

Chapter 4: Site Assessment

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Introduction

A site assessment is an essential step to developing a plan for successful reforestation. Before conducting the on-site assessment, reforestation practitioners should take the time in the office to collect relevant data from local and regional databases and prepare maps utilizing geographic information systems. This office or pre-field compilation, organization, and preliminary analysis of information is an efficient step that will benefit an immediate project as well as all future projects. As more detailed historic, current, and future projection information becomes available, it is important for practitioners responsible for more than a single project to keep the 'pre-field' compilation up-to-date with new resources as they become available. The on-site, or field assessment is key for verifying and adjusting the data from the pre-field compilation, and capturing key operational and logistical characteristics that also will contribute to successfully implementing the plan. Examples of practical on-site assessment forms are the Site Assessment Template and Unit Planning Information Sheet in the appendix. A completed Reforestation Site Assessment and Project Plan example is also in the appendix.

While on the site, important elements of the prescription should be considered such as appropriate tree species, planting density, competing vegetation, soil conditions and any limitations on planting access. The site visit is also an opportunity to ground-truth data acquired during the office research phase of the assessment. If the reforestation project is part of a green harvest, then an on-site assessment will be needed both before and after the harvest. The pre-harvest visit will assess the existing stand and the need for pre-harvest site preparation treatments. It can also assess the possibility of using the logging to help with site preparation and allow the forester to be involved in planning the harvest. The post-harvest visit will assess the conditions on the site after all logging activities have ended, allowing for an adjustment to the plan if needed.

Linking Pre-field and On-site Data for Effective Decision Making

The following table summarizes the assessment topics and which types of relevant information will need to be collected in the pre-field and on-site components of a site assessment. In many cases, the on-site work can be used as a verification that the data collected in the office assessment is valid. In some cases, especially those requiring identification of vegetation, the on-site assessments will be critical.

Table 4.1 Site assessment categories to be collected in the office or the field for each unit

Assessment Category	Topic	Pre-field	On-site
Location	Ownership	X	
	Legal description	X	
	Property lines & corners	X	X

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Assessment Category	Topic	Pre-field	On-site
	Acreage	X	X
	Neighboring properties	X	X
	Road access	X	X
	Easements and utilities	X	X
	Seed Zone	X	
Topography	Elevation	X	
	Slope	X	X
Climate	Precipitation	X	
	Temperature/humidity	X	
	Wind	X	
	Frost pockets	X	X
Soils	Soil type/texture	X	X
	Avail. Water Storage (AWS)	X	X
	Organic matter content	X	X
	Soil stability & erosion	X	X
	Soil maps & data	X	X
Vegetation	Site class	X	X
	Natural Regeneration		X
	Size and age class		X
	Vegetation species & cover	X	X
	Treatment Needs		X
	Conifers prior to harvest/fire		X
	Harvest history	X	X
	Fuel Loading		X
	Wildlife habitat elements		X
	Conifer Seed Zone	X	
Silviculture	Logging method	X	X
	Silvicultural method	X	X
	Site prep needs		X
	Planting needs		X
Sensitive Sites and Species	Water quality	X	X
	Aquatic species	X	X
	Endangered species	X	X
	Archeological sites	X	X
Pests, Insect, Disease	Animal damage		X
	Insects and disease		X
Fire Risk	Surrounding stands	X	X
	Residual crown fuels		X
	Ladder tree and shrub fuels		X
	Snag and down wood fuels		X
	Predicted plantation fire risk		X

Making and Utilizing Maps During the Pre-field Assessment

Compiling and utilizing existing data to make site-specific maps is a critical element for reforestation planning. Virtually all activities will utilize the maps. Reforestation foresters must be aware of what other informational maps are available that will aid in reforestation planning and create the necessary maps. Unless the project is very small, utilizing computer based geographic information systems (GIS) will be an essential step for both operational and regulatory activities. Table 4.2 provides an overview of the many topics that will be useful for reforestation and whether the data can be collected at the office, requires on-site visits, or both. In most cases, the utilization of information collected from sources available at the office will be more cost effective, especially for large operations. On-site evaluation is often mainly a verification that the previously mapped data is correct but the field assessment should also identify specific locations where different actions will need to be taken.

Using Geographic Information Systems (GIS) in Reforestation Assessment, Planning and Implementation

The most critical part of organizing data is determining what data are needed and how they will be used. A valuable tool for organizing and presenting all the data available is a geographic information system (GIS) software package. The development and widespread use of various GIS software packages, especially when used in conjunction with spreadsheets, has greatly improved the forester's ability to organize and track information. Spreadsheet data can easily be exported to or imported from GIS software for further advancing analyze that can be useful for making management decisions.

Mapping of Operational Units with Similar Characteristics for Seedling Survival

For effective reforestation projects, the primary goal is to define units that have similar physical characteristics and can be treated with the same package of treatments. A GIS allows for easy and accurate mapping of the planning units based on the data sources used, as well as tracking during implementation and follow-up. Not all data layers need to be utilized in reforestation projects, as some of the layers may be more general and more relevant for larger scale reforestation programs or longer term projections. Planning and operational units, usually just called 'units', are sub-areas within the project boundaries with similar biological and operational characteristics. These characteristics include soils, aspect, slope, water availability and site quality. Draft units can be delineated prior to field assessment and then verified in the field or created during the site visit by drawing lines or by laying the unit out and taking GPS points. Once the units are created and are given a unique identifier, relevant site assessment information can be tracked by unit, and specific operational or landscape level prescriptions can be applied to each unit.

GIS does not just create pretty maps but more importantly serves as a data management tool. Once the data are created either through direct input or GIS calculation, it can then be easily exported to a spreadsheet for analysis and organization. Units can be sorted by size, soil type, site class, water holding capacity, slope, year of planting, or any other factor for which data is available. If data are added to a spreadsheet, it can be merged back into the GIS system provided it is tied to a unique identifier. The ability to link GIS systems with spreadsheet data has increased the organizational abilities and efficiencies of planners and implementers significantly over the last two or three decades.

Key Regional Datasets for Baseline Maps

Before collecting and integrating on-site level data into a GIS, it is valuable to integrate some of the key regional key site factors (Lavender et al. 1990, Spittlehouse and Stathers 1990, Stathers et al. 1990) that have been well documented to affect seedling survival and growth. The five broad categories of necessary information are:

- locational attributes
- climate
- soil
- vegetation
- fire risk

Some of the themes can be primarily addressed with regional data available from published maps and databases, but others will require on-site assessments and verifications. There are many sources for regional data that are constantly improving. It is important to realize that regional datasets and spatial coverages have often been created by interpolating between a relatively small number of field plots and therefore may not be accurate at the microsite scale that often determines seedling survival. Successful reforestation must use both the regional information that is now available for most forest regions with the local and microsite information that can only be collected with detailed site visits.

Pre-Field Site Assessment

Office research will supply important information about the site from local and regional databases and a variety of other relevant documents. The maps and data acquired during map development are essential to the next steps in site assessment process. Data available online and from other sources include information on soils, vegetation types, botanical surveys, endangered species, archeological sites, logging history, and climate. This information is useful to field personnel in preparation for conducting onsite-specific analysis and is important when planning a reforestation project.

Making a Site Map

A comprehensive base map is the foundation of a site assessment. It is needed to organize information and to divide the site into units with similar treatments. The elements (layers) of a useful map include:

- a) Contour lines for information on elevation, slope, aspect and topography. Traditional survey data is available from US Geological Survey (USGS) sources and other sites that often combine the basic data with other information. More advanced sources of detailed elevation data including LiDAR, radar, and advanced photogrammetry are constantly being improved and are increasingly used in forest management in the United States, Canada and Europe.
- b) Roads to determine access. Data on roads is available from many sources:
 - Counties and state agencies often have GIS layers that are up to date and downloadable;
 - Most large companies and agencies have their own databases;
 - Aerial photography and imagery can be used to determine road locations.

The locations, condition, and accessibility of all office mapped roads relevant to the project should be confirmed during site visit(s).

- c) Water features including springs, streams, lakes and watersheds. Domestic water sources (ditches, water intakes, wells, etc.) need to be mapped to give adequate protection from silvicultural treatments and to minimize liability. Identifying specific water drafting source(s) is also important for spray operations and road dust abatement operations, if needed. In addition to state agency resources, the National Hydrography Dataset (NHD) managed by the US Geological Survey is an excellent source of accurate data on streams, lakes, and watershed boundaries (United States Geological Survey 2019b)
- d) Property lines, property corners, utility and access easements, and parcel data for determining ownership and ownership patterns. These may affect road right-of-ways, access to the property and, depending on neighbor concerns, which treatments can be used.
- e) Infrastructure, such as buildings, powerlines, waterlines, wells, water intakes and gates, are some of the structures that may affect management decisions and mitigation measures.
- f) National Agriculture Imagery Program (NAIP) with digital ortho-photography gives aerial images of vegetation patterns that are useful for vegetation typing and other data development (United States Department of Agriculture Farm Services Agency 2019). GIS contours can be overlaid on the imagery to provide a contour map and vegetation typing all in one.

Locational Attributes

Ownership information for both the subject property and neighboring properties can be obtained from the county assessor's offices, past Timber Harvest Plans (THPs), or other online sources. This information, including maps, can provide the legal description, property lines and corners, neighboring property owners and identify access and utility easements across the property. All legal owners of the subject property must be identified prior to any activity. Acquiring adjacent ownership information is important to ensure that access permission is obtained before a project is undertaken. Rough acreages for the project may be obtained from initial mapping efforts. As mentioned above, seed zone maps can be obtained from Cal Fire's FRAP website for the project area to identify the appropriate conifer seedlot(s) to use for growing conifer seedlings in the project area.

Coverages for locational attributes such as elevation, latitude and longitude, slope, aspect are included as base maps in most GIS systems. Additional data can be downloaded from the USGS (United States Geological Survey 2019a) and other entities. More detailed products using technologies such as new satellites, LiDAR, radar, and advanced photogrammetry are continually being developed. The more advanced systems provide data at a much finer scale that may provide valuable microclimate data relevant at the individual planted seedling level. The advantages of using the more detailed information need to be weighed against the higher costs and limited track record on their long term efficacy in creating the desired stand of mature trees over the next few decades.

Topography

Basic topographical information including elevation, slope and aspect can be gathered from topographic base maps that are available in digital form. Elevation ranges must be identified for each management unit. This data, along with vegetation, soil, logistical and other operational information can be used to divide the project into units. These units can be sorted and organized by similar prescriptions, schedule of activities and cost. Elevation is a critical factor for determining conifer seed requirements, conifer species, planting window, access issues, vegetation control and spray timings.

Slope influences water and air drainage and soil stability. Flats areas may be frost pockets that require planting frost tolerant conifer species. Slope also influences what management tools are available due to operability constraints on mechanical equipment. Slope can also significantly influence the viability and cost of mechanical or manual treatments.

Aspect has a strong influence on micro-site and vegetation complex, and therefore has a strong influence on vegetation management prescriptions. Aspect is often used to define units of a project due to its strong influence on many management activities. North facing slopes receive less solar radiation and are

therefore colder and have less evaporation. South facing slopes are warmer and can often be planted earlier but also will experience low soil moisture availability earlier. Aspect will affect the choice of conifer species to plant and the timing of planting. Sites with different aspects can have very different soil surface temperatures and retain snow for significantly different periods of time. North and others (2019) suggest that topography, slope, and aspects serve as an appropriate ecological foundation for reforestation decision making that may drive changes in reforestation tactics.

Climate Data

Climate will dictate many decisions in formulating a reforestation plan. The species planted, stock size, planting season and timing of vegetation management treatments are all influenced by climate. Most climate information can be obtained before conducting an on-site field assessment. The most important climate factor for reforestation in Mediterranean climates is precipitation. Since available soil water is the greatest limiting factor on seedling survival, the initial precipitation sets the limit on how much water will eventually be available for potential storage in the soil profile and available for seedlings growth. In general, reforestation efforts are more successful on sites with high precipitation and more challenging where water is limited. The timing and type of precipitation will influence reforestation plans. Areas where precipitation occurs mainly as rain throughout the winter are usually suited to planting between winter and early spring with spring applications of residual herbicides. In contrast, high elevation sites where precipitation mainly occurs as snow and can impede access may be more conducive to fall planting or fall residual herbicide applications or planting from early spring to late spring..

Extreme temperature and wind can negatively affect conifer seedlings growth and survival (Kolb and Robberecht 1996). High temperatures can cause sunscald that girdles the cambium of tree seedlings, while high winds can lead to desiccation and abrasion issues. Climate data may help forecast these conditions so that the forester can potentially mitigate the issues through stock type, natural or man-made sunshades, planting season or mechanical site preparation method. Topographic maps can be useful for identifying potential frost pockets that may be verified in the field.

Before beginning the on-site assessment and creation of operational maps, baseline maps from available regional data sets should be compiled, especially for large projects. If the landowner does not have locally relevant climate records, current and historical climate data relevant for reforestation in California can be downloaded from sites such as the Desert Research Institute, PRISM, and Cal-Adapt (Desert Research Institute 2019, PRISM Climate Group 2019, UC Berkeley's Geospatial Innovation Facility (GIF) Cal-Adapt). Those entities have developed wall to wall map layers based on advanced modeling of the data from many weather stations on temperature, precipitation, wind, solar radiation, fire weather and vapor

pressure deficits. Having better information beforehand on these factors can have significant value on determining what steps should be taken to guarantee high seedling survival. The species we plant are long-lived species (100 years plus) and climate is predicted to change during this period. Tools like Cal-Adapt may help foresters bet-hedge against future climate change by adjusting species, seed zones by incorporating this analysis into their pre-field assessment. This is beyond seedling survival but more apropos to tree persistence. For example, the historic temperature and precipitation data can provide information on the probability of future drought or high temperature conditions that may warrant even greater attention to controlling water use by competing vegetation (Balandier et al. 2005, Zhang Jianwei et al. 2013) the potential utility of seedling shade devices, and the choice of more drought tolerant seedlings (Young et al. 2019).

Soils Data

Soil is the very foundation of the forest ecosystem and critical to its sustainability. Knowing the soil type is helpful in determining whether the site can support a conifer forest, the likely productivity of the site and potential limiting factors. The most relevant soils data sets are all based on the Natural Resources Conservation Service (NRCS) Web Soil Survey data and are accessible through a number of applications that present the data in a variety of easy to use formats for both desktop and mobile devices.

Characteristics of soil types that are useful in developing plans are: soil texture (percent sand/silt/clay), depth to bedrock, rock content and available water storage (AWS). Other relevant factors include organic matter content, nutrient availability and mass movement potential. For example, in conjunction with climate data, and aspect, soil texture and AWS can influence which species to plant. Depth to bedrock or hardpan, nutrient availability and AWS combine with climate and aspect to influence productivity. Rock content and compaction can affect the choice of planting tool, seedling stock type and cost (See “Planting” Chapter). Organic matter content can affect the choice and rate of pre-emergent herbicides used for vegetation control (See “Vegetation Management” Chapter) (Neary et al. 1983). Identifying unstable soils is necessary for developing operational constraints and mitigation measures. Coarser soils with low organic matter are more susceptible to erosion and may need wider equipment and spray buffers. Sandy soils have lower water holding capacities but are less susceptible to compaction during harvest and mechanical site preparation. Soil color can influence heat reflectance and soil temperatures.

Soils data is readily available for most forested areas of California from the Natural Resources Conservation Service (NRCS) Web Soil Survey and the California Soil Resource Laboratories (CSRL) Soil Web application hosted by the University of California Davis. Since the original data is mapped at a 1:20,000 scale, users should realize that the accuracy of the information may not be accurate for small mapped units. Reports also include vegetation data on conifer, weed and brush species associated with

each soil type. Links for the two sites can be found at

<http://websoilsurvey.sc.egov.usda.gov/app/websoilsurvey.aspx> NRCS Web Soil Survey and <https://casoilresource.lawr.ucdavis.edu/> CSRL Soil Survey and SoilWeb Apps.

An example of how Soil Web Survey data is used for reforestation decisions can illustrate its value. Figure 4.1 shows a soil type map of an area within the reforestation after the 1992 Fountain Fire (Zhang Jianwei, Jeff Webster, Robert F. Powers, John Mills 2008). Using the NRCS Web Soil Survey site, a specific ‘Area of Interest’ was chosen to provide insights into the relative reforestation success in the area. After the fire, Douglas-fir conifer seedling survival planted in the mid 1990s on Cohasset soils was better than on Windy-McCarthy. Table 4.1 shows a significant difference in available water storage (AWS), with Windy-McCarthy soils having a much lower AWS than Cohasset. A lower AWS indicates less total water availability in the soil profile, greater competition for water by all plants, and hence a greater need for vegetation management to ensure survival and growth of the planted seedlings. A low AWS is also an indication of the potential benefits of planting conifer species such as ponderosa pine that are more adapted to harsher sites, rather than species such as true fir or Douglas-fir that need more water.

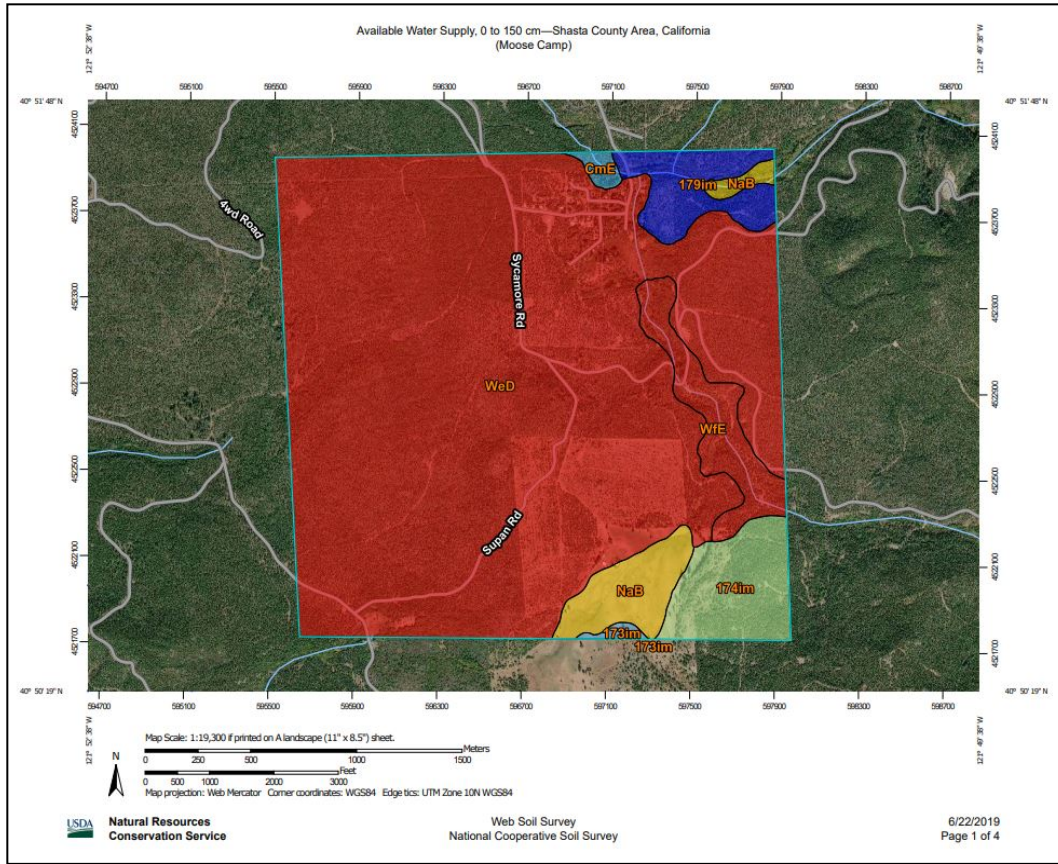


Figure 4.1 Soil types for a portion of the 1992 Fountain Fire near Moose Camp, Ca. Location: 40.851 N, -121.853 W, <https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx>.

Table 4.2 Available water storage for several soil types within a unit in the 1992 Fountain Fire.

Table Available Water Supply, 0 to 150 cm - Shasta County, California

Moose Camp

Map unit symbol	Map unit name	AWS rating (cm)	Acres in AOI	Percent of AOI
173im	Gaspar-Scarface complex, moist, 15 to 30 percent slopes	22.73	3.8	0.3%
174im	Gaspar-Scarface complex, moist, 30 to 50 percent slopes	20.72	67.5	5.1%
179im	Goulder, gravelly sandy loam, 15 to 30 percent slopes	25.20	51.3	3.9%
CmE	Cohasset stony loam, 10 to 15 percent slopes, MLRA 22B	22.36	6.4	0.5%
NaB	Nanny gravelly sandy loam, 0 to 8 percent slopes	13.53	51.4	3.9%
WeD	Windy and McCarthy stony sandy loams, 0 to 30 percent slopes	10.60	1,072.6	81.8%
WfE	Windy and McCarthy very stony sandy loams, 30 to 50 percent slopes	8.92	58.5	4.5%
Total			1,311.5	100.0%

Source: Soil Web Survey . <https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx>

Vegetation

The status of the vegetation for a reforestation project will vary based on the type of project. Reforestation after a timber harvest will be on a 1 to 25 acre unit surrounded by older forest stands. The vegetation for a restoration project will typically be a mix of shrub and grass species currently occupying a site that once was covered in trees. The vegetation after a wildfire will be mainly fire-killed understory vegetation with tree mortality ranging from 0 to 100%. California's public agencies have developed a number of vegetation products that have relevance in describing what tree species have historically been present as well as other vegetation that may compete with new seedlings. The California Department of Forestry and Fire Protection maintains the FVEG system (Fire and Resource Assessment Program 2019), the California Department of Fish and Wildlife has developed a number of wildlife and vegetation map products that may be of value for reforestation projects (California Department of Fish and Wildlife 2019), Region 5 of the USDA Forest Service maintains their own vegetation map system (Pacific Southwest Region 2019), the Forest Inventory and Analysis unit of the USDA Forest Service maintains maps based the system of over 5,000 FIA plots (USDA 2019), and other federal agencies collaborated to produce the Ecoregions maps (United States Environmental Protection Agency 2019). Each of these products provides a slightly different product based on different sources of information and projected uses. From a reforestation perspective, the most relevant vegetation products are often related to funding and regulatory issues of the project.

Beyond the large scale mapped vegetation units, ortho-photography and other aerial imagery can be used to do basic vegetation typing in preparation for the on-site assessment. The full color National Agricultural Imagery Program (NAIP) coverages along with other datasets can be downloaded (Natural Resources Conservation Service 2019) and integrated into the project GIS. This imagery will give the forester an initial estimate of what conifers are capable of growing on the site as well as what woody or herbaceous vegetation may be on the site that may become a problem. The species and type of vegetation present will also aid the forester in determining site quality.

Understanding the disturbance history can give valuable insight as to why the species currently present on a site exists there. For example, a past harvest may have removed a dominant over-story of ponderosa pine, leaving the white fir under-story that is drought intolerant to dominate the site. This stand may become susceptible to drought and insect attack long-term. If the forester does not know the stand history, it might be incorrectly assumed that the area is a white fir site and should be replanted to that species rather than to pine species that are more adapted to that site.

A document search prior to going out in the field can also provide valuable insight into the stand's recent history. Timber harvest plans (THPs) are public documents and should be available from CALFIRE's

CALTREES database information system: <https://caltreesplans.resources.ca.gov/caltrees/> for any timber harvest activity conducted since 1973. The USFS also maintains timber sale records at the district ranger or supervisor offices of each National Forest. Fire history is mapped for the state by CAL FIRE and the USFS and is available on the FRAP website either as pdf maps, viewers or download of GIS data: <https://frap.fire.ca.gov/mapping/>. Landowner insights can also be a valuable source of early harvesting history and fire information that may not be captured in publicly available maps or databases.

Silviculture

Before going out in the field, the forester should know what logging and silvicultural systems have been used on the site and will be used in the future. In many areas the historic silvicultural practices will have left major changes to the current vegetation. Historic preferences for higher value species such as pine and a dependence on natural, rather than planted, regeneration have produced mixed conifer stands in many regions with relatively fewer pines and far more white firs compared to what may be a more productive and resilient mix of species. Considering what mix of species is best suited for each reforestation site is an important step for a new reforestation project. The proposed silviculture activity that is planned immediately before the reforestation will affect what condition the unit will be in after logging and what are the necessary requirements for regeneration. Different silvicultural systems, such as clear cutting, shelterwood or group selection, can influence the amount of artificial regeneration required. The type of logging system used significantly impacts the amount of slash generated and hence the potential need for mechanical site preparation.

Sensitive Species and Sites

Any potential issues regarding sensitive sites or endangered species should be researched prior to the on-site field assessment. Potential water quality impacts from excess soil runoff can also be a major potential issue for fish and amphibian species. Foresters should conduct an initial assessment using aerial photography, past THP's, GIS, or local knowledge to identify any potential water issues such as sensitive streams, domestic water sources, ditches, ponds and lakes.

Protection of sensitive, endangered and threatened species should be evaluated in planning for any forest management project. Any species listed under federal or state Endangered Species Acts that may occur in the area should be identified. The California Natural Diversity Database (CNDDB), managed by the California Department of Fish and Wildlife, is a required check for getting any project that involves state funding or approval: <https://www.wildlife.ca.gov/Data/CNDDB>. A QuickView Tool is available for free but access to complete location data entails a fee. Most large organizations and forestry consultants have subscriptions to this service.

The California Native Plant Society (CNPS) provides a database (<http://rareplants.cnps.org/>) of its Inventory of Rare and Endangered Plants with various search tools for rare plant locations and their status. The CNPS Rare Plant Ranking System ranges from presumed extinct species to limited distribution species now on a watch list. One search tool that is particularly helpful is the “9 Quad search” that provides a list of rare plant species in the nine USGS quadrangle map area around a project area.

CAL FIRE funded or permitted projects (e.g., THPs, Emergencies, CFIP, etc.) require a “Records Check” using the Centers for California History Information System (CHRIS) to determine if known archaeological sites exist in the project area. After records check information has been received, an archeologist or a trained RPF must conduct a field survey of the proposed project area.

Fire Risk

Fire risk is an increasingly important consideration in reforestation planning for a number of reasons. Wildfires are an increasingly significant driver of reforestation needs, especially on federal lands (Starrs et al. 2018) and need to be taken into account when managing the stand for at least 50 more years. Data on the historic impact of wildfires on vegetation as well as future fire risks are relevant reforestation programs in terms of what can be done to increase the probability of survival of the planted trees and the role that trees and other vegetation in creating the fuel loads. Statewide data on fire risk levels can be accessed from CAL FIRE’s Fire and Resource Assessment Program (Fire and Resource Assessment Program 2019). Natural regeneration after wildfires in California is not assured, especially when the fire severity is high (Shive et al. 2018, Welch et al. 2016). Areas with high fire risk are becoming areas that need pre-planning in the event of future reforestation needs (Tepley et al. 2017, Thompson et al. 2007, Zald and Dunn 2018). High fire risk areas are also factors to consider after the seedlings are established with respect to how the future tree density and levels and types of competing vegetation will add to fuel loads and affect future fire behavior. Land managers may want to manage to lower tree densities and patterns of other vegetation to reduce any future fire severity and tree mortality (Kobziar et al. 2009) (Dodge et al. 2019, Zhang Jianwei et al. 2019). It may be desirable to include in the design of reforestation projects in areas with a high and increasing fire probability plans to treat stands of different ages to reduce wildfire mortality (Jain et al. 2019), as well as more explicit permanent fire breaks with limited tree density and control of understory vegetation to limit fuel loads and fire spread over coming decades.

On-Site Assessment

The main purpose of the onsite field assessment is to verify information that was obtained from other sources and to evaluate critical factors regarding reforestation that cannot be obtained in the pre-site

assessment. Field observations cover a wide range of topics and are the foundation of any reforestation plan (Table 4.2). To help facilitate the field assessment, it is a good idea to have some type of site assessment or planning information sheet for each unit such as (Webster 1992) or (Rynearson 2008b). An example of a completed site assessment and project plan, (Rynearson 2008a), is in the appendix along with the examples of site assessment and planning templates.

Locational Attributes

The topographic layout of the units will be important for access, planting activities, and identifying steep or unstable slopes that will need field level evaluations to determine any specific operability constraints and specific actions that will need to be taken during future activities. The area within the boundaries of the reforestation project is the primary focus of the assessment, but some important considerations will require observations of adjacent lands and access roads. The reforestation site should be divided into smaller more homogenous units that will each require a separate set of observations. Accurate acreage is important for reliable reforestation planning and budgeting. If feasible, use a Geographic Positioning System (GPS) to confirm and mark the closest known surveyed corners and identify surveyed property boundaries on the ground. If the project area has poorly defined property boundaries, it may be necessary to have a survey conducted by a licensed surveyor. Acreage for project or unit boundaries can be determined after final flagging and GPS mapping.

Identifying who owns the land surrounding the project site and how it is being managed can help prevent misunderstandings or problems later on. Neighbors are often concerned with aesthetics, water quality, equipment noise, and the use of pesticides so these concerns might need to be addressed during the planning phase. Communicating with neighbors before a project starts could prevent later problems or facilitate helpful mitigations. Neighboring properties can be a source of problems as well. Issues such as wind-throw from recently logged stands, weed encroachment or illegal building across property lines are common issues that may need to be addressed.

Road systems may impact cost, management feasibility and eventual success. Access to the property through other ownerships may require permission or permits and locked gates may restrict access. Identify which roads are permanent, seasonal or temporary on the map. Note the proximity and the type of roads closest to each unit (e.g. seasonal dirt road all the way into unit a few miles from paved county road). Whether roads are rocked or native surfaced can affect access early or late in the season during planting or spraying season when conditions are wet. Check to see if any road work may need to be done to facilitate equipment or vehicle access. Note the aspect and timber cover of roads within the project area. Roads on north faces or that have heavy timber cover, may require snow removal in the spring for

planting or spraying access or may require fall planting. Be sure to participate in the harvest planning process so that roads will remain open and usable for reforestation activities after the harvest is complete. Locate all easements, including above and belowground utilities on or near the project site. These sites may need to be avoided by heavy equipment and when planting. It is also necessary to survey for any domestic water uses coming from the subject property as special concern must be taken to avoid any water pollution. Water rights held by others on the reforestation site or illegal water use may also need to be addressed.

Climate Data

Most of the relevant climate information can be obtained before the field visit. However, frost pockets are the one thing that needs to be verified in the field since the relevant topographic patterns that can create frost pockets are often not recognizable from maps. Low, cold, flat areas with poor wind drainage are especially susceptible to frost, especially on the east side of the Cascade or Sierra Nevada Range. Frost pockets will require planting species that are more tolerant to cold conditions. In most cases, this means avoiding planting frost susceptible species such as Douglas-fir seedlings and planting more frost tolerant species such as pine.

Soils Data

Soil types from soils maps needs to be verified in the field. As noted by the NRCS, the soils are mapped at a 1:20,000 scale and may not be accurate for a small number of acres. Don't take for granted that the mapping of soil types is precise enough for a particular unit within the project area. The soil type, texture and percent organic matter will significantly affect residual herbicide efficacy and mobility. Soils should also be evaluated for rockiness to determine the planting method and stock type. The available water storage (AWS) will directly control water availability to the seedlings and other competing vegetation. If the forester is unfamiliar with the soil type, soil samples can be taken and sent into a lab to determine the soil type and texture as well as the percent organic matter. Erodible or unstable areas need to be mapped and mitigation for vegetation management and mechanical site preparation treatments need to be developed for these areas.

Vegetation

The on-site assessment will complement the existing information with more detailed information of the species and condition of competing vegetation, the condition of the advanced tree regeneration in terms of future growth, seeding potential, insects and disease presence, fire history impacts, and other factors. At the site assessment the forester can verify the site quality based on the vegetation present. In addition to assessing the growth rate of mature conifers, site quality information can also be ascertained from the

competing vegetation. Poorer sites in California may have a brush complex consisting of buckbrush, whiteleaf manzanita, chamise and yerba santa, whereas higher quality sites may have tanoak, bigleaf maple and deerbrush. The presence of grey pine or Oregon white oak also indicates very low site quality.

The presence of advanced regeneration can affect planting patterns, density, and species choice. Some important questions to evaluate include:

- If there is advanced regeneration, will it be damaged by the logging and is it worth saving?
- Is the advanced regeneration grouped or evenly distributed?
- Does it have at least 50% live crown? Is it growing sufficiently to release?
- Is it infected with a disease such as mistletoe or is it vulnerable to infection by overstory trees not marked for harvest?
- Is it shade tolerant or sun tolerant?
- Will it survive the exposure to sun?
- Will the advanced regeneration have a negative effect on growth and health of a new plantation through competition for sunlight or water?

Another factor to evaluate is whether any natural regeneration might occur on the site. Generally, small group selection units will be within the dispersal zone of surrounding trees and will seed in at least partially, but larger clearcuts and wildfires are more sporadic in scale and density of natural reseeding. If there is a viable cone crop the year of logging, there is a good chance some natural regeneration will occur. Some silviculture methods, such as seed tree or shelterwood cuts, can increase the chance of natural regeneration as seed bearing trees will be left on site for a decade or more. The number of trees per acre at planting can be adjusted lower if significant natural regeneration is likely. The species mix to plant can be adjusted to account for species likely to seed in versus species not likely to seed in.

Some things to consider when developing prescriptions during an on-site visit are: What is the current stand structure? What age classes are present? What is the distribution of species and age class? Will the current residual trees release or are they too old? Is an uneven-age stand worth keeping or is there too much brush in the under-story to create new regeneration? Is it time to start over? With such issues, it is very beneficial for the reforestation forester to be part of the silviculture prescription process to help address them sooner than later.

Detailed information about competing vegetation on the site is essential, particularly the approximate percent cover by species of hardwood, brush and herbaceous vegetation. The type and cover of vegetation on a site can indicate site quality as well as determine vegetation management prescriptions, mechanical site preparation needs, potential animal damage (habitat) and herbicide application techniques required. It

is also important to note whether a change in vegetation type will occur once the stand is harvested. Sometimes when a stand is harvested, vegetation that has not been visible on the site for many years establishes itself from the seed bank. Looking at open areas near the current project or for brush skeletons within the project may yield clues as to what vegetation may germinate after logging.

The type of vegetation present on a site will also let the forester know how to treat it. If there is large woody brush in the under-story piling may be necessary. If the brush is low growing and accessible by hand crews, the stand is probably well suited to pre-harvest chemical site preparation. This treatment typically eliminates the need for piling as a site preparation treatment after logging. If conifer production is a desired objective, a mature hardwood component in the stand may dictate that an herbicide treatment (e.g. hack and squirt treatment) is required. It's imperative for regeneration foresters to understand how to deal with not only the vegetation that is present prior to logging but also the vegetation that may show up after the logging operation as some seeds and plants will respond positively to the disturbed conditions. See Chapter 9-“Vegetation Management” for more information.

Silviculture, logging and fire history has a significant effect on conifer and other vegetative species present on a site. The mix of conifer species currently present may not be what was originally there and may not align with landowner objectives. The site visit and assessment should examine the underlying conditions on the site and not just the existing species when determining the species that can be successfully planted.

Silviculture

Foresters need to anticipate how the different silviculture regimes and series of treatments will affect reforestation treatment needs. The reforestation forester needs to be aware of how the stand will be logged and address any potential issues that may affect the reforestation. The method of logging will have a significant impact on how much additional site preparation will be needed. For example, whole-tree logging dramatically reduces slash loads and the subsequent need for piling. In comparison, cable logged units are usually steeper, leave the most branches and tops on site, are covered in post-harvest slash and usually have limited road access – all factors that affect the design and specifications of subsequent site preparation and reforestation activities.

The type of silviculture may also have a dramatic effect on stocking levels, spraying method, mechanical site preparation needs and disease issues (e.g. mistletoe). The site visit is the time to determine what type of site preparation methods will be necessary: chemical, manual, mechanical, burning or a combination thereof. The stand structure, logging method, silviculture and vegetation complex will all contribute to the decision-making process.

Planting requirements, such as seed specifications, planting method (i.e. hoe, shovel, auger), and planting stock and density also need to be evaluated at the site visit. The type of silviculture and whether the harvest resulted from a wildfire or green timber sale will affect the number of trees per acre to plant. Slash loading may also affect stocking levels. Seedling stock type and size also need to be addressed at the site visit. Animal issues, wind or sun exposure, rockiness of soil and access will have an effect on planting method and what size and type of stock is planted.

Wildlife habitat is an important ecological and social aspect of forest environments. This term can refer to vegetation type, seral stage, stand structure, or key elements such as snags or large woody debris (LWD). What habitat elements should be retained or encouraged? Important habitat elements to note at the onsite assessment include species and size of snags (especially those with evidence of use), LWD and hardwoods. These need to be balanced with potential impacts to the land manager's objectives and influence on the young plantation. The quantity of each influences fuel loading and future fire risk. Excessive fine fuels are a greater risk than incidental amounts of LWD. LWD can also provide favorable micro-sites for planting.

Sensitive Areas

The on-site field assessment is critical to confirm and evaluate sensitive resources for protection. Hydrologic features such as streams, springs, wetlands ponds and lakes should be evaluated to confirm proper field location and flow or status data. Consultation with the landowner is important to determine if there are any domestic water issues and to confirm if any special buffer zones around these features are required. Determine if there are any domestic water issues such as irrigation or domestic ditches, water lines or wells that need to be protected. Locate and confirm suitability of specific water drafting sources that could be used for spray operations and road dust abatement if needed. When on the site, maintain an awareness of potential sensitive species and confirm their presence if possible. Verify any results from NDDDB and CNPS database searches. The archeological survey may be conducted during the site assessment if such a survey is required and has not already been done by an archeologist.

Pests, Insects and Disease

Evidence of animal pests, insects and disease is difficult to collect in the pre-field assessment but can play an important role in the success or failure of reforestation efforts. It is important to observe and document the subtle signs that might give indications of challenges likely to be encountered. See Chapter 10 for more detail on damage. The forester should examine existing vegetation for any evidence of the many species insects that can damage seedlings and young trees. Sometimes problems can be anticipated by observing insect activity in adjacent stands. Prevention of insect problems during seedling establishment

is often accomplished by good vegetation management and conifer stocking control. Minimal competition from other vegetation increases tree vigor and the seedling's ability to defend against insect attacks.

Identifying potential pest problems may aid in determining the species to plant. Signs of diseases are often present in existing stands prior to harvest and can sometimes be mitigated. For example, in stands where black stain root disease is present, altering the conifer species has a beneficial effect since the disease is host specific to either pine or Douglas-fir. Dwarf mistletoe, a parasitic plant that reduces vigor, often causes death in the host tree by secondary agents. It is likely to infect the under-story trees and adjacent stands but is also host specific. By altering the species composition to non-host species and removing infected over-story trees, the spread of the diseases can be controlled promoting a healthy future stand. Root rots can be particularly difficult to mitigate. Chapter 11, "Damage" describes the symptoms and treatment strategies of common root rots.

Low site quality can also be an indicator of potential damage from future insect and disease and animals. Trees on lower site qualities are more prone to attack than those on higher quality because the seedlings will be under greater stress. Attacks by insects such as pine tip moth, pine reproduction weevil and pine needle sheath miner are relatively more common on poor sites. In addition, note any obvious existing animal damage to older trees in the vicinity, such as cattle grazing, deer browse, bark removal by bears, and gopher tunnels or gopher related pockets of mortality (See Chapter 11 for a more complete list). Estimate the cover of dead brush skeletons and slash that can be used as hiding and denning cover for rodents and other animals that may increase populations. It is also valuable to note whether the area is in a deer or elk migration or winter range area, as different herbivory patterns can complement competing vegetation control or, alternatively, lead to high seedling mortality (Stokely et al. 2018).

Fire Risk

Mortality from future fires is a great concern for any reforestation project. For reforestation projects after a wildfire or to restore a shrub field that came up after a historic fire, there is strong evidence that the fire risk is high. Before the harvest or vegetation removal in a restoration project is undertaken, the forester should estimate the current fuel loading and how the harvesting, salvage logging, or brush conversion will affect the remaining fuel load. It is important to assess if there is an opportunity to biomass harvest smaller material to reduce the eventual fuel load. This requires a market, operator and suitable topography. Steep slopes will limit the harvest techniques available and cost to treat fuels. Reforestation activities also have the potential to increase or decrease fuel loads as the stand grows and develops (Knapp and Ritchie 2016, Kobziar et al. 2009). As the stand develops, the amount of live and dead fuel within the unit will increase. The reforestation plan can consider actions that would reduce the homogeneity of the fuel load in the developing stand.

Summary

A thorough site assessment, particularly the field site assessment to validate and improve on the pre-field assessment, is critical in the development of the schedule of activities and prescription for a reforestation project. It should provide information on all of the physical and biological characteristics of a reforestation site and the operational and logistical characteristics needed to successfully develop and implement the plan. The final plan will integrate this information with the objectives of the landowner, and the realities of project financing to create a prescription and a schedule of activities for the project.

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Appendices

Unit Planning Information Sheet (Webster 1992)

Site Assessment Template (Rynearson 2008)

Reforestation Site Assessment & Project Plan – Saddle Mountain (Rynearson 2008)

Project Plan – Saddle Mountain

Project Photos – Saddle Mountain

Chapter 4: Site Assessment

Unit Planning Information Sheet

Landowner/Property: _____ Date: _____

Unit: _____ Evaluator: _____

Acres: _____

Aspect & Topography (micro climate, temp. extremes, wind, frost pockets): _____

Soils (site plantability, bareroot vs plug, soil type & texture, slope stability): _____

% Slope (equipment operability):

Silviculture method: _____

Tree species present prior to harvest: _____

Logging Method: _____

Logging History: _____

Fuel Loading (type, amount & distribution, fire hazard vs. plantability): _____

Wildlife (Endangered species, local deer herds, winter range, summer range, habitat elements, snags, large woody debris, oaks): _____

Plant Species by % (with current climate, future climate): _____

Plant TPA (regulatory requirements, expected survival, desired TPA at first commercial harvest, PCT):

Residual Stocking (quality & distribution, seed sources): _____

Brush Species Present by % and total cover (successional trends, expected response to vegetation treatments): _____

Animal Damage (deer browse, gophers, cattle, etc.): _____

Chapter 4: Site Assessment

Insect & Disease Problems (root rots, mistletoe, etc.): _____

Access Issues (road network during needed season, snow, gates, etc.): _____

Site Prep Needed:

Spray (hand or aerial): _____

Pre-harvest or Post-harvest: _____

Foliar or Residual: _____

Mechanical (pile, rip, mulch): _____

Burn (broadcast or piles): _____

Planting Timing (early spring, late spring, fall) _____

Thinning Needs (treatment of thinned trees): _____

Neighbors (local concerns): _____

Fuel Loading (tons/acre now, expected over time): _____

Other: _____

Recommendations: _____

Harvest Vol/Acre:

PP

SP

DF

WF

IC

Other

% Species: _____

% Small/Large: _____

SITE ASSESSMENT TEMPLATE

_____ (landowner-tree farm name)

BACKGROUND (might need to break the following descriptions into separate units with distinct acreage for each, if each unit would have a separate plan of activities or cost)

Legal: T _____ N R _____ W or E Sec _____ (sub-section: _____)

Acres: approx. _____ (suitable & feasible for reforestation project)

Access: (proximity of road to unit & type of closest accessible road to unit.; proximity to main county road or highway etc. e.g. "seasonal dirt road all the way into unit a few miles from paved county road"; also is there legal road access or are right of way permits needed and/or watercourse crossing installation(s) needed etc.).

Survey lines & corner locations: (if feasible GPS closest known surveyed corner/s which might aid in future mapping)

Easements & Utilities (location of all easements, including above and underground utilities on or near project)

Sensitive areas (e.g. streams, springs, Unstable Areas, Arch. Sites, improvements etc.):

Annual Avg PPT: approx. _____" _____ (avg annual ppt + form of ppt e.g. "mostly snow" etc.)

Seed Zone: _____

Elev: approx. _____

Slope: _____ % - _____ %

Aspect(s): _____

Site Class: _____

REFORESTATION SITE ASSESSMENT & PROJECT PLAN

Landowner/Project Name: xxxxxxx / Saddle Mountain Project

Legal: NE¼ NE¼ Section xx and S½ SE¼ SE¼ Section xx, TxxN RxxE.

Acres: 40 (proposed for reforestation)

Access: County paved and then private rocky road to within ¼ mile of unit and then dirt road to within 300' of unit. Need to confirm or obtain easement/ROW from landowners to the west of NE¼ NE¼ Section xx.

Survey lines & corner locations (if feasible GPS closest known surveyed corner/s which might aid in future mapping): No corners or surveyed lines were readily located during site visit. Since project boundary will be close to property line see pre-condition #2 in the following project plan.

Easements & Utilities (location of all easements, including above and underground utilities on or near project): The landowner knows of no easements, including utilities within or adjacent to the project area. No utilities were observed on the site visit or aerial photos.

Sensitive areas (e.g. streams, springs, Unstable Areas, Arch. Sites, improvements etc.): None observed on site visit or on topo maps or aerial photos.

Annual Avg PPT: approx. 20" to 25" (in the form of rain and snow)

Seed Zone: 732 **Elev:** 3,600'-4,200'

Slope: 10%-45% (several steep pitches that flatten off to benches) **Aspect:** N to NW

Site Class: IV (Dunning)

Soil Type: (NRCS Intermountain Soil Survey) Chirpchat: very deep (60"+), well drained sandy loam soils that formed in volcanic ash and alluvium derived from volcanic rocks; Soils are stony with large boulders scattered throughout the project area, enough good, deep forest soils to plant most of the area to full stocking with commercial conifers.

Vegetation: Dense, decadent brush consisting of deerbrush (*Ceanothus integerrimus*), buckbrush (*Ceanothus cuneatus*), whitethorn (*Ceanothus cordulatus*), greenleaf manzanita (*Arctostaphylos patula*) and squawbush (*Rhus trilobata*). Deciduous tree overstory consisting of 15% canopy cover Oregon white oak (*Quercus garryana*) and 5% canopy cover California black oak (*Quercus kelloggii*). There are large conifer stumps left logging many decades ago in the proposed project area as well as scattered large ponderosa pine trees in brushfields outside the project area but nearby on the same soil type as project area.

General Comments:

The proposed project area is surrounded by several hundred acres of similar brush/oak type on Saddle Mountain that has become well established in what historically was a predominantly ponderosa pine / oak forest prior to logging several decades ago and disruption of the "natural" fire regime (i.e. instead of frequent light ground fires burning beneath an open overstory of large fire resistant pines, keeping brushy fuels low, now fires are less frequent but much hotter, burning decadent brush and relatively small oaks, that rapidly re-sprout and grow into a hazardous fuel load until the next fire). This alteration of the fire regime and vegetation dynamics does not allow for natural ponderosa pine regeneration and/or growth to maturity.

This project would be a good demonstration reforestation project since it would be typical of the hundreds of acres of moderately steep, non-stocked forestland in this vicinity that require management to establish productive native conifer forests again. But prior to contracting for the implementation of the following project plan there are two tasks that would need to be completed:

1. Landowner would need to confirm existence of easement(s) or obtain temporary easement from adjacent landowners (west of project area) to provide general contractor's equipment and crew access to conduct all of the planned operations.
2. RPF would need to obtain survey records and locate all 4 property corners bounding the NE¼ NE¼ Section xx, TxxN RxxE, or the landowner would need to contract with a licensed surveyor to establish those corners and lines if they are not in.

PROJECT PLAN

1. Year 1, Summer: Contract to aerial spray brush and some oaks to kill root systems to facilitate subsequent piling operations and prevent re-sprouting after clearing and planting (this step will facilitate subsequent piling operations as crawler tractors will not have to root out brush and disturb topsoil, but instead just clear enough herbicide-killed brush to facilitate planting operations). Landowner stated that Contractor could use helicopter landing site for loading chemical on Ranch property 1.2 miles NE of the unit.
2. Year 1, Summer/Fall: RPF locate and purchase ponderosa pine (PP) and some Douglas fir (DF) seed (zone 732 elev. 3.5 to 4.0) from CAL FIRE and/or a private timber company and contract w/ Cal Forest Nursery to grow seedlings in Year 2 for outplanting spring of Year 3.
3. Year 2, Summer: Contract to clear & pile, in some areas simply crush, dead brush skeletons with crawler tractor equipped w/ brush rake (do not need complete removal just enough to access ground for planting). Although slopes are steep in some places for tractor piling (up to 45%), having the brush dead for a year will make tractor work for site preparation feasible and not cost prohibitive, with minimal topsoil disturbance.
4. Year 2, Fall: RPF submit Smoke Management plan and obtain necessary permits and burn piles.
5. Year 2, October: Obtain necessary permits & PCA recommendation and contract to broadcast spray 3.5 lbs. Velpar DF per acre on 40 acres.
6. Year 3, January or February (after seedlings lifted and packed at nursery): Transport seedlings from Cal Forest Nursery and place in cold storage.
7. Year 3, March or early April (after snowmelt & soil temperature has reached 42 degrees or higher): Contract to plant 10,000 styro 5 containerized Ponderosa pine and 2,000 styro 6 containerized Douglas fir on 40 acres at 300 trees per acre (12' x 12' spacing)
8. Normally at this elevation and general area we do not net seedlings, but in this case with the surrounding brush habitat for rabbits and the winter deer herd on Saddle Mtn. the site should be closely monitored and if needed install protection netting after planting.
9. Years 4 to 6: Monitor competing vegetation and spray if necessary and funds available from private and/or state cost share sources. Although the pre-harvest foliar spray of current re-sprouting brush on the site, combined with the pre-emergent spray of to control new germinate weeds should greatly reduce the number of follow up sprays needed, it is likely an additional follow-up weed control treatment will be needed in Year 4 or Year 5.
10. Years 10 to 13 (7 to 10 years after planting): pre-commercial thin plantation to 135 trees per acre (18' by 18' spacing), favoring any DF that might survive. Even though at PCT age DF will be shorter than PP, within another 10 years DF should equal or exceed PP growth. Also, where present, thin black oak stump sprouts to 2 or 3 stems per clump.

REFORESTATION SITE ASSESSMENT & PROJECT PLAN



Brushfield in the proposed project area pictured in the foreground.



Large healthy ponderosa pines and sugar pines on a nearby site with the same soil type and precipitation as the proposed project area.



Illustration of Oregon white oak sprouts that cover approximately 15% of the proposed project area that along with dense brush will prevent natural establishment of shade intolerant conifers that are adapted to this fire prone site with relatively low annual precipitation .