Regenerating a Forest

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There are few things more satisfying than visiting a forest stand that you had a hand in regenerating. Many forest landowners like the thought of planting trees. Some enjoy the hard work that is involved. Others prefer to hire an experienced crew. If you are regenerating a forest, you want your efforts to be successful the first time. This article will help you understand what is involved in forest regeneration.

The California Forest Practice Act requires that landowners regenerate their forest following a timber harvest. The regulations of the Forest Practice Rules require that a stand have a minimum number of trees within 5 years following harvest. Compliance is monitored by a California Department of Forestry and Fire Protection (CDF) inspector. The exact rules vary by region and site. Planning before harvest will go a long way towards reducing costs and securing adequate regeneration quickly.

The silvicultural systems used for harvesting a stand are a means to regenerating that stand. Stand regeneration is an important consideration when planning any forest management activity. Securing rapid regeneration prevents erosion and shortens the total time from establishment of the stand to harvesting. Any costs incurred establishing the stand must be carried to the harvest which is 40 to 70 years after planting. Since this exceeds the time most people have ownership of their land, factors such as improved property value, visual appeal, environmental protection, and wildlife habitat need to be considered.

New tree seedlings to regenerate a forest stand can be secured in two ways, namely, naturally or artificially.

Natural regeneration comes from seed produced by the trees left in a seed tree, shelter wood, or selection harvest, or from trees bordering a clear cut. Another source of natural regeneration is sprouts from stumps or roots. In California, certain oaks and redwood are effective sprouters. Many brush species and weed trees such as tanoak and madrone are vigorous sprouters that may inhibit regeneration of desirable trees. Natural regeneration is the least expensive option for the landowner and should be encouraged whenever possible. Natural regeneration requires seed production, successful germination, and seedling growth. Artificial regeneration reduces the risk of a poor seed year or poor conditions for germination by using large, hardy 1- to 2-year-old seedlings.

Artificial regeneration requires the landowner to sow seed or plant seedlings to regenerate the stand. Artificial regeneration is used when natural regeneration fails or is inadequate to establish a stand, to change species composition, to establish a stand of genetically superior trees, or to give the young trees a better chance of competing against brush, grass, animals, drought, or the myriad of other things lurking at the soil level.

Getting Ready - Site Preparation

A seedling faces a great number of difficulties on its way to becoming a tree. There is the constant threat of rodents or rabbits gnawing it, deer or livestock may browse or trample it, or frost action may heave it from the soil. Seedlings are susceptible to being burned, drowned, shaded, or starved. Seedlings, whether they are artificially planted or come from naturally germinated seed, need all the help you can give them.

Consider every likely threat to the new regeneration and try to minimize it. Posting the area, fencing out livestock, and removing brush piles that harbor rabbits and rodents are all techniques that will help seedlings survive. The greatest challenge, however, is making sure that the seedlings get their full share of soil moisture and nutrients. This is especially critical in California with its Mediterranean climate characterized by long, rain-free summers. Soil moisture is severely limiting under these conditions.

Site preparation is an essential first step in limiting the competition that a seedling will have to face in its first years, which are most critical to survival. Without adequate site preparation your entire planting investment might be lost. The objective in site preparation is to reduce the competition that the seedling faces by removing as much brush and grass as possible. Site preparation will also take into account potential animal damages by removing shelter or cover or food sources for animals. Site preparation is required to prepare a seed bed that will favor good seed germination in natural regeneration systems. All site preparation must minimize loss of valuable topsoil through erosion or removal to windrows.

Studies have shown that neglecting site preparation in California leads to losses of seedlings ranging from 40 percent to nearly 100 percent in many cases. With good site preparation and proper planting techniques, a landowners can expect less than 20 percent seedling mortality.

Management of competing vegetation does not necessarily end after planting. When brush is especially vigorous, you may have to repeat some treatments, either by hand or with machines to ensure survival. Every planting effort should be followed by a regeneration survey. To do a regeneration survey, a landowner visits new planting sites as often as possible to determine if any follow-up work is needed. At a minimum, the site should be inspected at least once a year for the first three years following planting. Remedial treatments to remove competing brush may be necessary. The Forest Practice Rules require the owner (or owner's agent) to submit stocking reports following a harvest until the harvested stands achieve required stocking levels.

Planting trees is a major investment in your property. This investment is reflected by the land value within five years after planting, assuming that regeneration is successful. Potential buyers are willing to pay more for land that has been successfully regenerated. It is in your best interest to assure success of planting with adequate site preparation, use of proper planting techniques, and careful follow up with regeneration survey and remedial treatments.

Mechanical Preparation: Various devices attached to a bulldozer or farm tractor are used for mechanical site preparation.
Brushy areas may require crushing, chopping, or brush raking the woody vegetation with high-powered equipment. Logging residue, called slash, must be cleared from the planting site to facilitate planting and weed control activities and to minimize fuel loads and fire risk. Brush rakes are a specialized type of blade mounted on a tractor or crawler used to uproot and push brush and logging debris into piles (called windrows) to rot or be burned. With a careful operator, very little soil is scraped up with a brush rake, helping to maintain soil productivity.

Unburned windrows may serve as habitat for small animals. Depending on landowner objectives this can be an asset or liability. Landowners that wish to encourage wildlife, such as quail or rabbits, might want to leave the windrows. This is likely to result in some seedling loss, mainly from small rodents.

Controlled Fire: Used with care, controlled fire is an inexpensive method to reduce logging debris (called slash) or large brush buildups to allow access for planting crews. Controlled burning also reduces fire hazard by using up fuel. Burning alone may not be effective for complete site preparation. Fire encourages the regeneration of some undesirable shrub species. Seeds of some species can remain dormant in the soil for 40 years or more. Fire breaks seed dormancy and allows the shrubs to quickly occupy a burned area. Post planting treatment of brush might be necessary on some sites.

Fire may also have undesirable effects on physical and chemical soil properties. With an intense burn, soil nutrients may be lost. The soil may become less permeable to water; that is, water will run off the surface causing erosion rather than being absorbed into the soil to be used by the roots. This, combined with a lack of plants to hold the soil, increases the chance for serious erosion and lessens the chance for a plantation's survival.

A professional forester and local fire officials must be consulted before attempting controlled burning. Controlled burns require a fire permit along with a plan to control the fire should it escape. You may be required to submit a plan that describes which direction that you expect the smoke to go. This is known as a smoke management or air

pollution control plan. The landowner may be held liable should the fire escape. You may be legally responsible for all damages and suppression costs related to an escaped fire.

While there are some negatives involved in using fire as a site preparation tool, used carefully fire can be highly effective and very cost efficient. Fire is the tool of choice for site preparation in many commercial operations.

Chemical Site Preparation: Herbicides are used to reduce competition from weeds, especially in follow-up treatments. They are often the most cost-effective site preparation method for large areas. Herbicides can be sprayed over large areas quickly from the air or more slowly but under closer control from the ground.

Using the correct herbicide, at the proper rate, and at the right time are important considerations. By federal law, every herbicide must be registered with the Environmental Protection Agency. The regulations require that all herbicides be labeled with proper use and warning information that tells the user how to safely and effectively apply the product. You are required by law to **READ AND FOLLOW THE LABEL** instructions. Your county agricultural commissioner can provide you with information on the registration of different chemicals used in the forest and any legal considerations that may apply.

Artificial Regeneration

The choice in artificial regeneration is between direct seeding and planting.

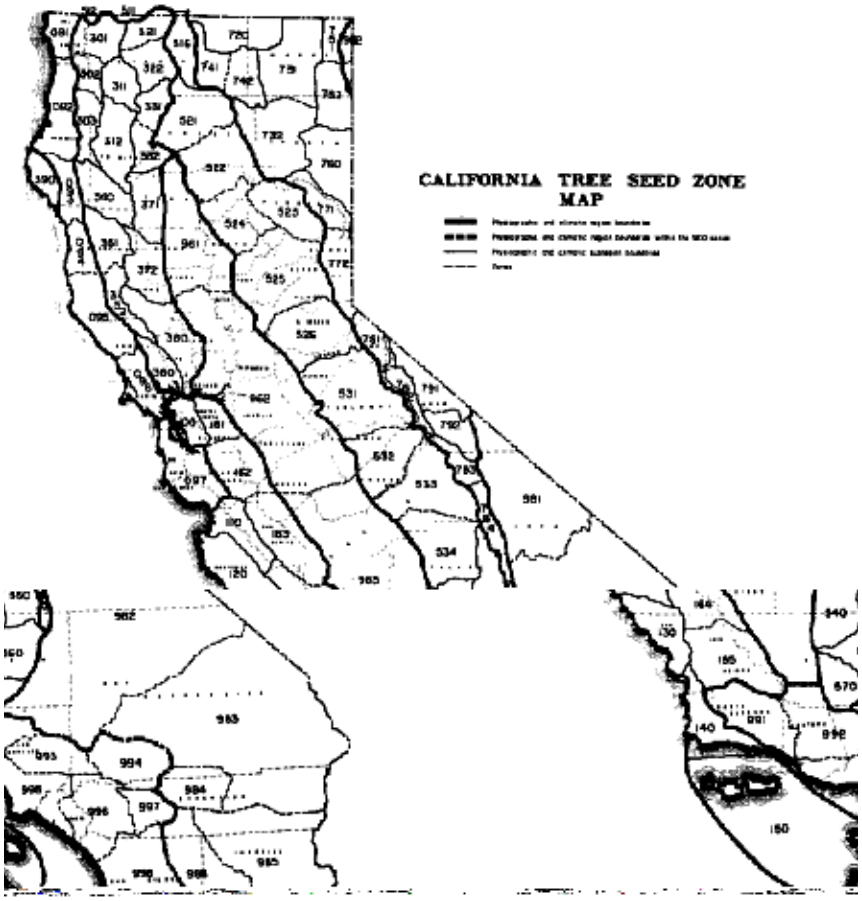
Direct Seeding: Direct seeding has the advantage of lower initial costs than the purchase of seedlings. A major disadvantage is that seedling spacing may be highly irregular. Some areas may have poor survival leading to understocking, while other areas may have exceptional survival leading to overstocking. Losses of seeds and seedlings due to animals are common. Another disadvantage to seeding is the extra time it takes for the seeds to germinate and grow. Young trees grown from seed are much more susceptible to weed competition than planted seedlings. Planted seedlings have an early height advantage over competing weeds.

Both broadcast seeding, spreading seed over the entire area, and spot seeding, placing seed at specific sites, have been occasionally effective in California. However, animals, insects, drought, freezing, heat, and fungi have all taken their toll on seeding operations. Successful seeding operations are always accompanied by good site preparation and animal control practices.

Planting: The most consistently successful artificial regeneration method applied in California has been planting seedlings. Spacing, species, and genetic composition can be controlled. Planting reduces the time from harvest until the establishment of a new stand. The key to planting success is proper planning. Planning needs to start about a year in advance of the actual planting.

Stock Selection: When picking planting stock, it is usually recommended to choose species that are already growing on the site or nearby. Seedling survival depends on how well the seedling is adapted to the site it is planted on. Adaptability depends on elevation, aspect, available moisture, and local soil conditions.

The California Department of Forestry and Fire Protection (CDF) has established tree seed zones for the state. These zones match seed and seedlings to local conditions. The seedlings selected should come from the same tree seed zone and same elevation as your planting site. The CDF Nursery at Davis can supply you appropriate seedlings by knowing the county, nearest town, and elevation of your planting site. This information is provided on a nursery order form which you can obtain from your local CDF office. Large (10,000+) orders for seedlings can usually be contracted 1 or 2 growing seasons in advance of planting, depending upon the type of stock being ordered.



Two types of seedlings are available - bare root and containerized. Bare root seedlings are grown outdoors in a nursery bed. They are harvested by carefully lifting the seedling from the nursery bed. The bare roots of the seedlings are kept moist with a material such as sphagnum moss or wood shavings called shingle tow until planted.

Nursery catalogs list bare root planting stock as 1-0, 2-0, 2-2 or some other combinations of two numerals. The first numeral refers to the number of years the tree spent in a seed bed. The second numeral is the number of years the tree spent in a transplant bed. Therefore, 2-2 stock is 4 years old. Trees that come directly from a seed bed (1-0, 2-0, 3-0) are called seedlings. Those that come from a transplant bed are called transplants. A rule of thumb is to use transplants on harsh sites and seedlings for easier sites. Transplants cost considerably more because it takes more time and labor to produce them.

Planting stock should be evaluated when received from the nursery. Trees must be dormant. The buds should be firm with no evidence of new growth or shoot elongation. White root tips should be less than 1/4 inch. Mold or a sour odor suggests improper storage. Strip back the bark of the stem and root system on a couple of trees. The inner bark should be moist and glistening white. If they are yellow, brown, or have brown spots, the stock is badly damaged and has little survival potential.

Proper care of your planting stock will increase their chances for survival. Keep the roots moist, and the trees cool (between 32° and 36° F). Plant as soon as possible after receiving your seedlings. If you must store the trees more

than 3 days, heel in your seedlings by planting them temporarily in a trench in a cool, shaded place. You can store the trees this way for 7 to 10 days.

The second type of seedling is known as containerized seedlings. The seed is germinated and grown in a plastic container filled with a special soil mixture. Containerized seedlings are usually produced in a greenhouse where careful control of the environment can be maintained. These seedlings can be planted during the growing season because their roots remain encased in the growing medium. Bare root nursery stock must be planted while dormant to avoid damage to the roots.

Containerized seedlings are usually more expensive than bare root stock; however, they can be grown in a shorter time, 4 to 8 months, thus reducing the lead time involved in the planning process. Containerized seedlings may be easier to plant in rocky soils where it is difficult to open a hole for larger bare root seedlings. Evaluation of containerized stock is similar to bare root stock except that container stock does not need to be dormant.

Timing: The best time to plant varies with the type of planting stock, soil condition, climate, and your location in the state. Before planting, the soil moisture should be at field capacity to a depth of at least 12 inches. Field capacity is the maximum water the soil can store against the force of gravity. This will require about 2 inches of rainfall for most timber soil types. The soil temperature at 3" depth should be at 40° F or higher, and on a warming trend. These moisture and temperature requirements are essential for root growth to occur.

Many landowners report best survival when seedlings are planted during a light rain or drizzle. Avoid planting during extended warm and dry periods, or when frost or extreme winds are likely. At higher elevations, plant when the snow is gone, and the chance of frost is minimal.

In the Sierra Nevada, Northern California, and the eastern side of the Coast Range, planting conditions are usually optimum in late winter to early spring. On the warmer west side of the Coast Range, planting can begin as early as late fall, once the rains have saturated the soil and can continue through to late winter.

Stocking and Spacing: The number of seedlings to plant depends on the size of the planting area and the spacing you will use. Spacing is a function of the products that you expect to harvest (landowner's objectives). Timber is usually grown at spacings from 8 by 8 feet (680 tpa) to 12 by 12 feet (300 tpa). Closer spacing is necessary if poor survival is expected. Christmas trees are planted closer, commonly 5 by 5 feet (1240 tpa) or 6 by 6 feet (1210 tpa). Eucalyptus for firewood is planted at 6 by 6 feet (1210 tpa) to 7 by 7 feet (890 tpa).

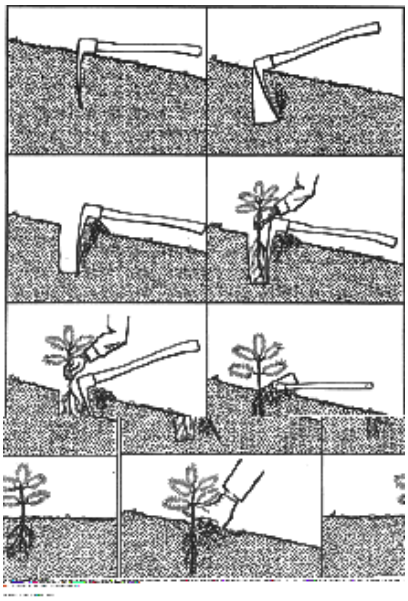
The following steps will help you determine the number of seedlings you will need:

- Calculate the number of square feet per tree from the spacing. For example a 10 by 10 feet spacing equals 100 square feet per tree (10 X 10=100).
- Next divide the number of square feet in 1 acre (43,560) by the number of square feet per tree. Example 43,560 sq. ft. per acre/100 sq ft. per tree = 435.6 trees per acre.
- Finally multiply the number of trees per acre by the number of acres in your planting area to get the total number of trees you will need to order. Nurseries usually sell trees in lots of 100 or 500 trees so round up the number that you need.

Nurseries need to plant at least a year in advance, so determine your planting needs early – another reason for stewardship planning – and send in your order.

Calculating Number of seedling required:			
Figure square feet per tree when the spacing is	10	feet	
by	X 10	= 100	sq. ft.
Divide by square feet per acre	÷ 43,560	= 435.6	trees per acre
Multiply by the number of acres you are planting	X 20	8,712	trees needed

Planting Techniques: Various hand and power tools and machines are used for planting. Planting bars, hoe-dads (also called a western planting tool) and mattocks are used with easily worked soil. The hoe-dad is generally the most effective in rough terrain with rocky soils. Power driven augers are used to dig holes in compacted soils or soils with a hard pan. Planting machines are limited to fairly level sites with careful site preparation. These machines are cost effective only when planting large areas.



Whichever technique is used, care of seedlings is paramount in importance. The roots should always be kept moist, with no more than 3 hours worth of stock in the planting bag at one time. The seedling should be planted erect at the depth it was planted at the nursery. The roots should be properly placed, making sure they are pointing downward in the planting hole. Kinked roots or roots planted in a "J" shape will strangle themselves in a few years. Air pockets around the roots should be eliminated by firming the soil around the roots.

All planting should be followed by regular regeneration surveys. You should check for survival and plan for any replacement trees. Assess the need for releasing the trees from competing vegetation. Regeneration surveys should be completed after the first and second year at least and every other year until year ten.

Release from competing vegetation is commonly done by hand or herbicides. Hand work is hard work that may be financially viable on small areas. Safety is an important consideration. Working with sharp tools or machines on steep sites can be dangerous, especially when one is unaccustomed to strenuous activity. Herbicides are an attractive

alternative when treating large acreages. They are safer to use than hand methods, are relatively less expensive, and often more effective. The choice is up to the individual landowner.

Planting represents a large investment that is carried over the life of a stand. A successful plantation increases the value of your property to potential buyers. It is in your best interest to:

- Plan regeneration operations carefully.
- Prepare your planting site.
- Take proper care of your planting stock.
- Closely supervise your planting crew.
- Follow through with regeneration surveys indicating replanting and brush maintenance where necessary.

The success of your planting effort depends on each of these steps. Your planting operation can only be as successful as the weakest link of these 5 steps.

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