

Chapter 3: Planning a Reforestation Project

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Table of Contents

Introduction and Flow Chart	3
Developing and Implementing a Plan: The Essential Steps in a Successful Reforestation Project	3
Initiate a Reforestation Project	5
Identify an Experienced Reforestation Forester/ Silviculturist	5
Define Project Type	6
Define Goals & Develop a Funding Strategy	6
Forest Management Plans.....	7
Confirm Availability of Appropriate Seed	8
Perform a Site Assessment	9
Define Specific Objectives	9
Wildlife and Wildlife Habitat Objectives.....	10
Tree Density Objectives	11
Fuels Objectives	12
Describe Desired Planting Conditions and Outcomes	12
Develop Prescription and Schedule of Activities	13
Develop Budgets	13
Implement Reforestation by Project Type	14

Identify Necessary Permits	14
Green Timber Harvesting and Salvage Harvesting Permits.....	14
Water Quality, Fish and Wildlife Permits.....	15
Pesticide Application Permits.....	16
Burn Permits and Plans.....	16
Obtain Appropriate Seed	17
Order Seedlings and Identify Cooler Storage.....	17
Pre-harvest Vegetation Management Spray and Contractor Selection.....	18
Coordinated with Harvest Operations.....	18
Find Site Prep Contractors	19
Site Preparation for Vegetation Management.....	19
Mechanical Site Preparation.....	19
Manual Site Preparation.....	19
Burning Site Preparation.....	20
Vegetation Management-Chemical Site Preparation.....	20
Request Timing of Seedling Packing and Delivery.....	20
Find Planting Contractors.....	20
Obtain Seedling Delivery	21
Plant Seedlings (or store seedlings for later planting).....	21
Post-Planting Follow-up /Monitoring.....	21
Year 1-5 Survival and Release Sprays after Planting to Control Competing Vegetation	21
Monitor for Insect, Disease and Animal Damage and Treat as Needed	22
Perform Pre-Commercial Thinning (PCT).....	22
Perform Pruning and Other Fuel Reduction Treatments	23
Document Lessons Learned	24
Project Schedule of Activities: Some Examples.....	24
Example 1: Post-Timber Harvest (Spring Planting) Schedule of Activities.....	24
Example 2: Post-Wildfire Project Schedule of Activities.....	25
Example 3: Rehabilitation Project - Brush Field Conversion Schedule	26
Summary.....	31
Acknowledgements	31
References.....	31

Introduction and Flow Chart

Successful reforestation in California is a complicated undertaking spread over multiple years. The planning process detailed in this chapter will help guide landowners, land managers, and reforestation practitioners through the myriad of steps necessary to meet their reforestation project goals. **It is important to realize that each step serves a specific purpose essential to the success of the project; failure at one can result in the reduced success or failure of the whole project even if all others are properly implemented.** Therefore, in all situations, the critical approach is to think through and plan out all the steps while being prepared to adjust the plan for unexpected complications, delays, or failures of the discrete steps. These basic steps are the same whether you are a small landowner, large landowner or a public agency, though slight modifications may be needed depending on project type and purpose. The three basic reforestation project types (and purposes) to be addressed in planning are: 1) post-harvest, 2) post-wildfire, and 3) rehabilitation / restoration.

Connecting the many reforestation activities that will occur over a number of years is also key to eventual success. To represent this process, the following Reforestation Flow Chart (Fig. 3.1) presents an overview of the necessary steps for each of the basic project types. In the sections that follow the chart, each of these steps is explained and references to the later chapters are offered where each practice is explained in more detail. The last section of this chapter offers “Schedule of Activities” spreadsheet examples of each of the three basic project types, with common details about the timing and interactions of the different steps. These examples are for general reference, as each project will need its own timeline based on the specific site where it is to be implemented.

Developing and Implementing a Plan: The Essential Steps in a Successful Reforestation Project

This chapter outlines the essential steps of reforestation planning and will guide readers through the complex process of forest establishment. Each section described a crucial step towards the ultimate goal of reforestation. References to other chapters in this manual are included where more detail is required.

Chapter 3: Planning a Reforestation Project

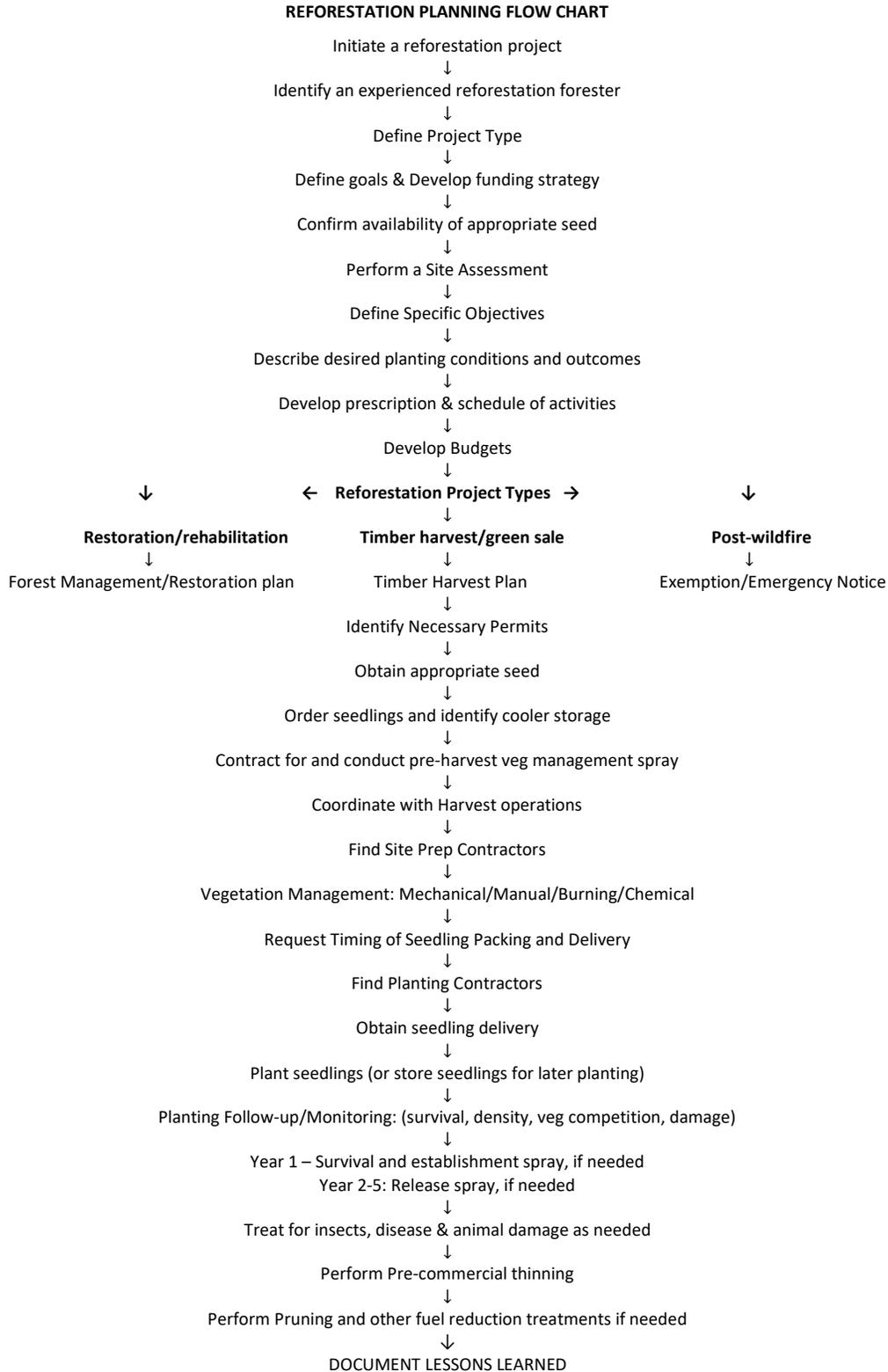


Figure 3.1 Reforestation flowchart outlining the necessary steps for each of the basic project types.

Initiate a Reforestation Project

Reforestation projects in California are implemented by a diverse range of forest landowners. These ownerships cover everything from highly productive timberlands to non-commercial forests with mostly aesthetic and wildlife values and include very small private woodlands to very large public and private forests. For all landowners, the decision to initiate a reforestation project begins with the desire to accelerate positive changes in the forest that they own or manage. Often this decision is forced by timber harvest or by a wildfire. Despite the differences in motivation and objectives, the best management practices (BMP's) outlined in this chapter and described in detail within this book will lead to a successful reforestation project.

Identify an Experienced Reforestation Forester/ Silviculturist

The administrative and biological steps outlined in the flow chart above (Fig 3.1) must be executed in a timely manner. It is advantageous to seek the services of a forester with expertise in reforestation. Large private ownerships often have a professional reforestation staff or consultants under contract while small landowners may have an on-going relationship with a local Registered Professional Foresters (RPF). Within the private sector RPFs are licensed by the California State Board of Forestry and Fire Protection (BOF). Contact CAL FIRE for a list of RPFs in the project area (CFIP list will have better chance of finding foresters with reforestation experience): <https://bof.fire.ca.gov/projects-and-programs/professional-foresters-registration/rpferm-rosters/>. Federal agencies will have reforestation specialists within their organizations and sometimes may need to contract out for specialized skill sets.

Landowners should be aware that not all RPFs are experienced in reforestation due to differences in specialization and previous work experience. An RPF experienced in preparing and administering THPs or salvage logging contracts after a fire may not necessarily be the best choice for the subsequent reforestation project. The following considerations will help identify an RPF with expertise in reforestation:

- What reforestation projects have they done and how successful were these projects? Consider visiting some of the project sites.
- Ask for references from other landowners the RPF has worked with.
- Ask if they keep up with the most current reforestation practices? There are many opportunities for foresters to improve their reforestation skills. Attending reforestation conferences such as the Forest Vegetation Management Conference (FVMC) and the California Forest Pest Council (CFPC) Summer Weed Tour are excellent opportunities. These groups also help members network with other reforestation specialists.

- Does the forester have other licenses pertinent to reforestation? A forester with a Pest Control Advisor (PCA) license or a Qualified Applicators License (QAL)/Certificate (QAC) can make pest control recommendations or administer pesticide application contracts.
- If both harvest and reforestation activities are planned, consider hiring a firm or individual that is experienced with both.
- If different RPFs are chosen to manage the harvest and the reforestation effort, can they communicate with each other and coordinate activities as needed?

Define Project Type

Reforestation projects normally fall into three types; 1) Timber harvest: planting after a green timber harvest, 2) Wildfire: planting after a wildfire, 3) Rehabilitation or restoration: brush field conversion or reclaiming a site from exotic or invasive species. While each project type has its own characteristic needs and challenges, most projects need to follow the sequence of steps along the similar paths as shown in the Flow Chart. Different project types will have different timing constraints based on the status of the competing vegetation and the time needed to order the appropriate seedlings. Detailed schedule of activities for each of the three scenarios are described in the Schedule of Activities at the end of this chapter. More detailed information on different examples of project implementation is provided near the end of this chapter.

Define Goals & Develop a Funding Strategy

After the project type is determined, the goals of the landowner for the property need to be identified. A goal is a broad, general statement of intent that tends to describe a long-term vision. Examples include: produce income; enhance wildlife habitat; protect soil and water resources (OSU Extension, 2018). The US Forest Service’s reforestation program has four major goals, such as “to improve the quality and yield of the timber resource” (USFS 2019). This goal-setting step is also essential to identify the relevant funding necessary to implement a project. Specific objectives to reach these goals should be developed after the site assessment phase when more details are known about the property.

Reforestation is an expensive long-term investment, as described in Chapter 2, “Investing in Reforestation”. Acquiring the funding needed to complete the many steps of a multi-year project can be challenging, particularly for small landowners. Be aware that under-investing in necessary activities such as vegetation control and seedlings and planting will result in failure, or the need for additional, even more expensive, work to salvage the project. Identifying and pursuing the relevant financial grant assistance for reforestation activities from state and federal cost-share programs, when needed and available, is an important early first step. Grant approval can take anywhere from a couple months to

Chapter 3: Planning a Reforestation Project

more than a year after an application is received. It is important to plan for the reality that the timing of funding may not always coincide with climatic or biological windows that may dictate timing of each step.

Large landowners usually finance the project with a portion of the net income from the sale of forest products from the project acres and other private investment funds. The forester will need to document the plan and budget necessary for a successful reforestation project to get the necessary initial funding. The reforestation team will need to submit expense requests for inclusion in annual or multi-year budgets. For government agencies including the USDA Forest Service and the California Department of Forestry and Fire Protection (CAL FIRE), funding must be allocated from the general fund through spending bills from Congress or the State Legislature. A first step for an agency forester is to get the project listed (i.e., justified and internally approved) in the annual budget request for relevant programs (e.g., USFS's Vegetation and Watershed Management Program, federal Reforestation Trust Fund). It may be several years before the funds actually become available for use or disbursement for work already completed. A significant backlog in reforestation needs on federal lands is occurring as a result of the huge increase in acreage burned by wildfires, and administrative obstacles to salvage logging, and controlling competing vegetation.

Forest Management Plans

A written Forest Management Plan for a private property (or a unit of public agency land) can help guide reforestation planning in several ways. The geographic scale is usually the entire landowner's forest property, while the time scale provides a planning and expenditure horizon of at least 5 years with goals and objectives looking out over a much longer period. The plan will include much of the site assessment information relevant to long-term forest management that is also valuable for a successful reforestation project. A completed forest management plan will speed up the prescription process needed for reforestation planning.

A management plan can also facilitate reforestation funding, as described in more detail in Chapter 2. CAL FIRE requires a Forest Management Plan as a condition of receiving cost-share grants from the California Forest Improvement Program (CFIP), with 90% funding available to prepare the plan by an RPF for projects following a disaster such as a wildfire. Similarly, the Natural Resource Conservation Service (NRCS) asks that a conservation plan be done as a condition of its Environmental Quality Incentives Program (EQIP) grants, while the US Forest Service requires a plan for funding from its Forest Stewardship Program. The California Cooperative Forest Management Plan follows a common template to meet each of these agency requirements for grant agreements, as well as for grants from the American Tree Farm Association. In addition, CAL FIRE offers a Non-Industrial Timber Management Plan

(NTMP) option to promote long term management and planning on forest ownerships of 2,500 acres or less, with landowners agreeing to manage their forests through uneven-aged management and long-term sustained yield (Public Resources Code (PRC) §4593 et seq.). The NTMP can also be used to qualify for CFIP project funding.

Confirm Availability of Appropriate Seed

Without appropriate seed, a reforestation project cannot proceed. The importance of seed origin and quality to long-term reforestation success is well described in Chapter 5 – “Cone and Seed Handling”. Many years of research into California’s complex tree diversity and ecology are behind the division of California into the 85 separate and unique zones on the California Tree Seed Zones Map (depicted in Chapter 5, “Seeds”.) Within each zone, conifer seed collections are catalogued by 500-foot elevation bands and sub-zones less than 50 miles across. The potential that future climatic conditions may be considerably warmer for the mature trees has led to research into potential changes in guidelines for moving seed between seed zones and elevations.

Identify the necessary number of seeds, desired conifer species, seed zone and elevations for the project location before contacting conifer seed suppliers. Potential suppliers are the State Seed Bank at L.A. Moran Reforestation Center in Davis, private seed companies in California and neighboring states, and forest nurseries. The USDA Forest Service and some large landowners may also make seed available from their seed inventories if they have excess. Large landowners typically ask if the potential seed purchaser plans to follow all of the steps necessary for a successful reforestation project before selling their excess seed.

Finding out how much seed is potentially available for the project is a key step. An inadequate supply of seed might necessitate reducing the project size, planting fewer trees per acre (wider spacing), altering the species mix, or delaying the project until a suitable amount of seed can be obtained. Although determining the approximate quantity of seed needed and its availability is necessary prior to proceeding further, knowing exactly how much seed to order is determined later in the planning process (see the ‘Obtain Appropriate Seed’ section).

A landowner may choose to establish their own seed inventory to insure a supply of seed for future projects. This could be done by purchasing seed from one of the sources listed above or collecting and processing cones from their own or neighboring property with permission. How to collect cones when a good crop is present and process and store seed is also described in Chapter 5.

Perform a Site Assessment

The site assessment is the first step in the development of a project’s specific objectives and schedule of activities. The site assessment begins with an in-office assessment of the relevant regional information on climate and fire risks and then drills down to the project site to identify a wide range of important characteristics of the project area so that all project planning is firmly based on the realities of the site. Most planning efforts use Geographic Information Systems (GIS) and spreadsheets to organize, analyze and map relevant site information and to identify unit boundaries and conditions. Other digital or manual methods may also be used. Site information may lead to the division of the project area into units with similar characteristics to which the same treatments will be applied. Unitization of the project area into more homogenous sub-units is particularly important when the project area is large. The on-site assessment provides detailed site-specific information plus ground-truthing of information originally derived from other sources. See also Chapter 4 – Site Assessment for a detailed explanation of this process and Chapter 12- Post-Wildfire Reforestation for an example of unitization.

Define Specific Objectives

A broad range of environmental and economic objectives may be possible for each previously defined goal. Making objectives quantifiable can be helpful to measure success and facilitate post-project monitoring. Some objectives are not as easily quantified as others (such as for aesthetics), but it is always valuable to have information relevant to defined metrics (such as desired trees per acre by species). Objectives can be short-term or long-term in timing and vision.

Examples of goals, specific objectives, and possible measurable criteria are in Table 3.1.

Table 3.1 Examples of Objectives for a Reforestation Project

Goal	OBJECTIVE examples	Measures of Success examples
Sustainable timber	<p>Manage for a sustainable yield of commercial conifer timber trees.</p> <p>Manage for a broad mix of species for a sustainable yield of commercial conifer timber trees</p>	<p>-Meet post-harvest tree stocking needs per acre.</p> <p>-Meet total and per-species stocking needs per acre.</p>
Forest health	<p>Ensure seedling survival, vigor and growth by controlling competing vegetation.</p> <p>Maintain a tree density and species composition that will create a vigorous and healthy forest, including a diverse under-story.</p>	<p>-No competing vegetation within 5’ of seedling for 1 to 2 years after planting and minimal competing vegetation for next 3 to 5 years.</p> <p>-Planted desired species to reach number of Trees per Acre (TPA) desired within X years.</p>

Chapter 3: Planning a Reforestation Project

		-Removal of undesired species on Y acres over X years. -Pre-commercial thin to desired species and number by age 10.
Fire protection	Maintain the condition of the property to minimize wildfire risk and allow for effective fire suppression and post-fire recovery.	-Create fuel breaks for fire suppression and maintain roads for access. -Brush and dead woody debris is at acceptable levels at specified plantation age(s)
Post-wildfire	Replant all productive forest soils in burned areas with appropriate species.	-Number of trees per acre per species alive and growing after 2 years.
Wildlife habitat	Retain oak species to provide acorns for wildlife. Retain pockets of shrubs and small wood debris for small mammal habitat. Manage non-conifer vegetation to stay within desired conifer/non-conifer mix.	-Site preparation effort retains xx oaks per acres, preferably large acorn producing oaks.
Natural diversity	Enhance native plant species by reducing invasive and non-native plant species that can have negative effects on plant diversity and abundance.	-Eliminate or control invasive plants to acceptable levels.
Aesthetics	Consider short and long-term effects on viewshed, especially near houses and high use recreational areas.	Develop a low density of large trees per acre in the viewshed.
Erosion Control	Provide for effective ground cover on eroding or potentially erodible sites.	No visible signs of (sheet, rills, ruts, gullies or mass movement), and no impacts to water quality.
Fuels management	Manage live and dead above ground biomass to keep fire behavior to manageable levels.	Keep live and dead above ground biomass to less than 10 tones per acre

Defining an objective with measurable targets is described further in the following examples.

Wildlife and Wildlife Habitat Objectives

Elements left on site such as oaks, snags, large woody debris and other elements that will be helpful to meet long-term objectives for wildlife habitat, recreation, aesthetics and water quality are also key objectives to track during any reforestation project. Treatments needed for successful reforestation will also affect the characteristics of the stand. Hardwoods such as oaks provide important food through acorns to many species of wildlife as well as valuable habitat elements for cover, denning, and nesting. Depending on the stage of the development of a stand, one could consider objectives related to habitat elements that are important for desired wildlife species such as:

- A certain basal area (BA) of stems or square feet of cross-sectional stem area per acre (e.g. approximately 2-10% of the total BA or number of stems in a stand).

Chapter 3: Planning a Reforestation Project

- Snags are another important habitat element as the relatively rare large snags can provide important nesting and denning sites. Leaving so many per acre is a common way of describing objectives (e.g., 2 snags per acre over 20” in diameter.)
- Large woody debris provides habitat. Leaving large hollow logs that can be used for denning is very valuable (e.g., leave one large log greater than 30 inches in diameter, and at least 20 feet long per acre).
- Large diameter oaks can also provide important denning or nesting opportunities (e.g. leave one oak greater than 30 inches in diameter every 5 acres).
- Optimize habitat for game species at a forage-to-cover ratio of 60:40.
- Protect wildlife to the degree required while accommodating necessary forest management activities.
- Long-term objectives may be to have a mature mixed conifer or ponderosa pine stand with 10% oak cover. To achieve this objective, the forester will need to leave much less than 10% oak cover at planting to account for the growth of the hardwood canopies over time. A rapidly expanding oak cover can significantly diminish conifer growth if it exceeds the manager’s hardwood target.
- Brush and hardwoods are valuable wildlife habitat elements but compete with conifers for valuable resources and are ladder fuels for fire. Long-term objectives could include leaving a small specified percentage of the total area in brush and hardwoods for desired wildlife habitat areas.

Tree Density Objectives

The number of mature trees per acre (TPA) is the most widely used metric for assessing the success of a reforestation project after the initial decade. The initial number of seedlings planted will often exceed the projected number of mature trees to account for expected mortality and in some circumstances to promote more vertical tree form and to provide early revenue if there is a market for small diameter trees.

California and other western states also have tree per acre requirements after green timber harvests on private lands. The requirements can be met with a combination of newly planted seedlings as well as residual trees. In 2019, the California Board of Forestry and Fire Protection reduced the initial TPA requirements from 300/150 TPA for high and lower sites to 200/100 TPA that are in line with the reforestation requirements of other western states. Planting higher densities of seedlings can result in more total biomass growth, but the trees will have smaller diameters and will take longer to reach the necessary diameter for commercial sale in regions without a strong market for small diameter trees.

Within any area, it is also common to leave some pockets of non-commercial species, snags, leave trees,

and clumps of understory vegetation as wildlife habitat elements. At planting, the number of TPA will vary depending on the species planted or whether it was a wildfire rehabilitation or green harvest where minimum stocking standards must be met on private lands or voluntary reforestation after wildfires or as part of a restoration effort. In terms of the long term financial and ecological value of a stand, it is the TPA following pre-commercial thinning (PCT) that matters. The decision rules for the pre commercial thin can include tree vigor, species, spacing, as well as wildlife habitat elements. Foresters can choose to aim for an initial planting density that is the desired final density, or plant more seedlings and then thin based on vigor, species, and spacing characteristics. As long as competing vegetation is not significant, the wider the tree spacing, the faster the trees will grow in diameter. At wider spacings, each tree has access to more water and other resources and is therefore more resistant to insect attack, disease, drought and climate change.

Fuels Objectives

Choices made during the implementation of a reforestation project can have major effects on the future fire risk on the site. Site preparation and vegetation management methods, retention of woody material for wildlife habitat, and tree density objectives should all be evaluated for fire risk potential. A fuel loading target of less than 10 tons per acre is often used to keep fire behavior at manageable levels. Photos of common fuel models for California can be viewed in the “Appendix B Fire and Fuels”:

<https://gacc.nifc.gov/rmcc/predictive/Fire%20Behavior%20Fuel%20Model%20Descriptions.pdf>.

Additional information is available from the ‘fuels and fire danger’ page on the Rocky Mountain Area Coordinating Center web site at https://gacc.nifc.gov/rmcc/fuels_fire_danger.php.

Describe Desired Planting Conditions and Outcomes

Describing desired conditions applies to two timeframes: a) the physical and vegetative conditions at time of planting for successful survival and growth of the target seedlings; b) a series of post-planting conditions over time, leading to successful future outcomes. Long-term results could be from 10 to 70 years or more.

Determining the desired conditions at planting requires a thorough understanding of how planted conifers and competing vegetation will behave on a site. Important questions are:

- What will be the soil moisture and soil temperature conditions during establishment?
- What will be the air temperature, humidity, wind speed, and frost conditions during establishment?

- What is the shade tolerance of the preferred conifer species?
- What species are present in the under-story?
- How will potential competing vegetation respond after harvest, site prep or fire?
- How will the competing vegetation respond to treatment?
- What species of competing vegetation are present or are likely to germinate on site?

The regenerated stand will be a combination of species that have been planted, re-sprouted from root stock, and germinated from seed. Decisions will need to be made about which actions – or prescriptions - are necessary to achieve both the desired planting condition and the future forest condition. Conditions at planting to ensure seedling success vary for different species. For example, Ponderosa pine is a shade intolerant species. Residual trees that shade pine should be removed. Pine dominated units are typically more than one acre in size. Douglas-fir has intermediate shade tolerance and young stems are sensitive to heat damage, so microclimate conditions are important. Large logs, small debris and an intact organic layer can provide favorable micro-climates for establishment. Douglas-fir and white fir are susceptible to frost mortality. Leaving some over-story trees by utilizing a shelterwood harvest, smaller group openings or leave trees for protection in frost-prone locations to reduce damage. The larger leave trees will be effective users of soil moisture and sunlight and will reduce the growth of the new seedlings, especially for the seedlings closest to the leave trees.

Develop Prescription and Schedule of Activities

The prescription process incorporates site assessment, objectives and desired conditions into a series of treatments designed to achieve the objectives. The timing of these treatments is described in “Schedules of Activities”. Examples of schedules for several different project types which could be used as outlines for prescriptions are found at the end of this chapter. Depending on the landowner and the need for disclosure, prescriptions can be as brief as these schedules or quite lengthy documents detailing each step. Each activity on the schedule (e.g., plant seedlings) could also have its own detailed timeline as well as a separate budget.

Develop Budgets

The process of budgeting is facilitated by dividing the project area into smaller and more homogenous units - the unitization of the project. Providing accurate acreage for each unit in the mapping and spreadsheet data allows the forester to accurately estimate the cost of supplies, labor, timing, duration and other activities for each planning unit. Small landowners can use this information to justify funding when applying for grants. Large landowners and agencies can use the information for annual budgeting. If reforestation costs are being paid for with income from annual logging revenues, it is useful to know the

timing of future costs so the land manager can retain income in the appropriate years. Landowners who do not budget well for post-planting release treatments, Pre-commercial Thinning (PCT), or other future treatments may not have the resources to invest in future activities that are critical to long term success. A spreadsheet covering at least 10 years of estimated costs from initial site preparation to PCT is helpful for identifying budget needs and avoiding serious funding constraints.

The primary purpose of budgeting is to identify the amount and timing of funding needed throughout the scope of the project. Skipping, or even delaying, a particular activity due to lack of funds at the appropriate time can jeopardize the success of the reforestation project, cause money that was spent on prior activities to be wasted, and require even higher future treatment costs. Budgeting can facilitate an assessment of priorities if funding is limited. In these cases, the spreadsheet developed for each unit during the site assessment (See Chapter 4) can be used to establish priorities among the units so that the available funding will be allocated to those units. Having a spreadsheet with all units from the mapping system also helps ensure that a unit will not be overlooked. When the budgeting process is completed, the spreadsheet can list by priority which units will be treated with the funding available. Similar lists, developed within an agency, can be used to prepare proposals for bidding.

Implement Reforestation by Project Type

The following sections describe the many steps and timing involved to implement the three basic reforestation project types: restoration/rehabilitation, post-timber harvest (green sale), and post-wildfire. The largest differences will be in the timing of the activities to control competing vegetation, the ordering of seedlings, and acquiring the necessary permits. Once the seedlings are finally delivered to the site, the implementation of any project will follow a similar path. The timing or methods used in some steps may need to be modified, added to, or eliminated depending upon the specific project.

Identify Necessary Permits

Federal, state and local agencies require permits for several activities that may be part of reforestation projects. Permitting is an ever-changing process so it is advisable to check with appropriate agencies to determine the latest requirements. There are three general categories of permits which may be required:

Green Timber Harvesting and Salvage Harvesting Permits

Reforestation activities that are related to a green timber harvest on private land cannot begin until a Timber Harvest Plan (THP) that complies with the state Forest Practices Act and the California Environmental Quality Act (CEQA) is approved by the California Department of Forestry and Fire Protection (CAL FIRE). The preparation and approval of this permit can take from one to three years depending on the location and the issues involved. Reforestation needs should be determined in advance

Chapter 3: Planning a Reforestation Project

of the harvest so that once the plan is approved reforestation activities can be conducted at the appropriate times. Many of the surveys needed for the site assessment, including botanical, fish and wildlife, geological, and archeological, are required as part of the THP.

Post-wildfire reforestation activities on private and state lands are not usually delayed by the need for salvage harvest permits in California. Post-wildfire salvage logging operations may be conducted after filing an Emergency Notice or in some cases an Exemption Notice that may allow for logging to commence within 5 days after CAL FIRE accepts the notice for filing. Harvest operations conducted pursuant to Exemption and Emergency Notices must still comply with all of the operational requirements of the Forest Practice Rules. Exemptions have additional regulations and limitations compared to an Emergency Notice. An archeological records' check and other assessments may not be required for operations under an Exemption but the landowner and LTO are responsible to protect those sensitive resources. Prior to operations the RPF must still conduct an archaeological record check and survey along with other assessments to protect sensitive resources (e.g., botanical, fish and wildlife, and geological).

On federal lands, all timber sale operations need to comply with many federal laws such as the Multiple Use Act, National Environmental Policy Act (NEPA), Endangered Species Act (ESA), Clean Water Act, and the Clean Air Act. Projects going through the NEPA process can take two years or more to get approved and longer if appeals and litigation are filed. This uncertainty can complicate project planning and lead to operational delays.

Water Quality, Fish and Wildlife Permits

Most often these types of permits, or conditional waivers of permits, are related to timber harvest activities that can potentially affect the beneficial uses of water or threaten fish and wildlife. Examples include Regional Water Quality Control Board (RWQCB) Waivers of Waste Discharge Permit, California Dept. of Fish and Wildlife's (CDFW) 1600 streambed alteration permits, and CDFW surveys for spotted owls. Conditional waivers and 1600 permits can often be done within a month but can take longer. Surveys for the Northern Spotted Owl, protected under the state and federal Endangered Species Acts, can take up to two years. Salvage logging can still require these permits and surveys after a wildfire. Know what permits or waiver conditions are required and allow plenty of time to get them processed. The U.S. Fish and Wildlife Service, National Marine Fisheries Service and U.S. Army Corp of Engineers are some of the federal agencies that may also be involved, more often for timber harvest activities that could impact listed species or stream habitats. Some of these permits can take months or years to obtain.

Pesticide Application Permits

Pesticide application permits are issued and enforced by the local County Agricultural Commissioner (CAC) under authority of the California Dept. of Pesticide Regulation (DPR) and must be obtained before spray operations begin. To make pesticide applications for vegetation management in reforestation projects, an operator identification number (OIN) is required for the purchase and use of pesticides on the property. In addition to an operator identification number, a restricted materials permit is required for the application of pesticides (such as, specific herbicides and insecticides) that fall under the [state restricted materials list](#) (CDPR 2020).

An Operator Identification Number or Restricted Materials Permit for the application of certain herbicides or insecticides is required for reforestation projects (DPR 2018). The permit identifies the sites (“Site ID”) where applications may be made and lists specific conditions to be followed during the applications. If the applicant for the permit is not the landowner, the applicant must have written authorization from the landowner designating them as the landowner representative and possess a Pest Control Advisor license (PCA) issued by DPR.

Unless they are working on their own property, applicators must also be licensed as a pest control business (PCB) and have a qualified applicator license (QAL) on staff in order to apply pesticides for hire and must annually register with the CAC in each county that work is performed. After application of any pesticide, the landowner or applicator is responsible for reporting the use in a specific format to the CAC. Use reporting can be done online or on approved forms available from the CAC. Written pest control recommendations may be required from a licensed PCA when the person conducting the reforestation program is not the landowner. More information on pesticide licensing, permits and reporting can be found in Chapter 8 – Vegetation Management.

Burn Permits and Plans

Burning as a site prep method may require a Smoke Management Plan (SMP) from your county or regional Air Pollution Control District (APCD) or Air Quality Management District (AQMD). The size of the project, quantity of emissions, and your proximity to smoke sensitive areas will determine if one is required. Some district may also require an Air Pollution Permit (APP). There can be fees associated with these permits. California's 35 local Air Pollution Control Districts are responsible for regional air quality planning, monitoring, and stationary source and facility permitting. The districts are the California Air Resource Board's (CARB) primary partners in efforts to comply with the Clean Air Act. Acquiring the approval of smoke management plans under the recent trend of a declining number of burn days has made burning within a reforestation project more difficult in recent years.

Private land owners may also need to obtain a Project Burn Permit (LE5) from their agency responsible for fire suppression (usually Cal Fire). The LE5 is required if you want to burn within fire season, which can last into December.

Obtain Appropriate Seed

A source for sufficient seed should have already been located. The project's prescription details should have estimates of the quantity of seedlings needed by seed zone, elevation and species. The best way to obtain the proper quantity of seed is to contact the seedling nursery that has been selected and have them determine how much seed they will need. They will need the seed lot identification, seeds per pound and germination rate. How much seed the nursery needs depends upon the seed quality and how efficiently the nursery uses the seed. (See Chapter 6-Seedlings.) If a reforestation forester knows that a particular seedlot is in short supply, informing the nursery of the situation can result in more efficient seed use.

Order Seedlings and Identify Cooler Storage

Seedlings should be ordered by the first week of December at the latest (See the "Ordering Seedlings" section in Chapter 6, "Seedlings" for more details). If ordered in November or December, then one-year seedlings will be available for planting the following fall (10-11 months later), the next winter (12-14 months later), or the second spring (14-18 months later). Timely seedling orders will allow the nursery to optimize seed treatment and sow dates and therefore provide the best quality seedlings. If you haven't grown the species or contracted with the nursery before, it's good to contact them in advance.

The project prescription will identify the species and seedling stock types (container size or bare-root age) that are best suited for the project and list the quantities of each that are needed. If seed for the project has already been obtained, then the nursery will need to know the quantity and quality of that seed to determine how much is needed to grow the requested number of seedlings. If seed has not already been obtained, the nursery can obtain the needed seed if some is available. The seedling purchaser will be responsible for the cost of the seed as well as the seedlings.

Chapter 6, "Seedlings," offers extensive information on selecting species, seedling stock types, and a forest nursery and more detail on how to order seedlings. Chapter 9, "Planting," has more detail on species and stock types commonly used in various regions of California. Packing windows for seedlings are getting shorter making cooler storage more critical. This is a particular problem for small landowners and consultants with relatively small and often periodic reforestation projects. Try to line up cooler storage when seedling orders are placed. Often, the nursery can provide or arrange for cold storage. If not, locate an alternative storage location. Do not wait until the seedlings are packed and ready for delivery

and then try to find storage as nurseries usually have limited storage capacity. See Chapter 9, “Planting,” for more information on cooler storage.

Pre-harvest Vegetation Management Spray and Contractor Selection

Pre-harvest chemical site preparation before a green harvest, if done well, should substantially reduce the need for release treatments and reduce costs. These treatments to control competing woody and other vegetation occur before a site is logged so that the planted seedlings are not damaged. The treatments are particularly effective at controlling re-sprouting brush and hardwood species. Spraying should be done a minimum of three months prior to logging and depending on the species to be planted and the location, 1 to two years before planting. The need to spray before logging means that timber harvest or sale plans have to be completed well in advance. Having plans completed and approved two years before logging is tentatively scheduled will allow flexibility to still do the needed vegetation management treatment even if logging plans change. Road access can also be an issue. New road construction that provides access to the project area in the harvest area needs to be completed prior to treatment whenever possible to reduce labor costs and allow access into harvest units. Find a contractor equipped and experienced in pre-harvest chemical site preparation. This should occur at least six months if not a year prior to the planned application date to give contractors time to schedule the work, including securing a labor force. Permits for chemical use may also take time to obtain.

For more information, see Chapter 8, “Vegetation Management” and the examples at the end of this chapter.

Coordinated with Harvest Operations

Green timber harvest schedules often affect the timing of treatments needed for reforestation. Treatment plans may have to be adapted to account for changes in the timing of harvest. Harvest scheduling is often done to accommodate a mill’s processing capacity or the availability of a logging operator. Being involved with the scheduling process as much as possible will facilitate timeliness of reforestation treatments. Harvesting can take place any time of the year depending on the location and weather, but most logging is done from April through November. Some logging occurs on the east side of the Cascade or Sierra Nevada Range on snow or frozen ground from December through February. Logging can occur year-round on the Coast with well-rocked roads.

See “Identify Necessary Permits:Green Timber Harvesting and Salvage Harvesting Permits” for additional information.

Find Site Prep Contractors

All labor contracts need to be anticipated well in advance of when site preparation work needs to be done. Experienced crews and essential equipment operators are typically booked early. Getting a commitment from contractors several months prior to the project is wise. Seasonal availability varies by the type of site prep method. The summer season is very busy for equipment contractors, so the previous winter is a good time to locate and commit to a contractor to do mechanical site prep, for example. Spring can be the busy time for herbicide application contractors. Prescribed fire crews, who have a different skill than fire fighters, need to be available in the spring and fall burn windows. Plan ahead and be ready when your prescription window opens. Examples of three different Project Schedule are end of this chapter.

Site Preparation for Vegetation Management

Site preparation refers to any measure taken to prepare the site for regeneration of a forest stand and is considered by many practitioners to be the single most important step. Vegetation management is a primary controlling factor in successful reforestation. Chapter 7 describes how to determine the need for site prep and covers the three common methods: mechanical, manual, and burning. Chapter 8 focuses on the chemical (herbicide) methods of forest vegetation management used in the different steps of reforestation. Each method's advantages and disadvantages for various project sites should be evaluated, including their comparative cost and effectiveness. A combination of methods may also prove beneficial to seedling success.

Mechanical Site Preparation

Common reasons for mechanical site preparation include slash removal, vegetation control, reduction of soil compaction, and breaking up hydrophobic soils after a fire. Mechanical site preparation should be done in the summer or fall before planting to reduce the potential for undesirable vegetation re-establishing before planting. Where chemical pre-harvest site preparation has not occurred post-harvest chemical site preparation may be necessary. In this case, it is necessary to schedule chemical and mechanical treatments to allow for maximum efficacy while still accomplishing the objectives of any mechanical treatment.

See Chapter 7- "Site Preparation" for more information.

Manual Site Preparation

Manual labor can include grubbing, applying mulches, and hand piling. It is much more expensive per acres and tends to be used on sensitive sites such as steep slopes or urban-interface areas.

See Chapter 7- "Site Preparation" for more information.

Burning Site Preparation

The use of burning or prescribed fire as a site preparation tool is another option, although its use on private lands has declined significantly in recent years due to smoke management and liability issues. This method includes pile burning and broadcast burning.

See Chapter 7- “Site Preparation” for more information.

Vegetation Management-Chemical Site Preparation

Post-harvest foliar chemical site preparation may be necessary if pre-harvest chemical site preparation was not done or was ineffective. Some type of foliar treatment may be necessary during the summer prior to planting to control established woody brush and herbaceous vegetation. In some instances, depending on the species present, the unit(s) may need to sit fallow for a season to allow enough re-sprouting of woody vegetation to allow for eventual adequate chemical control when the plant is large enough to absorb sufficient herbicide. This usually occurs where there are difficult to control species such as snowbrush, tanoak or golden chinquapin. The downside is that planting is delayed for an entire year.

Following pre- or post-harvest foliar site preparation treatments, scheduling of a residual herbicide application for herbaceous control needs to be planned in either the spring or fall before planting depending on the elevation to control competitive grasses and forbs. Depending on the herbicide mix this may occur prior to or after planting.

See Chapter 8- “Forest Vegetation Management” for more information.

Request Timing of Seedling Packing and Delivery

The nursery should be contacted in the fall at least a month before packing begins to discuss the timing of seedling packing for a spring plant. Packing requirements should be discussed during the summer prior to planting if units are scheduled for a fall or winter plant. The approximate date(s) the seedlings are expected to be planted will affect their packing window and the type of cooler storage to use. Get your request in early and plan your cooler storage accordingly.

See Chapter 6- “Seedlings” and Chapter 9- “Planting” for more information.

Find Planting Contractors

Planting contractors can be very busy with existing commitments, so contact them as much as 6 to 12 months before their services are needed for your project. Government agencies that have lengthy contracting procedures, especially those with a complicated bidding process, may need even longer lead times to ensure that the planting contractors will be available for planting. See Chapter 9- “Planting” for more details.

Obtain Seedling Delivery

Seedlings packed for immediate planting, such as fall planting, will need to be picked up as soon as they are packed then stored properly, and planted within one to two weeks. Seedlings to be stored and planted later will be packed from November through January. Packed seedlings risk developing mold without proper storage. If storage at the nursery has not been arranged, seedlings need to be picked up immediately after they are packed and transported to cold storage. If the travel distance is long and the region is warm, transport in refrigerated truck or van may be warranted. The type of cold storage required near the planting site will depend on the length of time the seedlings will be in storage. See Chapter 9- “Planting” for more information.

Plant Seedlings (or store seedlings for later planting)

Planting is the culmination of the multi-step process leading up to it. Seedlings need to be properly handled with adequate transportation from the cooler storage to the field and then by the planters onto the site. Having an experienced planting crew, and good planting quality inspectors, will help ensure success. Doing all the other steps well will not guarantee success if the trees are not planted correctly.

See Chapter 9- “Planting” for more information about planting and storage.

Post-Planting Follow-up /Monitoring

It is essential to follow-up any planting project with periodic evaluations of survival, seedling density, vegetative competition and damage from insects, disease and animals. These monitoring activities will allow timely responses to post-planting changes on the site that can lead to poor performance or failure of the project.

See Chapter 9- “Planting” for more information.

Year 1-5 Survival and Release Sprays after Planting to Control Competing Vegetation

Release can occur any time after planting but usually occurs within one to five years after planting. Target weeds will vary by site and the appropriate treatment methods and/or chemicals will depend on the species, stage and condition of vegetation present. Depending on objectives, release may or may not be necessary. Release treatments done within one year after planting are usually done to assure survival rather than to improve growth rates. Treatments in years 2-5 are usually to control vegetation for enhanced growth and/or to reduce fuel loading for fire. If early post-planting monitoring indicates need for follow-up release spray, plan ahead to secure properly trained and equipped spray crews to complete the work. Securing a crew that is experienced in protecting seedlings from the spray is a must. See Chapter 8- “Forest Vegetation Management” for more details.

Monitor for Insect, Disease and Animal Damage and Treat as Needed

After planting, the site needs to be monitored for insect, disease and animal damage. Effective monitoring is based on knowledge of the agents that are in the area and what habitat they like. Insect problems are often controlled with good vegetation management, but this may be difficult on lower quality sites (i.e., low site index stands). Early identification will allow for timely treatment. Since the identification of insects and diseases may not be easy, assistance from State entomologists or pathologists and the Forest Health Protection (FHP) arm within the US Forest Service can be valuable.

For diseases, particularly root-based fungal rots, knowledge about pathogens in the area is helpful. For animal damage, knowledge of migration patterns or habitat issues in the case of small mammals can lead to successful preventative programs. If possible, schedule labor for any required treatments well in advance. Applications for insect infestations that occur over large areas are often aerial and lining up aerial contractors can be very difficult on short notice. Disease treatments are usually preventative and often occur at time of harvest. Animal damage is sporadic making scheduling of labor difficult. Some animal damage prevention if needed, can be done in conjunction with planting.

See Chapter 11- “Damage” for more information.

Perform Pre-Commercial Thinning (PCT)

The objective of pre-commercial thinning (PCT) is to establish a density of young trees that will grow into the desired sized trees over time. Treatments that involve pruning, branch removal, or other activities to reduce potential wildfire fuels that do not generate net revenue also promote the development of desired sized trees but are commonly referred to as ‘timber stand improvement’ (TSI) or fuels work. When the landowner has a dominant timber revenue objective, considerations might be: what size of tree is required for commercial viability, what are the price premiums for larger diameter trees, are there market reasons to favor certain species, and how will the treatments reduce potential wildfire losses? Ultimately, the goal of pre-commercial thinning is to prepare a forest stand to enhance commercially desirable qualities in the period between initial planting and when an initial economic return can be recovered.

The age at which precommercial thinning should be completed varies from site to site. Ideally, a thinning project should be implemented at the point where inter-tree competition begins to have a negative effect on individual tree growth. If the site also has competition from brush or hardwoods, the optimal time to do a PCT is when the conifers dominate the site but before growth per tree is constrained by inter-tree competition. Thinning before the time that the conifers dominate will in many cases result in a flush of growth from brush species that will negatively impact future tree growth. Plantations that started with

fewer seedlings and a wider spacing will take a little longer for conifers to dominate the site and thinning should be delayed to around year 10. Delaying thinning past the optimum time not only slows growth rate of crop trees, but also increases the level of fuels from thinned trees. Thinning late also increases the cost of thinning projects as larger trees take longer to cut and pile.

Understanding these studies and integrating them into the decision to thin is important, but desired spacing ultimately boils down to a number. That number is the distance between trees the forester prescribes and the thinning contractor will be required to achieve. Foresters often tend to want to leave stands too dense and have a difficult time when watching thinning crews cut trees they have planted and cared for. It is important to follow through with this crucial step at the right time with the proper spacing for the long term health and productivity of the stand. The key decision For example, a common prescription for productive sites in Northern California starts with planting 200 to 260 seedlings per acre, followed by a precommercial thin to a 18'x18' spacing (129 tpa) at year 6-7 (later for lower quality sites or sites that were initially planted at a lower density) to set the stand up for the first commercial thin at year 25 -30 when the post-thinned stand will have 26' spacing with 65 tpa. The optimal time for thinning may be a year earlier for very productive sites and a year or two later for drier and less productive sites.

It's important to avoid conducting at PCT during the spring bark beetle flight of May through July in ponderosa pine stands as the beetles will be attracted to the freshly cut trees. As with all the other treatments, lining up labor ahead of time is critical. With thinning there is usually more planning flexibility but the earlier a plantation is thinned, the cheaper it is and the lower the fuel load.

Thinning plantations that are single species makes choosing which tree to cut and which to retain is a relatively simple task. The "best trees" will be retained at the prescribed spacing. "Best tree" could be the tallest or the one with no defect, but the most important consideration is thinning to the prescribed spacing. Thinning guidelines are more complicated in mixed species plantings where saplings need to be ranked in order of future value rather than simply by height.

See Chapter 10- "Pre-Commercial Treatments" for more information.

Perform Pruning and Other Fuel Reduction Treatments

If post-planting monitoring finds excessive accumulation of fuels in a plantation, then a fuel reduction treatment should be considered. Pruning of lower limbs is no longer a common practice to increase wood quality but it can reduce the probability of surface fires getting up into the branches and can facilitate fire suppression efforts in some circumstances.

See Chapter 10- "Pre-Commercial Treatments" for more information.

Document Lessons Learned

Learning lessons from the project should always be a continuous and not necessarily a final step: what worked well, what could have been done better, what failed – and why. Understanding why may not always be obvious, but documentation of the steps taken (or not taken) with text and pictures will contribute to a better understanding of the project’s success – or lack thereof. Over time, the benefits of documenting lessons learned can substantially improve success rates.

Project Schedule of Activities: Some Examples

Three scheduling examples for different types of reforestation projects are provided in the following spreadsheet tables. Each schedule of activities provides a general example to facilitate the critical thinking necessary to develop and implement complicated biological, operational, and administrative processes. The left column in each example lists the series of activities that are necessary for successful execution of the project. These activities match the Flow Chart in Fig. 3-1. A description and where to find more information about these activities can be found in the relevant section of this chapter. The second column lists the chapter in this handbook where you will find very detailed information. The rest of the spreadsheet shows an example of when each activity might occur for this type of project. The numbers across the top show the years each activity may occur.

These schedules are examples only. Each project should have its own schedule of activities with a timeline developed for the specific needs of that site.

There are a lot of steps: think through your situation and come up with a schedule of activities (prescription/plan) that works for your particular situation.

Example 1: Post-Timber Harvest (Spring Planting) Schedule of Activities

This example in Table 3.2 is the most common form of reforestation because it applies to even-age forest management that is often practiced on large industrial ownerships. It can also apply to replanted group selection units that are considered un-even-age management under California regulations. Planting usually occurs during the spring as soon after harvest as possible if commercial conifer stocking levels are inadequate in the harvest area. However, many harvested sites can also be planted in the fall or winter if the conditions are right. See the “Planting” Chapter for details on planting seasons.

A post-harvest project has the benefit of a longer planning horizon because the planning of a harvest has to meet very detailed regulatory requirements that lead to a Timber Harvest Plan. The Schedule indicates this long lead time in the 3rd and 4th columns, with 1 to 3 “minus” years showing the time frame of certain pre-harvest activities prior to the reforestation phase. Although many steps are the same as for the other

two reforestation types, post-harvest reforestation can benefit from pre-harvest biomass and spray treatments that are not possible with the other types of reforestation projects.

Example 2: Post-Wildfire Project Schedule of Activities

While the need for post-fire projects is becoming increasingly too common, reforestation success can be improved when planning begins immediately after the fire and the proper steps are taken (Zhang et al. 2008.) The planning and implementation timing of activities for salvage and reforestation after a wildfire, depicted in Table 3.3, is compressed considerably. Quick action with the salvage process will increase income to help offset reforestation costs. Wildfires tend to occur from June through November with later wildfires further compressing planning timelines.

The first activity for a successful and cost-effective response after a wildfire is usually a salvage harvest. The objectives are to salvage the dead wood and capture as much value as possible before the wood deteriorates and prepare the site so that it achieves its potential growth rate from residual and newly planted trees. This action usually is performed within one year, especially for smaller fire damaged areas. On private land, a Notice of Emergency Operations can be filed, and logging can start within 5 days of filing acceptance by CAL FIRE. The salvage operation still has to comply with all relevant Forest Practices Act requirements. Water Quality and Fish and Wildlife permits are still required. Archaeological record checks and surveys must be done prior to harvest operations. Large landowners have the advantage of having staff that can immediately get started and most know what they need to do, based on past experience with fires. However, large landowners that do not have manufacturing facilities, along with small landowners, need to take time for the extra step in marketing the salvage timber and executing contracts with mills and logging contractors. The decline in the number of sawmills in California over the past decades has made it more difficult and expensive to get logs to market. If other landowners also experienced fire damage, nearby mills may not have the capacity to process all the local fire killed trees. It is important to start the process of looking for potential log buyers and transporters as soon as possible after the fire loss.

Smaller landowners can be at a disadvantage for planning a salvage harvest after a severe wildfire, especially if they do not have an existing relationship with an experienced forester or have an existing Forest Management Plan. Many landowners lose not only their forestland but also their homes, so getting a place to live and dealing with insurance companies becomes the priority. Many are in shock and don't know who to trust and want to wait to make a decision even though quick action will reduce reforestation costs and improve success. For those landowners who have the ability to deal with salvage and reforestation, time is of the essence. It is recommended to hire an experienced Registered Professional

Forester (RPF), preferably one with reforestation experience, as soon as possible. Foresters and loggers after a big fire are usually in short supply. Loggers can very quickly become committed to the larger projects of larger landowners. Ask foresters and loggers for their licenses and check with CAL FIRE about any problems with violations to help find trustworthy professional advice. If small landowners don't know the process or who to trust, they should call CAL FIRE and talk with the Forest Practices staff about salvage logging and the Forestry Assistance Specialist (FAS) about California Forest Improvement Funding (CFIP) for reforestation funding (see Ch. 2 – “Investing in Reforestation” for more information). Contacting these agency personnel can be difficult during and immediately after a fire since they may be working on that fire or another fire, as is often the case during fire season.

Salvage logging and reforestation funding applications need to be worked on concurrently. Applications for funding should ideally be filed by October 1 to have a chance at approval before December 1, so an order for seedlings can be placed. If the reforestation process is delayed for one year, the brush and grass can become well established, and then reforesting will be more expensive and success will be more difficult to achieve. Federal reforestation projects can take much longer as they require a NEPA process that can take 1-2 years, assuming no further delays from lawsuits and appeals. There is no emergency process for expediting post fire reforestation for the federal agencies. Once salvage logging is complete, the sequence of reforestation activities is very similar to all other type of projects.

Example 3: Rehabilitation Project - Brush Field Conversion Schedule

A rehabilitation project involves restoring conifer species to land previously forested but now dominated by other vegetation. The reforestation steps for this brush field conversion example vary from the other two types of projects primarily in the activity of site preparation (Table 3.4). Preventing the return of heavy brush after the site preparation with pre- and post- planting vegetation control is another key activity. Brush field conversions require less permitting related to harvestable trees than other reforestation project types. The permitting requirements are constantly changing, so landowners and foresters need to check prior to any project. Pesticide use permitting is required regardless of the project type. Brush field conversions are similar to a green timber harvest in terms of timely (rather than emergency) planning, but typically have much higher mechanical site preparation costs. A big obstacle with conversion projects, regardless of who owns the land, is funding. Small landowners may be able to get help with funding from federal and state cost-share programs.

Several approaches can be taken with brush field conversions. Tractor piling followed by burning of piles is very common. Where feasible the brush is typically sprayed with foliar herbicide(s) prior to piling in order to kill the root systems and facilitate piling. This “pre-piling” spray greatly reduces piling time and

Chapter 3: Planning a Reforestation Project

costs, reduces topsoil disturbance, facilitates burning of piles free of dirt and eliminates re-sprouting brush that otherwise would be very costly to control after planting. In either situation, the piling and burning activity is usually followed by a site prep herbicide before planting. Where herbicides are not used, then manual site prep is used as a release in conjunction with planting.

Summary

Positive progress with reforestation over the past several decades has led to many changes in the details of planning a project. However, certain common-sense planning recommendations and principles from a 1992 reforestation guide from Oregon (Hobbs et al. 1992) still ring true for California today:

- *The region's environment and its well-adapted non-conifer vegetation interact to create often-hostile conditions for survival and growth of seedlings. Such conditions require careful and timely execution of well-thought out plans for reforestation.*
- *In order to succeed, managers must work to identify long-term objectives.*
- *Regardless of management objectives, sustainability of forest productivity must be a primary concern, with a major component of sustainability being reforestation after natural disturbance or harvest. An understanding of (1) ecological principles, (2) management practices, and (3) analysis capabilities pertinent to the reforestation process is relevant to managing lands for all of the listed purposes.*
- *Managers must make monitoring of reforestation efforts by technically competent people a high priority.*
- *Actions must be biologically sound, make economic sense, be socially acceptable and be operationally feasible.*

Acknowledgements

The authors sincerely appreciate suggestions on this chapter provided by the following reviewers: Herb Baldwin, Mark Gray, Teri Griffis, Tom Jopson, Keli McElroy, Martin Ritchie, and Sari Sommarstrom.

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Chapter 3: Planning a Reforestation Project

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