Cambria Forest Management Plan

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Preface

This Forest Management Plan was made possible by a grant from the California Department of forestry and Fire Protection (CDF) under Senate Bill No. SB 1712 which allocated $350,000/yr for six years to undertake the management of pitch canker invasion of California's Monterey pine forests.

SB 1712 was sponsored by Senator McPherson and Assemblyman Fred Keeley. The bill was passed and signed into law on 21 September 1998. The fund has been administered by the CDF.

In 1999 a Grant of $110,000 was awarded to the Cambria Community Services District to develop a management plan for the indigenous stand of Monterey pines (*Pinus radiata* Don) in and around the Community of Cambria in Northwest San Luis Obispo County.

The consulting firm of Jones & Stokes was engaged to develop the management plan and ancillary documents under the guidance of the Cambria Forest Committee. The Committee is planning to apply for 501(c)(3) status as Non-Profit, Public Benefit California Corporation.

Reader's Guide

Why a Management Plan?

Monterey pine forests represent a unique and rare resource that occurs naturally in only 5 locations along the coast of California and Mexico. In addition to the Cambria forest, native Monterey pines are found on the Monterey peninsula, in the Año Nuevo area, and on Guadeloupe and Cedros islands off the Pacific coast of Baja California. All of the California populations are at risk as a result of past logging activity, development, and increased fire suppression, which have decreased the range of the species and substantially altered the natural processes to which Monterey pine ecosystems are adapted. Consequently, the species' continued existence in its natural occurrences now depends on proper management and conservation in these areas. The Cambria Forest Management Plan was created in response to this need.

The Cambria Forest Management Plan provides an integrated framework of techniques for the management of mixed native Monterey pine and coast live oak forest in the Cambria community and surrounding area. It will help to create a program dedicated to the conservation of the forested area, offering the flexibility to respond to changes in forest structure, funding, and management priorities over time.

As in any complex natural system, the needs of all native species in the Cambria area are intimately connected; appropriate management for Monterey pine success will benefit other native species as well. However, although the Cambria Forest Management Plan emphasizes management for Monterey pine success, it also addresses other species, such as coast live oak, that co-occur and interact with Monterey pines, in order to ensure an ecosystem-based management approach.

Who Will Use the Management Plan?

The Cambria Forest Management Plan was written to serve as both a guide for the experienced Professional Forest Manager and as a source of information for the Cambria community. Descriptions of treatment prescriptions and techniques

in this document address the expert but contain sufficient detail to be useful to readers who may be less familiar with forestry practices and terminology, but have intimate knowledge of the forest in which they live. The document also includes a glossary of selected technical terms.

How to Use this Document

This document was intended to be used as a practical management guide, cross-referencing between chapters as necessary. Alternatively, it can be read as a book, from cover to cover. In either case, each self-contained chapter will guide the user to related material in other chapters.

Most users will likely want to begin by reading chapter 1, which provides a brief introduction to Cambria's forest; summarizes the goals, objectives, and methodology of the Cambria Forest Management Plan; and provides an overview of the steps to be followed in implementing the Forest Management Plan.

Chapter 2 describes

- the steps the Forest Manager will follow to divide the forest into management units;
- how to establish forestwide management priorities;
- how to establish priorities for individual management units; and
- how to identify appropriate treatment prescriptions and techniques for each management unit, using the Site Condition Checklist presented in chapter 3.

The Site Condition Checklist in chapter 3 is designed for use in the field by the Forest Manager, where it will allow him/her to select a palette of appropriate treatments, based on existing site conditions. Because the checklist was intended to be a convenient and time-efficient tool, the questions it poses are specific enough to identify appropriate treatments, but will not result in an exhaustive inventory of resources. More detailed information may be collected as the Forest Manager prepares to implement the selected treatments.

Chapter 4 describes a range of possible treatment prescriptions, including their objectives and potential ecological benefits and consequences, as well as specific techniques for implementation.

Chapter 5 describes the regulatory context for management of Cambria's forest resource. Consulting chapter 5 will help to identify the regulatory and permitting requirements, if any, that apply to each of the treatment prescriptions identified by the Site Condition Checklist.

Chapter 6 is intended to support the Forest Manager in developing a monitoring and adaptive management program for each management unit under treatment. It describes the philosophy of adaptive management and the relationship between

monitoring and effective adaptive management; provides examples of monitoring parameters and schedules; and offers guidance for identifying the need to implement adaptive management.

Contents

Tables and Figures

1
Introduction

The Monterey pine forest in and around Cambria, in the North Coast Planning Area of San Luis Obispo County, California (figure 1-1, figure 1-2) is one of the most threatened native forest in the world. The importance of this tree as a world resource is unparalleled, however the genetic attributes of the native stand are in peril. In fact, the Monterey pine was petitioned in 2000 for listing as a threatened species.

The Cambria Forest Management Plan is intended to serve the community of Cambria and its environs and will provide an integrated framework of techniques for the management of the forest. It was created for use by an experienced Professional Forester to ensure comprehensive and effective management of a sustainable forest for the present and future benefit of the North Coast Planning Area's people, plants, and animals. The Professional Forester would be responsible to the implementation agency (i.e. a Services District). The Cambria Forest Committee may act in an advisory capacity to the forest management implementing agency.

Because of combined pressures resulting from the spread of pitch canker, the abrupt mortality associated with this disease, and the accelerating pace of development in the Cambria area, the Cambria forest is a rapidly changing ecosystem. Loss of Monterey pines in and around Cambria has been compounded by a lack of active forest management; both the boundaries of the forest and the conditions of trees within individual forest stands are altering on an ongoing basis. As a result, even the most thorough and well-designed forestwide inventory quickly becomes obsolete.

In response to this management challenge, the Cambria Forest Management Plan takes a programmatic approach, providing information and guidance designed to build on an experienced Forest Manager's knowledge and experience. The Cambria Forest Management Plan focuses on providing a system of tools and strategies that will be equally appropriate for situations in

which funding is available to conduct forestwide inventories and for times when forestry funding is more limited. In addition, the plan's emphasis on adaptive management grounded in the natural ecology of Monterey pine forests will allow the incorporation of future improvements in forestry practice as understanding of the Monterey pine forest ecosystem continues to increase, benefiting both the forest ecosystem and the community of Cambria.

Background

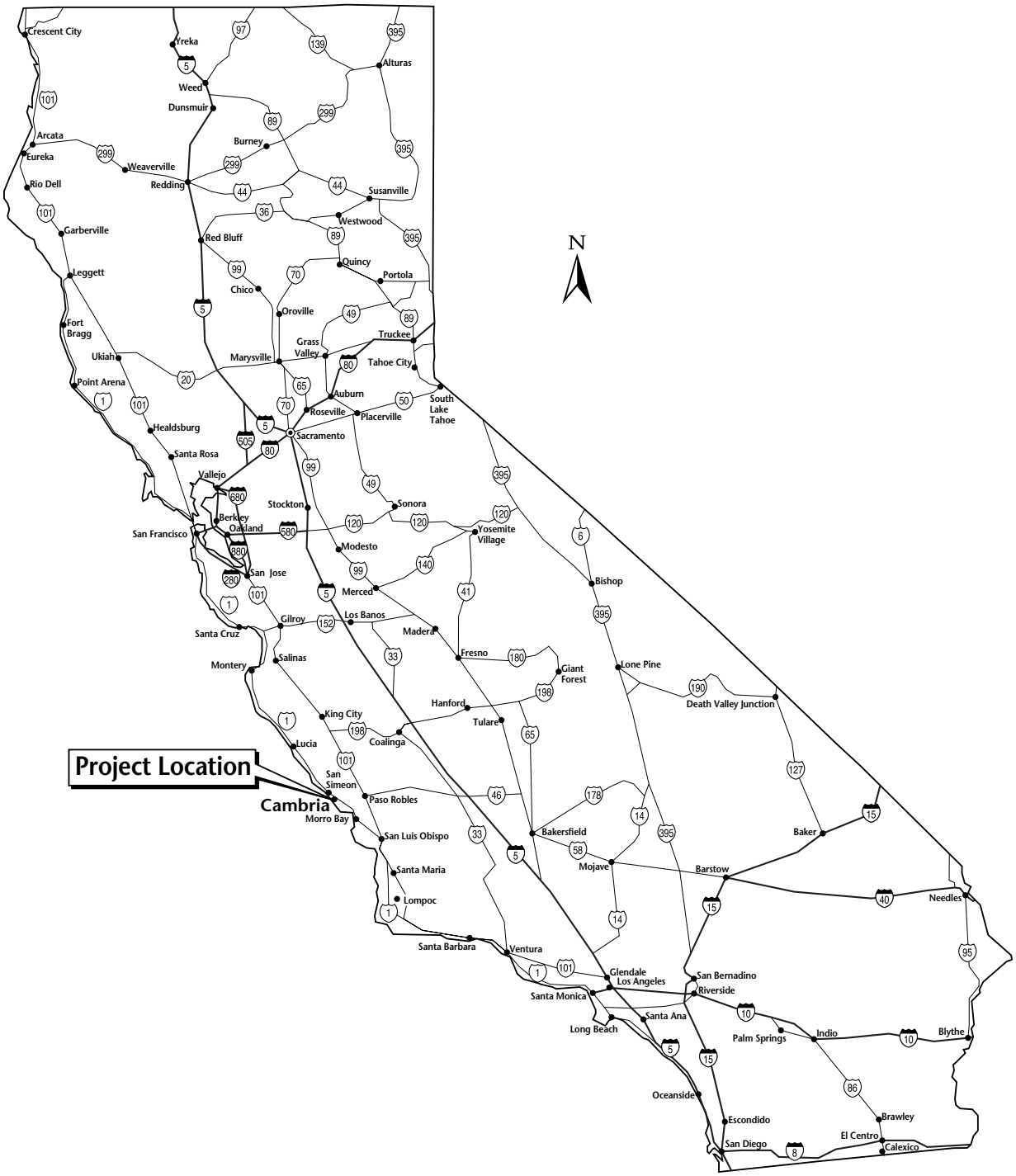
Monterey Pine Forest—a Unique Natural Resource

Monterey pine forest is a distinct form of closed-cone conifer forest, instantly familiar to Californians and visitors alike as a characteristic element of California's dramatic coastal landscapes. Monterey pine (*Pinus radiata*) is limited to a narrow range of soil, moisture, and temperature conditions. In addition, the species has a naturally short regeneration period and is dependent on the disturbance regime historically typical of coastal California habitats. As a result, Monterey pine forest has only a few natural (indigenous) occurrences: in and around Cambria, on the Monterey peninsula, and at Año Nuevo in California; and on Guadalupe and Cedros islands off the Pacific coast of Baja California (Jones & Stokes 1994). In these forests, Monterey pine co-occurs with other important California native plants such as coast live oak (*Quercus agrifolia*), creating a complex ecosystem uniquely adapted to local conditions.

Evidence from the fossil record suggests that native closed-cone pines, including Monterey pines, formed widespread forests along the outer coasts of California and Baja California at the end of the last ice age, approximately 10,000 years ago. Naturally occurring intervals of warmer, dryer climatic conditions during the last 10,000 years substantially reduced the extent of native pine forest, restricting Monterey pines in particular to small, isolated populations in especially favorable locations (Jones & Stokes 1994, Coffman 1995).

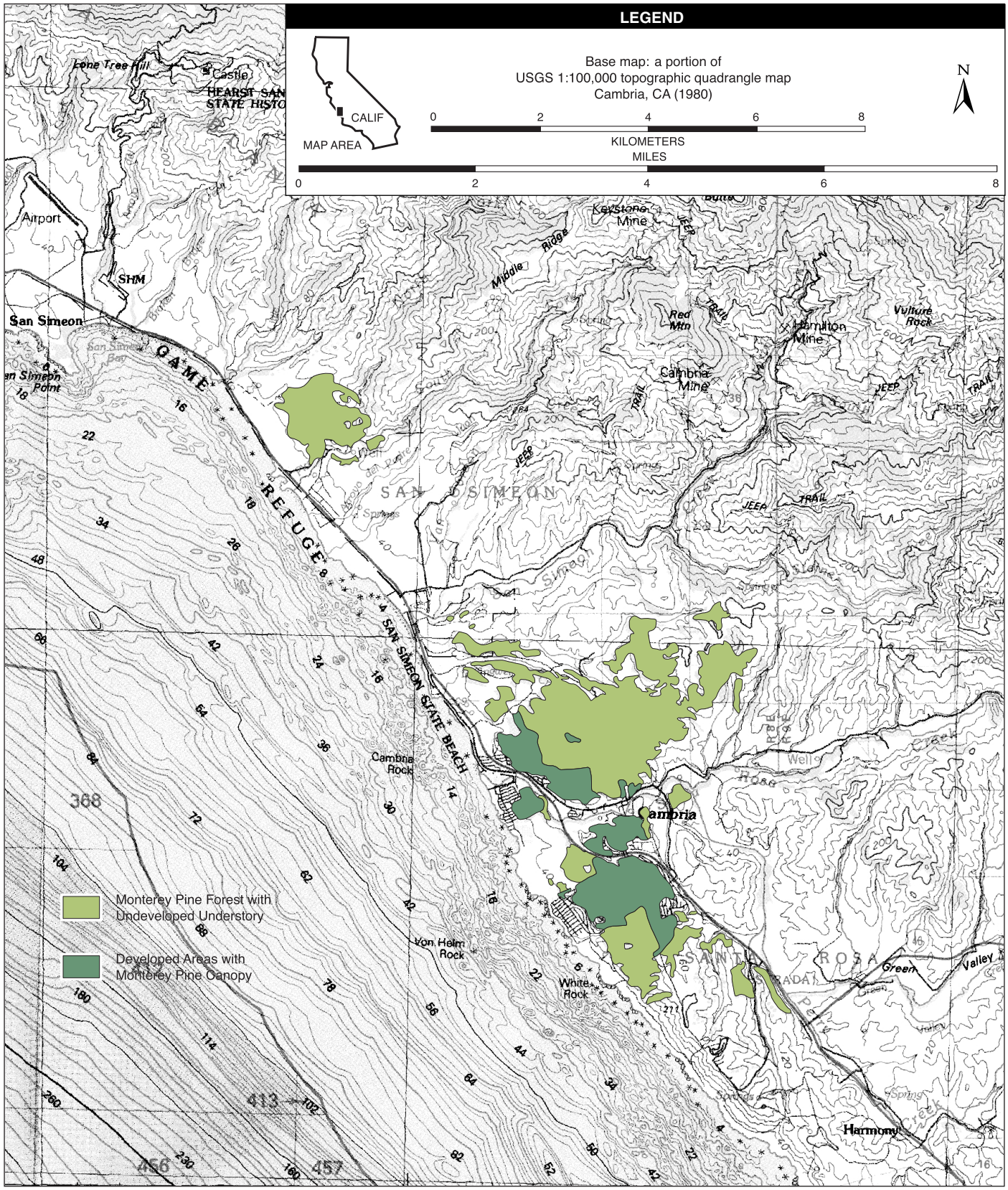
Monterey pine is now a federal species of concern and is on the California Native Plant Society's List 1B of species that are considered rare, threatened, or endangered in California and elsewhere. The total area of existing native Monterey pine forest is estimated to be about 13,500 acres. Monterey pine (not necessarily the Cambria variety) has also been planted extensively outside of its indigenous range, both in California and around the world (Jones & Stokes 1994, Huffman & Associates 1994).

Monterey pine forest covers approximately 3,500 acres in and around the community of Cambria. About 2,300 acres of the Cambria forest remains undeveloped; an additional 1,200 acres intergrades with developed areas. The Cambria forest represents a significant proportion (about 17%) of the remaining native Monterey pine forest in California and Baja California. Monterey pines at



Jones & Stokes

Figure 1-1
Regional Location



Jones & Stokes

Figure 1-2
Native Monterey Pine Forest Location

Cambria are genetically distinct from other populations (Millar 1986, Moran et al. 1988, Libby 1990, Rogers 2001).

Monterey pine forest has special value for the Cambria community. The forest moderates local climates and is a key feature of the area's scenic beauty, enhancing property values and attracting visitors who play an important role in the local economy. In addition, the forest provides wildlife habitat, offers recreational opportunities, and serves as a living natural link to Native American traditions.

Need for Management

Effective management of California's native Monterey pine forests is of great concern because it is a unique plant community with a naturally limited distribution. In addition, the ecological conditions that support California's native Monterey pine populations also support several other special-status plant and wildlife species in addition to the coastal live oak. Like Monterey pine, many of these species are restricted to specialized habitats along the coast.

The expansion of human populations in coastal California has reduced both the extent and the health of the state's native Monterey pine forests. Factors that have contributed to the forests' decline include:

- logging in the 19th and early 20th centuries,
- expansion of residential and recreational development at the expense of native forest, and
- increasing suppression of the periodic fires that promote natural forest regeneration in this disturbance-adapted ecosystem.
- recently introduced diseases

The introduction and spread in recent decades of pitch canker (a lethal disease caused by the nonnative fungus *Fusarium circinatum*) represents a further significant threat (Storer and Dallara 1992, Storer et al. 1995, Gordon et al. 1997, Storer et al. 2001). Much of the state's remaining native Monterey pine forest now consists of senescent or diseased trees. Another recently introduced fungal disease, Sudden Oak Death, is lethal to coast live oak, an important native codominant species in Monterey pine forest (Garbelotto et al. 2001). Although no cases of sudden oak death have been reported in the Cambria area, the disease is spreading in California's central coast region. Moreover, because the state's Monterey pine forests are located near growing communities, undisturbed forest and urbanized forest form a complex mosaic; carefully planned forest management is needed to differentiate and meet the management needs of both undisturbed and urbanized forest.

Development of the Cambria Forest Management Plan

The Cambria Forest Management Plan (hereafter, CFMP) was created in response to the need for well-designed and effective management of native Monterey pine et al. forest in the Cambria area. In the mid-1990s, an alliance of local builders, botanists, zoologists, engineers, and other concerned citizens received moneys for forestry services from a San Luis Obispo County Erosion-Control Fund. This initial award supported work that resulted, some years later, in an additional grant from the California Department of Forestry and Fire Protection to support the development of a comprehensive forest management plan. The community group reorganized and determined to incorporate as a California nonprofit public-benefit corporation under the name *Cambria Forest Committee* (CFC). The CFC now comprises a coalition of local citizens and some 20 organizations, representing virtually all government and private groups with a stake in the health of the Cambria forest. In 2000, the CFC retained Jones & Stokes to work closely with committee members and the Cambria community to complete the new CFMP.

Goals and Objectives of the CFMP

Following are the primary goals and objectives of the CFMP.

Goal 1. Improve forest health and maintain biological diversity, consistent with the Forest Management Plan and applicable laws, policies, and regulations.

- Maintain a mix of forest ages.
- Maintain/enhance habitat for native plants and animals in the forest.
- Control invasive nonnative plant species in the forested areas.

Goal 2. Reduce hazards to life and property, consistent with the Forest Management Plan.

- Measure and control fire-hazard materials throughout the forest.
- Establish and maintain fire-management guidelines.
- Develop criteria for identifying hazardous trees and implement a trimming/removal program.

Goal 3. Maintain and enhance aesthetic values of the forest, consistent with the Forest Management Plan.

- Maintain native-forest aesthetic values within residential neighborhoods; ensure that criteria for tree removal and replacement support maintenance of these values.

Overview of CFMP Methodology

The CFMP relies on a mosaic approach to meet its objectives. The mosaic approach was chosen because it mimics the "patchy" disturbance regime characteristic of natural forest processes, and because it can be administered and managed relatively easily.

The Forest Manager will divide the Cambria forest into individual management units (analogous to the tiles in a mosaic) and assess the status and needs of each management unit. Individual management units may be managed in different ways and for different outcomes, depending on site-specific conditions in and around each unit. Depending on the availability of funding and staff, on the cooperation of landowners and on the needs of each unit, 1 or more units may be actively managed in any given year. The overall "picture" created by implementing the CFMP will reflect the results of management actions in each of the Cambria forest's various management units.

Rationale

The CFMP was designed to be a flexible, responsive framework for ongoing adaptive management. Flexibility and responsiveness will be essential to the CFMP's success, because conditions in the Cambria forest are expected to continue to change over the CFMP's lifespan, as development continues and as diseases such as pitch canker, and possibly sudden oak death, progress in the plan area. In addition, forest conditions will change in response to management actions implemented under the CFMP; in order to be useful on an ongoing basis, the CFMP must support future adaptive management in response to these changes. Finally, our understanding of Monterey pine forest ecology and management continues to improve and the CFMP is designed to accommodate future improvements in forestry management practices. In order to support adaptive management, the CFMP includes a monitoring program.

The CFMP was also designed to provide tools and approaches that will be useful under a wide range of funding conditions. The methodology of the CFMP is appropriate for the ideal case in which an exhaustive forestwide inventory is conducted as a basis for management strategy. However, because conditions in the Cambria forest are changing rapidly, forestwide inventories must be repeated annually or biannually to ensure that the management database remains current. The CFMP recognizes that funds may not be available to support regular exhaustive inventories; thus, the mosaic approach permits targeted collection of data, which will support intelligent and effective forest management under a wide range of funding conditions.

Structure of the CFMP

Figure 1-3 diagrams the structure and function of the CFMP. Because funds to support forest management may be limited, the CFMP assumes that in any given year active management will take place only in selected portions of the forest. The Forest Manager will be responsible for establishing each year's management priorities, selecting the portions of the forest to receive active management based on an evolving understanding of the needs of the forest and the voluntary cooperation of the affected landowners. Following are the basic steps in the CFMP process as shown in figure 1-3.

I. **Define limits of the forested area in and around the community of Cambria potentially subject to treatment under this plan.**

II. Define management units.

III. Complete the Site Condition Checklist provided in Chapter 3 for each management unit that may require active management.

IV. Based on the results of the site conditions checklist and with the cooperation of the landowner, define management actions and techniques for each unit.

- Select appropriate objectives and "prescriptions" for each management unit under treatment.
- Select appropriate techniques for implementing each treatment prescription.

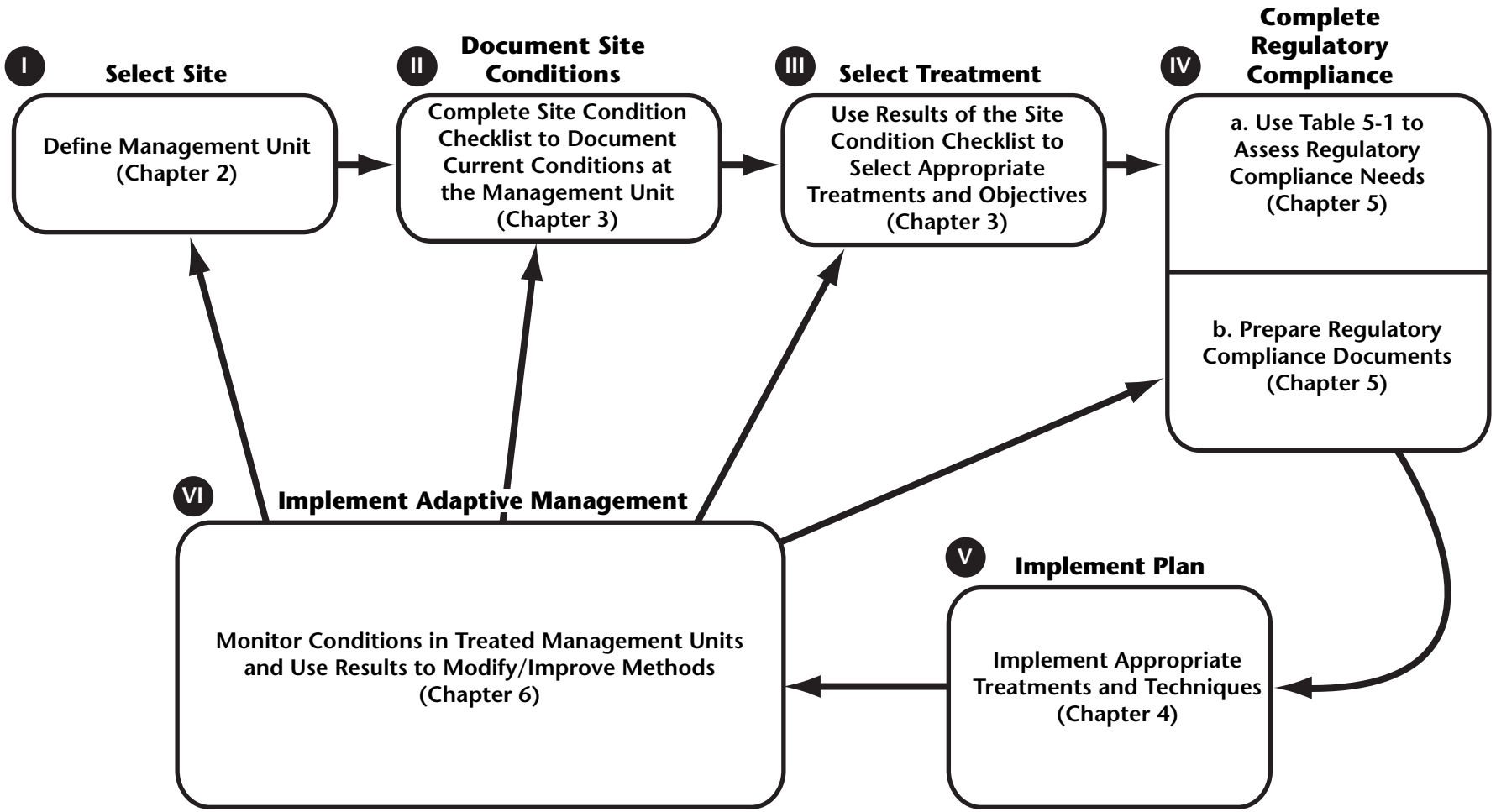
V. Use the Regulatory Compliance Matrix (table 5-1) provided in Chapter 5 to assess the likely impacts of the management actions selected and identify the necessary procedures for compliance with applicable laws and regulations.

- Identify and initiate the regulatory compliance processes for the selected management actions.
- If necessary, modify the treatment or technique selected to minimize or avoid adverse environmental impacts, or design appropriate mitigation.

VI. Implement the selected management actions and any necessary mitigation measures.

VII. Monitor conditions in the treated management units; use monitoring results to assess outcomes of management actions, improve future decisions regarding choices of management actions, and improve management procedures.

Implementation of the CFMP



Jones & Stokes

Figure 1-3
Overview of the Cambria Forest Management Plan

The CFMP is designed to be implemented by a locally based full-time Professional Forest Manager, supported by an appropriate implementing agency. The CFC may function in an advisory capacity to the implementing entity. The Forest Manager will be selected by and report to the implementing agency with Cambria Forest Committee approval. S/he will be a licensed Professional Forester/Forest Ecologist and will have experience in natural resources management, forest ecology, and central California coastal habitats and species, with specific expertise in Monterey pine forest ecology. The Forest Manager's responsibilities will include the following.

Working with the CFC and local stakeholders to create a vision for the Cambria forest that will realize the CFMP's goals and objectives.

- Facilitating meetings with the CFC and the public.
- Establishing management priorities, in conjunction with the CFC.
- Defining boundaries for forest management units.
- Completing the Site Condition Checklist (see chapter 3) and selecting treatments for forest management units.
- Consulting the Regulatory Compliance Matrix (see table 5-1) and ensuring that regulatory compliance needs are met for all management actions.
- Preparing treatment implementation plans for management units in cooperation with willing and affected landowners.
- Conducting regular forest maintenance and management tasks.
- Developing and implementing appropriate monitoring measures.
- Facilitating the adaptive management process.
- Educating the community about Monterey pine ecosystems, conservation, and management.

Organization of this Document

This document is divided into chapters that correspond to the steps in the CFMP process. Table 1-1 summarizes the content and purpose of each chapter.

Table 1-1. Overview of this Document

Chapter 1	**Introduction.** Provides basic background on the Monterey pine forest and the need for effective management of this resource; summarizes development of CFMP; presents goals and objectives of the CFMP; provides overview of CFMP structure and function.

Chapter 2	**Site Selection Process and Application of the Site Condition Checklist.** Describes procedures for defining forest management units and completing Monterey pine forest Site Condition Checklist to identify appropriate treatment prescriptions for each management unit.
Chapter 3	**Site Condition Checklist.** Provides the Monterey pine forest Site Condition Checklist to be copied and used in the field.
Chapter 4	**Forest Treatment Prescriptions and Techniques.** Describes management actions (treatment prescriptions) and techniques for implementing them.
Chapter 5	**Regulatory Issues.** Summarizes the regulatory compliance requirements associated with the management actions (treatment prescriptions) described in chapter 4.
Chapter 6	**Monitoring and Adaptive Management Plan.** Describes the philosophy of adaptive management and the relationship between monitoring and effective adaptive management; provides examples of monitoring parameters and schedules; and offers guidance for identifying the need to implement adaptive management.
Chapter 7	**References.** Lists the references consulted in the preparation of the CFMP.
Appendix A	**Special-Status Species in the Cambria Area**
Appendix B	**Tree Planting Techniques**
Appendix C	**Pitch Canker Severity Rating Systems**
Appendix D	**Additional Contacts for the Forest Manager**

Each chapter of this document was designed as a separate module. This will make it possible to update or replace individual chapters as needed, if new information becomes available or accepted management practice changes, or if the condition of the forest changes beyond the extent envisioned in this document.

2

Site Selection Process and Application of the Site Condition Checklist

This chapter describes the decision making process for

- dividing the forest into management units in cooperation with willing landowner participation,
- prioritizing management units for treatment, and
- identifying appropriate treatment techniques for the specific forest conditions that exist in each management unit.

It must be emphasized from the outset that this is a FOREST management plan and will not be applied to non-forested areas such as wetlands or pastures. The Plan boundaries are the Monterey pine forest boundaries in the North Coast Area of San Luis Obispo County and do not extend into oak woodlands, stream headwaters or other areas that do not support natural stands of Monterey pines.

The CFMP's success will depend on the willing cooperation of landowners of forested areas which will determine the degree to which the entire forested area is assessed for potential treatment and on the effectiveness of the specific management unit treatments selected. The CFMP implementation scheme will facilitate the appropriate identification of management units and will identify a wide range of suitable treatment prescriptions, including the possibility of no treatment.

This chapter provides practical management guidance based on a series of planning exercises and the field checklist presented in chapter 3. It is intended to provide the Forest Manager and the CFC with a platform for discussion of spatial and temporal management options that will lead to a specific methodology for achieving the goals of the CFMP.

Defining and Selecting Management Units—the Site Selection Process

The site selection process is a 2-tiered approach to forest management in which the Forest Manager defines the forest types to be treated and identifies specific locations for possible treatment, and defines the spatial pattern of management activity within the forest as a whole.

The 1st tier addresses the need for a practical implementation scale by focusing management on individual management units. This approach accommodates changing patterns of funding, labor availability, and landowner interest.

The 2nd tier provides an equally necessary forestwide perspective. Although management will occur on a relatively small scale, management activities should be implemented within the context of the CFMP's forestwide goals to create and maintain a spatially and ecologically diverse and functional Monterey pine forest. As the CFMP is implemented over time, the accumulation of actions taken in management units will create an overall pattern across the Cambria forest. The vision for this overall pattern is described in *Forestwide Priorities* below.

This chapter presents a series of guidelines and considerations that will permit the Forest Manager and cooperating stakeholders to apply their collective knowledge of the Cambria community and surrounding forest to describe forest components and define discrete units for management. Defining management units and selecting sites for treatment may not require fieldwork in all cases. The process may be carried out using topographic maps, zoning or parcel maps, or any other existing documents that supply relevant geographic and land use information. Moreover, the site selection process may be undertaken as a planning exercise at the outset of CFMP implementation, or site priorities can be developed over time, as funding becomes available for management actions. In either case, once sites have been selected for treatment, a Site Condition Checklist is completed for each.

Recommendations for Defining Management Units

The Cambria forest is a dynamic system composed of a mosaic of patches that are proceeding through different successional stages (Harris 1984). In the past, this mosaic condition resulted from natural disturbances of various sizes and intensities that created openings in the canopy and allowed seedlings to regenerate the forest. Before European settlement of the Cambria area, disturbance patterns were controlled by natural processes, including: fire; infection by diseases or parasites such as western gall rust (*Endocronartium harknessii*) and dwarf mistletoe (*Arceuthobium campylopodum*); natural senescence as individual trees or stands aged; and natural disasters such as landslides, earthquakes, and storms. These processes no longer operate unchecked. Consequently, the CFMP relies on specific management techniques to mimic the effects of natural disturbance patterns that historically affected the Cambria forest.

Before appropriate management techniques can be selected, management units must be defined. The distribution and characteristics of the management units selected for treatment enable the Forest Manager to determine the proper techniques for each individual management unit as well as the appropriate sequence of treatment throughout the Cambria forest over time. Following are recommendations for defining useful and effective management units. Figure 2-1 shows a hypothetical example.

1. Management units must have discrete boundaries to define the extent of the area that will be assessed and treated. Management units should be bounded by obvious, relatively permanent physical features, such as roads, trails, fences or property boundaries, and ridgelines. Using these artificial and natural physical boundaries allows for the most effective and safe management, particularly with regard to access and fire control. In addition, the forest is a dynamic landscape; change is inherent both in its natural processes and in the forest management process, making it unlikely that treated management units will appear structurally identical from year to year. Boundaries defined on the basis of the density of trees, abundance of shrubs, or other characteristics that may be altered by natural processes or by management activities may be difficult or impossible to identify at a later time. Discrete physical boundaries allow the Forest Manager to easily and consistently monitor or repeat treatments in a specific area and to establish, collect, and maintain historical records that will support future management, including the adaptive management program.

2. The scale of the management units defined by the site selection process should reflect ownership issues and the level of funding available to the forest management program. Funding limitations and variability directly impact the ability of the Forest Manager to administer the CFMP. However, there are at least 2 ways to work within the constraints of available funding. Management units can be identified at the outset of the project and treated as funds become available for each unit's particular scale, needs, and priority. Alternatively, management units can be identified "on demand," with boundaries based on the areal extent of treatment that available funding will support. *Either way, the size of the management unit should reflect the area that can successfully be treated and monitored using the CFMP.*

3. The CFMP should allow for changes in the boundaries and shapes of management units to accommodate changing forest conditions or management needs. The dynamic nature of the Cambria forest needs to be addressed and accommodated in the CFMP. However, management unit boundaries should not be changed unless management of the forest using the original boundaries becomes impracticable.[1] Any changes in management unit boundaries will complicate monitoring and adaptive management, as well as data archival.

The Forest Manager should anticipate and respond to significant alterations in circumstances within the forest that may necessitate changes in the boundaries of the management units. Such alterations include construction of new roads and

[1]The Forest Manager will be responsible for defining what constitutes *impracticable* management conditions, based on funding, staffing, or other relevant considerations.

major developments, and sudden changes in funding availability. The revised management unit boundaries should be based on permanent landscape features.

Boundary changes must be discussed with the affected parties and carefully documented. The historical dataset should be maintained and applied to the new configuration so that a continuous treatment and monitoring record is created. If possible, changes should involve merging or dividing entire units rather than portions of units; this will facilitate the transference of data to the new management unit.

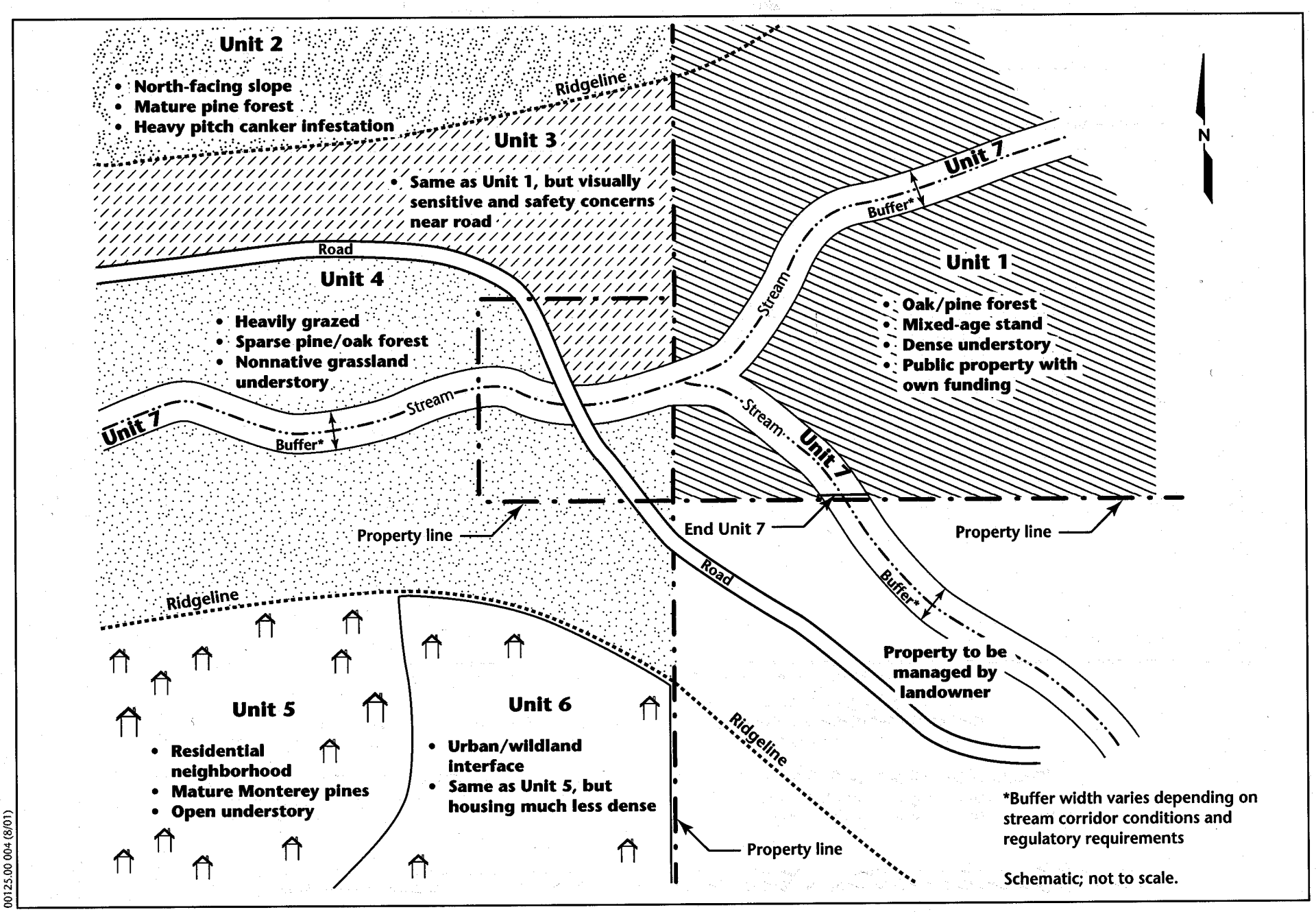
4. Characteristics of the natural features and ecological processes within each management unit should be as homogeneous as possible. The more complex and heterogeneous the habitats in a management unit are, the more difficulty the Forest Manager will have in choosing an appropriate treatment for the site. Conversely, as the ecological complexity of the site increases, the more unlikely it is that a treatment will be successful in creating the desired results for that unit. Boundaries should be chosen to encompass a management unit that is sufficiently homogeneous that the appropriate treatment prescription is the same throughout.

5. Management unit size will be limited by regulatory restrictions, safety considerations, and forestwide goals. Various factors will impose pragmatic constraints on the sizes of individual management units. For example, air quality regulations that help manage smoke, preserve air quality, and reduce complaints will place conditions on burn treatments implemented under the CFMP, which may in turn limit the size of management units. Safety considerations related to controlled burns may also require that treatment areas be limited in size. In addition, to fulfill the goal of creating a mosaic of forest stages, individual management units should be small enough that they do not dominate their vicinities.

6. Management units can be described or prioritized according to public perception and concern. Certain areas of the Cambria forest are well known or recognized for their Monterey pine assemblages and have become part of the unique landscape and heritage of the community. The value of such areas may warrant their delineation as separate management units to facilitate the application of specialized treatment and monitoring. In addition, because of the multiyear approach of the CFMP, prioritizing management units according to their importance as visual resources may be attractive.

Area Subject to the CFMP

The land areas subject to the CFMP will be defined by the implementation scheme adopted for the program. The success of the CFMP will depend on the degree to which the entire forested area is assessed for potential treatment and on the effectiveness of the specific management unit treatments selected. The CFMP implementation scheme will facilitate the identification of management units and identify a wide range of suitable treatment prescriptions, including the possibility of no treatment.



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Jones & Stokes

Figure 2-1
Hypothetical Management Unit Delineation

Treatment Priorities

The CFMP is designed to be implemented over several years as interested landowners work cooperatively with the Forest Manager. The CFMP's strategy assumes that funding will be the most important factor limiting the number and types of treatments that can be implemented throughout the forest in any given year. The limited availability of funding, the size of the forest and diversity of its structure, and the wide distribution of pitch canker make it necessary to prioritize the treatment of management units in the Cambria forest.

Prioritizing management units will help direct the organization and application of treatments in anticipation of funding. The outcome of prioritization should reflect the goals and objectives of the CFMP, and the process should result in a prioritized list of management units (or at the very least of general areas) that will direct the sequence of treatment application.

In general, priorities for treatment will parallel the goals of the CFMP described in chapter 1: restoring health to the Cambria forest, decreasing risks to life and property, and maintaining forest aesthetics. However, the balance among these priorities will vary according to the location of the treated management units within the forest. For example, decreasing hazards to people, homes, and businesses is a higher priority in areas of urban forest than improving ecosystem health. In wildland areas, improving ecosystem health may be more important. In addition, prioritization should take into account the degree of pitch canker infestation; higher priority should be given to management units with high levels of infestation.

In order for the CFMP to succeed, the prioritization of management units for treatment must involve a cooperative community. Community interest will ensure support for the CFMP; community knowledge will contribute to the success of any action taken in the forest, both in urban and in wildland areas. And in the end, it is the citizens of the larger Cambria community who will contribute the most to this effort, and in return, will derive the greatest benefits from the health, safety, and beauty of the forest ecosystem around them.

The following sections provide additional information on priorities at the management unit level (*1st-tier priorities*) and at the forestwide level (*2nd-tier priorities*).

Priorities at the Management Unit Level

In areas of urban forest, some treatment priorities have already been identified and mapped through the combined work of the California Department of Forestry and Fire Protection's (CDF's) Fire and Resource Assessment Program (FRAP), the Cambria Fire Safe Focus Group, and the Cambria Fire Hazard Reduction Project (California Department of Forestry and Fire Protection and San Luis Obispo County 2000). The Forest Manager must coordinate with these ongoing fuel reduction programs to implement treatments that are consistent with the creation of fuel reduction zones. The fuel reduction zone prescription has the

highest priority in urban forest areas because it addresses the goal of reducing risks to life and property while remaining consistent with the goals of restoring ecosystem health and diversity and maintaining visual resources. Nonetheless, fuel reduction programs must recognize the overall health of the ecosystem in the prospective fuel reduction areas.

The undeveloped or wildland portions of the forest provide the greatest opportunities to prioritize management to emphasize ecosystem health and diversity. In addition, ecologically significant management units, such as the forested headwaters of streams or wetlands, should be prioritized for treatment to maintain proper function of this very important and fragile system. However, even in wildland areas, certain high-profile, high-visibility, or culturally significant areas will take precedence over more remote areas because of their value to the public.

Forestwide Priorities

The 2nd tier of forest management involves management priorities at a holistic, forestwide scale: while individual treatment priorities will be assigned to different management units, the vision or goal for the entire forest must also be addressed. The relationships between management units must also be defined, so the forest can be managed to mimic, to the extent practicable, the disturbance and recovery regimes of a natural Monterey pine forest.

Historically, Monterey pine forest probably regenerated on 2 distinct scales: in large, contiguous cohorts of the same age, following stand-replacing disturbance events such as crown fires; and in stands of mixed ages where smaller disturbances such as tree falls resulted in small canopy gaps. Most wildfires, even catastrophic crown fires, result in a mosaic burn pattern in which some areas are burned down to mineral soil, other areas are less intensely burned and retain scarred and partially burned trees, and still other areas contain unburned islands of green trees. Therefore, many researchers predict that native Monterey pine forest under a natural fire regime would display a pattern of patches of uneven age. Monterey pines also successfully regenerate in small canopy gaps that open when single trees or small groups of trees die as a result of age, disease, windfall, or erosion. This process of canopy recruitment results in only a small number of new trees reaching the canopy layer after each event. Unlike wildfires that affect larger, contiguous patches, these events are distributed throughout the forest in very small patches. As a result, undisturbed Monterey pine forest should display a combination of a few large patches of relatively even-aged cohorts and many smaller, multi-sized or even-aged stands that exhibit multiple canopy layers (Harris 1984, Owen 1998, Roy 1966).

Management to provide a diverse mix of forest stand compositions and structures will result in a forest that is more resistant to disease and disturbance, has reduced fuel hazards, and supports a greater diversity of habitats for wildlife and understory plant species. By addressing a variety of reproductive settings for Monterey pine (such as small canopy gaps, sites with thick duff and litter, sites with mineral soil, and larger cleared patches), the CFMP will provide much of the range and variety of selective pressures that naturally affect Monterey pine

evolution. This approach will function to retain the inherent genetic diversity and distinctiveness of the Cambria forest (Moran et al. 1988; Forde 1964a, 1964b, 1964c, 1964d; Libby 1990; Millar 1986, 2000; Roy 1966; Lindsay 1932).

The more management units the Forest Manager can plan treatments for at the same time, the better the chance of establishing a healthy and ecologically functional forest will be. The treatments in each management unit will function as single elements in the complex pattern of disturbance and succession making up the forestwide pattern of the CFMP. The relationships between treatments in adjacent management units will represent the "pieces" of the mosaic of integrated forestwide ecologic function. The system will not be natural in all areas, but it will contribute to both public safety and ecosystem health, and it will retain the functions and structure of a more natural forest.

Site Condition Checklist

General Description

After defining and selecting a management unit, the Forest Manager must determine which treatments will be appropriate to implement. The Site Condition Checklist (chapter 3) is a practical tool designed to enable the Forest Manager to:

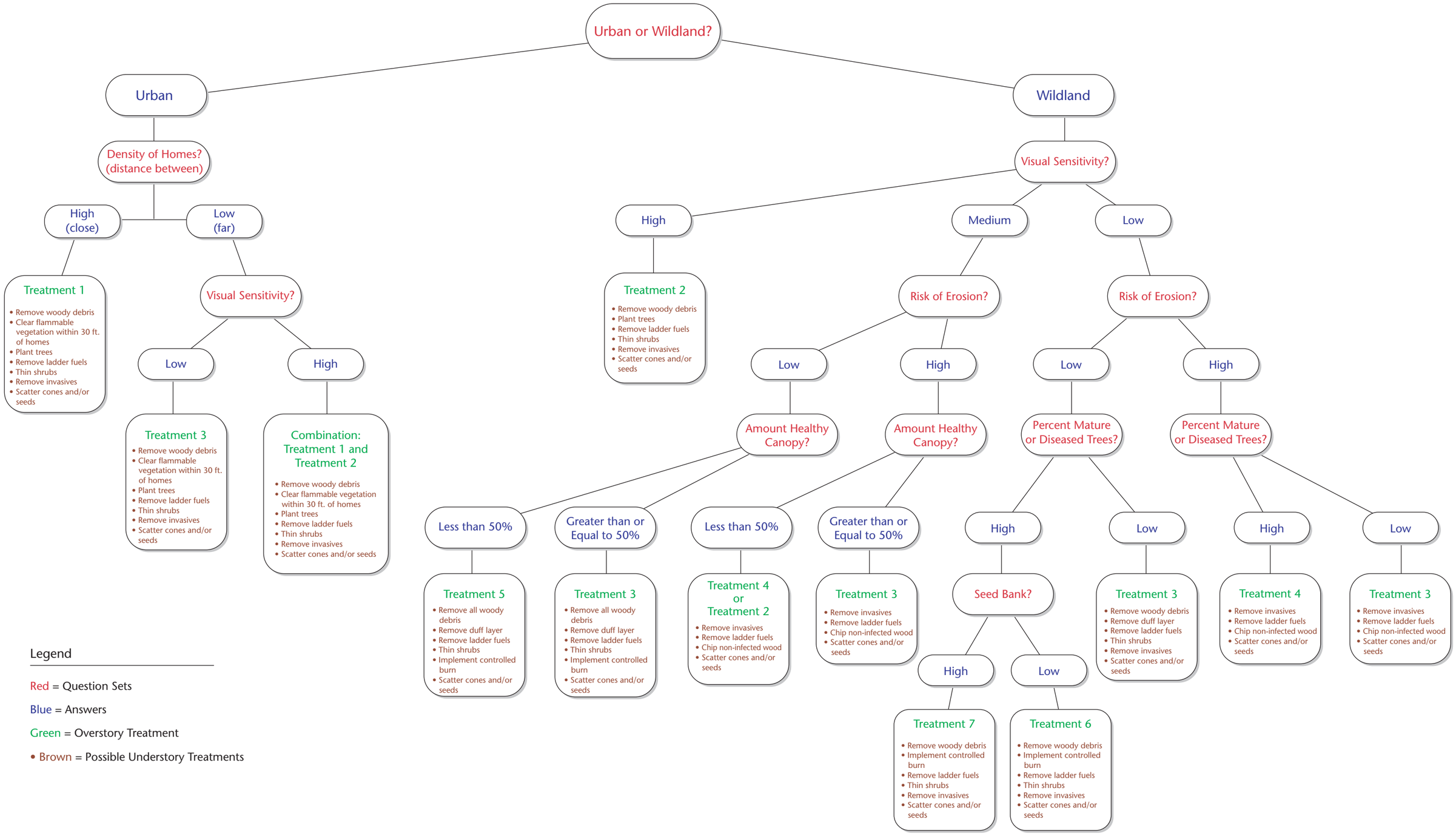
- collect general information about a management unit,
- quickly assess and quantify the condition of specific resources at the site, and
- select appropriate overstory and understory treatments.

The checklist reflects the questions and pathways of the decision tree shown in figure 2-2, which was developed on the basis of the recommendations and priorities discussed in this chapter. The checklist is designed for use in the field and requires the Forest Manager to answer a series of directed questions that lead to a palette of potential treatments for the site.

Although the checklist will record some information about the site, it is not intended to be a tool for exhaustive forest inventory. Instead, it poses only the questions needed to discriminate between various treatments that may be appropriate to achieve the previously defined goals and priorities of the CFMP. Additional questions presented in chapter 6 address the need for monitoring and further study. The ecological implications of treatment choices, discussed in chapter 4, should also be considered in selecting treatments.

Application

The Forest Manager should complete the checklist while in the field in a representative portion of the management unit. Before completing the checklist for a management unit, the Forest Manager should secure the cooperation of the landowner and walk the site; the best place to actually complete the checklist is a vantage point overlooking the management unit. During the site assessment, the



Jones & Stokes

Figure 2-2
Decision Tree for Selection of Appropriate Treatments

Forest Manager should also take photographs documenting site conditions and record a description of the site's general condition to retain with the records for that management unit.

At some point during the implementation of the CFMP, the Forest Manager is likely to encounter a management unit that is only partially described by the checklist criteria. For example, conditions within a management unit may be heterogeneous. In these cases, the Forest Manager must decide among the following options.

Choose a treatment that applies to the dominant condition, if the intensities of the treatment choices are similar, or if one of the conditions applies only to minor portions of the management unit.

- Complete a checklist for each condition and choose the treatment of lesser intensity. This would be an appropriate choice if an unacceptable risk of erosion or other failure would result from the more intensive treatment.
- Consider splitting the management unit into smaller units with more homogeneous conditions.

After completion, the checklist will indicate which treatments are recommended for the management unit. Chapter 4 describes the treatment prescriptions identified on the checklist, including restrictions, special conditions, and other information to consider in creating an implementation plan for each treatment.

If the Forest Manager is unable to complete the checklist because of complex site conditions or is unsure of the answer to any question on the checklist, s/he should:

- seek a 2nd opinion,
- sample and measure the site to determine actual values for the parameters that affect the treatment choice,
- choose a very low-intensity treatment such as pruning or individual tree removal, or
- decide not to pursue treatment in that management unit.

3

Site Condition Checklist

The Site Condition Checklist presented on the following pages is a stand-alone assessment tool designed to be copied from the CFMP and used in the field by the Forest Manager.-

The questions on the Site Condition Checklist specifically target the aspects of a management unit that determine which overstory treatments are appropriate for the unit. Although other ecological components of the management unit are also important and must be considered in designing an overall treatment program for the unit, they do not affect the choice of treatment for the forest overstory.

The questions on the Site Condition Checklist also identify a palette of understory treatments appropriate for use in combination with each overstory treatment under various forest conditions. The Forest Manager should select from the palette of potential understory treatments based on existing conditions and on the management goals for each unit. Both over- and understory treatments are described in detail in chapter 4.

Because of the limited range of the species, the ecological importance of the Cambria forest, and the resulting need to manage and conserve the unique resource represented by Cambria's Monterey pines, the Site Condition Checklist focuses on the condition of Monterey pines within management units. As discussed in chapters 1 and 2, oaks (*Quercus* spp.) are also an important component of the Cambria forests, and should be considered in selecting treatment prescriptions to ensure that management does not inadvertently select for either species. However, the bulk of the challenges facing Cambria's forest are related to the survival and persistence of Monterey pines. Moreover, the oak population in Cambria is healthy and is expected to respond to forest treatment as it would to any natural disturbance. Consideration of oaks in relation to treatments is discussed further in chapters 4 and 6.

Cambria Forest Site Condition Checklist

1. Is the management unit in an urban or wildland setting?

- ❑ If wildland (>1,000 ft from urban areas, homes, etc.), ↄ ***go to question 2.***
- ❑ If urban (all other areas), ↄ ***go to question 11.***

2. Fill out Evaluation Table 1. Visual Sensitivity.

- ❑ Answer **No** to both questions = Low visual sensitivity. ↄ ***Go to question 3.***
- ❑ Answer **Yes** to 1 or more questions = High visual sensitivity. ↄ ***Go to question 7.***

3. Fill out Evaluation Table 2. Erosion Potential.

- ❑ Answer **Yes** to 1 or more questions = High erosion potential. ↄ ***Go to question 4.***
- ❑ Answer **No** to all questions = Low erosion potential. ↄ ***Go to question 5.***

4. Fill out Evaluation Table 3. Monterey Pine Size Category.

- ❑ Answer to question IV or V = **Dense**. ↄ **Use Treatment 4.**
  Understory treatment choices = remove ladder fuel, scatter cones and seeds, remove invasive species, chip woody material.
- ❑ Answer to question IV or V = **Sparse** or **Moderate**. ↄ **Use Treatment 3.**
  Understory treatment choices = remove ladder fuel, scatter cones and seeds, remove invasive species, chip woody material.

5. Refer to Evaluation Table 3. Monterey Pine Size Category.

- ❑ Answer to question IV or V = **Dense**. ↄ ***Go to question 6.***
- ❑ Answer to question IV and V = **Sparse** or **Moderate**. ↄ **Use Treatment 3.**
  Understory treatment choices = remove duff layer, scatter cones and seeds, remove invasive species, remove woody debris, remove ladder fuel, thin shrub layer.

6. Refer to Evaluation Table 3. Monterey Pine Size Category.

- ❑ Answer to question I = **Dense**. ↄ ***Go to question 17.***
- ❑ Answer to question I = **Sparse** or **Moderate**. ↄ ***Go to question 18.***

7. What is the distance from the visual receptor to the management unit?

- ❑ More than 1 mile = Moderate visual sensitivity. ↄ ***Go to question 8.***
- ❑ Less than or equal to 1 mile = High visual sensitivity. ↄ ***Go to question 14.***

8. Refer to Evaluation Table 2. Erosion Potential.

- ❑ Answer **Yes** to 1 or more questions = High erosion potential. ə ***Go to question 9.***
- ❑ Answer **No** to all questions = Low erosion potential. ə ***Go to question 10.***

9. Refer to Evaluation Table 3. Monterey Pine Size Category.

- ❑ Answer to question V = **Dense**. ə **Use Treatment 4 and/or Treatment 2.**
  Understory treatment choices = remove ladder fuel, scatter cones and seeds, remove invasive species, chip woody material.
- ❑ Answer to question V = **Sparse** or **Moderate**. ə **Use Treatment 3.**
  Understory treatment choices = remove ladder fuel, scatter cones and seeds, remove invasive species, chip woody material.

10. Refer to Evaluation Table 3. Monterey Pine Size Category.

- ❑ Answer to question V = **Dense**. ə ***Go to question 19.***
- ❑ Answer to question V = **Sparse** or **Moderate**. ə **Use Treatment 3.**
  Understory treatment choices = remove duff layer, conduct controlled burning, scatter cones and seeds, remove woody debris, remove ladder fuel, thin shrub layer.

11. What is the distance between homes?

- ❑ Less than 500 feet = High density. ə ***Go to question 13.***
- ❑ More than 500 feet = Low density. ə ***Go to question 12.***

12. Refer to Evaluation Table 1. Visual Sensitivity.

- ❑ Answer **No** to both questions = Low visual sensitivity. ə ***Go to question 15.***
- ❑ Answer **Yes** to 1 or more questions = High visual sensitivity. ə ***Go to question 16.***

13. Refer to Evaluation Table 2. Erosion Potential.

- ❑ Answer **Yes** to 1 or more questions = High erosion potential. ə **Use Treatment 1 and/or Treatment 2.**
  Understory treatment choices = Clear 30 feet around buildings, plant trees, remove ladder fuel, remove invasive species, scatter cones and seeds.
- ❑ Answer **No** to all questions = Low erosion potential. ə **Use Treatment 1.**
  Understory treatment choices = remove woody debris, thin shrub layer, clear 30 feet around buildings, plant trees, remove ladder fuel, remove invasive species, scatter cones and seeds.

14. Refer to Evaluation Table 2. Erosion Potential.

❑ Answer **Yes** to 1 or more questions = High erosion potential. ɔ **Use Treatment 2 combined with Treatment 3.**
Understory treatment choices = Clear 30 feet around buildings, plant trees, scatter cones and seeds, remove invasive species, remove ladder fuel.

❑ Answer **No** to all questions = Low erosion potential. ɔ **Use Treatment 2 combined with Treatment 3.**
Understory treatment choices = remove woody debris, clear 30 feet around buildings, plant trees, scatter cones and seeds, remove invasive species, thin shrub layer, remove ladder fuel.

15. Refer to Evaluation Table 2. Erosion Potential.

❑ Answer **Yes** to 1 or more questions = High erosion potential. ɔ **Use Treatment 3.**
Understory treatment choices = Clear 30 feet around buildings, plant trees, scatter cones and seeds, remove invasive species, remove ladder fuel.

❑ Answer **No** to all questions = Low erosion potential. ɔ **Use Treatment 3.**
Understory treatment choices = remove woody debris, clear 30 feet around buildings, plant trees, scatter cones and seeds, remove invasive species, thin shrub layer, remove ladder fuel.

16. Refer to Evaluation Table 2. Erosion Potential.

❑ Answer **Yes** to 1 or more questions = High erosion potential. ɔ **Use Treatment 1 or Treatment 2.**
Understory treatment choices = Clear 30 feet around buildings, plant trees, scatter cones and seeds, remove invasive species, remove ladder fuel.

❑ Answer **No** to all questions = Low erosion potential. ɔ **Use Treatment 1 or Treatment 2.**
Understory treatment choices = remove woody debris, clear 30 feet around buildings, plant trees, scatter cones and seeds, remove invasive species, thin shrub layer, remove ladder fuel.

17. Fill out Evaluation Table 4. Adjacent Parcel Inventory.

❑ Answer **No** to all questions. ə **Use Treatment 7.**
Understory treatment choices = conduct controlled burning, scatter cones and seeds, remove woody debris, remove ladder fuel, thin shrub layer, remove invasive species.

❑ Answer **Yes** to any question. əə You should not pursue treatment in this area this year. If treatment is urgent, use lower-intensity treatment.

18. Refer to Evaluation Table 4. Adjacent Parcel Inventory.

❑ Answer **No** to all questions. ə **Use Treatment 6.**
Understory treatment choices = conduct controlled burning, scatter cones and seeds, remove woody debris, remove ladder fuel, thin shrub layer, remove invasive species.

❑ Answer **Yes** to any question. əə You should not pursue treatment in this area this year. If treatment is urgent, use lower-intensity treatment.

19. Refer to Evaluation Table 4. Adjacent Parcel Inventory.

❑ Answer **No** to all questions. ə **Use Treatment 5.**
Understory treatment choices = remove duff layer, conduct controlled burning, scatter cones and seeds, remove woody debris, remove ladder fuel, thin shrub layer.

❑ Answer **Yes** to any question. əə You should not pursue treatment in this area this year. If treatment is urgent, use lower-intensity treatment.

Evaluation Table 1. Visual Sensitivity

		Yes	No
a)	**Is the management unit visible from any of these receptors:**		
	Burton Drive?		
	Ardath Drive?		
	Main Street?		
	Santa Rosa Creek Road?		
	Highway 1?		
b)	**Is the management unit considered a local landmark or point of interest?**		

Evaluation Table 2. Erosion Potential

Question	Yes	No
Is the slope of the site >20%?		
Does the management unit contain a stream or wetlands, or is it within 300 feet of a stream or wetlands?		
Are there signs of gully formation or other soil erosion onsite?		
Is the erosion class rating (from the local Soil Survey) for site soils "High" or "Moderate"?		

Evaluation Table 3. Monterey Pine Size Category			
	Ground Cover		
	Sparse (0–10%)	**Moderate (11–25%)**	**Dense (≥26%)**
I. Seeds and Cones (per square meter)			
	Canopy Cover		
	Sparse (0–25%)	**Moderate (26–50%)**	**Dense (≥51%)**
II. Seedlings and Saplings (<4 inches dbh)			
III. Pole size (4–20 inches dbh)			
IV. Mature (>20 inches dbh)			
V. Dead, Dying, and Infected (all sizes)			

Evaluation Table 4. Adjacent Parcel Inventory

a) Have any of the following treatments been applied to parcels of land adjacent to the management unit within the last 5 years?

Treatment:	Yes	No
Treatment 7		
Treatment 6		
Treatment 5		

b) Do any of the following conditions occur on parcels of land adjacent to the management unit?

Condition:	Yes	No
Less than 30% canopy cover of trees		
Gully erosion more than 8 inches deep		
Sheet erosion		

4

Forest Treatment Prescriptions and Techniques

This chapter describes specific treatment prescriptions and techniques that can be used to achieve the objectives and goals of the CFMP. *Treatment prescriptions* are defined as conceptual management actions designed for use under specific forest conditions. Once management unit boundaries have been established (see chapter 2), the Forest Manager should use the Site Condition Checklist presented in chapter 3 to identify existing forest conditions and select an appropriate treatment prescription or combination of prescriptions. Prescriptions included in this chapter were identified for inclusion in the CFMP palette because their goals and objectives are consistent with the CFMP's broader goals and objectives with regard to ecosystem health and diversity, hazards to life and property, and aesthetic values, described in chapter 1.

This chapter organizes treatment prescriptions into 2 broad categories: overstory treatments and understory treatments. In most cases, management goals will be most effectively achieved by implementing 1 or more understory treatments in conjunction with the overstory treatment identified as appropriate by the Site Condition Checklist; in addition to the overstory treatment, the results of the checklist will also identify several options for understory treatment.

Many implementation techniques are common to a number of over- or understory treatment prescriptions; thus, implementation techniques are described at the end of the overstory and understory prescription sections. Wherever possible, the implementation techniques described in this chapter incorporate best management practices (BMPs) to minimize adverse environmental effects. The descriptions of techniques are meant as a guide only; the user must weigh many factors in deciding which techniques to use, such as cost, availability of equipment and labor, schedule, project scale, and potential corollary effects.

Regulatory Requirements

Many local ordinances and regulations were consulted in the preparation of this chapter. However, before implementing any treatment, the Forest Manager should ensure that projected activities are consistent with federal, state, and local laws and regulations. Of particular importance in this context will likely be the Cambria Residential Design Plan. Chapter 5 describes relevant federal, state, and county ordinances and provides a matrix correlating treatment prescriptions with likely compliance requirements. Local regulations that may apply to treatment prescriptions include the Cambria Residential Design Plan and the Cambria Fire Department's weed abatement regulations.

Implementation Plan

Once the Forest Manager has selected appropriate treatment prescriptions and techniques for the management unit, s/he should begin preparing cooperative implementation plan. The agreed-upon implementation plan will serve as the primary documentation for the management and monitoring of the unit. At a minimum, it should include:

- a description of the management unit's location, including a location map;
- a clear statement of management goals and objectives for the unit (see chapter 2), for use in monitoring and adaptive management; the rationale should include consideration of wildlife habitat and pertenent regulations.
- an explanation of the rationale for the management unit boundaries and/or a description of the process used to select the boundaries;
- the completed Site Condition Checklist (see chapter 3);
- descriptions of treatments and techniques to be used, including BMPs, personnel needs, and equipment needs;
- a schedule for implementation and monitoring, including the consent of the landowner; and
- environmental compliance documents and appropriate permits, if required (if none were required, the plan should summarize the reasons) (see chapter 5).

Preparing the implementation plan will help the Forest Manager carefully consider all aspects of the management action, including regulatory compliance and long-term monitoring. In most cases, the implementation plan will be brief. However, more intensive treatments such as Treatment 7 or prescribed burns will require extensive planning before implementation.

Key Definitions

Following are definitions of key terms as they are used in this document. Additional terms are defined in the *Glossary of Selected Technical Terms*, which follows chapter 7.

- *Diseased tree* – A Monterey pine infected with pitch canker or an oak affected by sudden oak death.
- *Dying tree* – A Monterey pine, oak, or other tree that is succumbing to age, disease, or other natural processes. This term usually applies to trees in which >30% of standing biomass (plant tissue) is dry and nonfunctional.
- *Hazard tree* – A tree that has the potential to fall or to lose a limb or limbs and thus poses a risk to life or property. Hazard trees include dead, dying, and severely leaning trees, as well as trees that lack root support.
- *Leaning tree* – A tree growing at an angle, or a tree in which a large proportion of the mass is on 1 side of the tree. Leaning trees that are in danger of falling are considered hazard trees.

Overstory Prescriptions

The following sections describe the overstory treatment prescriptions identified on the Site Condition Checklist, techniques for implementing the prescriptions, and relevant ecological considerations. Treatments are presented in a general order from least intensive to most intensive, followed by a brief discussion of the no-treatment option.

The treatments and implementation techniques are specifically tailored to Cambria's Monterey pine forest ecosystem, but are based on standard forestry practices that will be familiar to the Forest Manager. The following general assumptions and principles apply to all of the overstory treatments discussed in this chapter.

- All treatments are designed to mimic disturbances in a natural Monterey pine forest ecosystem.
- All treatments are meant to reset succession in a way that prepares the management unit to support new Monterey pine and native oak trees and recover.
- To mimic a natural forest condition, snags that are free of disease vectors should be retained in management units whenever possible.
- Diseased Monterey pines should be removed only if death is imminent; diseased trees may survive an initial infestation of pitch canker.
- The Forest Manager should control vehicle and heavy equipment access to minimize soil disturbance and contamination of water resources.

- A complete monitoring and adaptive management plan must be implemented at all treated management units to evaluate the success of the treatment, identify potential problems, and provide a basis for implementing remediation treatments, if necessary.

Treatment 1—Simulate Small-Scale Ecological Processes via Tree Pruning

Objective

The objective of Treatment 1 is to reduce hazards to life and property by removing high-risk tree limbs. This treatment would only be applied in an urban setting near or adjacent to structures, roads, or utility lines. The Forest Manager should work with local public safety agencies to establish criteria for assessing the degree of hazard and identifying and prioritizing the need for pruning in urban settings.

Description

In this treatment, limbs are removed by hand (using a chain saw or telescopic pruners) or by mechanical means, pruning to clean or to thin the crown. *Pruning to clean* refers to removing dead, dying, weak, or diseased branches, and branches that rub together, from the crown of the tree. *Crown thinning* is the removal of live branches (either weak or healthy) to reduce weight and windsail. Trees adjacent to openings naturally grow towards the open space, developing lopsided crowns. Pruning the heavier side of the crown balances the tree's weight and reduces the chance of windfalls and damage to adjacent structures. Whenever possible, damage to nontarget trees and shrubs should be avoided by using a rope to lower large cut limbs gently to the ground.

After removal, tree limbs should be chipped and spread onsite, stockpiled and burned, or composted to help eliminate pitch canker pathogens from the management unit. If piling and burning is used as a method of disposal, burn permitting will be required; see *Understory Prescriptions* and *Techniques for Understory Prescriptions* below, and *Controlled Burns and Air Quality* and *California Department of Forestry and Fire Protection—Burn Permit Program* in chapter 5. CDF recommends that woody material infected with pitch canker be chipped and treated with fungicide and allowed to remain on the site for 1 year (Gordon et al. 2001). Chipping greatly reduces the number of beetles (disease vectors) that may emerge from a downed log. Allowing the chipped material to sit onsite ensures that it is rid of the fungus and prevents or slows transmission of pitch canker. With the appropriate permit, infected materials may also be piled and burned onsite.

Ecological Benefits and Consequences

Because not all infected trees succumb to pitch canker, removing limbs or other diseased parts of the tree may help individual trees to recover, as well as removing diseased material from the canopy. Chipping and properly treating cut materials will also reduce beetle population growth and accumulation of diseased materials on the forest floor (Gordon et al. 2001), reducing or destroying the reservoir of pathogens and vectors, and facilitating the control or management of pitch canker contagion.

Treatment 2—Simulate Small-Scale Ecological Processes via Individual Tree Removal

Objective

In urban areas, the objective of Treatment 2 is to remove hazard trees that have the potential to fall on structures, trails, or roads. The Forest Manager should work with local public safety agencies to establish criteria for assessing the degree of hazard and identifying and prioritizing the need for tree removal in urban settings. This treatment may also be used to comply with CDF's recommendation that a 30-foot defensible space be maintained around homes.

In rural areas, the objective of individual tree removal is to remove trees that are heavily infected with pitch canker, or other potentially lethal disease, from sensitive locations such as steep slopes and riparian corridors, or from areas of high visual sensitivity. Tree removal may also be necessary if trees have such poor structure that pruning would not alleviate further hazard. In low-density forests in rural areas, this treatment mimics the formation of small canopy gaps that develop when a single tree succumbs to age or other natural processes.

Description

Treatment 2 involves selecting individual hazard trees and removing them by hand or mechanical means. Pine trees likely to meet the criteria for removal include those rated *High* in the Pitch Canker Severity Rating System of Storer et al. (2000) (see appendix C), those with more than 50% canopy dieback, and those with top kill. Criteria for removal of oak trees afflicted with sudden death syndrome have not been developed as yet. Development poses substantial constraints on felling trees; cranes or special techniques such as cabling will be required to safely remove trees in some developed areas.

Ecological Benefits and Consequences

Much of the benefit derived from Treatment 2 is safety-related. Tree removal requires a substantial effort per tree removed; thus, the application of this treatment will generally be confined to developed areas or areas near roads, where the risk of property damage is greatest.

The ecological benefits of removing 1 tree are limited because removing a single tree represents a minimal change in the forest ecosystem. When a single tree is removed, adjacent trees are often able to grow fast enough to fill the resulting canopy gap before seedlings can germinate. Canopy regrowth reduces sunlight and warmth on the forest floor, slowing or stopping regeneration from seed stock and reducing the young stock available to replenish the canopy. This may be a particularly important consideration in an area with mature diseased trees, where young, growing stock will be needed to replace the canopy as disease removes trees from the forest.

Treatment 3—Simulate Medium-Scale Ecological Processes Creating Small Canopy Gaps

Objectives

The objectives of Treatment 3 are to reduce fuel loading and fire hazard, provide an ongoing seed supply from healthy and potentially disease-resistant trees, provide canopy gaps for Monterey pine tree recruitment, and retain appropriate species dominance in a stand. Treatment 3 mimics smaller natural disturbances that leave gaps in the canopy, such as windfalls, storm damage, or events causing individual trees to fall. This moderate-intensity treatment is appropriate in larger management units that cannot sustain intensive treatments but require tree removal.

Description

Treatment 3 is similar to the traditional forestry shelterwood treatment, and is most appropriate for areas with light to moderate pitch canker infection. It involves removing larger individuals in the overstory (preferably diseased or dying trees) while retaining 40–60% of trees in the *mature* and *senescent* categories (see chapter 3) as overstory canopy cover. Understory vegetation is treated along with the overstory. Techniques to minimize the spread of disease should be strictly followed in implementing Treatment 3, as described in *Programs for Capturing, Handling, Utilizing, and Disposing of Infected Pine Material in San Luis Obispo County* (Hawley et al. 1998). If piling and burning is used as a method of disposal, burn permitting will be required; see *Understory Prescriptions* and *Techniques for Understory Prescriptions* below, and *Controlled Burns and Air Quality* and *California Department of Forestry and*

Fire Protection—Burn Permit Program in chapter 5. BMPs should be incorporated in the treatment to control soil damage and prevent accelerated erosion, and to ensure that the treatment does not contribute to the spread of invasive exotic plant species.

The optimal per-acre density of retained trees is at least 16 trees with a diameter at breast height (dbh) of 20 inches, or 8 trees with a dbh of 24 inches. The maximum horizontal spacing between retained trees, or between retained trees and the edge of the treatment patch, should be less than the vertical canopy height; for mature Monterey pines, this is typically about 120 feet. This spacing will allow seed rain from the remaining trees to cover most of the treated area. The remaining trees will also provide partial canopy cover to most of the treated area.

Optimal trees for retention are those that meet the following criteria.

- Trees rated *Low* or *None* using the Pitch Canker Severity Rating method of Storer et al. (2000) (see appendix C).
- Healthy trees without significant lean.
- Trees in the *Mature* or *Senescent* size class (see chapter 3).

Some larger pole-size trees with full canopy exposure can also be retained.

Care should be taken to ensure that the existing ratio of Monterey pines to native oaks is preserved. Thus, oak trees should be included in this prescription to the extent that they occur naturally in the management unit. The Forest Manager should document the occurrence and status of oak trees within the unit before planning this treatment. The inclusion of oak trees will ensure that, as in a natural event, the whole of the forest overstory and not just the Monterey pines will be affected.

Ecological Benefits and Consequences

The implementation of Treatment 3 will mimic a natural disturbance. Storms, weak root systems, age, and disease may all cause 1 tree to fall, or several trees to fall at the same time, opening up the canopy and allowing regeneration of the forest. Successional reversion is only triggered in certain patches of the forest. This results in a mixed-age stand that is characteristic of a well-established, functioning forest.

The ecological risks of implementing Treatment 3 are much less than those associated with more intense treatments. In addition, because Treatment 3 is designed for application to a management unit with moderate to light pitch canker infection, the forest will retain its health and existing functions and values without extreme manipulation. Proper implementation of Treatment 3 will retain the existing density and distribution of Monterey pines and native oaks, maintaining the existing biodiversity and character of the management unit. In

addition, the understory in untreated sections of the management unit will be preserved, maintaining its value to wildlife. Treating understory vegetation along with the overstory will ensure that enough light penetrates to the forest floor to germinate seeds in the seed bank.

Treatment 4—Simulate Medium-Scale Ecological Processes Creating Patchy Canopy Openings in Environmentally Sensitive Units

Objective

The objective of Treatment 4 is to remove dead, dying, or diseased trees to reduce the risk of disease to remaining healthy mature trees. Treatment 4 is intended for areas that support sensitive resources (e.g., a riparian corridor or a population of special-status plants or wildlife) and are heavily infected with pitch canker. Where pitch canker infection is heavy, many dead or dying trees must typically be removed; individual tree removal or other less intense treatments will be impractical. However, the presence of sensitive resources on or near a site precludes the application of an intensive treatment such as Treatment 5. Treatment 4 allows the Forest Manager to treat as much of the unit (by removal of trees) as possible, without creating undue risk to sensitive resources.

As with Treatment 3, the intent of Treatment 4 is to simulate "patchy" natural canopy openings caused by fire, windfall, soil subsidence, disease, or storm damage. Like Treatment 3, Treatment 4 increases local light penetration to the forest floor, providing suitable recruitment and germination environments for Monterey pine seedlings. Treatment 4 creates larger openings and is more intense than Treatment 3, and would be applied to a management unit with <50% healthy canopy cover.

Description

Treatment 4 involves the removal of individual trees or small groups of trees that are dead, diseased, or otherwise subject to imminent mortality. It is similar to the traditional forestry sanitation or salvage cut technique, but incorporates restrictions to protect sensitive natural resources. Implementation of Treatment 4 specifically requires the Forest Manager to set limits on the degree of treatment based on conditions in the management unit. Limitations should be dictated by the number of trees or the amount of canopy required to maintain soil or slope stability or to protect other resources on the site. For example, on a site where 85% of the canopy trees are infected with pitch canker and steep slopes or unstable soil conditions are present, an appropriate restriction might be to cut 30–40% of the diseased trees, creating gaps no more than about ~120 feet wide

between trees.[1] Approximately 70% of the canopy cover would remain onsite to provide site stability, yet more than a third of the diseased trees would have been removed. Oak trees should be included in the treatment to maintain proper species ratios within the management unit.

Healthy trees should be left intact to provide a source of seeds for regeneration. This stock will contribute healthy, uninfected seeds to the seed bank; moreover, seed stock from healthy trees in areas where pitch canker is present may be genetically resistant to pitch canker. In addition, care should be taken in choosing trees for removal. Occasionally, diseased trees survive an initial infestation of pitch canker. Therefore, trees should only be felled when death is imminent. Techniques to minimize the spread of disease should be strictly followed in implementing Treatment 4, as described in *Programs for Capturing, Handling, Utilizing, and Disposing of Infected Pine Material in San Luis Obispo County* (Hawley et al. 1998). If piling and burning is used as a method of disposal, burn permitting will be required; see *Understory Prescriptions* and *Techniques for Understory Prescriptions* below, and *Controlled Burns and Air Quality* and *California Department of Forestry and Fire Protection—Burn Permit Program* in chapter 5.

Ecological Benefits and Consequences

The ecological benefits of Treatment 4 include the removal of as many diseased trees as possible within a constrained area, without adversely affecting sensitive resources. Thus, the unique and sensitive features of the forest within the management unit retain their functions and values while infection is controlled.

Although the within-population genetic structure of Cambria's forest is not well documented (Rogers 2001), retaining patches of healthy mature trees may contribute to the maintenance of a genetic reservoir for conservation. Even without genetic considerations, the potential contribution to the seed bank from a large number of uninfected trees is valuable. With the addition of understory treatments to prepare the site for seed germination, the regeneration of Monterey pines in response to Treatment 4 should be vigorous and diverse.

Like any treatment that requires the removal of trees, Treatment 4 has the potential to result in disturbance of site soils and understory vegetation. Precautions should be taken to reduce the risks of accelerated erosion caused by heavy equipment and vehicle traffic, and to ensure that treatment does not contribute to the spread of invasive exotic plant species. Precautions are especially warranted near roads and in other previously disturbed areas where invasive exotic plants or their seeds are present.

[1] See page 6, under *Description* in *Treatment 3—Simulate Medium-Scale Ecological Processes Creating Small Canopy Gaps.*

Treatment 5—Simulate Medium-Scale Ecological Processes Creating Patchy Canopy Openings

Objective

The objective of Treatment 5 is to remove dead, dying, or diseased trees to create patchy canopy openings resembling those caused naturally by fire, windfall, soil subsidence, disease, or storm damage. Creating canopy openings will allow light to penetrate to the forest floor, providing suitable recruitment and germination environments for Monterey pine seedlings. Because Treatment 5 includes a focus on removing diseased trees, it will also reduce the risk of disease to remaining healthy mature trees, however, dead or dying trees that do not show evidence of disease should be left on the forest floor to enhance forest ecosystem function. Treatment 5 is a moderate-intensity treatment appropriate for management units where less than 50% of the canopy is healthy.

Description

In a natural forest, a tree that dies and falls may destroy several other trees, creating a small gap in the forest canopy. Small canopy gaps are also created by localized ground fires that kill patches of mature trees. Once a gap is created, the remaining healthy mature trees surrounding the gap provide partial shade and a source of seeds.

Treatment 5 involves the removal of individual trees or small groups of trees that are dead, diseased, or otherwise subject to imminent mortality. It is similar to the traditional forestry sanitation or salvage cut technique. If possible, cut patches should be 0.25 acre or more in size. Natural canopy gaps of 0.25 acre or more allow the maximum amount of light onto the forest floor, creating conditions that favor rapid regeneration of Monterey pine. Thus, removing small patches of trees will mimic the natural pattern of regeneration that utilizes small canopy gaps. Oak trees should be included in the treatment to maintain proper species ratios within the management unit and ensure that well-defined canopy gaps are created.

Healthy trees should be left intact to provide a source of seeds for regeneration. This stock will contribute healthy, uninfected seeds to the seed bank. Moreover, seed stock from healthy trees in areas where pitch canker is present may be genetically resistant to pitch canker.

Care should be taken in choosing trees for removal. Occasionally, diseased trees recover from an initial infestation of pitch canker. Therefore, trees should only be felled when death is imminent. Techniques to minimize the spread of disease should be strictly followed in implementing Treatment 5, as described in *Programs for Capturing, Handling, Utilizing, and Disposing of Infected Pine Material in San Luis Obispo County* (Hawley et al. 1998). If piling and burning

is used as a method of disposal, burn permitting will be required; see *Understory Prescriptions* and *Techniques for Understory Prescriptions* below, and *Controlled Burns and Air Quality* and *California Department of Forestry and Fire Protection—Burn Permit Program* in chapter 5.

Ecological Benefits and Consequences

Although Treatment 5 is not limited by restrictions to protect sensitive resources in the management unit and vicinity, the ecological benefits and consequences for Treatment 5 are analogous to those described above for Treatment 4. Because the treatments are essentially the same except for restrictions to protect sensitive resources, the same precautions taken for Treatment 4 should also be taken at sites where Treatment 5 will be implemented.

Treatment 6—Simulate Large-Scale Ecological Processes while Retaining Seed Trees

Objective

The objective of Treatment 6 is to mimic a large natural event that would remove many of the trees in the overstory. This treatment is intensive, and should be used sparingly; it would only be appropriate where a large number of dead and dying trees need to be removed, but enough non-symptomatic trees are present to provide an ongoing supply of seed. This treatment would retain healthy and potentially pitch canker–resistant trees and provide suitable seed-bed conditions for Monterey pine germination and eventual canopy recruitment.

Description

Treatment 6 is similar to the traditional forestry technique of seed tree retention. Treatment 6 involves the removal of the dead and dying forest canopy, leaving at least 8 healthy trees with a dbh $\geq$20 inches per acre. If larger, healthy individuals are represented in the patch, then as few as 4 trees with a dbh $\geq$24 inches can be retained per acre, as long as the spacing requirements are met. The optimal maximum horizontal spacing between retained trees, or between retained trees and the edge of the treatment patch, is ~120 feet.[2] The minimum spacing for retained trees depends on the number of trees retained and the size of the management unit; seed rain from the retained trees should be able to cover most of the management unit to increase the probability that the trees providing seed for regeneration are of variable genetic stock.

The optimal canopy cover of residual overstory trees is approximately 20–30%. Optimal trees for retention are those that meet the following criteria.

[2] See page 6, under *Description* in *Treatment 3—Simulate Medium-Scale Ecological Processes Creating Small Canopy Gaps.*

- Trees rated *Low* or *None* using the Pitch Canker Severity Rating method of Storer et al. (2000) (see appendix C).
- Healthy trees without significant lean.
- Trees in the *Mature* or *Senescent* size class (see chapter 3).

As with previous treatments, oak trees should be included in Treatment 6 to maintain species ratios and biodiversity within the management unit. Mature oak seed trees should be retained in the management unit, and monitoring and adaptive management should be used to ensure the recovery of both Monterey pine and native oaks.

Techniques to minimize the spread of disease should be strictly followed in implementing Treatment 6, as described in *Programs for Capturing, Handling, Utilizing, and Disposing of Infected Pine Material in San Luis Obispo County* (Hawley et al. 1998). If piling and burning is used as a method of disposal, burn permitting will be required; see *Understory Prescriptions* and *Techniques for Understory Prescriptions* below, and *Controlled Burns and Air Quality* and *California Department of Forestry and Fire Protection—Burn Permit Program* in chapter 5.

Ecological Benefits and Consequences

The intensity of Treatment 6 allows the Forest Manager to effect a large change in the forest ecosystem within a short time frame. Because Treatment 6 provides for the retention of healthy mature Monterey pines and native oaks as seed trees, the amount of manipulation required to reestablish a healthy forest is less under Treatment 6 than under more intensive options such as Treatment 7. In addition, removal of the infected trees that surround healthy trees will decrease the possibility of further infection within the stand. Because the pitch canker pathogen remains viable in and on the surface of seeds and cones from infected trees, removal of these sources will increase the likelihood of successful germination of seeds from healthy trees.

However, the ecological risks associated with removing many trees at the same time are significant. For example, the intensity of Treatment 6 has the potential to substantially disturb soil and understory resources and to facilitate the establishment of invasive exotic plants within the management unit. Consequently, the need for active monitoring and adaptive management is greater with Treatment 6 than with less intensive treatments.

Treatment 7—Simulate Large-Scale Ecological Processes without Retaining Seed Trees

Objective

The objective of Treatment 7 is to mimic a catastrophic natural disturbance such as a crown fire or landslide that would destroy an entire stand at once. Because such events occur infrequently in nature, this treatment will probably be used sparingly, if at all. Treatment 7 would be appropriate only where a large proportion of the Monterey pines on a site were dying or dead, and where visual sensitivity and erosion risk were low.

As with a catastrophic natural event, Treatment 7 would return the forest in the treated area to an earlier successional stage, exposing the entire forest floor to full sunlight and allowing seedlings and saplings to grow rapidly into the canopy, creating an even-aged stand. Natural Monterey pine forests are fire-dependent; combining Treatment 7 with a prescribed burn would create optimal conditions for Monterey pine seed regeneration. If burning is not feasible, then duff removal would mimic some of the effects of a fire and enhance regeneration after a complete patch removal. Where large areas of forest are cleared care must be taken to insure that the areas are not colonized by non-native invasive species.

Description

Treatment 7 involves the removal of the entire forest overstory by hand or with machinery. This treatment is very similar to the traditional forestry complete patch removal treatment. The techniques used to implement Treatment 7 will depend on conditions at the site, its accessibility, and the size classes of trees present. Techniques to minimize the spread of disease should be strictly followed in implementing Treatment 7, as described in *Programs for Capturing, Handling, Utilizing, and Disposing of Infected Pine Material in San Luis Obispo County* (Hawley et al. 1998). If piling and burning is used as a method of disposal, burn permitting will be required; see *Understory Prescriptions* and *Techniques for Understory Prescriptions* below, and *Controlled Burns and Air Quality* and *California Department of Forestry and Fire Protection—Burn Permit Program* in chapter 5.

Because Treatment 7 is meant to mimic a natural catastrophe, all trees, including oaks and other species of pines, should be removed. This will ensure that all species in the forest are similarly affected by the treatment; unequal treatment of different tree species could favor the regeneration of 1 species over another, altering the ecological balance and possibly changing the structure and function of the forest as a whole. Monitoring and adaptive management should be included in the treatment to ensure that recruitment rates are sufficient to supply seedlings of all canopy species.

In areas where Treatment 7 is applied, standing snags from uninfected trees and formerly diseased trees that no longer support pitch canker pathogens or vectors should be retained. These snags provide valuable habitat for wildlife, and are an important part of the forest ecosystem.

Ecological Benefits and Consequences

Selecting a high-intensity treatment allows the Forest Manager to effect rapid, dramatic changes in the forest interior. This may be essential in areas with severe pitch canker infection; pitch canker is a rapidly spreading disease, and high densities of dead and dying trees may accelerate rates of infection in nearby stands. When implementing Treatment 7, the Forest Manager could treat and dispose of infected cut materials onsite to decrease the potential for further infection by pitch canker fungus or other pathogens retained in slash and litter (Hawley et al. 1998).

Removal of standing dead and dry material would also decrease fire risk by decreasing the vertical contiguity of available fuels in the treated area. While onsite chipping and spreading of woody debris will not change the amount of fuel present in the management unit, the reduction of fuel height and removal of ladders would constrain the spread of fire.

As with Treatment 6, the ecological risks associated with removing many trees at the same time are significant; caution and concern are required for successful implementation of Treatment 7. There will be a delay between the removal of existing trees and the establishment of a healthy, young forest, during which the management unit may be subject to increased risk of slope failure, accelerated erosion, siltation in area watercourses, and other effects exacerbated by lack of vegetation. Furthermore, if seeds fail to germinate, or if they produce diseased or dying seedlings and saplings, slopes may remain bare longer than anticipated. The Forest Manager should ensure that a robust monitoring and adaptive management component is included in treatment programs that incorporate Treatment 7 to allow appropriate response, including remediation treatments, if optimal recovery is not observed.

The open canopy and burned or cleared understory produced by Treatment 7 will be conducive to quick regrowth of Monterey pine and native oaks, but may also trigger the germination of invasive exotic plants such as French broom (*Genista monspessulana*) and Italian thistle (*Carduus pycnocephalus*). Generally, invasive exotic plants are found in and around developed areas and transportation corridors, where disturbance to the soil has allowed their spread. If Treatment 7 is used sparingly and only within the deep interior of the forest, as anticipated, the risk of invasion by exotic species will be reduced. In addition, a robust monitoring and adaptive management program will aid in the detection and removal of invasive exotics.

Because Treatment 7 will be restricted to areas where most of the existing Monterey pines are dying or dead from pitch canker most of the seed bank in the

treated area will likely be infected. Infected trees often produce infected seeds, and the pitch canker pathogen cannot be removed from the seed; the resulting seedlings are often infected. An uninfected source of seeds or seedlings should thus be considered as a complement to Treatment 7.

No-Treatment Option

The Forest Manager may determine that it is preferable not to pursue treatment in some management units or in some years. The No-Treatment Option may be a good long-term choice for areas that are inherently sensitive or vulnerable, such as riparian corridors and areas with very steep slopes. In addition, the Forest Manager should be extremely cautious in treating areas adjacent to management units that have undergone intensive treatments, such as Treatment 6 or 7. These adjacent units should be considered for the No-Treatment Option to provide stable forest buffers around intensively treated sites.

Techniques for Overstory Treatments

The term *techniques* applies to standardized forestry methods used to manage the vegetation within forests. After choosing an overstory treatment, the Forest Manager should identify appropriate techniques to use in implementing the treatment. Although several techniques may offer the Forest Manager the ability to achieve a treatment's objectives, they may have different levels of intensity or different possible corollary effects. The Forest Manager should choose the most site-appropriate technique or combination of techniques based on site-specific constraints.

The following sections describe a palette of techniques that may be used to implement Treatments 1–7.

Felling and Removing Large-Diameter Logs

One or more of the following techniques will be used to fell trees and remove them from areas under treatment.

- Use of heavy equipment.
- Felling to the lead.
- End-lining.

Although these felling techniques may be used at any time, removal of felled materials may need to be postponed. Large-diameter logs can harbor viable pitch canker and pathogens for more than a year after felling, and should not be moved from the management unit within that time (Gordon et al. 2001). CDF has

suggested that during this waiting period, the Forest Manager debark the logs and treat them with a fungicide to help control pitch canker pathogens within the forest (Gordon et al. 2001). In addition, beetles that act as vectors of pitch canker disease typically emerge from large logs in the first 4 months after the logs are felled. The consequences of an entire host of beetles leaving a downed, infected log are unknown; CDF is currently conducting research. To further these efforts, and to support ongoing adaptive management, we recommend that logs felled in the Cambria forest be chipped and left onsite when possible, and that they be monitored.

Log landings have the potential to damage soil resources and understory vegetation substantially; log landing areas should thus be selected with care. To minimize disturbance, log landings should be restricted to sites with the following characteristics.

- Slope <20%, and/or location on ridge top or other drainage divide.
- Low existing soil erosion condition.
- Low erosion hazard.
- Low soil productivity.
- Duff layer of moderate to average or above-average thickness.
- Moderate to thick soil cover.

When possible, log landings should be located on existing roads or in other disturbed areas so that skidding across streams, wetlands, or other sensitive areas is not required. If logs must be hauled overland in undisturbed areas, only low-pressure vehicles should be used.

Following log removal, the landing site, travel routes, and skid area should be blocked from future vehicle access by retaining downed logs or other hindrances, and should be covered with chips created onsite so that vehicle tracks are no longer visible. All temporary landing sites should be replanted with Monterey pine and/or native oaks, consistent with pretreatment species distribution on the site. If possible, log landing and the processing of pitch canker–infected logs should be conducted in the same area to limit the area of forest floor and understory vegetation disturbed.

The following sections provide additional information on the use of heavy equipment in felling and log removal, on felling to the lead, and on end-lining.

Use of Heavy Equipment

Heavy equipment should be used sparingly and with great caution. Mechanical equipment has the potential to cause substantial damage to a treatment area and to slow post-treatment regeneration of Monterey pines by disturbing soils and crushing vegetation. Hand clearing will have less impact on soil resources;

however, it may not be feasible in larger management units or for more intensive treatments.

If heavy equipment is required to fell and remove logs from a treatment area, a low-pressure vehicle (such as a feller-buncher harvester) should be used in potentially sensitive areas, if possible. *Sensitive areas* are considered to including those with any of the following characteristics.

- No road access.
- Slope ≥20%.
- Active or dormant landslides.
- Moderate to high existing soil erosion condition.
- Moderate to high erosion hazard.
- High soil productivity.
- Duff layer of below-average thickness.
- Thin soil cover.

Additional measures that may be used to protect sensitive resources from heavy equipment include the following.

- Restricting the use of heavy equipment to dry periods (May 1–November 1, or at least 1 week after precipitation events).
- To the extent feasible, running equipment parallel to topographic contours, limiting turns, and minimizing the number of access points and routes. In some cases, lack of direct access to a site via roads or fire roads may preclude the use of heavy equipment because of the potential for damage to the forest.
- Limiting operating periods to minimize disturbance of special-status wildlife species (for example, avoiding songbird nesting periods in the spring).
- Flagging or fencing sensitive resources (such as populations of special-status plants, cultural resources, large oak trees, and habitat for sensitive wildlife species) so equipment operators can avoid them.
- Informing all equipment operators of the sensitivity of various areas and the operating restrictions imposed to protect them.
- Retaining a qualified biologist to monitor construction activities to ensure avoidance of sensitive areas.
- Restricting creek crossings to existing roads; if no roads exist, constructing temporary bridges over creeks to allow crossings that minimize erosion and siltation in aquatic habitats.

In addition, treatment plans that incorporate the use of heavy equipment should provide for post-treatment monitoring in the areas in which heavy equipment is

used. Immediate remedial action should be taken if signs of accelerated erosion, creek siltation, spread of invasive exotic plants, or other adverse effects are detected.

In many areas, draft animals are used in place of heavy equipment for the removal of logs from an area. This can reduce the adverse impacts of logging activity on soils and vegetation. However, draft animals can also introduce seeds of exotic pest plants, such as wild oats (*Avena fatua*), yellow star-thistle (*Centaurea solstitialis*), and Italian thistle. The Forest Manager may consider using draft animals as an alternative to heavy equipment, but draft animals should only be used in already-disturbed areas where the introduction of exotic plant species will not pose a significant threat to the forest.

End-Lining

End-lining refers to winching downed logs directly out of a treated area with a cable operated from outside the immediate treatment area. The use of end-lining allows the removal of logs while avoiding the potential impacts of heavy equipment on sensitive resources. Areas appropriate for end-lining include the following.

- Areas adjacent to existing roads.
- Buffer zones around streams or wetlands (see discussion in *Techniques for Avoiding Undesirable Corollary Effects* below).
- Landslide features.
- Areas with a high degree of existing soil erosion or high soil erosion hazard.
- Areas considered at risk of excessive soil compaction.
- Areas where soil productivity is high and could be substantially reduced by the effects of heavy equipment.

Felling to the Lead

Felling to the lead involves felling trees toward a central, predetermined location for skid removal. This practice minimizes heavy equipment operations within a treatment patch, and thus minimizes impacts on soil resources and understory vegetation.

Removing Trees and Other Vegetation by Hand

The removal of trees and other vegetation using hand tools is termed *handwork*. Tools used in handwork include axes, pulaskis, brush hooks, hoes, weed eaters, chainsaws, and other handheld tools and equipment. Handwork may be conducted during any season and may be used in the vicinity of structures or in

environmentally sensitive areas, such as wetlands, riparian corridors, areas with high soil erosion hazard, and special-status species habitats. Hand tools are also generally used to install control lines for prescribed burns, particularly in environmentally sensitive areas; to remove ladder fuels; and to remove individual trees.

Techniques for Avoiding Undesirable Corollary Effects

Precautions for Removing Diseased Trees

Because of the potentially devastating nature and rapid spread of pitch canker, and because no cure is known, CDF is particularly interested in preventing or slowing the transmission of the disease to uninfected Monterey pine stands. Their efforts focus on preventing diseased materials and contaminated equipment from leaving areas of pitch canker infection.

Based on current CDF recommendations, material generated by pruning or felling infected Monterey pines should remain onsite. If possible, woody material should be chipped, treated with a fungicide, and spread onsite. If conditions in a treated area render it necessary to remove infected woody materials, Gordon et al. (2001) recommend transporting and disposing of them in accordance with the procedures described in *Programs for Capturing, Handling, Utilizing, and Disposing of Infected Pine Material in San Luis Obispo County* (Hawley et al. 1998).

Tools and equipment used for pruning or cutting infected trees, or for chipping infected downed materials, should be cleaned and sterilized immediately after use. The recommended method is to use a Lysol or bleach solution, as described by Gordon et al. (2001).

Techniques to Minimize Impacts Related to Soils and Water Quality

The geologic context of a site will influence the treatment options available to the Forest Manager. Slope and soil stability are important factors to consider in regard to both forest management and protection of water quality. Forest management may be considered a non-point source of pollution that affects surface water quality by increasing suspended sediment, nutrients, turbidity, and temperature. For example, increased sediment discharges can result from landslides, increased surface erosion on hillslopes, or undercutting and destabilization of streambanks. Controlled burning results in combustion of soil organic matter and the litter layer, increasing the availability of some nutrients, which can be carried to receiving waters in dissolved form by runoff. Removal of overstory shading can adversely affect water temperature.

On sites with sensitive soils, at least 70% combined vegetative cover (overstory and understory perennial woody vegetation) should be retained. Mechanical techniques should be avoided to the extent feasible; if they cannot be avoided, low-pressure vehicles should be used. The existing soil cover and duff layer should be retained to the extent possible, and should not be reduced below the moderate level. Sites with sensitive soils are considered to include areas with any of the following characteristics.

- Areas of high soil erosion.
- Areas of high soil productivity.
- Slopes $\geq$20%.
- Active or dormant landslides onsite.
- Location within 75 feet of active landslide(s).

Importance of Maintaining Groundcover

A continuous groundcover should be maintained under the forest canopy on steep slopes and in other areas with high erosion risk. Groundcover increases the input of organic matter to soils and the retention of soil moisture, reduces runoff, and prevents excess infiltration. Branches and, if appropriate, boles generated by overstory removal should be chipped and distributed onsite to provide new groundcover. Chipping reduces downed materials to small pieces, ensuring good soil coverage.

In areas designated for tree removal, the litter layer that has accumulated under undisturbed forest should also be removed to allow for soil amendments and restoration planting. The litter layer should be removed either by ~~either~~ burning or by raking. Because the resulting bare soil will be highly prone to erosion, suitable erosion control blankets or netting and a straw mulch should be used as groundcover to provide erosion protection while native plants become established. Care should be taken to avoid colonization of bare areas by invasive species (see *Remove Invasive Species* section in *Understory Techniques* below).

Techniques to Establish Avoidance Areas (Buffer Zones)

No forest management actions (including vegetation removal and ground-disturbing activities) should be implemented in any of the following types of locations in the Cambria forest.

- Jurisdictional waters of the United States.
- Coastal streams and wetlands as defined in the Local Coastal Program's land use plan (see *California Coastal Act* section in chapter 5).
- Riparian or wetland vegetation communities.

- Active landslides.
- The headwalls or margins of dormant landslides.

In many cases, it is appropriate to establish an avoidance area or buffer zone around these features. Buffer zones serve 2 primary purposes: they protect sensitive biological resources, and they simplify permitting requirements for management activities.

Biologically, the purposes of a buffer zone around streams and wetlands are to maintain shade, vegetative cover, and wildlife habitat; to minimize the delivery of sediment and nutrients to aquatic habitats; and to avoid direct and indirect impacts on habitats for special-status species. Buffer zones around active and dormant landslides help to prevent management activities from exacerbating existing landslide problems (Murphy 1995, California Department of Forestry and Fire Protection 1997). Establishing buffer zones also ensures that some untreated areas are retained within the forest.

Most activities in and adjacent to streams and seasonal and perennial wetlands are regulated by state and federal agencies (see chapter 5); as a result, activities with the potential to result in direct or indirect impacts on these habitats require permits. Avoiding the potential for impacts on streams and wetlands will avoid the need for permitting, although consultation with the appropriate agencies is still recommended.

As shown in table 4-1, the width of the buffer zone required to protect a stream or wetland depends on the steepness of adjacent slopes and whether the stream or wetland is perennial or seasonal. The recommended widths for buffer zones are based on the widths of watercourse and lake protection zones for Class I and II watercourses, as specified in the California Forest Practice Rules.

Table 4-1. Recommended Widths for Stream and Wetland Buffer Zones, Based on Slope Steepness and Type of Stream or Wetland

Slope Gradient	Perennial Streams and Wetlands	Non-Perennial Streams and Wetlands
0–30%	75 feet	25 feet
30–50%	100 feet	50 feet
>50%	150 feet	75 feet

Buffer zone width should be measured from the upland edge of the stream or wetland. If the boundary of a wetland is difficult to recognize or define, it may be advisable to retain a qualified biologist or soil scientist to conduct a formal wetland delineation[3] to determine the boundaries of U.S. Army Corps of

[3] See *Clean Water Act* section in chapter 5.

Engineers and Local Coastal Program jurisdiction. If riparian or wetland vegetation communities[4] associated with a watercourse or wetland cover a larger area than that encompassed by a buffer zone of minimum width, the width of the buffer zone should be adjusted to ensure that these plant communities are entirely within the protected buffer zone.

Treatment prescriptions within buffer zones should be strictly limited to those shown in table 4-2. No mechanical techniques or controlled burning should be employed in buffer zones.

Table 4-2. Management Actions Approved for Use in Buffer Zones

Overstory Prescriptions	Understory Prescriptions	Techniques
▪ In extremely sensitive locations – Treatment 2. ▪ Treatment 3. ▪ Treatment 4.	▪ Ladder fuel removal (limbing and thinning, retaining at least 50% vegetation cover or existing cover, whichever is less). ▪ Chipping (chipping and spreading downed materials onsite). ▪ Removal of uninfected woody debris (removing all treated materials from the management unit if existing soil cover and duff layer are at least moderate).	▪ Use hand tools for all activities, including cutting and removal of woody material. ▪ After chipping, spread chips broadcast from a portable chipper, or pile and burn chips. All infected chipped material should be kept within the management unit. ▪ Restrict use of mechanized equipment to create fuel breaks to area >25 feet from buffer zones. ▪ Allow transport vehicles and heavy equipment to cross buffer zones only on existing roads.

Understory Prescriptions

Remove Understory Fuels

Objective

With increasing numbers of trees and limbs falling because of mortality related to pitch canker, available fuels in the understory of the Cambria forest are expected to increase substantially in the future. The objective of removing understory fuels from management units is to reduce the risk of catastrophic fires and resulting loss of life and damage to property.

[4] These habitats are regulated by DFG under Sections 1600–1607 of the California Fish and Game Code; see discussion in chapter 5.

Description

Fuels are typically described and measured in terms of *fuel load*, the flammable portions of live and dead vegetation. The key characteristics of fuel loads that determine fire hazard are:

- total load (usually measured in tons/acre);
- horizontal continuity (the proportion of the ground surface covered by fuels);
- vertical continuity (the presence or absence of "ladders"); and
- relative contribution of fine fuels (e.g., pine needles) and coarse fuels (e.g., fallen tree limbs, understory shrubs).

Fine fuels include woody and herbaceous material up to 3 inches in diameter. Accumulated fine fuels are relatively hazardous because they ignite at lower temperatures and support more rapid fire movement than coarse fuels. Although coarse fuels can ultimately produce more heat than fine fuels, they contribute little to the risk of catastrophic fire, especially in locations where fire suppression crews can respond quickly, such as the Cambria forest.

Reduction or removal of understory fuels can be accomplished with several treatments used alone or in combination: ladder fuel removal, removal of woody debris, and duff removal. Removal of understory vegetation should be conducted in accordance with Cambria Community Services District guidelines, which include a requirement that certified understory abatement contractors be retained to create defensible spaces around buildings. The following sections provide additional details.

Remove Ladder Fuel

The objective of ladder fuel removal is to reduce risks associated with high fuel loads or hazardous fuel conditions by reducing the vertical contiguity of fuels. The removal of ladder fuels reduces the chances of a ground fire reaching the canopy.

Ladder fuel removal can include 1 or more of the following: limbing, thinning, pruning, and crushing. *Limbing* refers to the removal of all limbs up to 10 feet above the ground surface on trees that are to be retained. *Thinning* refers to cutting and removal of small trees and shrubs, such that total understory cover of vegetation >8 inches high is reduced below 25%. *Pruning* refers to hand removal of limbs. *Crushing* is the use of heavy equipment or vehicles to crush woody shrubs so that fuel height is reduced. In the Cambria forest, crushing will likely be most appropriate as preparation for a controlled burn (described below), although crushed shrubs can also be removed from a site by hand.

Reduce or Remove Woody Debris

In general, coarse woody debris contributes little to the risk of catastrophic fire in the Cambria forest. Therefore, it is not essential that woody debris be removed from the forest floor. However, in some situations, removal of woody material will reduce fire hazards considerably.

Management units with steep slopes will typically be subject to high erosion risk; consequently, treatment options for reducing fuel loads in these units will be substantially limited. At the same time, these units may be at considerable risk from fire, because rates of spread normally increase when fires encounter steep terrain, and fire control and suppression are more difficult on steep or rugged terrain. Hand removal of woody debris, in combination with duff removal (see below) can greatly reduce the total fuel load and the horizontal and vertical contiguity of fuels in steep or rugged management units.

In addition to contributing to vertical contiguity of fuel loads, woody debris also provides habitat for pests such as bark beetle, a leading pitch canker vector. The removal of woody debris is thus expected to slow the spread of pitch canker. In areas infected with pitch canker, downed woody debris must be retained onsite to avoid the spread of contagion; in these areas, debris should be chipped, treated with fungicide if appropriate, and spread on the forest floor, or piled and burned. If piling and burning is used as a method of disposal, burn permitting will be required; see *Understory Prescriptions* and *Techniques for Understory Prescriptions* below, and *Controlled Burns and Air Quality* and *California Department of Forestry and Fire Protection—Burn Permit Program* in chapter 5.

Remove Duff Layer

Removal or reduction of the duff layer offers several benefits, including reducing the horizontal contiguity of fuels and exposing mineral soil to increase germination of Monterey pine seeds. Because this treatment will also allow germination of nonnative species, including invasive species, the Forest Manager should closely monitor regeneration in duff clearings and remove invasive species as soon as they can be positively identified. The duff layer can be removed by hand with rakes or with low-pressure vehicles. Care should be taken to remove only the undecomposed leaf litter and to leave the rich topsoil undisturbed.

Ecological Benefits and Consequences

The removal of fuels can be beneficial to Monterey pines by preparing the forest floor for germination and growth of seedlings and saplings. However, care must be taken not to disturb the seed bank or nutrient-rich topsoil or that has accumulated over time. Other benefits include onsite treatment and/or aging of

infected woody material, which may help to control the spread of pitch canker in the forest as a whole (Gordon et al. 2001).

Conduct Controlled Burn

Objective

The objective of a controlled burn is to simulate the beneficial effects of a natural fire: reduction of fuel loads, pests, and pathogens; and creation of conditions favorable for Monterey pine seed germination and tree recruitment. Historically, the Cambria forest experienced periodic, naturally occurring fires, which varied in intensity from cooler ground fires that were confined primarily to the forest floor to hot fires that affected the entire forest from the forest floor to the canopy. Ground fires were usually the result of a lightning strike during mild weather, while hot fires occurred during the hottest months of summer. Ground fires sometimes kill mature trees by girdling them (Vogl et al. 1988), while hot crown fires probably almost always do. Consequently, ground fires likely resulted in many small canopy gaps and maintained stands of uneven age, while crown fires opened large clearings in the forest and generally produced large stands of even age.

Because of the fire suppression that has occurred in the Cambria forest over the last century or more, the greatest ecological benefit would be derived from a crown fire affecting a large area. However, this type of prescribed burn is not feasible because it is difficult to control and the risk to life and property is unacceptably high. For safety reasons, the result of a stand-replacing event of this type will be produced instead by implementing overstory Treatment 7 (described above) in conjunction with a controlled burn affecting only understory vegetation, woody debris, and the duff layer. Permitting requirements for controlled burns are discussed in chapter 5 (see *Controlled Burns and Air Quality* and *California Department of Forestry and Fire Protection—Burn Permit Program* sections).

Description

Use of prescribed burning to treat understory fuels without impacting the forest overstory and posing unacceptable safety risks requires a cool ground fire that burns quickly. The ideal burn will result in consumption of about 75% of all live understory vegetation, 75% of all woody debris, and 50% of all litter and duff.

The controlled burn understory treatment is best used in conjunction with application of Treatment 7 in the overstory, but could also be used in combination with a Treatment 6 or Treatment 3 overstory prescription. Prior to a burn, cone-bearing branches and individual cones from felled trees should be spread evenly within the treatment area. Depending on site-specific conditions and management objectives, the Forest Manager may also implement the fuel

removal and/or cone and seed scattering treatments (described below) in preparation for a controlled burn.

Ecological Benefits and Consequences

Of all understory treatments, a controlled burn is the least manipulative and most resembles natural processes. Monterey pines benefit from fires; heat or fire causes closed cones to open and release seeds, and prepares the soil for seed germination. Fires reduce understory vegetation, and partially or completely remove the layer of leaf litter on the soil surface (the duff layer), leaving an open site with nutrient-rich ash in which seeds can germinate and seedlings can thrive. In addition, fires remove pests and pathogens, including invasive exotic plant species, the pitch canker pathogen, and beetles that act as pitch canker vectors.

Scatter Cones and/or Seeds

Objective

Intensive overstory treatments such as Treatments 6 and 7 will leave few or no mature trees in the overstory to provide a source of cones and seeds for regeneration. If the number of cones on the ground after such treatments is insufficient, the Forest Manager may want to supplement the seed population by scattering cones or seeds. The objective of scattering cones and/or seeds is to ensure a large and diverse seed population for Monterey pine regeneration.

Description

Cones and seeds should be collected from many healthy trees within the management unit where they are to be scattered to ensure germination of stock that is adapted to local microclimates. Either cones or seeds may be scattered. Scattering open cones will likely be the most cost-effective method. Closed cones can be taken from healthy mature limbs by pruning small limbs or portions of large limbs and cutting the cones off the limbs by hand. The cones can then be artificially heated to open them or placed in the open on hot summer days, where they should open on their own. Cones should be scattered as evenly as possible in open areas to maximize the chance that seedlings will grow in suitable microsites. Care should be taken to insure that genetic differences between management units are considered when scattering seeds.

This treatment is appropriate for use where a delay between treatment and recruitment is acceptable. On sensitive sites where groundcover or regeneration is required immediately after treatment, planting trees (see below) is the desired understory treatment.

Ecological Benefits and Consequences

Scattering cones and seeds evenly over an entire management unit increases the chances of germination within that unit. If pitch canker is present within the management unit, some of the seeds scattered may be infected; these will produce infected seedlings if they germinate. Other seeds will be from healthy, perhaps genetically resistant, trees and are expected to germinate successfully. Because healthy trees may not be evenly spaced throughout the management unit, scattering their cones will increase the probability that these viable seeds will germinate in several places. Scattering cones and seeds would be especially helpful as an addition to an intensive overstory treatment, where regeneration of a healthy, even-aged cover of Monterey pines is important to protect soil and understory resources.

Plant Trees

Objective

Tree planting is an important supplement to overstory treatments in sensitive areas, such as management units with steep slopes. The objective of tree planting is to speed regeneration of Monterey pine cover in areas under treatment. Planted trees will replace trees removed from the overstory.

Description

Appendix B provides detailed information on recommended techniques for tree planting. At least 3 trees should be planted for each removed tree with a dbh >20 inches. Planted trees should be 5-gallon stock of disease-free Monterey pines native to the Cambria area, coast live oak, or other tree species approved by the CFC or Cambria Design Committee. All native tree species to be planted should be propagated from stock native to the Cambria forest. All Monterey pines should be derived from an approved propagation program intended to develop pitch canker–resistant stock from local trees.

Ecological Benefits and Consequences

Planting healthy stock free of pitch canker infection will help to increase the survival of young trees in management units within the Cambria forest. This will be especially beneficial in areas with sensitive resources, where it is important to regenerate healthy canopy cover as quickly as possible. In addition, tree planting, or tree planting used in conjunction with cone and seed scattering, will contribute to greater biodiversity, improved soil conditions, and better overall forest health compared to reliance on cone and seed scattering along, because the

survival rate of planted seedlings and saplings is higher than that of naturally germinated seeds.

Remove Invasive Species

Objective and Description

Invasive species is used here to refer to plant species that are not native to the Cambria forest and that have the ability to spread rapidly and displace native species. The objective of removing invasive species is to increase the diversity of native plant species in the understory by removing existing infestations of invasive species and minimizing the chance of future colonization and spread. Many exotic weedy species are found only in disturbed soils such as those present in roadside areas and along trails; however, some of these species can spread into undisturbed soils of wildlands.

Table 4-3 lists the invasive species found or likely to be found in the Cambria forest and suggests appropriate techniques for their removal. These species should be eradicated from treatment areas if possible. Because many of these species have long-lived seed banks, managers should monitor treated sites frequently to remove seedlings and resprouts before they reinfest the area. If removal of invasive exotic species is included in the prescription for a management unit, the Forest Manager should develop a multi-year plan that provides guidance for initial removal, monitoring, and follow-up and maintenance treatments. Detailed information on techniques for controlling the most problematic invasive plants can be found in Bossard et al. (2000) and through the website of the California Exotic Pest Plant Council (www.caleppc.org).

Table 4-3. Invasive Weeds Reported to Occur in the Cambria Forest and Vicinity

Common Name Scientific Name	Habitat	Recommended Removal Techniques
English ivy Hedera helix	Forests near urban areas; riparian zones.	Hand removal of vines on forest floor and tree trunks.
Milk thistle Silybum marianum	Disturbed or grazed areas, especially in former sludge disposal areas.	Hand removal (with gloves); chemical treatment.
Periwinkle Vinca major	Escapes from gardens into riparian areas and wetlands.	Hand removal; chemical treatment.
Nasturtium Tropaeolum majus	Steep slopes and recent landslides near developed areas.	Hand removal.
Quaking grass Briza major	Grasslands and forest understories, especially in areas subjected to weed abatement.	No available techniques control this species effectively; prescribed burns may reduce abundance.

Table 4-3. Invasive Weeds Reported to Occur in the Cambria Forest and Vicinity

Cape ivy Delairea odorata	Shady, moist areas such as riparian zones.	Removal is difficult; species regrows from fragments. Chemical and physical techniques are effective, but only with frequent monitoring and reapplication.
Italian thistle Carduus pycnocephalus	Grassland, roadsides, and disturbed wildland areas.	Chemical treatment; physical techniques are generally ineffective except on small infestations.
Poison hemlock Conium maculatum	Roadsides, disturbed areas, and moist riparian areas.	Hand removal, mowing, or chemical controls.
Castor bean Ricinus communis	Roadsides, drainage ditches, and moist riparian areas.	Hand removal; chemical treatment.
Kikuyu grass Pennisetum clandestinum	Moist areas, including riparian zones.	Chemical treatment appears to be most effective on a related species, fountain grass (P. setaceum).
Wild radish Raphanus sativus	Disturbed areas, grasslands.	Hand removal; chemical treatment.
Italian ryegrass Lolium multiflorum	Disturbed and grazed grasslands.	No available techniques control this species effectively; prescribed burns may reduce abundance.
Black mustard Brassica nigra	Disturbed areas, grasslands.	Hand removal; chemical treatment.
Sow thistle Sonchus asper	Roadsides and disturbed areas.	Hand removal; chemical treatment.
Eucalyptus Eucalyptus spp.	Planted as ornamental and windbreak; may escape into nearby wildlands and forests.	Mechanical removal combined with stump spraying to control sprouting.
Blackwood acacia Acacia melanoxylon	Established in Fern Canyon; may spread if not controlled there.	Mechanical removal combined with stump spraying to control sprouting.
Distaff thistle Carthamus spp.	Rangelands.	Chemical treatment or physical techniques.
Purple star-thistle Centaurea calcitrapa	Rangelands.	Chemical treatment or physical techniques.
Yellow star-thistle Centaurea solstitialis	Margins of Highway 1; grasslands.	An aggressive program of chemical, physical, or biological control techniques is necessary.
Pampas grass Cortaderia selloana	Margins of Highway 1; roadcuts.	Cut to ground level, then treat with chemicals; burning is not recommended.

Table 4-3. Invasive Weeds Reported to Occur in the Cambria Forest and Vicinity

Scotch broom Cytisus scoparius	Road margins, including those in forested areas.	Cut mature shrubs in fall and burn them in early summer; if burning is not feasible, use physical or chemical treatments.
French broom Genista monspessulana	Road margins, including those in forested areas; grasslands and shrublands.	Remove mature shrubs using physical techniques; follow with chemical treatment

Sources: Bossard et al. 2000, Hopkins pers. comm., Lee pers. comm., Schicker pers. comm., Krause pers. comm.

The most abundant invasive species in the Cambria area, and the ones that will require the most aggressive treatments, are pampas grass (*Cortaderia selloana*), French broom, Scotch broom (*Cytisus scoparius*), and Cape ivy (German ivy) (*Delairea odorata*). Many of the invasive grasses that are common in Cambria and throughout California cannot be effectively controlled because they spread so rapidly or resprout from substantial existing seed banks. For example, quaking grass or rattlesnake grass (*Briza major*) is a naturalized invasive weed that often colonizes areas in the Cambria forest immediately after clearing, in many cases hindering Monterey pine germination or growth. Complete removal of this species from an area is unrealistic; the Forest Manager should instead attempt to reduce its abundance in favor of native species, and include planting of Monterey pines in the treatment program.

Ecological Benefits and Consequences

The removal of invasive exotic plant species will contribute to the maintenance or increase of native biodiversity in the Cambria forest. Because invasive species spread rapidly and displace native species, early detection and removal is essential to the health of the forest.

Techniques for Understory Activities

Conduct Controlled Burns

Controlled burns are used to clear understory vegetation, debris, and litter. Hand ignition techniques (drip torch, flamethrower, or fusee) are typically used. Burning may occur throughout the year; however, it is usually conducted during late summer or fall after plants have completed their yearly growth and their moisture content has declined. At this time, the light fuels will be dry enough to carry a fire, but the larger vegetation will retain enough water to resist ignition. Some burning in forest-grassland ecotone areas may be conducted during the late spring after the annual grasses have cured.

In preparation for a controlled burn, hand or mechanical techniques should be used to construct control lines. In most cases, it will also be necessary to perform some mechanical or hand-tool vegetation treatment prior to burning. Examples of prefire treatments include: removing ladder fuel; felling trees and thinning the forest overstory; removing large logs and other heavy fuels; crushing understory vegetation; chipping; and broadcasting chips and slash, especially cone-bearing branches and individual cones. If any handwork is conducted prior to a controlled burn, then all slash and cut vegetation should be broadcast or evenly spread in the treatment area to ensure even distribution of fuels and soil cover. These prefire activities will reduce the risks associated with conducting the controlled burn and are expected to increase Monterey pine seedling germination and improve management of pitch canker pathogens and vectors.

Prior to the burn, cone-bearing branches and individual cones of Monterey pine should be spread as evenly as possible in the management unit to distribute seeds. Fuels should not be allowed to accumulate in piles or around retained trees and shrubs should be avoided; burn piles may generate too much heat and burn too long for Monterey pine seeds to survive the fire. In addition, Monterey pines are less fire-resistant than many other pine species because of their thin bark and shallow roots. Therefore, all ladder fuels and woody vegetation should be removed to establish control lines around the bases of retained trees and prevent incidental mortality of these trees.

If there is a risk that a controlled burn may create conditions fostering excessive soil erosion, gullying, or rill formation, or may exacerbate an existing risk of slope failure, special techniques can be applied to affected or potentially affected patches prior to the onset of precipitation. Prior to controlled burning, water bars should be installed in all fire control lines, and logs and woody debris should be aligned parallel to slope contours in locations where channeling of surface water may occur. In addition, the use of heavy equipment should be avoided to the extent feasible.

After the completion of a controlled burn, suitable groundcover should be broadcast before the onset of precipitation so the soil surface is evenly covered in locations where channeling of surface water may occur, and in other areas vulnerable to erosion, rilling, or gullying. Appropriate groundcover materials include: wood chips generated onsite or in nearby management units; locally derived mulch from an approved greenwaste facility; and certified weed-free straw. In locations where channelization of surface water has already occurred, certified weed-free hay bales should be placed, or wood chips, mulch, or straw should be installed as described above, to a depth of at least 1 inch.

Chip Woody Debris

Chipping refers to the use of portable machinery to reduce downed woody materials to small pieces for reuse or disposal. Chipped materials are often broadcast as groundcover in a treated area. Alternatively, chips may be piled and burned, or they may be composted (Gordon et al. 2001). Chipping is generally

used for materials <12 inches in diameter, although chippers that can accommodate materials up to 24 inches in diameter are available.

The objectives of chipping woody understory debris are to enhance soil cover and reduce the risks of soil erosion, slope failure, and weed invasion. Chipping may also reduce fire hazard; although the overall fuel load on the site following a chipping operation may be unchanged, fire behavior is substantially altered by reducing fuel height and contiguity and reducing ladder fuels.

Use Mechanical Means to Clear Vegetation

Mechanical clearing techniques for the understory rely on rubber-tired or tracked vehicles and equipment mounted on trailers to crush or cut vegetation, and to chip and broadcast or offhaul cut materials. For example, bulldozers may be used to crush shrubs and other understory vegetation with a straight blade or brush rake. Rotary head cutters on articulated booms serve to cut shrub vegetation and trees with a dbh <4 inches. Feller-bunchers and forwarder-processors are generally used to cut and remove trees with a dbh of 4–22 inches. Tractors may also be used to move downed materials to a landing for subsequent transportation.

Mechanical techniques are frequently used to install control lines for prescribed burns and to pretreat vegetation before implementing the burn. They may also be used alone. Mechanical vegetation clearing using tracked or wheeled vehicles may not be appropriate at all in the Cambria forest because of the potential for excessive damage to dirt roads, increased sedimentation, and soil erosion and compaction, the use of mechanical techniques should be restricted to the period between May 1 and November 15 or times when soils are not water saturated.

Clear Vegetation by Hand

Handwork includes cutting vegetation with axes, pulaskis, brush hooks, hoes, weed eaters, chainsaws, and other handheld tools and equipment. Handwork may be conducted during any season and, unlike some mechanical techniques, may be used in close proximity to structures. Handwork is also used to avoid impacts on environmentally sensitive areas such as wetlands and riparian or special-status species habitats, areas at risk of soil erosion, and other potentially sensitive sites. Hand tools are also commonly used to install control lines for prescribed burns (particularly in environmentally sensitive areas), to remove individual trees, and to remove ladder fuels.

Techniques for Removing Vegetation from the Forest

Some treatments will require removal of downed materials from treated areas. Offsite transport of logs, chips, and cut materials should be conducted in strict accordance with the guidelines described by Owen (2000) and Hawley et al. (1998). These reports, which should be considered incorporated by reference into the CFMP, provide detailed information on the existing voluntary quarantine of pitch canker–infected materials, on methods of covering loads for transport, and on options for local disposal, treatment, and reuse of pitch canker–infected materials.

5

Regulatory Issues

Introduction

This chapter describes the principal environmental laws, regulations, and policies that apply to implementation of the CFMP and ongoing management of the Cambria Monterey pine forest, and summarizes the procedures necessary to comply with them. Separate sections address federal, state, and county regulations; as appropriate, individual sections also describe the articulation between federal and state laws. Table 5-1 presents the likely compliance requirements associated with each treatment prescription described in chapter 4. Table 5-2 provides a list of local agencies with regulatory and/or management responsibilities that may affect Cambria's forest.

Federal Regulations

National Environmental Policy Act

The National Environmental Policy Act (NEPA) (42 United States Code [USC] 4321, 40 Code of Federal Regulations [CFR] 1500.1) is intended to ensure that the actions of federal agencies are evaluated for the potential to cause environmental damage. NEPA is unique in its interdisciplinary

perspective; it requires the evaluation of impacts on the natural (physical and biological) environment but also contains environmental justice provisions designed to prevent federal agency actions from resulting in disproportionate impacts on low-income or minority communities. NEPA applies to all federal agencies and to most of the activities they manage, regulate, or fund that affect the environment. Projects undertaken and managed by state, local, or private entities may also be considered federal agency activities under NEPA if they are funded, permitted, approved, or otherwise assisted by the federal government.

NEPA requires federal agencies to assess and to publicly disclose the environmental consequences of their proposed actions through the preparation of appropriate documents. Typically, the federal agency that proposes a project or is most directly involved in project permitting or implementation is designated as the *lead agency* for NEPA compliance. The lead agency is responsible for preparing the environmental documentation for the proposed project, referred to as an *action* under NEPA. The President's Council on Environmental Quality (CEQ) has adopted regulations and other guidance providing detailed procedures that federal agencies must follow to implement NEPA; most federal agencies have additional guidelines regarding NEPA compliance procedures within the agency.

Several types of documents may be used to comply with NEPA. Some types of actions are categorically exempt from the assessment and disclosure of impacts required by NEPA; for such actions, a **categorical exclusion** is filed. More commonly, the first step in NEPA compliance is preparation of an **environmental assessment** (EA) in order to determine whether a proposed action is likely to result in a significant adverse effect on the environment. If the EA shows that no significant impact is likely, the lead agency files a **finding of no significant impact** (FONSI). If the EA shows that one or more significant adverse impacts may result from the proposed action, the lead agency must complete an **environmental impact statement** (EIS). The EIS is required to evaluate the likely environmental impacts of the proposed action and a reasonable range of feasible alternatives that would accomplish the same goals, and to identify the environmentally preferable alternative.

Many projects are subject to both NEPA and the California Environmental Quality Act (CEQA) (see below). If both NEPA and CEQA compliance are necessary, the lead agency or agencies may choose to cooperate in the preparation of a joint environmental document that complies with both federal and state environmental law.

Federal Endangered Species Act

The Endangered Species Act (ESA) was enacted in 1973 to protect plant and wildlife species determined by the U.S. Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service (NMFS) to be at risk of extinction. It is administered by the USFWS and NMFS. In general, NMFS is

Table 5-2. Agencies with Roles and Responsibilities That May Affect Cambria's ~~Monterey Pine~~ Forest

Agency	Roles and Responsibilities[1]	Contact Information[2]
U.S. Fish and Wildlife Service, Region 1 Ventura Field Office	▪ Issues biological opinions (BOs) in response to biological assessments (BAs) ▪ Has authority to issue incidental take statements and incidental take permits ▪ Reviews habitat conservation plans (HCPs) ▪ Protects and regulates take of migratory birds	805/644-1766
National Marine Fisheries Service, Southwest Region	▪ Issues biological opinions (BOs) in response to biological assessments (BAs) ▪ Has authority to issue incidental take statements and incidental take permits ▪ Reviews habitat conservation plans (HCPs)	562/980-4000
U.S. Army Corps of Engineers, Los Angeles District	▪ Regulates discharge of dredged and fill materials into waters of the United States ▪ Reviews applications for permits under Clean Water Act Section 404 ▪ Establishes protocols for wetland delineations ▪ Regulates construction activities in, under, and over navigable waters	213/452-3908
Environmental Protection Agency, Region 9	▪ Administers National Pollutant Discharge Elimination System (NPDES) program	415/947-8701

[1] See chapter 5 for discussion of regulatory terms and concepts.
[2] Contact information is current as of November 2001.

Upper Salinas–Las Tablas Resource Conservation District	▪ Develops, implements, and administers local resource conservation programs and activities ▪ Provides technical conservation assistance to other agencies and landowners	Don Funk 805/434-0396 don.funk@ca.usda.gov
California Department of Forestry and Fire Protection, San Luis Obispo Unit	▪ Responsible for forest fire prevention and suppression on lands in state responsibility areas ▪ Identifies very high fire hazard severity zones ▪ Administers burn permitting program; issues permits for burns to reduce fire hazard and for range improvement burns ▪ Authorizes prescribed burns and mechanical vegetation management in forested areas ▪ Designs and implements burn plans ▪ Develops smoke management plans for landowners ▪ Administers Forest Practice Act; reviews timber management documents and conducts inspections of logging sites	Ben Parker 805/543-4244 x2106 Phil Hanon 805/927-4262
California Department of Transportation, District 5	▪ Provides landscaping plans for Highway 1 right-of-way ▪ Responsible for landscaping installation and maintenance along Highway 1, including Monterey pines	Roy Freer 805/549-3124 Lisa Schicker 805/549-3628
State Resources Water Control Board	▪ Administers NPDES program	916/341-5254
Central Coast Regional Water Quality Control Board, San Luis Obispo	▪ Oversees NPDES program; reviews Storm Water Pollution Plans; issues NPDES permits ▪ Issues water quality certifications and waivers under Clean Water Act Section 401	805/549-3147

San Luis Obispo County Department of Planning and Building	▪ Guides and manages growth through implementation of County General Plan, County Land Use Ordinance, and Coastal Zone Land Use Ordinance ▪ Issues tree removal and grading permits ▪ Reviews site drainage plans	John Kelly 805/781-5600, 805/781-5979
Cambria Fire Department	▪ Responsible for fire prevention and suppression in Cambria under authority of Cambria Community Services Department	Curt Hatton (Weed Abatement Office) 805/927-6240
Cambria Fire Safe Focus Group	▪ Part of San Luis Obispo County Fire Safe Council ▪ Citizen advisory group working with Cambria Fire Department and California Department of Forestry and Fire Protection ▪ Identifies areas in Cambria's urban forests where fuel loads require reduction, including open space and defensible space around structures ▪ Carries out public education and outreach activities relevant to fire prevention and fire hazard reduction	Bob Putney 805/927-6240
Pacific Gas & Electric Company	▪ Regulates activities within power line setbacks	Greg Holquist 707/577-7152

responsible for protection of ESA-listed marine species and anadromous fishes while other listed species are under USFWS jurisdiction.

ESA Prohibitions

ESA Section 9 prohibits the take of any fish or wildlife species listed under the ESA as endangered. "Take" of threatened species is also prohibited under Section 9 unless otherwise authorized by federal regulations.[1] *Take*, as defined by the ESA, means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." *Harm* is defined as "any act that kills or injures the species, including significant habitat modification." In addition, Section 9 prohibits removing, digging up, cutting, and maliciously damaging, or destroying federally listed plants on sites under federal jurisdiction.

Appendix A lists plants, fish, and wildlife that are federally listed as threatened or endangered and are known to occur or may occur in the Cambria area.

ESA Authorization Process for Federal Actions

ESA Section 7 provides a means for authorizing take of threatened and endangered species by federal agencies under certain circumstances. It applies to actions that are conducted, permitted, or funded by a federal agency. Under Section 7, the federal agency conducting, funding, or permitting an action (the lead agency) must consult with USFWS or NMFS, as appropriate, to ensure that the proposed action will not jeopardize endangered or threatened species or destroy or adversely modify designated critical habitat. If a proposed project "may affect" a listed species or designated critical habitat, the lead agency is required to prepare a biological assessment (BA) evaluating the nature and severity of the expected effect. In response, USFWS or NMFS issues a biological opinion (BO), with a determination that the proposed action either

- may jeopardize the continued existence of 1 or more listed species (*jeopardy finding*) or result in the destruction or adverse modification of critical habitat (*adverse modification finding*), or
- will not jeopardize the continued existence of any listed species (*no jeopardy finding*) or result in adverse modification of critical habitat (*no adverse modification finding*).

The BO issued by USFWS or NMFS may stipulate "reasonable and prudent" conservation measures. If the project would not jeopardize a listed species,

[1] In some cases, exceptions may be made for threatened species under ESA Section 4[d]; in such cases, the USFWS or NMFS issues a "4[d] rule" describing protections for the threatened species and specifying the circumstances under which take is allowed.

USFWS or NMFS issues an **incidental take statement** to authorize the proposed activity.

ESA Permitting Process for Nonfederal Entities

ESA Section 10 provides a means for nonfederal entities (states, local agencies, and private individuals) to receive authorization for take of threatened and endangered species under certain circumstances. ESA Section 10 applies to projects that have no federal agency involvement. It allows USFWS and/or NMFS to issue an **incidental take permit** authorizing take resulting from otherwise legal activities, as long as the take would not jeopardize the continued existence of the species. Section 10 requires the applicant to prepare a habitat conservation plan (HCP) addressing project impacts and proposing mitigation measures to compensate for those impacts. The HCP is subject to USFWS and/or NMFS review and must be approved by the reviewing agency or agencies before the proposed project can be initiated.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) (16 USC 703) enacts the provisions of treaties between the United States, Great Britain, Mexico, Japan, and the Soviet Union and authorizes the U.S. Secretary of the Interior to protect and regulate the taking of migratory birds. The MBTA is administered by the USFWS. It sets seasons and bag limits for hunted species and protects migratory birds, their occupied nests, and their eggs (16 USC 703, 50 CFR 21, 50 CFR 10). Most actions that result in taking or in permanent or temporary possession of a protected species constitute violations of the MBTA. Examples of permitted actions that do not violate the MBTA include: the possession of a hunting license to pursue specific gamebirds; legitimate research activities; display in zoological gardens; bird-banding; and other similar activities (Faanes et al. 1992)

Clean Water Act

The Clean Water Act (CWA) is the primary federal law that protects the quality of the nation's surface waters, including lakes, rivers, and coastal wetlands. The CWA empowers the U.S. Environmental Protection Agency (EPA) to set national water quality standards and effluent limitations and includes programs addressing both point-source and nonpoint-source pollution. Point-source pollution is pollution that originates or enters surface waters at a single, discrete location such as an outfall structure or an excavation or construction site. Nonpoint-source pollution originates over a broader area and includes urban contaminants in stormwater runoff and sediment loading from upstream areas. The CWA operates on the principle that all discharges into the nation's waters are unlawful unless specifically

authorized by a permit; permit review is the CWA's primary regulatory tool.

The following paragraphs provide additional details on specific sections of the CWA.

Permits for Fill Placement in Waters and Wetlands

CWA Section 404 regulates the discharge of dredged and fill materials into "waters of the United States." *Waters of the United States* include oceans, bays, rivers, streams, lakes, ponds, and wetlands. Project proponents must obtain a permit from the USACE for all discharges of dredged or fill material into waters of the United States, including wetlands, before proceeding with a proposed activity.

Waters of the United States in the Cambria forest are under the jurisdiction of the USACE, Los Angeles District. Before any management actions that may impact surface waters are carried out (table 5-1), a delineation of jurisdictional waters of the United States should be completed for the affected management units, following USACE protocols (Environmental Laboratory 1987). The purpose of the delineation is to determine whether the affected management units encompass wetlands or other waters of the United States that qualify for CWA protection. These include any or all of the following.

- Areas within the ordinary high water mark of a stream, including non-perennial streams with a defined bed and bank and any streamchannel that conveys natural runoff, even if it has been realigned.
- Seasonal and perennial wetlands, including coastal wetlands.

Wetlands are defined for regulatory purposes as areas "inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 CFR 328.3, 40 CFR 230.3).

Section 404 permits may be issued only for the least environmentally damaging practicable alternative. That is, authorization of a proposed discharge is prohibited if there is a practicable alternative that would have less adverse impacts and lacks other significant adverse consequences.

Some general categories of activities have been issued permits by USACE on a nationwide basis (*nationwide permits*). Specific nationwide permits may apply to activities in management units at Cambria and these permits should be considered for use.

Certain activities are exempt from the Section 404 permitting process. Exempt activities include:

- farming, ranching, and forestry activities that are considered normal and ongoing (as of 1985 conditions), such as plowing, harvesting, and minor drainage of upland areas to waters of the United States;
- construction and maintenance of stock ponds and irrigation ditches;
- maintenance of drainage ditches;
- construction and maintenance of farm, forest, and mining roads in accordance with BMPs;
- construction of temporary sedimentation basins in upland areas; and
- activities regulated by an approved program of BMPs authorized by CWA Section 208(b)(4).

Permits for Stormwater Discharge

CWA Section 402 regulates construction-related stormwater discharges to surface waters through the National Pollutant Discharge Elimination System (NPDES) program, administered by the EPA. In California, the State Water Resources Control Board is authorized by the EPA to oversee the NPDES program through the Regional Water Quality Control Boards (see related discussion under *Porter-Cologne Water Quality Control Act* below). The Cambria area is under the jurisdiction of the Central Coast Regional Water Quality Control Board (RWQCB).

NPDES permits are required for projects that disturb >1 acre of land. The NPDES permitting process requires the applicant to file a public notice of intent to discharge stormwater and to prepare and implement a Storm Water Pollution Prevention Plan (SWPPP, pronounced "swip"). The SWPPP includes a site map and a description of proposed construction activities. In addition, it describes the BMPs that will be implemented to prevent soil erosion and discharge of other construction-related pollutants (e.g., petroleum products, solvents, paints, cement) that could contaminate nearby water resources. Permittees are required to conduct annual monitoring and reporting to ensure that BMPs are correctly implemented and effective in controlling the discharge of stormwater-related pollutants.

Water Quality Certification

Under CWA Section 401, applicants for a federal license or permit to conduct activities that may result in the discharge of a pollutant into waters of the United States must obtain certification from the state in which the discharge would originate, or, if appropriate, from the interstate water pollution control agency with jurisdiction over affected waters at the point where the discharge would originate. Therefore, all projects that have a federal component and may affect state water quality (including projects that require federal agency approval, such as issuance of a Section 404 permit) must also comply with CWA Section 401. Section 401 certification or

waiver for the Cambria area is under the jurisdiction of the Central Coast RWQCB.

Rivers and Harbors Act

The Rivers and Harbors Act (RHA) protects the nation's navigable waters. As defined by the RHA, *navigable waters* include all waters that are

- subject to the ebb and flow of tides; and
- presently, historically, or potentially used for foreign or interstate commerce.

Regulations implementing Section 10 of the RHA are coordinated with those implementing CWA Section 404. Specifically, the RHA regulates

- construction of structures in, under, or over navigable waters;
- excavation or deposition of material in navigable waters; and
- all work affecting the course, location, condition, or capacity of navigable waters.

The USACE is responsible for administering the RHA. The USACE, Los Angeles District has jurisdictional authority over navigable waters in the Cambria area.

Clean Air Act

Overview

The Clean Air Act (CAA) of 1970 established national ambient air quality standards (NAAQS) for 6 pollutants: carbon monoxide (CO), ozone, particulate matter with a diameter less than 10 microns (inhalable particulate matter or PM10), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and lead. Most standards were set to protect public health; however, for some pollutants, standards are based on other values, such as protection of crops, protection of materials, and avoidance of nuisance conditions. Except for ozone, NAAQS represent short-term (24 hours or less) concentrations that may be exceeded no more than once per year and annual concentrations that may never be exceeded. NAAQS for ozone may be exceeded no more than 3 days in 3 years.

Air quality is regulated through county and regional air pollution control districts (APCDs) and air quality management districts (AQMDs). The APCDs and AQMDs issue permits and monitor new and modified sources of air pollution to ensure that emissions from these sources comply with national, state, and local emissions standards. The San Luis Obispo Air Pollution Control District (SLOAPCD) has jurisdiction over air quality in the Cambria area.

Areas that fail to meet NAAQS are called nonattainment areas. In recent years, the County has been a nonattainment area for ozone and PM10. Special provisions apply to the regulation of air quality in nonattainment areas; any management actions that have the potential to impact air quality (including any that rely on gasoline- or diesel-powered equipment) may be required to comply with air quality programs administered by the SLOAPCD.

Controlled Burns and Air Quality

Open burns, including burns necessary to clear public rights-of-way, or to reduce fire hazards (fuel loading) or control disease or pests that cannot be addressed by any other means, are permitted under the SLOAPCD's District Rule 501. The SLOAPCD issues burn permits for both agricultural and prescribed burns. As part of its responsibility to oversee burns, the SLOAPCD also reviews and authorizes smoke management plans for prescribed burns, provides notice to the California Air Resources Board (CARB) of large or multi-day burns, and consults with CARB on procedures for CARB review and approval of large and multi-day burns. Any controlled burn implemented under the CFMP will require a permit from the SLOAPCD.

CARB's Smoke Management Guidelines for Agricultural and Prescribed Burning (Guidelines) (17 CCR 80100–80330) require annual or seasonal registration of all planned burn projects, including areas where naturally ignited wildland fires may be managed for resource benefits. The Guidelines also require burn proponents to prepare smoke management plans for all burn projects. State Smoke Management Guidelines are implemented under District Rule 502 – Agricultural (range Improvement and Prescribed) Burning.

Smoke management plans for burn projects that will affect an area of <10 acres or produce <1 ton of particulate matter must contain at least the following information.

- The location, types, and amounts of material to be burned.
- The expected duration of the fire from ignition to extinction.
- The names and telephone numbers of responsible personnel.

Smoke management plans for burn projects that will affect an area of >10 acres or produce >1 ton of particulate matter must also identify and provide information on the locations of all smoke-sensitive areas that may be affected.

Smoke management plans for fire agency projects at the urban-wildland interface that will affect an area <10 acres or produce <1 ton of particulate matter, and smoke management plans for all burn projects that will affect an area >100 acres or produce >10 tons of particulate matter must also contain information on the following.

- The meteorological conditions necessary for burning.
- The smoke management criteria the land manager or his/her designee will use to make burn ignition decisions.
- Projections of where the smoke from the burn is expected to travel during the day and at night, including a map.
- Specific contingency actions (such as fire suppression or containment) that will be taken if smoke impacts occur or if meteorological conditions deviate from those specified in the smoke management plan.
- An evaluation of the alternatives to burning that were considered; if environmental documentation was prepared for the burn project pursuant to NEPA or CEQA, the alternatives analysis is attached to the smoke management plan.
- Discussion of public notification procedures.

Smoke management plans must include monitoring procedures if

- the burn will affect an area larger than 250 acres;
- the burn will continue burning or producing smoke overnight;
- the burn area is located near smoke-sensitive areas; or
- the SLOAPCD requires monitoring for any other reason. Monitoring procedures may include visual monitoring, ambient particulate matter monitoring, or other monitoring approved by the SLOAPCD.

The SLOAPCD may require additional information or coordination with other agencies. For example, burn proponents may be required to obtain a statement from the California Department of Fish and Game (DFG) certifying that the burn is desirable and proper if the burn is to be carried out primarily to improve wildlife or game habitat.

Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) was enacted in 1972 to regulate development affecting coastal waters and adjacent shorelines. The CZMA also applies to the inland belt that has "significant and direct impacts on coastal waters." Under the CZMA, states are encouraged to voluntarily develop coastal zone management programs (CZMPs) to preserve and protect the unique features relevant to each coastal area. CZMPs are approved by the Office of Ocean and Coastal Resource Management of the National Oceanic and Atmospheric Administration. All federal projects and projects that require a federal permit must be consistent with approved CZMPs. In California, Local Coastal Programs developed under the California Coastal Act serve as each area's CZMP (see *California Coastal Act* below).

Section 106 of the National Historic Preservation Act

Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, requires federal agencies or agencies to which they provide funding or issue permits to take into account the effects of their actions on cultural resources, including historic properties and historic and prehistoric archaeological sites. In addition, Section 106 requires lead agencies to

- provide review and comment opportunities on actions that may affect cultural resources to the Advisory Council on Historic Preservation (ACHP) (an independent federal agency responsible for advising the president and Congress on historic preservation), and to
- coordinate with the State Historic Preservation Officer (SHPO) in the state where the proposed action will take place.

The Section 106 compliance process has four basic steps.

1. Identify and evaluate cultural resources, including historic properties, in the project area.
2. Assess the potential effects of the project on cultural resources.
3. Consult with the SHPO and other interested parties regarding potential adverse effects on cultural resources, resulting in a memorandum of agreement (MOA).
4. Proceed in accordance with the MOA.

State Regulations and Programs

California Environmental Quality Act

The California Environmental Quality Act (CEQA) (Public Resource Code 21000 et seq.) is the cornerstone of environmental law and policy in California. Like NEPA, CEQA requires project proponents to assess and publicly disclose the environmental implications of their proposed actions through the preparation of appropriate documents. The primary objectives of CEQA include:

- ensuring that the potential environmental impacts of proposed projects are disclosed to decision makers and the public;
- ensuring that environmental damage is avoided, reduced, or compensated for by the implementation of carefully designed mitigation measures;
- making the public aware of the reasons for an agency's approval of a project with significant, unavoidable, and unmitigable environmental impacts;
- fostering cooperation between agencies in the review of projects; and

- enhancing public involvement in the planning and review of projects that may impact local communities and their natural environment.

CEQA applies to discretionary activities proposed, implemented, or approved by California public agencies, including state, regional, county, and local agencies. Typically, the agency that proposes a project or is most directly involved in project permitting or implementation is designated as the *lead agency* for CEQA compliance and is responsible for preparing the environmental documentation for the proposed project (CEQA use of the term *project* is analogous to NEPA use of *action*; see table 5-3).

Several types of documents may be used to comply with CEQA. Some types of actions are categorically exempt from the assessment and disclosure of impacts required by CEQA, and for such actions, a **categorical exemption** is filed; this is analogous to a **categorical exclusion** under NEPA (table 5-3). For most projects, the first step in CEQA compliance is preparation of an **initial study** (IS). The IS is roughly analogous to the environmental assessment prepared as the first step in NEPA compliance; its purpose is to determine whether a proposed project is likely to result in a significant adverse impact on the environment. If the IS shows that no significant impact is likely, the lead agency files a **negative declaration**; if project impacts can be reduced below the level of significance by the implementation of 1 or more mitigation measures, the lead agency may file a **mitigated negative declaration**. However, if the IS shows that the proposed project is likely to result in 1 or more significant adverse impacts that cannot be adequately reduced by mitigation, the lead agency must complete an **environmental impact report** (EIR). The EIR is similar in scope and purpose to the EIS required under NEPA. It must evaluate the likely environmental impacts of the proposed project and a reasonable range of feasible alternatives that would accomplish the same goals, and is required to identify the environmentally superior alternative.

Many projects are subject to both CEQA and NEPA. If both CEQA and NEPA compliance are necessary, the lead state and federal agencies may choose to cooperate in the preparation of a joint environmental document that complies with both state and federal environmental law.

Table 5-3. Correspondence between Key CEQA and NEPA Terms

CEQA Term	NEPA Term
Lead Agency	Lead Agency
Responsible Agency	Cooperating Agency
Proposed Project	Proposed Action
Environmentally Superior Alternative	Environmentally Preferable Alternative
Project Objectives	Purpose and Need

Environmental Impacts	Environmental Consequences
Categorical Exemption	Categorical Exclusion
Initial Study	Environmental Assessment
Negative Declaration	Finding of No Significant Impact
Environmental Impact Report	Environmental Impact Statement

California Endangered Species Act

The California Endangered Species Act (CESA) protects wildlife and plants listed as threatened and endangered under the Act by the California Fish and Game Commission. It is administered by DFG. CESA prohibits all persons from taking species that are state-listed as threatened or endangered except under certain circumstances; the CESA definition of *take* is any action or attempt to "hunt, pursue, catch, capture, or kill."

CESA Section 2081 provides a means by which agencies or individuals may obtain authorization for incidental take of state-listed species. Take must be incidental to, and not the purpose of, an otherwise lawful activity. Requirements for a Section 2081 permit include: the identification of impacts on listed species; development of mitigation measures that minimize and fully mitigate impacts; development of a monitoring plan; and assurance of funding to implement mitigation and monitoring. CESA and the California Natural Community Conservation Planning Act include other means for obtaining take authorization from DFG for state-listed species, but an incidental take permit under Section 2081 is the most commonly used and in most cases will be the appropriate permitting mechanism for CFMP treatments affecting species in Cambria forest management units. CESA-listed threatened and endangered species and other special-status species that are known to occur or may occur in the Cambria forest are listed in appendix A.

California Coastal Act

The federal Coastal Zone Management Act of 1972 (see above) encourages the individual states to develop coastal zone management programs (CZMPs) to preserve and protect each coastal area's unique features. In 1976, the California legislature enacted the California Coastal Act, establishing the California Coastal Commission (CCC) and the San Francisco Bay Conservation and Development Commission (BCDC) as the state agencies with primary responsibility for enforcing the state's CZMP. The BCDC is responsible for the San Francisco Bay Area, and the CCC has jurisdiction over the state's coastal zone outside the Bay Area, including the Cambria area. The CCC and local governments cooperate in a unique partnership to manage the conservation and development of coastal resources through a comprehensive planning and regulatory program. Under this program, local

governments prepare planning frameworks called local coastal program (LCP) land use plans and issue coastal permits for all development in their LCP area. The CCC is responsible for review and oversight of LCPs.

The California Coastal Act also defines Environmentally Sensitive Habitat Areas (ESHAs). ESHAs include rare or unique habitats (including Monterey Pine forest), habitats that support special-status species, coastal streams, and wetlands. The California Coastal Act's definitions of *streams* and *wetlands* are more inclusive than the CWA's criteria for identifying jurisdictional waters of the United States (see *Clean Water Act* above); thus, the California Coastal Act regulates habitats that are not regulated under the CWA.

Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act articulates with the federal CWA (see *Clean Water Act* above). The Porter-Cologne Act, passed in 1975, provides for the development and periodic review of Water Quality Control Plans (basin plans) that designate beneficial uses of California's major rivers and groundwater basins and establish narrative and numerical water quality objectives for those waters (California Regional Water Quality Control Board 1995). Basin plans are primarily implemented by using the NPDES permitting system to regulate waste discharges so that water quality objectives are met (see discussion of the NPDES system in the *Clean Water Act* section above).

California Fish and Game Code Sections 1601–1607 (Lake or Streambed Alteration Agreement Program)

Under Sections 1601–1607 of the California Fish and Game Code, DFG regulates projects that affect the flow, channel, or banks of rivers, streams, and lakes. Sections 1601 and 1603, respectively, require public agencies and private individuals to notify and enter into a streambed or lakebed alteration agreement with DFG before beginning construction of a project that will:

- divert, obstruct, or change the natural flow or the bed, channel, or bank of any river, stream, or lake;
- use materials from a streambed; or
- (Section 1601 only) result in the disposal or deposition of debris, waste, or other material containing crumbled, flaked, or ground pavement where it can pass into any river, stream, or lake.

Sections 1601–1607 may apply to any work undertaken within the 100-year floodplain of any body of water or its tributaries, including intermittent stream channels. In general, however, it is construed as applying to work within the active floodplain and/or associated riparian habitat of a wash, stream, or lake that provides benefit to fish and wildlife. Sections 1601–1607 typically do not apply to drainages that lack a defined bed and banks,

such as swales, or to very small bodies of water and wetlands such as vernal pools.

Z'berg-Nejedly Forest Practice Act of 1973

The Z'berg-Nejedly Forest Practice Act (FPA) of 1973 regulates commercial timber harvesting operations. It is administered by the State Board of Forestry (BOF) under the auspices of CDF; implementation of the FPA's provisions is guided by the state's comprehensive Forest Practice Rules. BOF review and permitting authority serves as the FPA's primary regulatory mechanism.

Under the FPA, all commercial timber operations on nonfederal timberlands are required to have 1 of the following.

- A nonindustrial timber management plan approved by BOF.
- A timber operator license and a timber harvesting plan (THP) prepared by a registered professional forester and approved by BOF, or, for the commercial cutting or removal of Christmas trees, tanbark, fuelwood, root crown burls, posts, or split products, a limited timber operator license issued by BOF.
- A program timber environmental impact report (PTEIR).

BOF is responsible for reviewing timber management documents (including THPs and applications for timber operator licenses) for compliance with the FPA, relevant BOF rules, and other state and federal laws enacted to prevent adverse impacts on watersheds and wildlife. FPA also empowers CDF foresters to conduct onsite inspections of sites where timber harvesting has been proposed, in coordination with specialists from local, state, and federal resource agencies.

Coastal Commission Special Treatment Areas

The California Forest Practice Rules use the designation *Coastal Commission Special Treatment Areas* to refer to forest areas that fall within the coastal zone and are thus under CCC jurisdiction (see related discussion in *California Coastal Act* section above) and that support specific conditions limiting forestry practices. Coastal Commission Special Treatment Areas have been designated in locations where timber harvests could result in adverse impacts on significant habitat, on the biological productivity associated with the coastal ecosystem, and/or on scenic or public recreation resources. They also include buffer zones adjacent to designated highways with coastal scenic view corridors as well as areas adjacent to publicly owned preserves and recreation areas. The Monterey pine forests in San Luis Obispo County include Coastal Commission Special Treatment Areas identified for scenic view corridors and sites of significant scenic value. Treatment is not precluded in these areas, but treatments must comply with

Article 11 of the California Forest Practice Rules and should use only prescriptions appropriate for areas with high visual sensitivity.

California Department of Forestry and Fire Protection—Burn Permit Program

Under Sections 4113 and 4125 of the Public Resource Code (PRC), CDF is responsible for preventing and extinguishing forest fires on lands defined as state responsibility areas (SRAs). SRAs include lands that provide forest or range products and watersheds that are not owned or managed by the federal government or encompassed within the boundaries of incorporated cities. CDF is also responsible for identifying very high fire hazard severity zones in SRAs and on lands protected by local fire agencies, such as the Cambria Fire Department. Through its regional ranger units, CDF administers a permitting program for 4 types of burn activities: residential backyard burning, burn barrels, burns to prevent fire hazards, and range improvement burns (Lewin pers. comm.). Under the burn permit program, landowners assume all costs and liability for permitted burns.

The CDF's San Luis Obispo Ranger Unit (SLORU) oversees burn permitting in the Cambria forest and surrounding areas; the SLOAPCD is responsible for overseeing the air quality impacts of permitted burns. The SLORU issues permits for prescribed burns to prevent fire hazards and for range improvement burns. As of March 2001, non-agricultural backyard burning of green waste has been prohibited in most of the County's developed areas, including the Cambria area.

California Department of Forestry and Fire Protection—Vegetation Management Program

The CDF's Vegetation Management Program (VMP) authorizes the use of prescribed fire and mechanical means to reduce wildland fuel hazards and address other resource management issues in the state's forested areas, including SRAs. Under the VMP, private landowners enter into a contract with CDF for fire protection and other aspects of resource management; this offers landowners the advantage of cost-sharing and shared logistical responsibility.

Under the VMP, CDF is responsible for most aspects of burn design and implementation. When a landowner interested in implementing a prescribed burn under the VMP contacts CDF, CDF evaluates the feasibility of the roject and gathers relevant information from other involved local, state, and federal agencies. This includes coordinating the required approvals and consultations, such as developing a smoke management plan to be approved by the local air pollution control district. CDF is also responsible for designing a detailed burn plan. The burn plan is required to include: information on the location of the burn site and the objectives of the burn; a

description of the weather, fuel moisture, and soil and duff moisture conditions under which the burn may proceed; a description of desired fire behavior; and a public information plan. Once the burn plan has been developed, CDF enters into a contract with the landowner, notifies the community, and, when conditions meet the requirements described in the burn plan, implements the burn.

A programmatic EIR (PEIR) was prepared for the VMP, with CDF serving as the lead agency. In compliance with CEQA, the PEIR analyzed the VMP's environmental impacts and identified ways to mitigate its unavoidable adverse impacts. CDF uses an environmental checklist to evaluate the likely environmental impacts of projects proposed under the VMP and determine whether these impacts are addressed in the PEIR. If a proposed project is within the scope of the VMP and its likely environmental impacts are addressed in the PEIR, no additional CEQA documentation is required. If a proposed project may result in one or more significant impacts that are not addressed in the PEIR, additional CEQA documentation is necessary; the project proponent must prepare an IS, leading to a negative declaration, a mitigated negative declaration, or an EIR.

Existing County Regulations and Programs

The County's Land Use Ordinance (LUO) and Coastal Zone Land Use Ordinance (CZLUO) (Titles 22 and 23 of the San Luis Obispo County Code) establish regulations to implement the County General Plan and LCP and to guide and manage the future growth of the County in accordance with those plans. The LUO and CZLUO contain standards for the preparation of construction sites designed to protect the health, safety, and welfare of persons on or near a project site. The County's standards are intended to:

- prevent unwarranted or unsafe grading,
- prevent soil erosion as a result of grading,
- define appropriate circumstances for tree removal, and
- provide for adequate site drainage.

The County's Department of Planning and Building is responsible for administering the LUO and CZLUO and associated regulations, and for permitting under these ordinances.

The following sections provide additional information on County grading and tree removal permits and drainage plans.

Grading Permit Program

The County requires proponents of projects that will include grading activities to apply for a County grading permit. The permit review process is designed to ensure that impacts on surface drainage, natural vegetation, and

wildlife as a result of proposed earthmoving activities are identified and mitigated. A County grading permit may be required for any activity that involves:

- grading, excavation, or placement of fill;
- diking or dredging that affects wetlands and riparian areas; or
- earthwork, paving, surfacing, or other construction activity that alters any natural or other existing offsite drainage pattern, including but not limited to any change in the direction, velocity, or volume of flow.

Activities that may be exempt from grading permit requirements include:

- excavations <2 feet deep;
- excavations that do not create a cut slope >5 feet high and steeper than 1.5:1 (horizontal:vertical);
- placement of fill that is <1 foot deep and placed on natural terrain with a slope less than 5:1 (horizontal:vertical), or is <3 feet deep and is not intended to support structures, and does not exceed 50 cubic yards on any 1 lot or obstruct a drainage course.

To apply for a County grading permit, project proponents are required to submit a permit application and 2 sets of plans prepared by the appropriate licensed professional.

As required by Title 14 of the California Administrative Code, grading activities with any of the following characteristics will also require an environmental review under CEQA:

- grading on terrain with slopes greater than 10%;
- grading that requires more than 5,000 cubic yards of earthmoving; or
- grading within a sensitive resource area.

Drainage Plan Standards

County drainage control standards require projects to minimize the harmful effects of stormwater runoff, including inundation and erosion on project sites, and to protect neighboring and downstream properties from drainage problems resulting from new development. Project proponents are required to submit a drainage plan with or incorporate a drainage plan into the grading permit application for any project that:

- involves a land disturbance (grading, or removal of vegetation down to duff or bare soil, by any method) of >40,000 square feet;
- will result in an impervious surface of >20,000 square feet;

- is subject to local ponding because of soil conditions and lack of identified drainage channels;
- is located in an area identified by the County Engineer as having a history of flooding or erosion that may be further aggravated by or have a harmful effect on the project;
- is located within a Flood Hazard combining designation;
- involves land disturbance or placement of structures within 50 feet of any watercourse shown on the most current U.S. Geological Survey 7.5-minute topographic quadrangle map;
- involves hillside development on slopes steeper than 10%;
- involves development on a site adjacent to any coastal bluff; or
- may, by altering existing drainage, cause an onsite erosion or inundation hazard or change the offsite drainage pattern, including but not limited to any change in the direction, velocity, or volume of flow.

If a proposed project requires a drainage plan, CEQA compliance will be necessary.

Tree Removal Regulations

Tree removal refers to the destruction or displacement of a tree by cutting, bulldozing, or other mechanical or chemical methods, resulting in physical transportation of the tree from its site and/or death of the tree. County tree removal standards are intended to protect existing trees and other coastal vegetation from indiscriminate or unnecessary removal, consistent with the CCA and with the policies of the County's LCP.

Under the County LUO and CZLUO, tree removal may take place only when:

- a tree is dead, diseased beyond reclamation, or hazardous;
- trees are crowded and good horticultural practices dictate thinning;
- a tree interferes with existing utilities, structures, or right-of-way improvements;
- a tree obstructs existing or proposed improvements that cannot be reasonably designed to avoid the need for tree removal;
- a tree blocks sunlight needed for active or passive solar heating or cooling, and the building or solar collectors cannot be oriented to collect sufficient sunlight without removing the tree;
- a tree conflicts with an approved fire safety plan where required by Section 22.05.080 of the LUO; or
- the tree to be removed will be replaced within a 10-year period by another that will provide equal or better shade, screening, solar efficiency, or visual amenity, as verified in writing by a licensed

landscape architect, licensed landscaping contractor, or certified nurseryman.

A tree removal permit is required for the removal of any tree located within urban or village reserve limits or in other specific areas identified by the planning area standards in the most recent County General Plan's Land Use Element.

The following types of tree removal are subject to Minor Use Permit approval:

- removal of riparian vegetation near any coastal stream or wetland;
- tree removal that is not accompanied by a land use permit for development;
- removal of trees located in any appealable area;
- removal of trees located in any sensitive resource area where the identified resources are trees, as shown on official combining designation maps (Part III of Land Use Element, County General Plan); and
- tree cutting that will cumulatively remove more than 6,000 square feet of vegetation (measured on the basis of canopy area).

Approval is required before the removal or replacement of any existing trees *except* trees that:

- are identified and approved for removal in an approved Plot Plan, Site Plan, or Development Plan, provided that such removal is subject to the standards of Section 22.05.064 of the LUO (Tree Removal Standards);
- are located in areas designated for residential land use on sites developed with residential uses;
- are located within or adjacent to a utility right-of-way, when such trees are to be removed by a public agency or public utility or are to be removed under an encroachment permit issued by a public agency having jurisdiction;
- are in a hazardous condition that presents an immediate danger to health or property;
- have trunks measuring <8 inches in diameter at 4 feet above grade;
- are to be removed in preparation for agricultural cultivation and crop production in an area designated for agricultural land use; or
- are to be removed as part of management practice in orchards under commercial agricultural production.

Proposed County Regulations

The County is currently in the process of developing guidelines for new and infill construction and exterior remodels in Cambria's residential areas. The

guidelines were created in recognition of the distinctive character of Cambria's neighborhoods, in order to give area property owners, developers, and architects a clear sense of the design that the community hopes to achieve in each neighborhood. Specific goals of the new guidelines include:

- promoting residential design that is consistent with the context of the built neighborhood and the surrounding Monterey pine forest;
- encouraging site-sensitive design that respects the natural features and limitations of each site;
- and ensuring that building size, massing, and location are in scale with surrounding development.

The new guidelines had not been approved at the time the CFMP was prepared, but may be in force by the time it is implemented.

6

Adaptive Management Planning and Monitoring

Introduction

The management of natural systems entails an unavoidable component of uncertainty, but this uncertainty can itself be managed by

- implementing appropriately designed and practicable programs to evaluate the success of management actions, and
- using monitoring results to adjust management activities as necessary.

The CFMP's long-term success, like that of any natural resources management plan, will depend on effective implementation of this process of *adaptive management*.

This chapter has 3 primary purposes: to describe the processes of monitoring and adaptive management, including the role of research in long-term adaptive management; to provide monitoring and adaptive management concepts for the CFMP; and to provide the Forest Manager with guidelines for implementing effective monitoring and adaptive management as components of the CFMP.

What Is Adaptive Management?

Kershner (1997) has described adaptive management as:

> "…the process whereby management is initiated, evaluated, and refined (Holling 1978, Walters 1986). It differs from traditional management by recognizing and preparing for the uncertainty that underlies resource management decisions. Adaptive management is typically incremental in that it

> uses information from monitoring and research to continually evaluate and modify management practices. It promotes long-term objectives for ecosystem management and recognizes that the ability to predict results is limited by knowledge of the system. Adaptive management uses information gained from past management experiences to evaluate both success and failure, and to explore new management options."

Adaptive management has its roots in adaptive control process theory and operations research and management science. It was first employed in the early 1970s in the management of forest resources in New Brunswick and fisheries resources in British Columbia (McLain and Lee 1996). Today, adaptive management is proposed, in varying capacities, for nearly every major environmental planning process in the United States; locations where this approach has been used include the Florida Everglades, Glen Canyon, the Columbia River Basin, Chesapeake Bay, and the Sacramento–San Joaquin Delta and San Francisco Bay.

Although adaptive management is a popular concept, it has not been successfully implemented in every application. Lee (1999) feels that adaptive management has been more influential as an idea than as a practical tool, but suggests that the type of social learning it proposes may be critical for future management. Following are 4 basic philosophies that contribute to effective adaptive management.

- Stakeholders must be effectively integrated into the decision making process.
- Institutional architecture should be developed in such a way that it is amenable to adaptive management (i.e., the management framework should be flexible and should promote information flow and sound, responsive decision making).
- Clear goals and measurable standards should be established to provide a foundation for evaluating performance.
- Risk and uncertainty should be embraced as components of management.

Monitoring As a Component of Adaptive Management

Monitoring is an integral aspect of adaptive management and can be defined as "…the collection and analysis of repeated observations or measurements to evaluate changes in conditions and progress toward meeting…[management objectives]" (Gibbs et al. 1999). In order to be effective, a monitoring program must be explicitly linked to management objectives. Once the information is collected, it must be analyzed, carefully archived, and appropriately communicated to managers and stakeholders (Gibbs et al. 1999). Adaptive management cannot occur without an effective monitoring program.

Monitoring variables should be commensurate with the scope and duration of the project and the biological significance of its effects. The monitoring protocol must respond to the specific question(s) posed, and must be flexible so that it can be modified if necessary, based on the need for additional information. Moreover, in order to create a meaningful dataset, monitoring variables and standards should be structured so that results are comparable from 1 treatment area to another, and from 1 reporting period to another. In addition, monitoring variables should maintain consistency across sites to allow fair comparison among different treatments. Credible monitored units should reflect the biological objective's measurable units. For example, if the biological objective is expressed in terms of numbers of individuals, the monitoring program should measure the number of individuals. The monitoring program must be based on sound science; standard, established survey or other protocols should be used.

The Roles of Research in Adaptive Management

Research plays at least 2 roles in the implementation of adaptive management. First, research can serve to test and modify the hypotheses and working models that underpin the development of management objectives, the design of monitoring programs, and the choice of techniques for data analysis. Second, research can be employed to gather raw data for the purpose of filling information gaps that present obstacles to the achievement of management objectives. As with monitoring, in order for research to be useful over the short term, it must be explicitly linked to management objectives, and the information generated must be correctly analyzed, carefully archived, and appropriately communicated to managers and stakeholders.

Research also has a role to play over the longer term. Many questions relevant to the management of California's native Monterey pine forests remain unanswered or only partially answered. Some relate to the ecology of California's native Monterey pine forests; others center on the epidemiology of pitch canker and sudden oak death. Some are broad in scope, and some are specific. All, however, suggest directions for continued inquiry that could be used to guide long-term research programs. Such programs would expand on the data collection needed to support monitoring, which is intended specifically to evaluate the success of individual management actions. Extended monitoring and research will facilitate long-term adaptation and improvement in management practice.

Implementation of Monitoring and Adaptive Management in the CFMP

In conjunction with robust monitoring and research initiatives, adaptive management will provide a process to effectively address the uncertainty in a large-scale management effort such as the CFMP. Where gaps in the data occur

and questions regarding the long-term effects of implementing the CFMP cannot be answered, incorporating adaptive management provisions will be critical to the planning and management process and to the long-term survival and function of the forest. Monitoring will document the results of different applications of treatment prescriptions and will allow analysis to determine whether these activities are producing the required results. Adaptive management can then be utilized to modify treatment prescriptions as necessary to accomplish the CFMP's long-term goals.

The goals and objectives of the CFMP will be most effectively attained by full integration of adaptive management, monitoring, and ongoing research into the implementation of the program. Adaptive management should be grounded in the 4 principles described in *What is Adaptive Management?* above, and should also

- employ extensive monitoring,
- be based on the best scientific information available,
- identify scientific questions that require further investigation,
- propose research to resolve these questions, and
- design and evaluate each treatment alternative as a scientific experiment when possible.

Adaptive management in the CFMP is therefore not a separate activity or a separate program, but rather a collaborative and wholly integrated approach to implementation of the plan, which employs the best science available. This approach embraces the scientific method and employs extensive monitoring and research with the purpose of reducing uncertainty and increasing the assurance that program objectives will be achieved.

Principles for Effective Adaptive Management in the CFMP

Recommended principles for the incorporation of adaptive management into the CFMP include the following.

1. Long-term (10-year) forestwide priorities and short-term (1- or 2-year) management unit treatment plans should be developed, establishing clear goals, measurable standards, and milestones that are explicitly linked to goals and objectives addressed by the CFMP.

2. When possible, management initiatives and projects included in the forestwide priorities and management unit treatment plans should be proposed as scientific experiments that identify objective(s), experimental controls, monitoring protocols, evaluation and analysis methods, and data collection and management processes.

3. Annual reports should be prepared for CFC, which include landscape-level and management unit–level evaluations and recommendations.

4. Management unit treatment plans should be evaluated according to the objectives, standards, and milestones provided in the forestwide priorities and goals and objectives of the CFMP, and should be modified or redirected as appropriate.

5. Anomalies detected by monitoring and/or research and determined to be relevant to the program should be further investigated with more detailed evaluations or changes in the treatment or site selection methods.

7. Long-term forestwide priorities and short-term management unit treatment plans should include contingency planning elements in order to contend with unforeseen circumstances.

8. If possible, funding should be dedicated to basic scientific research in support of adaptive management.

9. With some specific exceptions, information generated by adaptive management, monitoring, and research should be managed and archived so that it is accessible to program participants and the public and is available for future analysis.

10. The Forest Manager and the CFC should review the entire adaptive management process every 3–5 years; as part of the review process, independent scientific peer review should be solicited.

Monitoring

What to Monitor: Defining Success Criteria

The treatment prescriptions incorporated in the CFMP will have varying degrees of impact on the environment. Treatments such as complete removal (Treatment 7) are considered intensive because they commonly remove vegetative cover and expose the soil. Other treatments, such as individual tree removal (Treatment 2), require less manipulation within the management unit and result in less structural and environmental change.

Because different treatments or combinations of treatments leave a management unit in widely varying states, this document cannot prescribe monitoring techniques and success criteria that are both standardized and specific. Rather, the flexibility and variability of the CFMP lends itself to the development of individual monitoring parameters in conjunction with a specific treatment implementation plan. For example, if the checklist has identified removal of individual trees from an urban area as an appropriate treatment, the monitoring parameters may include assessing the resulting decrease in hazard to life and

property and the success of regeneration/recruitment of new trees to take the place of the removed tree or trees. By contrast, the monitoring parameters for a shelterwood cut (Treatment 3) on a high-erosion wildland management unit might include assessing the recruitment, growth, vigor, cover, density, and survival of Monterey pine and other species; the amount of erosion caused by construction/implementation techniques; and the degree of encroachment by invasive plant species.

Criteria for the evaluation of management success should be developed from the monitoring parameters. In general, the Forest Manager should monitor each site for general health, including:

- cover, density, and survivorship of healthy Monterey pines and coast live oaks;
- infection or reinfection of Monterey pines by pitch canker;
- understory composition and diversity;
- erosion caused by the treatment application or removal of vegetation; and
- infestation by invasive exotic species.

Monitoring variables should be realistic, clear, and quantitative, in light of the following.

- The natural communities in the management unit.
- Characteristics that reflect the growth and vigor of the community.
- The physical stability of the treated landscape.
- The condition of adjacent properties or management units.
- The life history of the Monterey pine.
- Special features within the management unit (e.g., cultural resources, streams, wetlands, etc.).

The success criteria should be used to create a checklist or other guide or form that will standardize the collection of data and facilitate the Forest Manager's collection of appropriate data for comparison. The checklist may also require the Forest Manager to collect information to fill data gaps that were identified for the research needs for the adaptive management plan.

When to Monitor: Developing a Monitoring Schedule

Like success criteria, monitoring schedules should reflect the severity of the treatment and the projected or anticipated future conditions on the treated site. Monitoring intervals should be appropriately spaced to permit the identification of any potential concerns and to track successional changes; the precise interval

will depend on the treatment and the success criteria. Following is a sample monitoring schedule for a high intensity treatment, such as seed tree retention.

1. **Immediately prior to implementation of the treatment.** The first monitoring visit should document existing site conditions, in order to provide a baseline for comparison with post-treatment conditions. This visit will also contribute to the development of success criteria for the management unit over the next 5–10 years and will help to identify potential issues that may affect the success or stability of the treated unit.
2. **Immediately after implementation of the treatment.** The second monitoring visit should document the immediate post-treatment conditions in the management unit; it will also allow the Forest Manager to ensure that the treatment prescription was executed properly and that the immediate goals for the treatment have been met. The "picture" established during this visit will help to refine the success criteria for the management unit's next 5–10 years and improve the identification of potential issues that may affect the ongoing success or stability of the treated unit.
3. **Every year for the first 5 years.** Monitoring efforts should continue every year for 5 years following treatment. The continuous collection of data will document successional changes and regrowth and health of Monterey pines within the treated management unit and help to identify potential problems. It will also contribute to evaluations of the Site Condition Checklist's model. By comparing data from neighboring management units, the Forest Manager will be able to track forest structure throughout the Cambria forest. Monitoring data should also be compared to the success criteria and baseline data to help identify any necessary changes in management practice or in the implementation of specific treatments.
4. **Every 3 years for the next 15 years (or indefinitely, budget permitting).** Long-term monitoring will allow further tracking of changes in forest structure and physical stability of the treated management unit, and should also be used to determine if and when the unit needs to be treated again. The Forest Manager should continue to document the successional changes within the treated management unit. Synthesis of data collected from a number of management units will help to manage the whole forest by tracking the forestwide patterns of disturbance and regeneration. Long-term monitoring will also permit the identification and control of reinfestations or other problems long before they affect the entire forest. Ongoing monitoring will also detect possible new infections in the managed area; this will provide an early warning system for the arrival of the potentially devastating sudden oak death syndrome, which has not yet been reported in the Cambria forest but is spreading rapidly on the central California coast.

What to Do with the Results: Archiving and Analyzing Monitoring Data

All monitoring data should be entered into a database. The database must be systematically organized so it provides a usable archive of historical information about the treated management units. It should also offer the means to make comparisons between pre- and post-treatment data, and between the monitoring results and the success criteria.

Any spatial data (e.g., locations of management unit boundaries, locations of wetlands, etc.) should be maintained in a geographic information system (GIS) database using software such as ArcView or ArcInfo. As the number of treated management units increases and as the monitoring data are characterized and tracked over time, this type of spatially organized database will help the Forest Manager analyze data and administer treatment to many management units within the CFMP quickly and easily. This type of analysis can also accommodate any spatial modeling needs for the Cambria forest.

The database should be used to compare the quantitative data and the spatial data. The comparisons will help assess how well the treated area is progressing relative to the success criteria for the management unit, and the goals and objectives of the CFMP as a whole.

Adaptive Management

When to Engage Adaptive Management

In general, Adaptive Management should be an integral part of the forest management process and should always be in process. However the extent of application should be keyed to ongoing assessment of forest conditions.

Response to Forest Conditions

For each performance metric and its associated success criteria, a threshold should be established that serves as the indicator, or "trigger," at which point the adaptive management process starts. Adaptive management triggers are derived from two sources:

- the performance and recovery expectations established during the development of the specific implementation plan for the treatment prescription; and
- the success criteria.

The triggers must be quantitative, in order to permit explicit (binary or "go/no go") comparison between the monitoring data and the trigger threshold.

When the trigger is tripped for a given performance metric, the management response process begins. The Forest Manager has 2 options.

1. S/he may choose to conduct or fund experimental controlled research immediately to assess whether management activities are the likely cause of the observed decline before adaptive management steps are taken; or
2. s/he may draw on recent literature and research to speculate on the cause of the decline in performance and amend management (or create new treatments) accordingly. If downward trends continue, the monitoring regime should be intensified and management practices modified as appropriate based on a joint analysis by the Forest Manager and the CFC. If the decline still persists, research should be conducted.

In either case (with research as a first response or as a last), new treatments, implementation techniques, or protection measures must be developed, or the checklist decision tree must be revised to establish new links between the checklist and existing treatment prescriptions.

After the appropriate changes have been made and modified monitoring requirements are identified and approved by the Forest Manager and CFC, a re-implementation phase will begin. The steps described in this chapter for defining a specific implementation plan with a corresponding monitoring plan and success criteria should be followed again, reinitiating the iterative cycle for the management unit.

Response to Scientific Advances

New information from outside research may become available in the literature; in addition, practical knowledge gained from experience implementing the CFMP will become increasingly useful. The flexibility of the CFMP, including its monitoring and adaptive management plan, is designed to support change as these advances are observed or developed. As knowledge of Monterey pine forest ecology, pitch canker, erosion control, fire ecology, or other related fields expands, the CFMP must incorporate new treatments or courses of action. These changes should be integrated into the CFMP via

- the Site Condition Checklist,
- specific implementation plans,
- monitoring parameters, and
- success criteria

as the information becomes available. This process will retain the solid, scientific basis on which this plan was created, and will ensure an enduring and successful forest management plan.

7

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Glossary of Selected Technical Terms

Adaptive Management
A management style that embodies change or modification ("adaptation") in response to the outcome of previous management actions or to advances in scientific understanding. Under adaptive management, management action is initiated, results are monitored (see **Monitoring**), and subsequent management actions are adjusted for better outcome, based on information collected during monitoring or other new data.

Annual Plant
A plant that matures, sets seed, and dies within a single year.

Best Management Practices (BMPs)
Procedures, precautions, or other measures instituted during project implementation to minimize adverse environmental effects. Examples of BMPs include: using silt fencing or hay bales to control runoff and prevent increased sediment input to watercourses during ground-disturbing activities; requiring contractors to muffle vehicle exhausts to reduce noise-related disturbance of wildlife; and limiting the seasons when controlled burns are permitted to prevent impacts on nesting birds. Most agencies in California follow BMP recommendations of the California Department of Transportation (1999).

Canopy
The stems, branches, and leaves of an individual tree; or, collectively, the stems, branches, and leaves of all of the trees in a woodland or forest environment. If a tree, forest, or woodland has multiple layers, *canopy* refers to the uppermost layer. See **Crown**.

Canopy Dieback
Mortality of leaves or branches within the canopy. Compare **Top Kill**.

Closed-Cone Conifers
Conifers with cones that remain closed until exposed to an external stimulus such as heat (fire); once the cones are sufficiently open, the seeds are released.

Conifer
Tree belonging to class Gymnospermae. Characterized by production of seeds that lack an enclosing ovary and are contained in a cone.

Coarse Fuel
Flammable woody and herbaceous materials >3 inches in diameter, such as downed tree limbs and the stems and branches of large understory shrubs.

Crown
The uppermost branches and foliage of a tree or shrub; the crowns of trees in a forest together make up the forest canopy. See **Canopy**.

Crown Fire
A fire that burns through the canopy without involving the understory or lower portion of standing timber. See **Crown**, **Canopy**, **Understory**.

Diameter at Breast Height
Standard measure of tree size used in forestry and ecology; outside diameter of tree trunk measured at 4.5 feet above mean ground level.

Duff
Partially decomposed leafy and woody material on the forest floor, in which the original organic structures are no longer recognizable. See **Litter**.

Ecosystem
A community of organisms together with their physical environment, and the interactions between and among them.

Exotic
Refers to plants or animals that are not native to a particular area; may be used to describe both deliberately and accidentally introduced species. See **Native**.

Fill, Fill Material
Soil or other material artificially emplaced in order to bring the ground surface up to a specified elevation or gradient ("finish grade" or "finished grade").

Fine Fuel
Flammable woody and herbaceous materials $\leq$3 inches in diameter, such as small downed branches, small understory shrubs, leaves, and pine needles. See **Coarse Fuel**, **Fuel**, **Fuel Load**.

Forest
A plant community in which trees form an unbroken, or nearly unbroken, canopy.

Forestry
The science of managing forest resources and/or cultivating forest plantations.

Fuel
Combustible material; in the context of forestry, fuels include living plant material as well as snags, downed materials, litter, and the duff layer. See **Duff**, **Litter**, **Snag**.

Fuel Load
The total available fuel in a given area; includes flammable portions of both live and dead vegetation. Key characteristics of fuel load that determine fire hazard in a given area are

- total load (usually measured in tons/acre);
- horizontal continuity (the proportion of the ground surface covered by fuels);
- vertical continuity (the presence or absence of "ladders"); and
- relative proportion of fine fuels (e.g., pine needles) and coarse fuels (e.g., fallen tree limbs, understory shrubs).

See **Fuel**, **Ladder**, **Ladder Fuel**.

Geographic Information System (GIS)
Software designed to manage, analyze, and present data with a spatial component (spatially located data).

Goals and Objectives
Refers to the purpose or desired outcome of a project or other initiative. *Objectives* represent small-scale, measurable targets. *Goals* articulate the larger vision that should be achieved by realizing the objectives.

Ground Fire
A fire confined primarily to the ground and low-growing vegetation. In a forest setting, a ground fire typically burns part or all of the duff layer and understory vegetation, with little or no effect on the canopy. See **Crown Fire**, **Duff**, **Overstory**, **Understory**.

Habitat
The environment usually occupied or used by an organism; includes both living (plant and animal) and nonliving (physical environment) components.

Hazard Tree
A tree that has the potential to fall or to lose a limb or limbs and thus poses a risk to life or property; may include dead, dying, and severely leaning trees, as well as trees that lack root support. The term *hazard tree* is typically applied only in urban contexts or near roads or structures, since hazard to life and property is minimal or nonexistent in undeveloped areas.

Invasive
Refers to an exotic species that has the potential to spread rapidly, displacing native species that occupy a similar ecological niche. See **Exotic**.

Ladder
A fire is said to ladder when it spreads via a fuel path. The term is most commonly used with reference to forest fires, and generally refers to vertical spread, although horizontal laddering may also occur.

Ladder Fuel
Fuel that contributes to the continuity of an area's fuel load, increasing the potential for fires to ladder. See **Fuel**, **Fuel Load**.

Leaning Tree
A tree that grows at an angle, or a tree in which a large proportion of the mass is on 1 side of the tree. In urban areas or adjacent to structures, leaning trees that are in danger of falling are considered hazard trees. (See **Hazard Tree**.)

Litter
Incompletely decomposed leafy and woody material in which the original organic structures are still recognizable.

Low-Pressure Vehicle
A vehicle, such as a feller-buncher harvester, designed to exert a minimum of pressure on surfaces over which it travels.

Management Unit
The basic geographic unit for forest management planning used in the Cambria Forest Management Plan. An area that has similar physical and biological characteristics and similar needs in terms of forest health, public safety, or forest aesthetics, and can therefore be managed uniformly, with the expectation that the entire unit will respond to management activities in a similar way.

Monitoring
In adaptive management, refers to the collection of data to evaluate changes in response to management activities and measure progress toward management objectives. In order to be effective, a monitoring program must be carefully planned and implemented, and must be explicitly linked to management objectives. See **Adaptive Management**.

Monitoring Parameter
An aspect of a natural system that is regularly observed, measured, or documented as part of a monitoring program.

Monitoring Variable
See **Monitoring Parameter**.

Mulch
A substance—such as straw, wood chips, or leaves—used to cover the soil surface in order to inhibit weed growth and/or prevent the loss of moisture or heat.

Native
Refers to a species that occurs naturally in a region. See **Exotic**, **Nonnative**.

Nonnative
See **Exotic**.

Non-Point Source
Refers to pollutants that do not originate at a specific, discrete, stationary source. Common constituents of non-point source pollution include: automotive fuels and lubricants; metals from automotive brake linings and other sources; pesticides, herbicides, and fertilizers; sediment from areas where the ground surface is disturbed by wildland management activities or by construction; plant litter and animal wastes; and air pollution deposited on the ground and carried away by surface runoff. See also **Point-Source Pollutant**.

Overstory
The upper level of a forest or woodland canopy, formed by the tallest trees in the environment.

Patch
A portion of a forest to which a treatment is applied. Roughly analogous to the Cambria Forest Management Plan's usage of *management unit*. See **Treatment**, **Management Unit**.

Perennial
Refers to a plant that survives for more than 2 growing seasons, or to a stream that conveys surface water throughout the year.

Point-Source
Refers to pollutants that originate at a discrete, stationary, defined origin such as a leaking underground fuel-storage tank, a drain from an industrial facility, or the discharge from a sewage treatment plant. See **Non-Point Source**.

Prescription
Management activity (treatment) identified as appropriate for a portion of a forest or other ecosystem, based on existing resources and conditions. Commonly intended to repair damage or address adverse conditions. See **Treatment**.

Recruitment
Influx of new members into a population by reproduction or immigration. In a forestry context, *recruitment* can be used refer to growth of young trees to fill an opening in the forest.

Riparian
Refers to the environment associated with a stream. E.g., riparian vegetation, riparian habitat.

Riparian Corridor
The habitat corridor along a stream.

Saturated
Said of soils when all void spaces between particles are filled with water.

Sediment
Generally used to refer to particles physically broken down and transported from their source by the action of water, ice, or wind. Strictly defined, sediment also includes components dissolved from a parent rock source and carried in solution by surface water and groundwater. See **Soil**.

Seed Rain
Deposition of seeds on the ground. In the CFMP, *seed rain* is used to refer specifically to the deposition of Monterey pine seeds on the forest floor as cones open.

Snag
A dead tree that remains standing.

Soil
Unconsolidated mineral and organic material on the surface of the earth, formed by physical, chemical, and biological weathering of parent rock or sediment over time, and capable of supporting land plant growth. See **Sediment**.

Soil Erosion
Removal of topsoil or underlying soil layers by water or wind activity; erosion that affects and removes soil layers, particularly where erosion is initiated or accelerated as a result of human activity.

Soil Productivity
The ability of an in-situ soil to produce a specified plant or sequence of plants under a specified system of management. Related to the quality of the soil and to its fertility, but a more narrowly defined concept than fertility.

Special-Status Species
Plants and animals that are subject to regulatory protection, including those in any or all of the following categories.

- Plants and animals listed or proposed for listing as threatened or endangered under the federal Endangered Species Act (ESA); plants and animals that are candidates for possible future listing as threatened or endangered under ESA.
- Plants and animals listed by the State of California as threatened or endangered under the California Endangered Species Act (CESA), and those that are candidates for possible future listing under CESA.

- Plants and animals that meet the definition of *rare*, *threatened*, or *endangered* under the California Environmental Quality Act (CEQA).
- Plants listed as rare or endangered under the California Native Plant Protection Act.
- Plants considered "rare, threatened, or endangered in California" by the California Native Plant Society.
- Animal species of special concern to the California Department of Fish and Game.
- Animals that qualify as "fully protected" under Sections 3511, 4700, and 5050 of the California Fish and Game Code.

Stand
A group of trees or shrubs.

Top Kill
Death of portions of a tree's crown. See **Canopy Dieback**.

Topsoil
A soil layer formed at the ground surface or immediately below the duff or litter layer; characterized by the loss of the original character of the parent rock or sediment and by the presence of distributed organic matter, and/or by properties resulting from cultivation or other agricultural use.

Treatment
A management activity intended to improve the condition of a portion of a forest or other ecosystem under management. See **Prescription**.

Understory
An intermediate or lower level of a forest or woodland, usually made up of shade-tolerant trees, shrubs, forbs, or grasses.

Water Quality
Describes the aspects of a water body that affect its ability to support aquatic organisms: temperature, purity, clarity (sediment content), dissolved oxygen content, etc.

Weed
An unwanted plant; commonly, an invasive exotic plant. Typically restricted to disturbed areas. See **Exotic**, **Invasive**.

Wetland

In the broadest sense, refers to an environment in which water is a defining or critical characteristic, typically adjacent to a body of water and/or characterized by high soil moisture content. Wetland environments may be influenced by fresh, brackish and/or salt water, and include riparian areas, areas adjacent to lakes and ponds, tidal settings, fresh and salt marshes, and coastal habitat. *Jurisdictional wetland* refers to a wetland meeting specific criteria in Section 404 of the federal Clean Water Act.

Woodland

An environment in which trees and shrubs are common, but are widely spaced, forming a broken or discontinuous canopy.

Sources consulted in the preparation of this glossary include: Lincoln et al. 1989, Walker 1989, Lincoln and Boxshall 1990, Jackson 1997.

Appendix A

Special Status Species

Table A-1. Special-Status Plant Species That May Be Affected by Implementation of the Cambria Forest Management Plan

Common Name *Scientific Name*	Status[a] Federal/State/ CNPS	Geographic Distribution	Habitat Requirements	Blooming Period
Hickman's onion *Allium hickmanii*	SC/–/1B	Central coast; Monterey and San Luis Obispo Counties, especially Monterey Peninsula and Arroyo de la Cruz. Known from <20 occurrences.	Closed-cone conifer forest, maritime chaparral, coastal prairie, coastal scrub, valley and foothill grassland, 20–185 m.	Apr–May
Arroyo de la Cruz manzanita *Arctostaphylos cruzensis*	SC/–/1B	Coastal Monterey and San Luis Obispo Counties. Known from <20 occurrences.	Sandy soils in coastal scrub, chaparral and oak woodland, valley and foothill grassland, 60–310 m.	Dec–Mar
Hearst's manzanita *Arctostaphylos hookeri* ssp. *hearstiorum*	SC/E/1B	Endemic to San Luis Obispo County. Known from <5 occurrences near Arroyo de la Cruz.	Sandy substrate in maritime chaparral, coastal prairie, coastal scrub, valley and foothill grassland, 55–210 m.	Feb–Apr
Santa Lucia manzanita *Arctostaphylos luciana*	SC/–/1B	Endemic to Santa Lucia Range, San Luis Obispo County.	Shale outcrops in chaparral, 350–850 m.	Feb–Mar
Pecho manzanita *Arctostaphylos pechoensis*	SC/–/1B	Endemic to Pecho Hills area, San Luis Obispo County.	Siliceous shale in closed-cone conifer forest, chaparral, coastal scrub, 150–850 m.	Nov–Mar
Santa Margarita manzanita *Arctostaphylos pilosula*	SC/–/1B	Southern Coast Ranges; near Santa Margarita; Monterey and San Luis Obispo Counties.	Shale outcrops and slopes in closed-cone conifer forest, chaparral, 170–1,100 m.	Dec–Mar
Wells's manzanita *Arctostaphylos wellsii*	–/–/1B	Endemic to Coast Range hills southeast of San Luis Obispo, San Luis Obispo County.	Sandstone outcrops in closed-cone conifer forest, chaparral, 30–400 m.	Dec–Apr

Marsh sandwort *Arenaria paludicola*	E/E/1B	Known from 3 occurrence near Black Lake on Nipomo Mesa, San Luis Obispo County. Historic range included wider portions of central and southern coastal California.	Boggy meadows, freshwater marshes, swamps, 3–170 m.	May–Aug
San Simeon baccharis *Baccharis plummerae* ssp. *glabrata*	–/–/1B	Endemic to San Luis Obispo County. Known from 3 occurrences near San Simeon.	Coastal scrub, 50–480 m.	June
San Luis mariposa lily *Calochortus obispoensis*	–/–/1B	Endemic to southwestern Coast Ranges, San Luis Obispo County.	Chaparral, coastal scrub, valley and foothill grassland, common in serpentine grassland, 75–730 m.	May–Jul
Dwarf calycadenia *Calycadenia villosa*	–/–/1B	Known from 20 occurrences in inland foothills of southern Coast Ranges, San Luis Obispo and Monterey Counties. Historically occurred in Kern County*.	Chaparral, oak woodland, juniper woodland, grasslands. On open dry flats and hillsides or alluvial fans, 285–1,350 m.	May–Oct
San Luis Obispo sedge *Carex obispoensis*	–/–/1B	San Luis Obispo and Monterey Counties.	Sargent cypress forest, chaparral, coastal prairie, coastal scrub, valley and foothill grassland, common near seeps in serpentine, 10–790 m.	Apr–Jun
Hearst's ceanothus *Ceanothus hearstiorum*	SC/R/1B	Endemic to San Luis Obispo County. Known from <10 occurrences near Arroyo de la Cruz.	Maritime chaparral, coastal prairie, coastal scrub, 75–245 m.	Mar–Apr
Maritime ceanothus *Ceanothus maritimus*	SC/R/1B	Endemic to San Luis Obispo County. Known from <10 occurrences near Hearst Ranch.	Maritime chaparral, valley and foothill grassland, 10–150 m.	Jan–Mar
Purple amole *Chlorogalum purpureum* var. *purpureum*	T/–/1B	Northeastern portion of the southern Coast Ranges (eastern Santa Lucia Mountains, Monterey County).	Cismontane woodland, valley and foothill grassland.	May–Jun
Camatta Canyon amole *Chlorogalum purpureum* var. *reductum*	T/R/1B	Endemic to San Luis Obispo County. Known from 2 occurrences in La Panza Range.	Blue oak savannah, woodland on serpentine, 600–615 m.	Apr–May

Table A-1. Continued

Chorro Creek bog thistle *Cirsium fontinale* var. *obispoense*	E/E/1B	Endemic to San Luis Obispo County. Known from <10 occurrences.	Seeps and stream banks on serpentine, in chaparral and oak woodlands, 35–365 m.	Feb–Jul
La Graciosa thistle *Cirsium loncholepis*	E/T/1B	South-central coast; Santa Barbara and San Luis Obispo Counties. Known from <20 occurrences.	Coastal dunes, brackish marsh, 4–220 m.	Jun–Aug
Compact cobwebby thistle *Cirsium occidentale* var. *compactum*	SC/–/1B	South-central coast; San Francisco*, Monterey, and San Luis Obispo Counties. Known from <20 occurrences.	Chaparral, coastal dunes, coastal prairie, coastal scrub, 5–150 m.	Apr–Jun
Pismo clarkia *Clarkia speciosa* ssp. *immaculata*	E/R/1B	Endemic to San Luis Obispo County.	Oak woodland and grassy openings in chaparral on sandy soils, 25–185 m.	May–Jun
Dune larkspur *Delphinium parryi* ssp. *blochmaniae*	SC/–/1B	Coastal areas of Santa Barbara, San Luis Obispo, and Ventura Counties.	Maritime chaparral, coastal dunes, 0–200 m.	Apr–May
San Luis Obispo serpentine dudleya *Dudleya abramsii* ssp. *bettinae*	SC/–/1B	Endemic to San Luis Obispo County.	Serpentine outcrops in coastal scrub or chaparral, 20–180 m.	May–Jul
Blochman's dudleya *Dudleya blochmaniae* ssp. *blochmaniae*	SC/–/1B	Coastal California from San Luis Obispo County to San Diego County; also occurs in Baja California. Known from <20 occurrences.	Clay soils, rock outcrops, commonly on serpentine; coastal scrub and adjacent grasslands, 5–450 m.	Apr–Jun
Indian Knob mountainbalm *Eriodictyon altissimum*	E/E/1B	Endemic to San Luis Obispo County.	Sandstone ridges; in open areas in maritime chaparral, oak woodland, 80–270 m.	Mar–Jun
Hardham's bedstraw *Galium hardhamiae*	–/–/1B	Monterey and San Luis Obispo Counties.	Closed-cone conifer forest on serpentine substrate, 395–975 m.	Apr–Oct
Jones's layia *Layia jonesii*	SC/–/1B	Coastal Monterey and San Luis Obispo Counties.	Clay soil and serpentine outcrops in chaparral and grasslands, 5–400 m.	Mar–May

Carmel Valley bush mallow *Malacothamnus palmeri* var. *involucratus*	SC/–/1B	Monterey and San Luis Obispo Counties.	On talus hilltops and slopes in chaparral, oak woodland, 30–1,100 m.	May–Aug
Dudley's lousewort *Pedicularis dudleyi*	SC/R/1B	Monterey, Santa Cruz*, San Luis Obispo, and San Mateo Counties. Known from <10 occurrences.	Maritime chaparral, North Coast conifer forest, valley and foothill grassland, 60–900 m.	Apr–Jun
Hooked popcorn-flower *Plagiobothrys uncinatus*	SC/–/1B	Monterey, San Benito, Santa Clara, and San Luis Obispo Counties.	In sandy areas; chaparral, cismontane woodland, valley and foothill grassland, 300–730 m.	Apr–May
Gambel's water cress *Rorippa gambelii*	E/T/1B	Coastal southern California from San Luis Obispo County to San Diego County. Known from 4 occurrences.	Freshwater or brackish marsh, 5–330 m.	Apr–Jun

[a] Status explanations:

Federal
E = listed as endangered under the federal Endangered Species Act.
T = listed as threatened under the federal Endangered Species Act.
SC = species of concern (species for which existing information may warrant listing but for which substantial biological information to support a proposed rule to list is lacking).
– = no listing.

State
E = listed as endangered under the California Endangered Species Act.
T = listed as threatened under the California Endangered Species Act.
R = listed as rare under the California Native Plant Protection Act. (This category is no longer used for newly listed plants, but some plants previously listed as rare retain this designation.)
– = no listing.

California Native Plant Society
1B = List 1B species (rare, threatened, or endangered in California and elsewhere).
* = known populations believed extirpated from that County.

Sources: California Department of Fish and Game 2000, California Native Plant Society 2000

Table A-2. Special-Status Wildlife Species That May Be Affected by Implementation of the Cambria Forest Management Plan

Common Name *Scientific Name*	Status [a] Federal/State	California Distribution	Habitats	Breeding Season
INVERTEBRATES				
Monarch butterfly *Danaus plexippus*	–/SSC	Winter roosting sites extend along the coast from northern Mendocino County to Baja California. Adults hibernate by roosting in trees from San Francisco into Baja California.	Habitat mostly open places, especially moist valley bottoms. Roosts and overwinters in groves of eucalyptus, Monterey pine, and cypress trees protected from the wind, often with nectar and water sources nearby.	Summer
FISHES				
Steelhead (South-Central Coast Evolutionarily Significant Unit) *Oncorhynchus mykiss irideus*	T/–	Along central coast from Pajaro River (inclusive) in Santa Cruz County to (but not including) Santa Maria River in San Luis Obispo County.	Requires cold, clear streams with clean gravel of appropriate size for spawning. Most spawning occurs in headwater streams; therefore, passage to headwaters is important. Critical habitat was designated on February 16, 2000 (65 FR 7764).	Winter through early spring
AMPHIBIANS AND REPTILES				
California red-legged frog *Rana aurora draytonii*	T/SSC	Along the coast and in coastal mountain ranges from Humboldt County to San Diego County; at mid-elevations (above 300 m) in the Sierra Nevada from Butte County to Fresno County.	Permanent and semipermanent aquatic habitats (such as creeks and coldwater ponds) with emergent and submergent vegetation and riparian species along the edges. May estivate in rodent burrows or cracks during dry periods. Critical habitat has been proposed and includes the entire Cambria forest area.	Breeds January–July in the south and March–July in the north.

Common Name *Scientific Name*	Status [a] Federal/State	California Distribution	Habitats	Breeding Season
Southwestern pond turtle *Clemmys marmorata pallida*	SC/SSC	Along the central coast and inland to the Sierra Nevada; along the southern coast and inland to the Mojave and Sonoran Deserts. Range overlaps with that of the northwestern pond turtle (*C. m. marmorata*) throughout the Sacramento–San Joaquin Delta and in the Central Valley from Sacramento County to Tulare County.	Woodlands, grasslands, and open forests; aquatic habitats, such as ponds, marshes, or streams, with rocky or muddy bottoms and vegetation for cover and food.	Lays eggs between March and August; incubation period is ~80 days.
Two-striped garter snake *Thamnophis hammondii*	SC/SSC	Known range extends through the Coast Ranges west of the San Joaquin Valley and the Peninsular Ranges, from the Salinas Valley and the southeastern slopes of the Diablo Range south to the Mexican border.	Perennial and intermittent streams with rocky beds bordered by willow thickets or other dense vegetation; also inhabits large sandy riverbeds if a strip of riparian vegetation is present, and stock ponds if riparian vegetation and fish and amphibian prey are present.	Courtship and mating occur in the spring soon after emergence.
BIRDS				
Prairie falcon *Falco mexicanus*	–/SSC	Permanent resident on the south coast and in Transverse, Peninsular, and northern Cascade Ranges, in the southeastern deserts and White–Inyo Mountains, in Modoc, Lassen, and Plumas Counties, and in the foothills surrounding the Central Valley. Winters in the Central Valley, along the coast from Santa Barbara County to San Diego County, and in Marin, Sonoma, Humboldt, Del Norte, and Inyo Counties.	Nests in cliffs or escarpments; forages in adjacent dry, open terrain or uplands, marshes, and seasonal marshes.	Breeds from mid-February through mid-September.

Common Name *Scientific Name*	Status [a] Federal/State	California Distribution	Habitats	Breeding Season
American peregrine falcon *Falco peregrinus anatum*	FPD/E	Permanent resident in the northern and southern Coast Ranges. May summer in the Cascade and Klamath Ranges and south through the Sierra Nevada to Madera County. Winters in the Central Valley south through the Transverse and Peninsular Ranges and on the plains east of the Cascade Range.	Nests and roosts on protected ledges of high cliffs, usually adjacent to lakes, rivers, or marshes that support large populations of other bird species.	Breeds early March–late August; incubation period lasts ~32 days.
California condor *Gymnogyps californianus*	E/E	Historically observed in rugged mountain ranges surrounding the southern San Joaquin Valley. Most individuals are now in captive populations, but a few birds were recently released in rugged portions of the Los Padres National Forest in Ventura County, on Catalina Island, and along the Big Sur coastline.	Requires large areas of open savanna, grassland, and/or foothill chaparral with large trees, cliffs, and snags for roosting and nesting.	Breeds annually or less often. Courtship has been observed as early as October. One egg is laid between February and May; incubation period lasts ~59 days.
Bald eagle *Haliaeetus leucocephalus*	T/E	Nests in Siskiyou, Modoc, Trinity, Shasta, Lassen, Plumas, Butte, Tehama, Lake, and Mendocino Counties and in the Lake Tahoe basin. Winter range includes the rest of California, except the southeastern deserts, very high elevations in the Sierra Nevada, and the region east of the Sierra Nevada and south of Mono County. Range is expanding. Reintroduced into central coast area.	In western North America, nests and roosts in conifer forests within 1 mile of a lake, a reservoir, a stream, or the ocean.	Breeds February–July; incubation period usually lasts 34–36 days.

Common Name *Scientific Name*	Status [a] Federal/State	California Distribution	Habitats	Breeding Season
Least Bell's vireo *Vireo bellii pusillus*	E/E	Small populations occur in southern Inyo County, southern San Bernardino County, and Riverside, San Diego, Orange, Los Angeles, Ventura, and Santa Barbara Counties. Not known from San Luis Obispo County, but the species' range is expanding northward.	Riparian thickets, near water or in dry portions of river bottoms. Nests along margins of bushes and forages low to the ground. Also uses mesquite and arrow weed in desert canyons.	Mid-March through September.
MAMMALS				
Pallid bat *Antrozous pallidus*	–/SSC	At low elevations throughout California.	Roosts in rocky outcrops, cliffs, and crevices. Requires access to open habitats required for foraging.	Mates late October–February; young are born April–July.

[a] **Status explanations:**

Federal

E = listed as endangered under the federal Endangered Species Act.
T = listed as threatened under the federal Endangered Species Act.
PT = proposed for listing as threatened under the federal Endangered Species Act.
PR = protected under the Bald and Golden Eagle Protection Act.
C = candidate species (species for which USFWS has on file sufficient information on biological vulnerability and threats to support issuance of a proposed rule to list).
SC = species of concern (species for which existing information may warrant listing but for which substantial biological information to support a proposed rule to list is lacking).
– = no listing.
FPD = proposed for federal delisting.

State

E = listed as endangered under the California Endangered Species Act.
T = listed as threatened under the California Endangered Species Act.
SSC = species of special concern in California.
FP = fully protected under Section 3511, 4700, or 5050 of the California Fish and Game Code.
– = no listing.

Sources: California Department of Fish and Game 2000, California Native Plant Society 2000

Appendix B

Tree Planting Techniques

Introduction

This appendix provides additional guidelines for planting trees within the Cambria forest. Tree planting will occur in areas that require supplemental regeneration after treatment (e.g., stands with a deficiency of mature seed-producing trees), or in stands that require additional ground cover to reduce erosion. Tree planting practices described in this section are manual methods for restocking trees in existing forest stands, creating new stands, and replacing landscaping trees (see *Forest Regeneration* below).

Soil Preparation and Protection

Fertilization

Soil fertility and productivity depend partially on geologic parent material and soil type. Sandy soils low in clay content have low cation exchange capacity and low available nutrient capacity. As a result, growth rates in such soils are relatively slow.

The principal sources of plant nutrients for the Cambria forest are organic matter and nutrient cycling of decaying organic matter. Preventing loss of the litter layer and surface soil horizon is the most effective means of maintaining soil fertility. Each generation of trees should grow somewhat more quickly than the previous generation because of incremental improvements in the soil's capacity for water retention and cation exchange.

Soil pH should be measured at several locations in each planting area. Maintaining a medium-acid to neutral pH permits optimal availability of plant nutrients. Lime may be used to change pH and should be applied for marked imbalances. Slow-release fertilizer pellets (e.g., 6- to 9-month 14-14-14 pellets) should be placed near the bottom of each planting hole.

Mulching

Mulching reduces weed competition, increases soil moisture levels, and inhibits soil erosion. Before tree planting occurs, soil should be mulched with wood chips. Mulching should be maintained continuously if the supply of chips allows.

Mulches such as wood chips and weed mats are the best means of controlling weeds for forest regeneration purposes. Before wood chips are applied, groundcover at the planting site should be turned into the soil. As a supplement to wood chips, permeable woven plastic sheets (3 x 3 feet) should be used for weed control at each planting site. The chips can be placed over the plastic to reduce visibility and vandalism.

Erosion Control and Soil Protection

The litter layer and soil surface should be disturbed as little as possible during regeneration cutting. Litter layers should be disturbed after tree removal where native vegetation will be established. Additional soil protection measures should be taken to reduce or eliminate erosion at critical sites before planting begins. These include redirecting drainage, filling or repairing gullies, and establishing some footpaths and abandoning others.

Selecting Planting Materials

Planting Stock

Non-local nursery stock of Monterey pine has been planted throughout the Cambria forest. The introduction of this non-local genetic stock into areas that support indigenous stands of Monterey pine can contaminate the local gene pool. Trees of non-local origin can spread their genes into the local population through pollen and seeds, and over generations the genetic composition of the locally native stands can be altered. Genetic contamination can affect the fitness of trees by reducing their ability to adapt to the local environment. Because of the possibility of genetic contamination and its potential adverse effects on the long-term viability of the Cambria forest, care must be taken to use only seeds and seedlings from native stock from the immediate area as sources of planting material.

Local nurseries should develop pitch canker–resistant cultivars of Monterey pine and use such cultivars to produce canker-resistant cuttings suitable for outplanting on a scale sufficient to reforest certain management units. The basis for developing canker-resistant cultivars is the genetic resistance to pine pitch canker that apparently occurs naturally in a small portion of the indigenous population. Estimates of the proportion of indigenous Monterey pines that is naturally resistant to pitch canker have declined substantially in recent years, as

increasing proportions of trees throughout its indigenous range have become infected. Nonetheless, approximately 15% of the overall indigenous population are currently believed to be resistant.

Cultivars with an estimated 80% probability of being resistant can be developed through the following process (Jones & Stokes 1998).

1. Select uninfected Monterey pine trees from a heavily infected stand.
2. Develop vegetative cuttings from the selected trees and inoculate them with pitch canker spores.
3. Select cuttings that do not display infection symptoms and reinoculate them.
4. Identify resistant trees, shear cambium material from them, and cultivate the material to develop vegetative points.
5. Separate the vegetative points into individual cuttings; allow each cutting to develop a root system.
6. Plant resistant cuttings in a nursery setting and grow until ready for outplanting.

This process will require approximately 24–30 months to complete.

The best seedlings to use are the youngest nursery-grown trees (e.g., 1 year old) that are practical to plant in an urban area. Larger seedling sizes may be necessary in highly visible areas. Nursery stock comes in 3 forms: bare root stock, liner stock, and container stock.

Bare Root Stock

One-year-old bare root seedlings should be the basic stock used in replanting the Cambria forest. Bare root stock seedlings generally perform better than other stock because root growth has not been inhibited in the nursery.

Liner Stock

Liners are plastic sleeves that surround the seedling's tap root but allow uninhibited downward growth. They are used to root seeds; the resulting seedlings are ready for planting when they are only a few weeks old. Liner stock performs as well as bare root stock but may cost more. Liner stock should also be considered for widespread use at Cambria.

Container Stock

Container stock is generally inferior to bare root and liner stock because root growth is often inhibited by the container. Although the seedling is larger, performance is generally inferior to that of bare root or liner stock. As such,

container stock should be used only where immediate replacement of high-visibility plantings is needed.

The most common container stock is the 1-gallon tree. By the time a tree has reached this container size, it has usually been transplanted 3 times. In larger containers (i.e., 15 gallons or larger), roots tend to encircle the root ball and girdle the tree later in life. Fifteen-gallon container trees have a relatively small chance of growing into strong, healthy trees.

Condition of Planting Stock

Seedlings should be young, healthy, and vigorous. The initial cost of a seedling is small compared to the cost of its planting and maintenance. A seedling in poor condition will not become a strong, healthy tree and should be discarded.

Trees should be individually selected by trained foresters or other experienced individuals. Representative trees of the potential planting stock should be inspected for the extent of their roots, root-to-shoot ratio, any evidence of stem and foliage diseases, and overall development.

Preplanting Care

Trees should be carefully transported to minimize stress. They should not be exposed to severe wind or excessive heat, as they would be in an open vehicle, for example.

When bare root seedlings are moved from the nursery, they should be planted as soon as possible, within 48 hours at the most. If they cannot be planted immediately, special steps should be taken, such as placing the seedlings' roots into a moist medium (called *heeling-in*) or putting them in cold storage. During storage, the roots should be covered at all times and growth should be prevented. Containerized stock should be handled by the container, rather than by the stem, because stems may be injured by the weight of the root ball.

Planting

Planting should generally be done in December, January, and February. Planting should be conducted by trained planters under the supervision of the Forest Manager or a qualified restoration specialist. The use of volunteer trainees is encouraged. Techniques for these planting steps are described below; further information on planting, especially planting landscaping trees, is given in University of California Division of Agricultural Sciences leaflets 2583 and 2576.

Container Stock

For container stock, the planting hole should be twice the width of and no deeper than the seedling container. The sides of the hole should not be smooth or glazed (as is caused by auguring in wet, clay-rich soils) because the tree roots will not penetrate this surface and will spiral inside the hole. The soil that is removed should be stockpiled.

All roots of the transplants should be inspected and any matted, dead, diseased, broken, twisted, or circling roots pruned. Inspecting and pruning the roots should be done very quickly because every minute of root exposure to the air results in a significant loss of root hairs. For most containerized nursery stock, vertical cuts should be made on opposite sides of the container-shaped rootball to deter root girdling.

Trees should be placed in the planting hole so that the root collar is 2–3 inches above final grade. Most container stock will be found planted deep in the container soil; soil should be removed from the stock to the top of the first major root. Set in the planting hole, the top of the root should barely be visible at finished grade.

As soil is backfilled, it should be worked around the roots so that they are not compressed into a tight mass, but are spread out and are supported by the new soil beneath them. After each 3–4 inches of soil has been placed in the hole, the soil should be pressed around the roots with foot pressure, with care taken not to damage the roots.

If the soil is dry, water should be applied before, during, and after the planting. Postplanting watering will eliminate possible air pockets and will help to settle the root ball into its final position.

Bare Root Stock

Planting bars, mattocks, western planting tools, and shovels are commonly used for bare root planting. The hole should be a slit approximately 10 inches deep with a nearly vertical wall on one side. The tree is taken from the moist planting bag, checked for root defects, and set into the ground by suspending it against the vertical wall slightly below natural grade. The primary concern in planting small trees is to make sure that no roots are kinked upwards ("J"-rooted). Roots should be fanned out, and the hole should be filled by holding the tree in 1 hand and packing the soil in with the other. The planting should be completed by firmly packing the soil with foot pressure.

If seedlings have a poor root-to-shoot ratio, corrective pruning should be done to decrease the foliage. Approximately 25% of the foliage can usually be removed without affecting tree health.

Planting Site Finishing

Irrigation Preparation

In some locations, the use of drip irrigation may appropriate during planting establishment. Otherwise, to prepare plantings for hand irrigation, a soil berm should be constructed around the planting to form a watering basin approximately 3 feet in diameter. In some areas of sandy soil, the addition of a clay-rich soil may be necessary to keep the berm from washing away. Chips applied as soil mulch should be backfilled into the basin, but should not rest against the planted stock.

Weed Cloth and Seedling Tube Installation

Commercial weed cloths consisting of permeable plastic sheets should be installed around each tree to inhibit growth of competing vegetation. A 3-foot by 3-foot square with a small central X-cut should be used, and a commercial seedling tube should be placed over the seedling and inserted into the cut opening. The tube allows light to penetrate but protects the seedling from herbivore browsing and other physical damage.

Use of Root Barriers

Rigid root barriers should not generally be needed in Cambria. However, if sidewalk or pavement damage has been a problem at the location in the past, a plastic or copper screen can be placed 18 inches deep near the edge of the structural surface to prevent roots from encroaching on the structure.

Staking

Coniferous trees, such as Monterey pine, generally do not need staking. However, in areas where the understory is mowed, single staking may be necessary to prevent mower damage. To provide a support structure, a stake should be placed outside of the root ball area on an axis perpendicular to the prevailing wind. Trees should be attached loosely to the stakes so that they bend slightly in the wind. Stakes should be removed before the third growth season.

Watering

Newly planted trees need watering during the planting day and shortly thereafter. At the time of planting, a watering basin should be graded or a drip irrigation system installed, as noted above. Irrigation is discussed below.

Seedling and Sapling Maintenance

This section describes procedures to ensure that planted trees and shrubs will survive and grow to their full potential.

Seedling and sapling maintenance involves weed control, irrigation, monitoring tree growth and health, and thinning. Watering regimes depend on local sources and site access. Weeding intensity depends on watering. As seedlings become saplings, they often begin to compete with each other; depending on site conditions, selective thinning may be needed. Each planting site requires a site-specific maintenance approach.

Four maintenance periods can be distinguished.

- **Planting to Year 1.** The first year of a seedling's life will determine whether it will be a thrifty tree or a sickly, suppressed tree that will be a long-term maintenance problem. The most important maintenance steps during this period are to water, weed, and monitor growth and health.
- **Years 1–3.** The seedlings are constantly cared for through a rigorous watering and weeding program. Poorly established trees are eliminated, sites prepared again, and new stock planted. Obviously defective branch growth is pruned.
- **Years 4–7.** The sapling stage requires careful thinning, weeding, monitoring, and preventive maintenance. The saplings are thinned and possibly pruned. If shrubs are to be interplanted, planting occurs during this period. The trees should be able to survive without irrigation.
- **Years 8–11.** The trees are integrated into the surrounding forest by additional thinning and pruning of potentially hazardous branch growth. Revegetation maintenance is discontinued as saplings become well established.

Irrigation

Drip irrigation systems or watering basins should be installed around each plant at the time of planting. Watering of seedlings for up to 3 years is cost effective, and in most locations, necessary to establish plantings. By carefully monitoring weather and soil conditions, confining watering to seedling root zones, and keeping aggressive weeds to a minimum, the effort and cost of watering can be minimized.

Watering Rates and Schedules

Newly planted trees may need several waterings during the planting day and the days immediately following, depending on temperature, precipitation, and soil

conditions. During wet periods, little initial watering may be required. Watering should normally occur semiweekly for the first month and weekly during the next 2 months.

During the first growing season, an average of 2–3 gallons of water should be applied to each seedling 3 times per month during the summer (June–September). Water should also be applied in the spring if soil moisture becomes limiting. One watering in March and 2 waterings per month in April, May, and October are normally required. The frequency of watering, as described, is more critical to seedling survival than the amount applied. Watering should be initiated when the soil surface has dried below a depth of 4 inches.

During the second maintenance period (years 1–3), watering frequency can be reduced. One or 2 waterings per month should suffice between May and September. Watering may not be needed during the third summer.

Watering schedules and application rates should be adjusted as reforestation proceeds and experience is gained. If drip irrigation is used instead of periodic hand watering, the total seasonal water application will be less.

Water Sources

Several methods of delivering water to plantings should be considered on a site-specific basis, including:

A. conveyance through existing pipes or buried hoses from the Cambria water system to the site, employing a drip irrigation system or manual application;

B. delivery by tanker truck or tractor-drawn tank, employing manual application; or

C. delivery by tanker truck to onsite storage drums or portable tanks, employing a drip irrigation system or manual application.

Method A should be used where a water system hose bib is within a few hundred feet of a planting site. Hoses may be buried temporarily to avoid vandalism, but this will cause gradual hose deterioration and limit hose reuse. Drip irrigation can be extended to more distant planting sites. When a drip irrigation system is installed, 4 emitters should be placed at each tree, at the edges of the original root ball and near the stem.

Methods B and C require vehicle access to the site for 2–3 years during the maintenance period. Drip irrigation systems used in methods A and C could be reused at subsequent revegetation sites.

Multiple water delivery methods will generally be required in each management area. Systems should be mixed as dictated by site-specific conditions.

In some areas where propagation of seedlings is desirable, irrigation water may not be available. In this case, the seedlings should be planted during the annual rainy season with the understanding that not all will survive without supplementary water.

Weed Maintenance

Removing weeds around seedlings is one of the most effective ways to increase survival rates and lengthen the interval between waterings. A seedling must extend its roots below the weed root zone before it can survive on its own.

Three methods of eliminating weeds are available: weeding by hand, applying herbicides, and rototilling. Timing of herbicide applications is important to maximize their effectiveness and reduce usage. Most weeds germinate in spring when the surface soil is moist and warm. Spring weeding (by hand or with a rototiller) reduces moisture competition in the summer moisture; in addition, well-rooted weeds will not have to be eradicated during summer.

Monitoring Growth and Survival

One of the most important vegetation maintenance tasks is monitoring seedling and sapling growth to evaluate plant vigor. The following sections discuss aspects of monitoring that relate directly to planting success; monitoring is discussed in detail in chapter 6.

Stock or Planting Deficiencies

Occasionally, poor planting stock passes initial health inspections and is planted. Monitoring should identify this problem in addition to poor planting techniques and mediocre performance by a particular tree species. Damaged or low-vigor seedlings or saplings should be removed and replaced whenever they are observed.

Pests

Numerous animals, insects, and diseases can injure or kill seedlings or attack mature trees. Some diseases can infect pine seedlings, but deformation may not be evident until the tree has senesced and becomes unhealthy, unsightly, or hazardous. Pests should be identified before they become epidemic. Maintenance crews should have a general knowledge of seedling physiology and stress-related symptoms.

Remedial Action for Seedling Losses

Damaged, defective, and poorly growing trees should be removed as soon as possible. Planting sites should be overplanted to compensate for such losses. If a large planting site suffers more than 50% mortality in the first 3-year period, a complete seedling replacement program should be initiated.

The cause of failure should be identified before replanting. This will dictate the scope of the replacement project and whether additional site preparation, use of different planting stock, different watering and weeding schedules, or other actions need to be taken.

Thinning

Trees in crowded stands tend to grow slowly. Indicators of the need to thin are crowded or overlapping tree crowns, closely spaced trunks, and thin stems. Thinning releases the trees from excessive competition, stimulates greater growth, and removes defective or malformed trees that will become a hazard in the future. Young tree stands should be thinned every 5–10 years until the stands reach mature form.

A final thinning should be performed to achieve desired spacing or to remove potentially hazardous trees before they grow out of the sapling stage. When stands have been thinned and are growing vigorously, shrubs and forbs naturally tend to occupy the understory. Most of the maintenance done in the maturing stands involves fuel management and erosion control, as described in the following sections.

Protecting Trees from Construction Disturbance

Management of urban forest stands requires careful planning to ensure that trees are protected from the effects of construction that may be implemented near planting area. During the planning and construction phases of a project, planners, architects, and contractors should work closely with the Forest Manager or other experienced individuals to ensure that the following construction practices are implemented and properly supervised.

- Trees should not be pruned or removed without consultation or supervision of the Forest Manager.
- Temporary fencing should be installed at each site to delineate the area where construction activities are permitted. Construction equipment, materials, and personnel should remain inside the fenceline when they are not on paved surfaces.

- Paint, cement, cleaning solvents, or residues from any other chemicals or materials associated with construction activities should not be disposed of onsite.
- Utility lines and associated junction boxes and related equipment for new construction or replacement of existing utilities should be located within existing roads or pathways, whenever feasible; and
- Outside the designated construction zone, vehicles should remain on paved surfaces at all times. Within the designated construction zone, temporary vehicle access should be established in unpaved areas using overlapping sheets of plywood.

Protecting Planted Trees from Wildlife

Although wildlife is an integral part of the natural forest ecosystem in Cambria, unnaturally high population densities of both native and exotic wildlife can affect the distribution and abundance of native plant species through extensive browsing or grazing. Black-tailed deer (*Odocoileus hemionus*) may pose a hazard to plantings in the Cambria area. In general, black-tailed deer prefer to browse certain shrubs, broadleaf tree seedlings such as oaks, and herbs rather than coniferous species like Monterey pine. However, during droughts when preferred browse is less available, deer will browse on pines, especially young and tender seedlings. Newly planted trees should be protected from catle, or cattle should be managed to reduce damage to small trees.

To protect pine and oak seedlings from deer browsing, exclosures should be installed around each tree. These exclosures should be at least 5 feet tall and composed of wire mesh (hardware cloth) or thick plastic. Exclosures should be wide enough to allow the seedling to lean and still retain all of its branches within the exclosure. Exclosures should be periodically inspected and maintained.

Appendix C

Pitch Canker Severity Rating Systems

Introduction

A number of rating systems have been developed to evaluate the severity of pitch canker in individual trees. The most widely used system—and the one used in the CFMP—is that of Storer et al. (2000). Alternatives include methods developed by researchers at California Polytechnic University San Luis Obispo and CDF.

The rating system of Storer et al. (2000) is intended specifically for application to Monterey pines. Its advantages include its comprehensive approach, its simplicity, and its flexibility. Under Storer et al.'s (2000) methodology, branch tip symptoms, stem cankers, and percent top kill (canopy dieback) are assessed and rated separately. The resulting scores can then be used in any of 3 ways to arrive at a quantitative evaluation of overall severity:

- the 3 scores can be used separately;
- the 3 scores can be combined to derive an overall score; or
- the branch tip score and the stem canker score can be entered in a rating matrix to determine a level of severity ranging from *None* to *Severe*.

Table C-1 (following page) presents the rating system of Storer et al. (2000).

Table C-1. Storer et al. (2000) Pitch Canker Severity Rating System for Individual Monterey Pine Trees

Tree	Branch Tip Symptoms (enter 0, 1, 2, 3)	Stem Cankers (enter 0, 1, 2)	Top Kill (enter 0, 1, 2, 3)	Severity Rating
1				
2				
3				

Explanation of Ratings

Branch Tip Symptoms

0 = No branch tip dieback
1 = 1 or 2 dead branch tips
2 = 3–10 dead branch tips
3 = >10 dead branch tips

Stem Cankers

0 = No stem cankers
1 = 1 stem canker
2 = ≥2 stem cankers

Top Kill

0 = No top canopy dieback
1 = < 10% top canopy dieback
2 = 10%–50% top canopy dieback
3 = >50% top canopy dieback

Pitch Canker Severity Rating

There are 3 methods:

(1) add up the 3 score values to give a sum value from 0 to 8;

(2) keep each of the 3 ratings separate;

(3) score a tree as *Zero*, *Low*, *Moderate*, or *Severe* using the following matrix.

	Stem Cankers Score		
Branch Tip Symptoms Score	**0**	**1**	**>1**
0	None	Low	Moderate
1–2	Low	Low	Moderate
3–10	Moderate	Moderate	Severe
>10	Severe	Severe	Severe

Appendix D
Additional Contacts for the Forest Manager

Table D-1. Additional Contacts for the Forest Manager

Contact	Agency or Company	Telephone/E-Mail	Relevant Expertise
Federal Agencies			
Susan Frankel	U.S. Department of Agriculture, Forest Service, Vallejo	707/562-8917 sfrankel@fs.fed.us	Pitch canker patterns and distribution.
Connie Millar	U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany (CA)	510/559-6435 cmillar@fs.fed.us	Pine genetics and genetic conservation; treatment patterns to maintain alpha and beta diversity; restoration of pine stands; long-range pine population dynamics; intra- and inter-population dynamics.
Det Vogler	U.S. Department of Agriculture, Forest Service, Institute of Forest Genetics, Placerville	530/758-6350 916/622-1225	Pitch canker patterns and resistance.
State Agencies			
Dave Adams	California Department of Forestry and Fire Protection, Davis	530/758-0306 916/653-7209	Regeneration using mineral seed bed conditions; burning treatments; self-thinning of infected stands.
Steve Harcourt	California Department of Forestry and Fire Protection, South Lake Tahoe	530/541-6564	Fuel modification zone design; defensible fuel profiles in urban-forest interfaces; fuel reduction treatment techniques; mechanical and hand treatments.

Geoff Holmes	California Department of Forestry and Fire Protection, Felton	831/335-5353	Photographic key to fuel types and fire behavior; fuel modification zone and shaded fuel break designs in urban interface areas.
Steve Jones	California Department of Forestry and Fire Protection, Sacramento	916/653-9450	Photographic key to fuel types and fire behavior.
Mike Kirkley	California Department of Forestry and Fire Protection, Camino	530/644-2345	Fuel modification zone design; defensible fuel profiles in urban-forest interfaces; fuel reduction treatment techniques; mechanical and hand treatments.
Don Owen	California Department of Forestry and Fire Protection, Redding Pine Pitch Canker Task Force, California Forest Pest Council	530/224-2494	Pitch canker patterns of infestation, mortality, and resistance; regeneration with chip and mulch; special concerns for senescent stand in Cambria.
Scott Rosikiewicz	California Department of Forestry and Fire Protection, Monterey	831/647-6208	Photographic key to fuel types and fire behavior; Pebble Beach Fuel Break Management Plan; mechanical fuel treatments; hand tools; inmate crews.
Butch Washington	California Department of Forestry and Fire Protection, Monterey	831/647-6208 Butch_washington@fire.ca.gov	Photographic key to fuel types and fire behavior; fuel break management.
Joanne Kerbavaz	California State Parks, Año Nuevo State Park	415/330-6323 jkerb@parks.ca.gov	Año Nuevo pine status; state park management; primary succession into abandoned fields; outlier populations; neonative sites.
County Agencies			
Robert Hopkins	San Luis Obispo County Agricultural Commissioner's Office	805/781-5910 805/781-5753	Weed species in Cambria area.
Mark Lee	San Luis Obispo County Agricultural Commissioner's Office	805/781-5907	Weed species in Cambria area.

City Agencies			
Mike Branson	Forester, City of Carmel	831/624-3543	City of Carmel Forest Management Plan; urban tree removal and replanting process; pitch canker infestation; public concerns; rate of mortality; use of checklist and severity ranking; tree removal decision making process.
Robert Reid	Forester, City of Monterey	831/646-3860	City of Monterey pine management practices; open space management; tree removal process; understory fuel management; natural pine regeneration in canopy gaps without fire.
Universities			
Scott Stephens	University of California, Berkeley	510/642-7304 stephens@nature.berkeley.edu	Fuel reduction and controlled burning prescriptions and techniques.
Andrew Storer	University of California, Berkeley	510/642-5806	Patterns of pitch canker and sudden oak death infestation; rates of mortality; pine regeneration in treated and untreated areas; long-term perspective on pitch canker effects; Site Condition Checklist items on pitch canker.
David Mladenoff	University of Wisconsin	djmladen@wisc.edu	Design of steady-state mosaic pattern of treatment patches.
Deborah Rogers	University of California, Davis	530/754-8507 510/845-9636 debrogers@ucdavis.edu	Conservation of genetic diversity in Cambria.
Private Organizations			
Steve Staub	Staub Forestry	831/335-1952	Regeneration of pines following treatments; natural pine regeneration in canopy gaps; treatment patch size; prescriptions and techniques to avoid post-treatment problems and improve regeneration; retention of healthy trees; stocking rates; slope and aspect influences.
Cambria Forest Committee			

Bill Hanna	Executive Steering Committee, Cambria Forest Committee (Chair)	805/927-5351 hanabill@tcsn.net	Cambria forest ecology.
Richard Hawley	Cambria Greenspace	805/927-2866	Local wood use; prescriptions and techniques for waste wood disposal; checklist items; agencies with land management responsibility in the Cambria forest; ethnobotany.
Galen Rathbun	Executive Steering Committee, Cambria Forest Committee	805/927-3059 grathbun@calacademy.org	Cambria forest ecology.

Forest Site Condition Checklist

1. Is the management unit in an urban or wildland setting?

- ❑ If wildland (>1,000 ft from urban areas, homes, etc.), ə ***go to question 2.***
- ❑ If urban (all other areas), ə ***go to question 11.***

2. Fill out Evaluation Table 1. Visual Sensitivity.

- ❑ Answer **No** to both questions = Low visual sensitivity. ə ***Go to question 3.***
- ❑ Answer **Yes** to 1 or more questions = High visual sensitivity. ə ***Go to question 7.***

3. Fill out Evaluation Table 2. Erosion Potential.

- ❑ Answer **Yes** to 1 or more questions = High erosion potential. ə ***Go to question 4.***
- ❑ Answer **No** to all questions = Low erosion potential. ə ***Go to question 5.***

4. Fill out Evaluation Table 3. Monterey Pine Size Category.

- ❑ Answer to question IV or V = **Dense**. ə **Use Treatment 4.**
  Understory treatment choices = remove ladder fuel, scatter cones and seeds, remove invasive species, chip woody material.
- ❑ Answer to question IV or V = **Sparse** or **Moderate**. ə **Use Treatment 3.**
  Understory treatment choices = remove ladder fuel, scatter cones and seeds, remove invasive species, chip woody material.

5. Refer to Evaluation Table 3. Monterey Pine Size Category.

- ❑ Answer to question IV or V = **Dense**. ə ***Go to question 6.***
- ❑ Answer to question IV and V = **Sparse** or **Moderate**. ə **Use Treatment 3.**
  Understory treatment choices = remove duff layer, scatter cones and seeds, remove invasive species, remove woody debris, remove ladder fuel, thin shrub layer.

6. Refer to Evaluation Table 3. Monterey Pine Size Category.

- ❑ Answer to question I = **Dense**. ə ***Go to question 17.***
- ❑ Answer to question I = **Sparse** or **Moderate**. ə ***Go to question 18.***

7. What is the distance from the visual receptor to the management unit?

- ❑ More than 1 mile = Moderate visual sensitivity. ə ***Go to question 8.***
- ❑ Less than or equal to 1 mile = High visual sensitivity. ə ***Go to question 14.***

8. Refer to Evaluation Table 2. Erosion Potential.

- ❑ Answer **Yes** to 1 or more questions = High erosion potential. ∋ ***Go to question 9.***
- ❑ Answer **No** to all questions = Low erosion potential. ∋ ***Go to question 10.***

9. Refer to Evaluation Table 3. Monterey Pine Size Category.

- ❑ Answer to question V = **Dense**. ∋ **Use Treatment 4 and/or Treatment 2.**
  Understory treatment choices = remove ladder fuel, scatter cones and seeds, remove invasive species, chip woody material.

- ❑ Answer to question V = **Sparse** or **Moderate**. ∋ **Use Treatment 3.**
  Understory treatment choices = remove ladder fuel, scatter cones and seeds, remove invasive species, chip woody material.

10. Refer to Evaluation Table 3. Monterey Pine Size Category.

- ❑ Answer to question V = **Dense**. ∋ ***Go to question 19.***

- ❑ Answer to question V = **Sparse** or **Moderate**. ∋ **Use Treatment 3.**
  Understory treatment choices = remove duff layer, conduct controlled burning, scatter cones and seeds, remove woody debris, remove ladder fuel, thin shrub layer.

11. What is the distance between homes?

- ❑ Less than 500 feet = High density. ∋ ***Go to question 13.***
- ❑ More than 500 feet = Low density. ∋ ***Go to question 12.***

12. Refer to Evaluation Table 1. Visual Sensitivity.

- ❑ Answer **No** to both questions = Low visual sensitivity. ∋ ***Go to question 15.***
- ❑ Answer **Yes** to 1 or more questions = High visual sensitivity. ∋ ***Go to question 16.***

13. Refer to Evaluation Table 2. Erosion Potential.

- ❑ Answer **Yes** to 1 or more questions = High erosion potential. ∋ **Use Treatment 1 and/or Treatment 2.**
  Understory treatment choices = Clear 30 feet around buildings, plant trees, remove ladder fuel, remove invasive species, scatter cones and seeds.

- ❑ Answer **No** to all questions = Low erosion potential. ∋ **Use Treatment 1.**
  Understory treatment choices = remove woody debris, thin shrub layer, clear 30 feet around buildings, plant trees, remove ladder fuel, remove invasive species, scatter cones and seeds.

14. Refer to Evaluation Table 2. Erosion Potential.

- ❑ Answer **Yes** to 1 or more questions = High erosion potential. ə **Use Treatment 2 combined with Treatment 3.**
  Understory treatment choices = Clear 30 feet around buildings, plant trees, scatter cones and seeds, remove invasive species, remove ladder fuel.

- ❑ Answer **No** to all questions = Low erosion potential. ə **Use Treatment 2 combined with Treatment 3.**
  Understory treatment choices = remove woody debris, clear 30 feet around buildings, plant trees, scatter cones and seeds, remove invasive species, thin shrub layer, remove ladder fuel.

15. Refer to Evaluation Table 2. Erosion Potential.

- ❑ Answer **Yes** to 1 or more questions = High erosion potential. ə **Use Treatment 3.**
  Understory treatment choices = Clear 30 feet around buildings, plant trees, scatter cones and seeds, remove invasive species, remove ladder fuel.

- ❑ Answer **No** to all questions = Low erosion potential. ə **Use Treatment 3.**
  Understory treatment choices = remove woody debris, clear 30 feet around buildings, plant trees, scatter cones and seeds, remove invasive species, thin shrub layer, remove ladder fuel.

16. Refer to Evaluation Table 2. Erosion Potential.

- ❑ Answer **Yes** to 1 or more questions = High erosion potential. ə **Use Treatment 1 or Treatment 2.**
  Understory treatment choices = Clear 30 feet around buildings, plant trees, scatter cones and seeds, remove invasive species, remove ladder fuel.

- ❑ Answer **No** to all questions = Low erosion potential. ə **Use Treatment 1 or Treatment 2.**
  Understory treatment choices = remove woody debris, clear 30 feet around buildings, plant trees, scatter cones and seeds, remove invasive species, thin shrub layer, remove ladder fuel.

17. Fill out Evaluation Table 4. Adjacent Parcel Inventory.

- ❑ Answer **No** to all questions. ə **Use Treatment 7.**
  Understory treatment choices = conduct controlled burning, scatter cones and seeds, remove woody debris, remove ladder fuel, thin shrub layer, remove invasive species.
- ❑ Answer **Yes** to any question. əə You should not pursue treatment in this area this year. If treatment is urgent, use lower-intensity treatment.

18. Refer to Evaluation Table 4. Adjacent Parcel Inventory.

- ❑ Answer **No** to all questions. ə **Use Treatment 6.**
  Understory treatment choices = conduct controlled burning, scatter cones and seeds, remove woody debris, remove ladder fuel, thin shrub layer, remove invasive species.
- ❑ Answer **Yes** to any question. əə You should not pursue treatment in this area this year. If treatment is urgent, use lower-intensity treatment.

19. Refer to Evaluation Table 4. Adjacent Parcel Inventory.

- ❑ Answer **No** to all questions. ə **Use Treatment 5.**
  Understory treatment choices = remove duff layer, conduct controlled burning, scatter cones and seeds, remove woody debris, remove ladder fuel, thin shrub layer.
- ❑ Answer **Yes** to any question. əə You should not pursue treatment in this area this year. If treatment is urgent, use lower-intensity treatment.

Evaluation Table 1. Visual Sensitivity

		Yes	No
a)	**Is the management unit visible from any of these receptors:**		
	Burton Drive?		
	Ardath Drive?		
	Main Street?		
	Santa Rosa Creek Road?		
	Highway 1?		
b)	**Is the management unit considered a local landmark or point of interest?**		

Evaluation Table 2. Erosion Potential

Question	Yes	No
Is the slope of the site >20%?		
Does the management unit contain a stream or wetlands, or is it within 300 feet of a stream or wetlands?		
Are there signs of gully formation or other soil erosion onsite?		

Is the erosion class rating (from the local Soil Survey) for site soils "High" or "Moderate"?		

Evaluation Table 3. Monterey Pine Size Category

	Ground Cover		
	Sparse (0–10%)	**Moderate (11–25%)**	**Dense (≥26%)**
I. Seeds and Cones (per square meter)			
	Canopy Cover		
	Sparse (0–25%)	**Moderate (26–50%)**	**Dense (≥51%)**
II. Seedlings and Saplings (<4 inches dbh)			
III. Pole size (4–20 inches dbh)			
IV. Mature (>20 inches dbh)			
V. Dead, Dying, and Infected (all sizes)			

Evaluation Table 4. Adjacent Parcel Inventory

a) Have any of the following treatments been applied to parcels of land adjacent to the management unit within the last 5 years?

Treatment:	**Yes**	**No**
Treatment 7		
Treatment 6		
Treatment 5		

b) Do any of the following conditions occur on parcels of land adjacent to the management unit?

Condition:	**Yes**	**No**
Less than 30% canopy cover of trees		
Gully erosion more than 8 inches deep		
Sheet erosion		

List of Acronyms

ACHP	federal Advisory Council on Historic Preservation
APCD	air pollution control district
AQMD	air quality management district
BA	biological assessment
basin plan	Water Quality Control Plan
BCDC	San Francisco Bay Conservation and Development Commission
BMPs	best management practices
BO	biological opinion
BOF	California State Board of Forestry
CAA	federal Clean Air Act
CARB	California Air Resources Board
CCC	California Coastal Commission
CDF	California Department of Forestry and Fire Protection
CEQ	President's Council on Environmental Quality
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFC	Cambria Forest Committee
CFMP	Cambria Forest Management Plan
CFR	Code of Federal Regulations
CO	carbon monoxide
County, the	San Luis Obispo County
CWA	federal Clean Water Act
CZLUO	Coastal Zone Land Use Ordinance
CZMA	federal Coastal Zone Management Act
CZMP	coastal zone management program
dbh	diameter at breast height
DFG	California Department of Fish and Game
EA	environmental assessment
EIR	environmental impact report
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ESA	federal Endangered Species Act
ESHA	Environmentally Sensitive Habitat Area
FONSI	finding of no significant impact
FPA	Z'berg-Nejedly Forest Practice Act
FRAP	Fire and Resource Assessment Program
FRZ	fuel reduction zone(s)
GIS	geographic information system
Guidelines	CARB's Smoke Management Guidelines for Agricultural and Prescribed Burning
HCP	habitat conservation plan
IS	initial study
LCP	local coastal program
LUO	County Land Use Ordinance
MBTA	federal Migratory Bird Treaty Act
MOA	memorandum of agreement
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NPDES	National Pollutant Discharge Elimination System
PEIR	programmatic environmental impact report
PM10	inhalable particulate matter
PRC	Public Resource Code
PTEIR	program timber environmental impact report
RHA	federal Rivers and Harbors Act
RWQCB	Central Coast Regional Water Quality Control Board
SHPO	State Historic Preservation Officer
SIP	state implementation plan
SLOAPCD	San Luis Obispo Air Pollution Control District
SLORU	San Luis Obis ger Unit
SO_2	sulfur dioxide
SWPPP	Storm Water Pollution Prevention Plan
SRA	Sensitive Resource Area
THP	timber harvesting plan
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
VMP	CDF Vegetation Management Program