees are small and the limbs close to the ground. Build firebreaks around and through the area at strategic places. To save trees and money, determine the location of firebreaks before planting. Firebreaks and access roads, which are essential for fire protection and for improvement work and harvesting, need annual maintenance. In addition, you can prevent the spread of fires by killing brush before it makes a potential fuel supply for a wildfire and by pruning trees as early as possible.

Insect or disease attacks may be as disastrous as fire unless you quickly detect the problem and treat it. Investigate any foliage that is turning yellow, new foliage that is drooping, or any other symptom of poor tree health. Identify the problem as soon as you notice it and get advice about control measures.

Although full site preparation before planting is the best method of controlling brush, you must periodically check to be sure that competing vegetation is under control. You can maintain control of vegetation in several ways: cultivate, mulch, or spray, either singly or in combination with cultivation. In general, it is most economical to use chemical sprays for forest plantations, but be extremely careful to select the right chemical and the right time to apply it. Some selective sprays, if applied either before or after the trees' growing period, kill brush but not trees. Always obtain advice from a licensed pest control advisor before using chemicals.

Animals are a major cause of damage to young trees. Porcupines, gophers, rabbits, deer, cattle, wood rats, and bears are the most frequent sources of damage. Since prevention is better than control, reduce these animals to safe proportions before planting. Fence a small area to exclude deer so you can check the extent of browse damage.

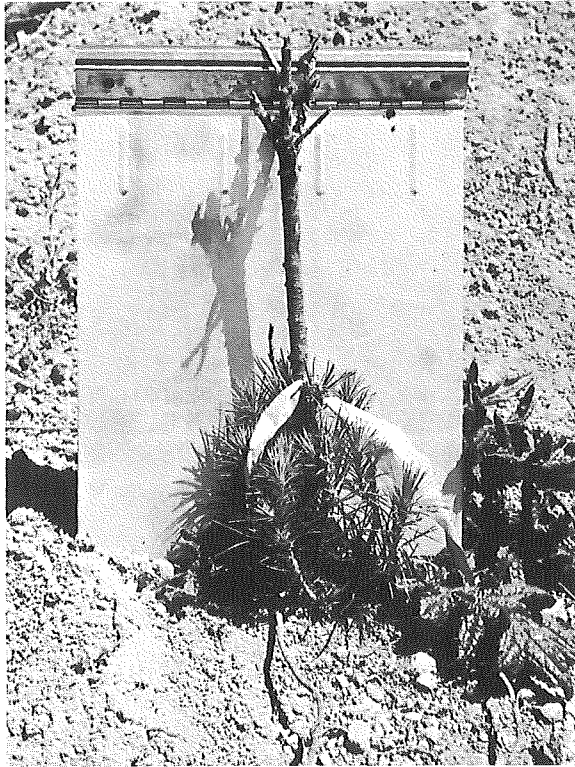


Figure 22. Animals have heavily browsed the top of this seedling, forcing new growth at the base.

While you can fence out cattle, it is probably not worthwhile to plant if the area is in a key winter range for deer. If you remove brush over several acres during site preparation, it will eliminate cover for rabbits until the brush grows back.

Animals can move into an area quickly or build up a large population seemingly overnight. Make periodic examinations for damage; if you take action in time, you can save a plantation. Pocket gophers can often kill trees 5 to 10 years after planting.

DETERMINE THE SUCCESS OF A PLANTING

You can determine the success of your reforestation project only by a systematic followup study of the planted or seeded trees. One method is to examine a select number of trees in representative parts of the plantation and record those dead and the cause of death. Natural reproduction from surrounding seed trees often adds to the number of trees per acre. Do not overlook these trees when judging the success of a plantation.

Use wooden stakes to mark trees selected for the study. That way you can find the planted trees or their remains. If marked, you cannot mistake the planted trees for natural seedlings and your count will be less time consuming. Use stakes at least 2 feet tall, preferably yellow-tipped by dipping in paint, and drive them into the ground so that animals cannot knock them over. Put stakes in rows of 50 to 100 or more trees or seed spots on several representative parts of the area. Have the rows cross the direction of the planting so as to contain the work of all planters and a variety of topography.

After making a tree count, determine the survival percentage. Divide the number of living trees found, or the number of seed spots containing one or more live seedlings, by the total number of trees examined. Example: 50 living trees out of 100 staked trees = $50 \div 100 = 50$ percent survival.

Check trees for survival each year for a minimum of 3 years after planting or seeding. However, it is recommended that you re-examine the staked trees closely and continuously throughout the first summer after planting. If you know *when* the seedlings die, you can learn a lot about *why* they die. Early mortality may be due to poor stock or poor planting techniques. Normal stock may also show early mortality if exposed to excessive heat or dry winds before active root growth takes place.

To determine causes of early losses, you may wish to place a sample of 50 to 100 trees, from the same shipping lot as those planted in the field, in a shady, well-cared-for, heel-in bed. If the sample trees develop normally, you can assume that the seedling trees were unharmed in shipment, but could not withstand the heat exposure because of slow root activity. Carefully heeled-in trees that die may also be an indication of poor handling in lifting, shipping, or storage before placement in the heel-in bed.

Late summer mortality may be caused by heavy plant competition for the available soil moisture, poor planting techniques, small planting stock, extreme exposure, or highly unfavorable weather. There is a special mortality that occurs after fall rains, and a winter mortality at high elevations when the roots cannot meet the demand for water because the soil is frozen.

Some losses will occur in any planting. More than 95 percent survival at the end of the first year is excellent. Most seedling mortality occurs during the first year, but losses may continue for several years.

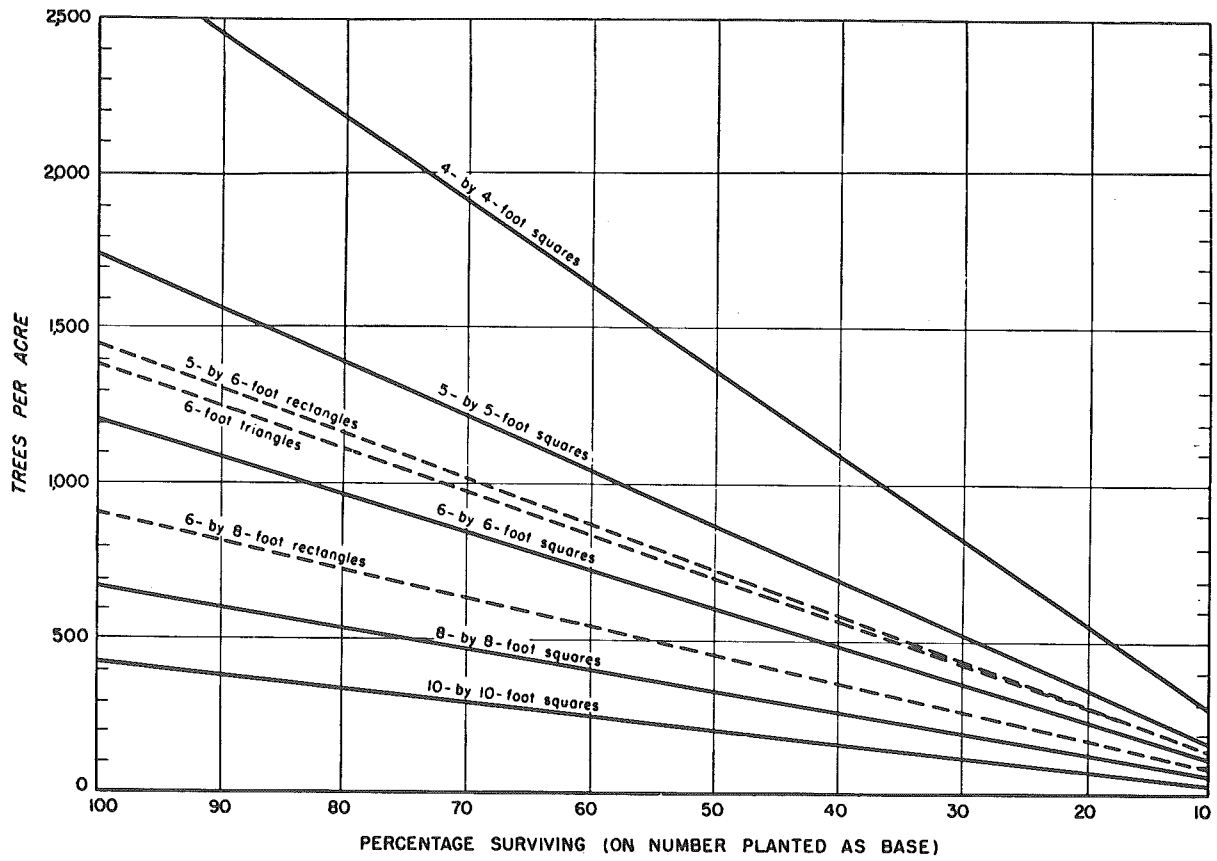


Figure 23. Trees per acre at initial spacings and varying percentages of survival.

APPENDIX 1

TREE DESCRIPTIONS

On the following pages are photographs and brief descriptions of trees commonly planted or seeded in California. Some species are shown as they appear when mature and others are shown as young trees.



Incense-cedar, *Libocedrus decurrens*

Native to the mountainous areas of California at elevations of 1,000 to 9,000 feet. Recommended for general forestry, windbreaks, and erosion control. Mature height is 50 to 150 feet. Leaves are dark yellow-green and scale-like.



Coast redwood, *Sequoia sempervirens*

Native to the coastal area of northern California. Recommended for general forestry. Rate of growth is 1 to 3 feet a year; mature height is 100 to 340 feet. Needles are light green and ½ to 1 inch long. Requires moist sites; cannot tolerate temperatures below 5° F; and does best in coastal areas.



Sierra redwood, *Sequoia gigantea*

Native to the central Sierra Nevada at elevations above 4,000 feet. Recommended for Christmas trees and general forestry. Rate of growth is 1 to 3 feet per year; mature height is 150 to 300 feet. Gray-green needles are awl shaped and $\frac{1}{2}$ inch long. Grows well on moist, well-drained soils in most mountainous areas at elevations up to 8,000 feet; cannot withstand temperatures below -5° F.



Douglas-fir, *Pseudotsuga menziesii*

Native to moist sites in the northern part of the California Coast Range and in the Sierra Nevada. Recommended for Christmas trees and general forestry. Rate of growth is $1\frac{1}{2}$ to 3 feet a year; mature height is 70 to 250 feet. Needles are dark green and 1 to $1\frac{1}{2}$ inches long. Grows in most mountainous areas up to elevations of 5,000 feet.



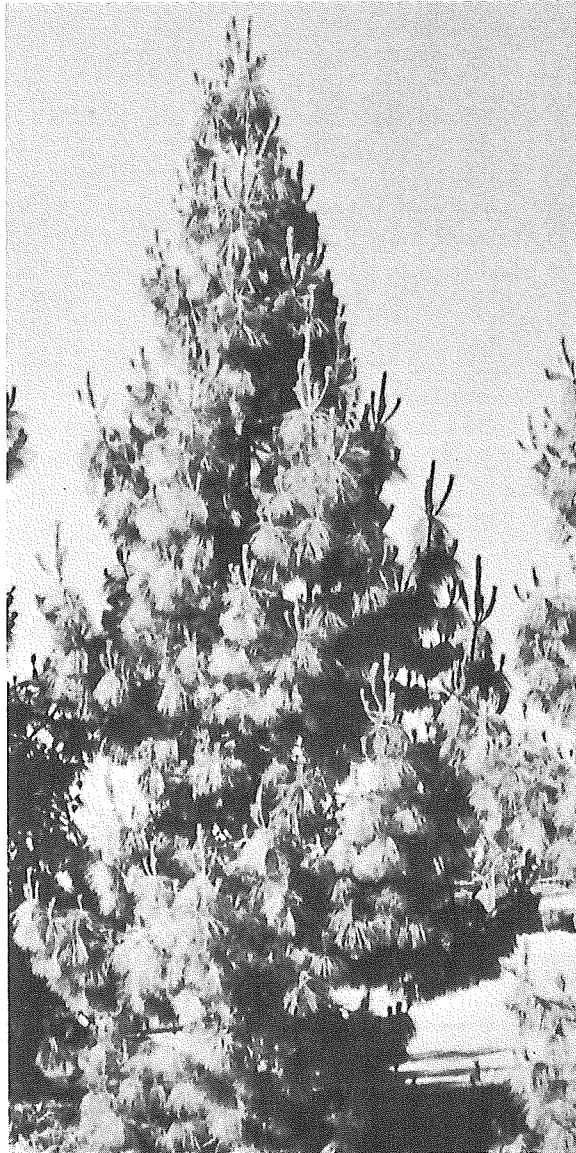
White fir, *Abies concolor*

Native to the interior and northern coastal mountains of California. Recommended for Christmas trees and general forestry. Rate of growth is slow in early years, followed by 1 to 3 feet per year; mature height is 60 to 200 feet. Needles are gray-green to dull green in color and 1½ to 2½ inches long. Planted for timber in mountainous areas of central and northern California at elevations of 2,500 to 6,000 feet; growing range extends to lower elevations for Christmas trees.



Red fir or Silvertip fir, *Abies magnifica*

Native to the interior and northern coastal mountains of California. Recommended for Christmas trees and general forestry. Rate of growth is slow in early years, followed by 2 to 24 inches per year; mature height is 60 to 200 feet. Grayish-green needles are glaucous and ¾ to 1½ inches long. Planted for timber in mountainous areas of central and northern California at elevations of 4,000 to 8,000 feet; growing range extends to lower elevations for Christmas trees.



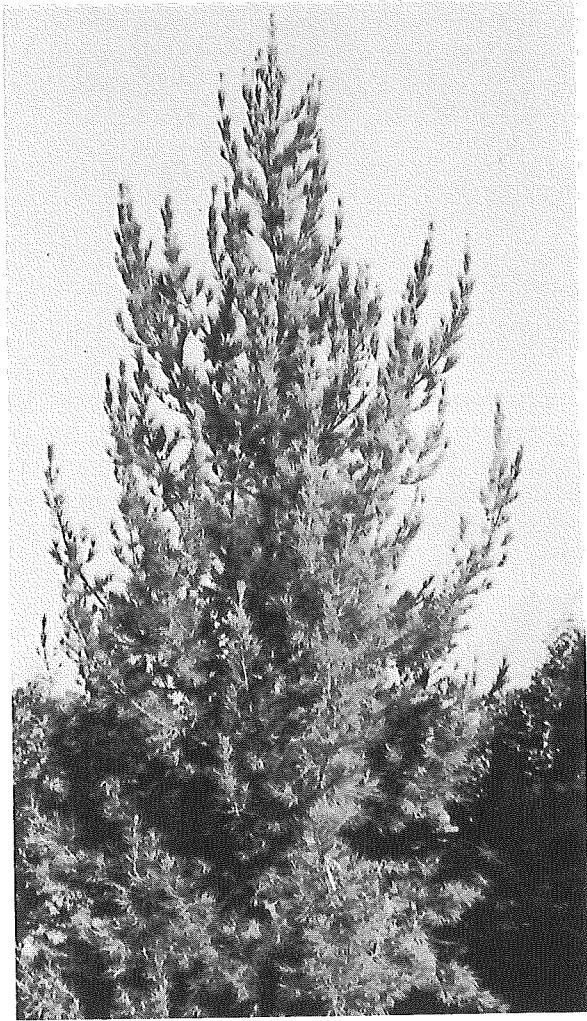
Canary Island pine, *Pinus canariensis*

Native to the Canary Islands. Recommended for erosion control and watershed protection plantings. Rate of growth is 3 feet or more per year; mature height is 60 to 80 feet. Gray-green needles are in threes, 9 to 12 inches long, and in dense tufts at ends of branchlets. Has drooping foliage and slender, spreading branches. Grows in very rocky and dry locations; does not tolerate freezing temperatures.



Monterey pine, *Pinus radiata*

Native to the central coast region of California. Recommended for general forestry and Christmas trees. Rate of growth is 2 to 4 feet a year; mature height is 40 to 100 feet. Dark-green needles are in twos or threes and 4 to 6 inches long. Requires a moist climate for maximum growth; may not withstand temperatures below 15° F.



Brutia pine, *Pinus brutia*

Native to the eastern Mediterranean region. Recommended for windbreaks and erosion control. Rate of growth is 2 to 4 feet a year at elevations up to 3,000 feet; mature height is 65 to 100 feet. Light-green needles are in twos and 4 to 7 inches long.

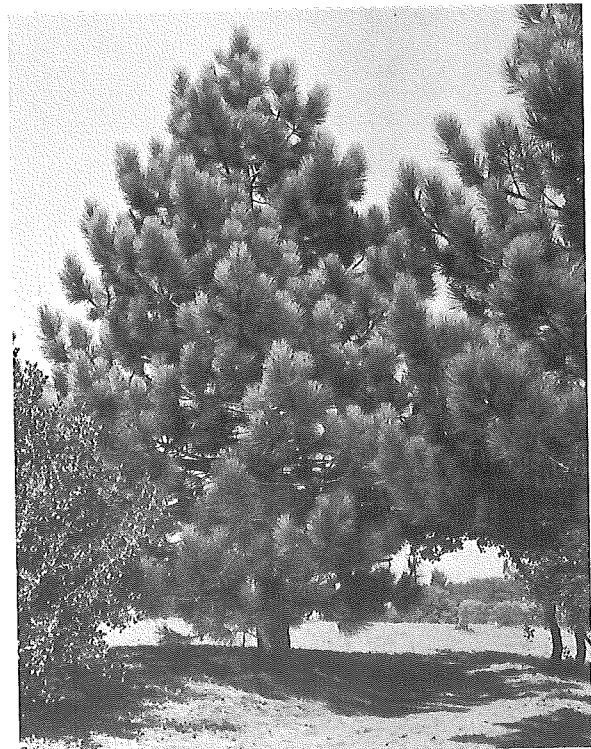
Coulter pine, *Pinus coulteri*

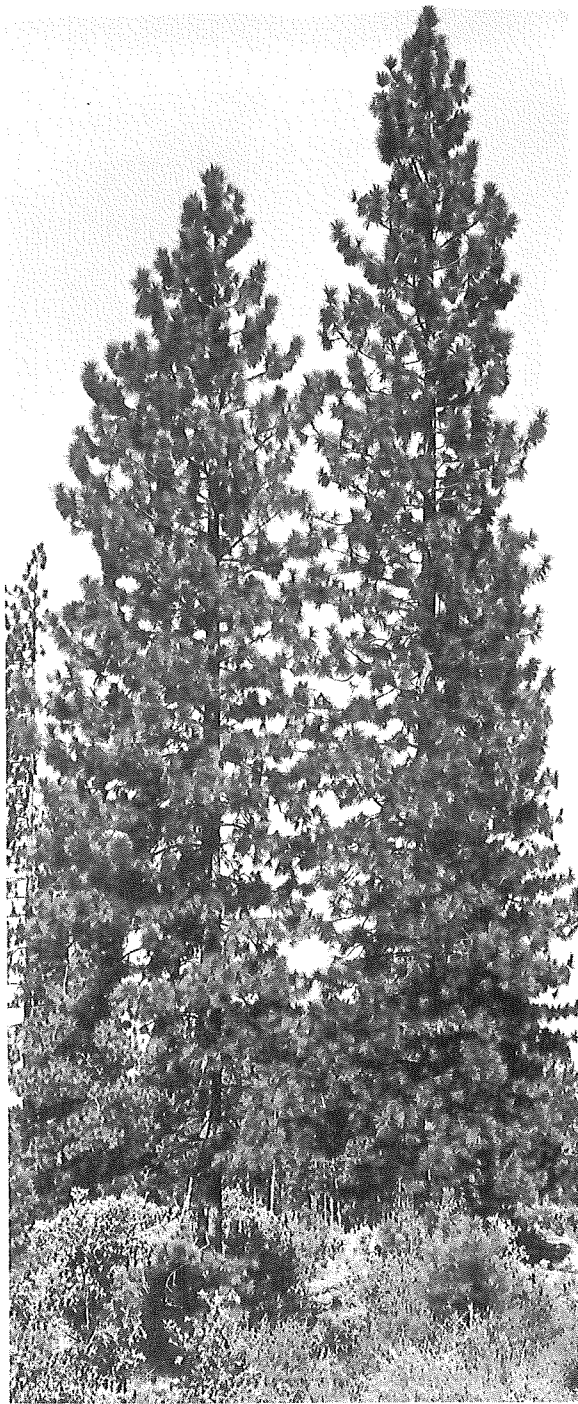
Native to the mountainous areas of southern California up to elevations of 5,000 feet. Recommended for general forestry, windbreaks, and erosion control. Mature height is 40 to 80 feet. Gray-green needles are in threes and 6 to 10 inches long.



Bishop pine, *Pinus muricata*

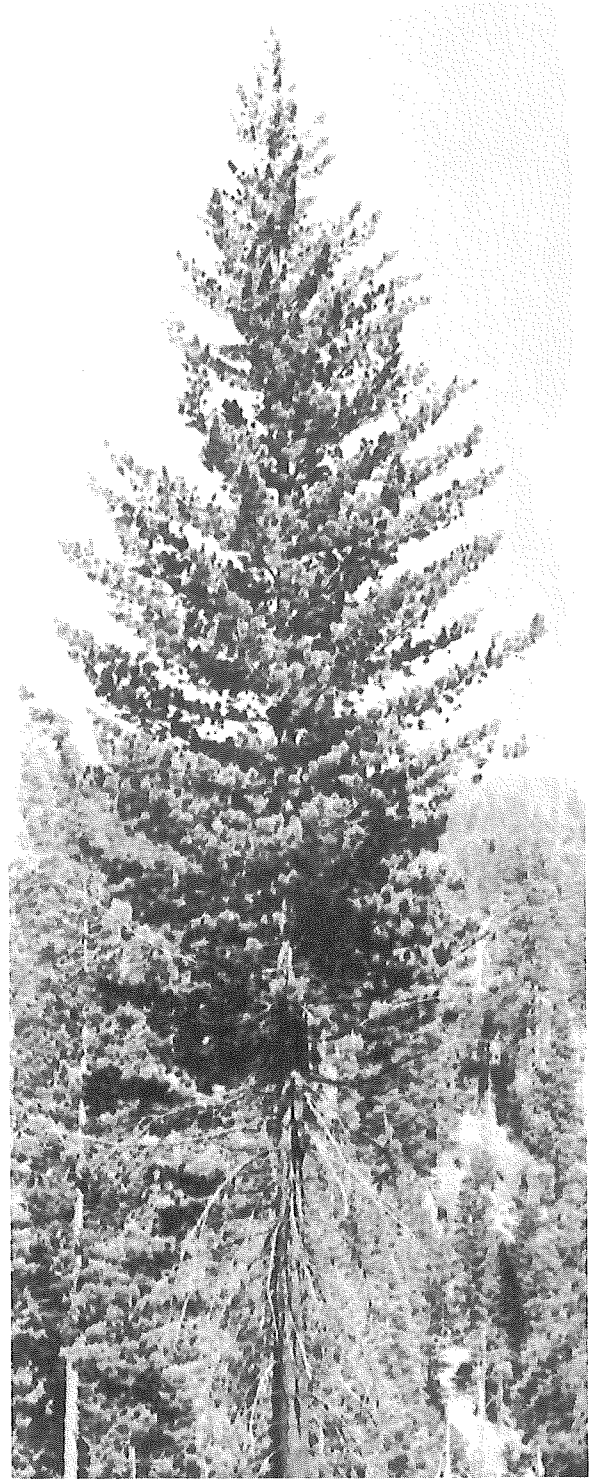
Native to the California coast. Recommended for general forestry and Christmas trees. Mature height is 45 to 75 feet. Dark-green needles are in twos and 4 to 6 inches long.





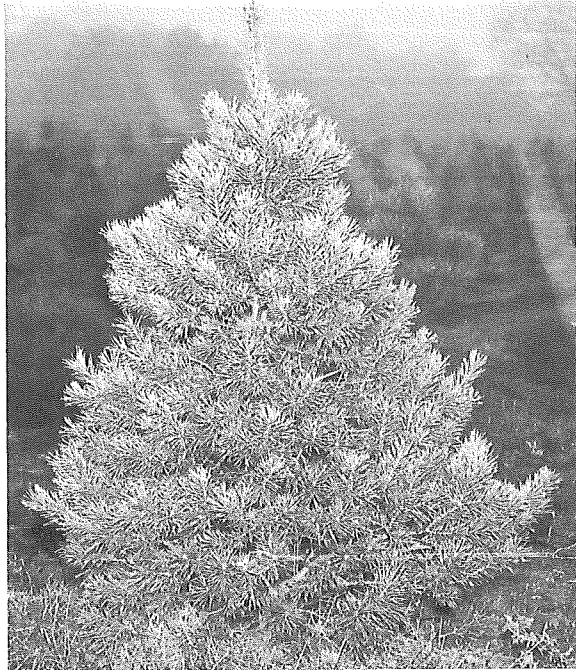
Ponderosa pine, *Pinus ponderosa*

Native to the mountainous areas of the western United States. Recommended for general forestry, windbreaks, and erosion control. Rate of growth is 1½ to 3 feet per year; mature height is 60 to 200 feet. Dark-green needles are in threes and 5 to 8 inches long. Grows in most of the interior mountain areas of California at elevations from 2,000 to 6,000 feet.



Sugar pine, *Pinus lambertiana*

Native to the interior and northern inner coastal mountains of California at elevations of 3,000 to 7,000 feet. Recommended for general forestry. Mature height is 70 to 200 feet. Blue-green needles are in fives and 2 to 4 inches long.



Scotch pine, *Pinus sylvestris*

Native to Europe and eastward to western Asia and northwestern Siberia. Recommended for Christmas trees. Rate of growth is 1 to 3 feet a year; mature height is 50 to 80 feet. Blue-green needles are in twos, usually twisted, and 1½ to 3 inches long. Hardy throughout California; thrives on poorer, sandy soils as well as on better loam soils.



Western redbud, *Cercis occidentalis*

Native to the lower elevations of California. Recommended for planting of public grounds and erosion control. Rate of growth is 2 to 4 feet a year; mature height is 10 to 20 feet. Dark-green leaves are 2 to 4 inches in diameter and heart shaped at the base. Does well on a variety of soils and in most areas of California at elevations up to 4,000 feet.

Russian olive, *Elaeagnus angustifolia*

Native to southern Europe and western Asia. Especially recommended for windbreaks, although it is a deciduous tree; may also be grown for bird and small game sanctuaries, erosion control, and beautification of public grounds. Rate of growth is 3 to 6 feet per year; mature height is 15 to 20 feet. Gray-green leaves are 2 to 3 inches long and somewhat velvety. It is an extremely hardy, drought-resistant species. Grows in a variety of soils, is salt tolerant, and withstands temperatures as low as 0° F, making it possible to plant the species in most regions of California from the desert areas to elevations of 8,000 feet.





Arizona cypress, *Cupressus arizonica*

Native to eastern Arizona and New Mexico. Recommended for windbreaks and erosion control. Rate of growth is 2 to 3 feet per year; mature height is 30 to 40 feet. Leaves are bluish-gray and scale-like. Species is drought resistant and grows in a variety of soils at elevations up to 3,000 feet.



Toyon or California Christmasberry, *Heteromeles arbutifolia*

Native to the chaparral regions of California. Recommended for windbreaks, erosion control, bird and small game sanctuaries, and beautification of public grounds. Rate of growth is 1 to 3 feet a year; mature height is 5 to 15 feet. Dark-green leaves are 2 to 4 inches long and elliptical in shape. Does well in most areas of California up to elevations of 5,000 feet; is quite drought resistant.



Manna gum, *Eucalyptus viminalis*

Native to Australia. Recommended for same purposes as ironbark as well as for pulp wood and erosion control. Rate of growth is 3 to 7 feet per year; mature height is 70 to 120 feet. Dull-green leaves are narrow, lance shaped, and 4 to 7 inches long. In general, species does best on good quality soils, but grows satisfactorily on medium quality soils. Does well in most low elevation sites in California and withstands temperatures as low as 15° F.

Ironbark, *Eucalyptus sideroxylon*

Native to Australia. Especially recommended for windbreaks; also suitable for fence posts and fuel wood. Rate of growth is 2 to 4 feet a year; mature height is 60 to 80 feet. Dark-green leaves are 2 to 3 inches long by ¼ to ½ inch broad. Does well in most low elevation sites in California where temperatures do not drop below 20° F; is drought resistant and can tolerate alkaline soils.



Red gum, *Eucalyptus camaldulensis*

Native to Australia. Especially recommended for windbreaks, but may be used for woodlots; the wood is also suitable for fence posts and fuel. Rate of growth is 4 to 8 feet a year; mature height is 50 to 125 feet. Dark-green leaves are 2 to 4 inches long and vary in shape from oval to elongate. Grows under conditions similar to those of the ironbark and in similar locations.





A fast growing plantation of ponderosa pine where the lower branches have been pruned.



A choose-and-cut Christmas tree plantation located along the north coast of California.

APPENDIX 2

ORDERING FOREST PLANTING STOCK FROM THE CALIFORNIA DIVISION OF FORESTRY

The Legislature of the State of California has authorized the Division of Forestry to produce and distribute tree planting stock. Planting trees contributes to the economic welfare of the state by making idle, inadequately stocked forest lands more productive. For example, trees protect farm lands and watersheds from wind- and water-caused erosion. Tree planting also improves public parks, school grounds, and public streets and highways.

Three nurseries are operated by the Division. They are the Davis Headquarters Forest Nursery near Davis in Yolo County, the Magalia Nursery near Magalia in Butte County, and the Ben Lomond Nursery near Felton in Santa Cruz County.

LAW GOVERNING SALES

State law governs the sale of planting stock from the Division of Forestry nurseries. The law is quoted in part:

Article 2. State Nurseries . . .

4681. Operation of State Forest Nurseries. State Nurseries shall be maintained under the management of the State Forester for the growing of stock for all of the following purposes:

- a) Reforestation of public and private lands.
- b) The planting of trees along public streets and highways.
- c) The beautifying of parks and school grounds.

4683. Stock Distribution. The State Forester may purchase nursery stock and seed, and may distribute stock or seed for public planting or reforestation of public lands, and for the purpose of soil erosion control, watershed protection, farm windbreaks, or the production of

forest products and farm woodlot products on private lands.

4684. SAME: Trees, plants, nursery stock, and seeds which are sold pursuant to this article shall be sold at prices that are established by the State Forester and approved by the Board (Board of Forestry).

According to the requirements of this law, planting stock can be sold only for following purposes:

- reforestation;
- planting along public streets and highways, on public grounds, and for beautification on lands of nonprofit organizations;
- soil erosion control;
- watershed protection;
- farm windbreaks;
- production of forest and farm woodlot products.

No stock can be sold for landscaping and beautification of private land, except when land is owned by nonprofit organizations. Stock cannot be used for commercial sale as nursery stock or for living Christmas trees.

HOW TO ORDER STOCK

Orders for any planting season will not be accepted until after that season's price lists have been released. Price lists are usually available about November 1. Orders are not accepted for bareroot stock after about April 1; for potted stock, after about May 1.

Order blanks and price lists are available from: Davis Headquarters Forest Nursery, 5800 Chiles Road, Davis 95616; the State Forester, Resources Building, 1416 Ninth Street, Sacramento 95814; Division of Forestry Ranger Unit offices; and various Soil Conservation Service, Cooperative Extension, and U.S. Forest Service offices. Those interested in buying planting stock, who qualify under the purposes enumerated above, may order stock by submitting an order blank to the Davis Headquarters Forest Nursery.

Before submitting an order, please read carefully the information contained in the price list.

A period of 3 weeks is required between the mailing of an order to the Headquarters Forest Nursery and the time delivery is desired. This allows time for the order to be processed.

Orders will be accepted as long as suitable stock is available. Refunds will be made for stock no longer on hand unless instructions are given for substitutions. Refunds require 3 to 4 weeks for processing.

Minimum Orders

Bareroot trees are sold in lots of not less than 500, as shown on the price list. All potted stock is sold in lots of not less than 100 trees. In addition, orders for quantities more than the 500 or 100 must be made in multiples of 100.

DELIVERY OF STOCK

Trees are usually shipped to the customer by common carrier. However, stock may be called for at the nurseries after an order and remittance have been filed with the Headquarters Forest Nursery. Requests for a "will-call" date cannot be honored unless 3 weeks have elapsed from the date the order is mailed. After a customer's order

is received, the Headquarters Forest Nursery will notify the customer from which nursery or nurseries the stock will come. Trees cannot be shipped from one nursery to another and, therefore, must be picked up at the nursery growing the class and species requested.

The Magalia Nursery is located 8 miles north of Paradise on the Stirling City Road (Skyway) and 1 mile east on Steifer Road. The Ben Lomond Nursery can be reached by taking the Felton Grade Road west from Felton to the Empire Grade Road, then north 6 miles on the Empire Grade Road. The Davis Headquarters Forest Nursery is located 10 miles west of Sacramento on Interstate Highway 80.

Prices are f.o.b. the nurseries. *All trees that are shipped are sent shipping charges collect.* Unless another type of carrier is designated, shipments will be made by truck lines because conditions by truck transportation are usually more favorable for trees.

Nurseries are not responsible for losses of stock caused by damage in shipment, delays in transit, or any other form of poor handling after leaving the nurseries. If such losses occur, claims should be made against the shipping carrier.

Shipments of trees will have an attached certificate indicating that the trees are free from inspection at destination.

APPENDIX 3

SOME VENDORS OF FORESTRY EQUIPMENT AND SUPPLIES

The Ben Meadows Company
3589 Broad Street
Atlanta, Georgia 30366

Conservation and Engineering Supply Company
P.O. Box H
Chester, California 96020

Forestry Suppliers, Inc.
P.O. Box 8397
205 W. Rankin Street
Jackson, Mississippi 39204

NASCO, Inc.
1524 Princeton Avenue
Modesto, California 95352

Owen Boat Works (Hand seeder)
1478 Orchard Home Drive
Medford, Oregon 97501

Santa Rosa Manufacturing Company
715 McGlincey Lane
Campbell, California 95008

Western Fire Equipment Company
40 West Valley Drive
Brisbane, California 94005

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CALIFORNIA'S CONSULTING FORESTERS

You can obtain names of consulting foresters who are members of the Association of Consulting Foresters by writing to:

Association of Consulting Foresters
P.O. Box 6
Wake, Virginia 23176

or

Association of Consulting Foresters
209 Standby
Ukiah, California 95482
(707) 462-5958

A list of all Registered Professional Foresters in California is available for \$1.00 from:

State Board of Forestry
Professional Foresters Registration
1416 Ninth Street
Sacramento, California 95814

NOTE: Not all registered foresters work as consultants.

LOCAL CONTACTS

For information on individuals to contact locally, write to:

Extension Forester
163 Mulford Hall
University of California
Berkeley, California 94720

Regional Forester
U.S. Forest Service
630 Sansome Street
San Francisco, California 94111

State Forester
California Division of Forestry
1416 Ninth Street
Sacramento, California 95814