C. Natural Resources Management Plan

Final Bidwell Park Master Management Plan Update

EDAW

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ABBREVIATIONS AND ACRONYMS

APHIS	Animal and Plant Health Inspection Service
BPMMP	Bidwell Park Master Management Plan
CAL-IPC	California Invasive Plant Council
CDF	Department of Forestry and Fire Protection
CEQA	California Environmental Quality Act
GIS	geographic information systems
GPS	geopositioning systems
I	incipient populations
NRMP	Natural Resources Management Plan
PG&E	Pacific Gas & Electric
SOD	Sudden Oak Death
U	ubiquitous populations
UHF	Ultra High Frequency
VMP	Vegetation Management Program
WIMS	Weed Information Management System
WS	widespread populations

1 INTRODUCTION

1.1 RELATIONSHIP TO THE MASTER MANAGEMENT PLAN

The Bidwell Park Natural Resources Management Plan (NRMP) is intended to provide a basic resource management framework for Bidwell Park (Park) that supports the goals and objectives of the Bidwell Park Master Management Plan (BPMMP). Chapter 2 of the BPMMP includes Park-wide resource assessments. Chapter 3 of the BPMMP contains the policy basis (goals and objectives) and implementation approach (strategies and guidelines) for Park operations. The NRMP provides information on how to achieve the goals and objectives provided in the BPMMP. It supplements the implementation strategies and guidelines in the BPMMP with more detailed information on a defined set of resources and establishes a framework for adding additional resource management information in the future. Resources to add to the NRMP may include soils, additional natural communities, vegetation elements, invasive animal species, or other physical or biological resources.

The NRMP has its basis in the 1990 BPMMP for the Park (Hardesty Associates 1990) that contained a suite of natural resource management elements (oak renewal, fire plan, invasive plants and vegetation management). During the 2005 BPMMP update, these natural resource elements were shifted from the BPMMP to this separate, focused NRMP that is included as an appendix to the BPMMP. Although the basic organization of the 1990 plan has been retained, major portions of each section have been revised to address changes in resource conditions, Park management priorities, and approaches to resource management.

1.2 PURPOSE AND ORGANIZATION OF THE PLAN

The purpose of the NRMP is to provide a functional framework for managing resources within the Park in a way that meets established Park-wide goals and objectives. Sections 2.3.1 and 2.3.2 of the BPMMP discuss the spectrum of physical and biological resources, respectively, within Bidwell Park. Although each of these resources deserves equal consideration in the development of a resource management plan for the Park, the NRMP focuses on three key natural resources: oak woodlands, invasive plants, and wildland fire. For each, the plan provides an overview, develops general resource management objectives, discusses issues that are relevant to meeting these objectives, and offers resource management recommendations and preliminary implementation measures. This NRMP is designed to be a living document that can be modified and expanded upon in the future as more is learned about the Park's resources and as knowledge, interest, and resources allow.

1.3 NATURAL RESOURCE GOALS AND OBJECTIVES SUMMARY

Many of the BPMMP's goals and objectives apply to the key natural resources addressed in this NRMP; future versions of the NRMP may cover additional goals and objectives, as needed. This version of the NRMP is especially intended to help achieve the following goals and objectives:

Goal NRMP:

Conserve, protect, and optimize natural resource functions and values in the Park and maximize their integration with natural resources in surrounding areas;

Objectives:

O. NRMP-1:

- Preserve high quality natural habitats.

O. NRMP-2:

- Where possible, increase natural regeneration and recruitment within vegetation communities.

O. NRMP-3:

- Protect populations of sensitive (or special status) plant species.

O. NRMP-4:

- Improve age class diversity within existing mature, even-age stands of oaks and other plant communities.

O. NRMP-5:

- Employ proper horticultural practices to preserve and maintain oaks and other native vegetation within developed areas, wildlands (only where necessary due to fire threat, etc.), and along trails.

O. NRMP-6:

- To the extent possible, provide wildlife habitats within Bidwell Park that provide good opportunities for nesting, foraging, hunting, and other essential wildlife activities for those species found within the Park.

O. NRMP-7:

- As soon as possible, control or eliminate undesirable or invasive plants that compete with or reduce native vegetation or degrade wildlife habitat.

O. NRMP-8:

- Utilize prescribed fire used as a management tool to protect and enhance habitats and reduce the risk of catastrophic fires within Bidwell Park.

O. NRMP-9:

- Utilize maintenance methods that minimize adverse impacts on natural conditions (irrigation, mowing, trimming, etc.) and control detrimental impacts caused by humans and natural processes (vegetation buildup, pests, acts of nature).

1.4 SENSITIVE RESOURCES

Protection of sensitive resources is consistent with the objectives and implementation strategies and guidelines concerning Bidwell Park as indicated in the BPMMP. Implementation of all management actions in the Park should avoid adverse effects on sensitive resources, including biological and cultural resources. Sensitive biological resources include plant, animal and fish species that are afforded special consideration or protection under the California Environmental Quality Act (CEQA), California Fish and Game Code and/or federal and state Endangered Species Acts. Other species that should be considered for protection include those that are considered of local significance due to their limited distribution or other factors that might influence management decisions. Wetlands and riparian areas are also considered sensitive resources and are protected under the Clean Water Act, Fish and Game Code, and Porter Cologne Act. Sensitive cultural resources are afforded protection under CEQA and by the State Historic Preservation Office. Please refer to Appendix I of the BPMMP for an overview of applicable local, state, and federal laws and regulations that pertain to the management of sensitive resources in the Park.

1.5 ADAPTIVE MANAGEMENT FRAMEWORK

The NRMP embraces the concept of adaptive management of natural resources in the Park. Adaptive management is an approach and process that incorporates monitoring, research, and evaluation to allow projects and activities, including projects designed to produce environmental benefits, to proceed in the face of some uncertainty regarding consequences (Holling 1978, Walters 1986). Adaptive management is typically a stepwise framework composed of actions that are evaluated periodically, with subsequent management decisions and actions modified as needed to achieve planned objectives. An adaptive management program includes stakeholder participation and recognizes that science, management, and stakeholder coordination are essential to the overall accomplishment of program objectives. General features of adaptive management are:

- Development of measurable objectives for restoration and management actions;
- Selection of indicators to measure success, failure, or general performance that are practical and efficient to use and capable of signaling change at a level needed to meet objectives;
- A fair, objective, and well understood program for collecting, managing and reporting information from monitoring and research projects;
- A structured and documented procedure for reviewing information, mediating different interpretations of the data, and making management decisions;
- A clear assignment of responsibility for responses necessary to attain objectives; and
- Implementation of actions based on a cooperative approach that utilizes the different areas or expertise and capability provided by participating agencies.

Adaptive management can and should be a simple, inexpensive, and effective process for evaluating and refining management actions, and for identifying and addressing conditions that would prevent meeting Park goals and objectives. Consequently, development and implementation of an adaptive management protocol would be an effective approach to managing the Park's natural resources and should be followed in managing all the resources discussed within the NRMP.

1.6 PUBLIC EDUCATION AND INVOLVEMENT

Programs to educate the public on the importance of Bidwell Park's natural resources should be initiated or continued, and appropriate opportunities for public involvement in managing these natural resources should be provided. These educational and public involvement efforts not only would support management of the Park's natural resources, but also support BPMMP goals and objectives regarding natural resource education and involvement of volunteers in Park management.

Educational programs should address management of fire, invasive species and oak woodlands and the ecology of other natural resources (e.g., riparian areas and streams). These programs can include docent led tours of oak woodlands, wildlife and wildflower tours led by local biologists, educational brochures, interpretive signs, sponsored field trips for local elementary schools and similar efforts. Public involvement in resource management could include participation in Park clean up days, involvement in oak woodland restoration, invasive plant species removal, wildlife enhancement programs (building and installing nest boxes and bat houses), and similar programs. Many of these programs and events are already taking place in Bidwell Park and can be built upon or expanded in the future.

2 NATURAL RESOURCES MANAGEMENT PLAN DEVELOPMENT PROCESS

The intent of this plan is to provide a framework for the subsequent development of a more comprehensive and detailed NRMP for Bidwell Park. The following suggests a process for the City to follow during further development of this document.

1. Review natural resource goals and objectives for Bidwell Park;

2. Develop NRMP components for additional natural resources (e.g., riparian areas, wetlands, soils), as needed to support natural resource goals and objectives;

3. Conduct biological (e.g., natural communities, sensitive or priority species populations), physical, and cultural resource inventory, assessments and mapping, using existing information and acquiring new data to fill data gaps;

4. Identify management opportunities and constraints, relative to overall goals and objectives, presented by current resource conditions;

5. Develop and prioritize management guidelines and recommendations for additional natural resources to include in the NRMP and refine guidelines and recommendations for current resources covered in the NRMP, if needed; and

6. Develop an adaptive management protocol to guide implementation of management actions.

Based on the NRMP, management actions may be developed and implemented that are consistent with the NRMP guidelines and recommendations as well as goals and objectives for natural resource and other Park resources, as provided in the BPMMP. The actions should be guided by the adaptive management principles discussed in Section 1.5, and should consider potential effects on sensitive resources and opportunities for incorporating education and public involvement.

3 VEGETATION MANAGEMENT

This section discusses management objectives, issues, and guidelines and recommendations for oak woodlands. Additional natural communities or vegetation elements may be provided in future NRMP versions.

3.1 OAK WOODLANDS

3.1.1 OVERVIEW OF BIDWELL PARK OAK WOODLANDS

Oak woodlands are the primary habitat type within Bidwell Park, comprising approximately 1,900 acres of the Park's total acres. These habitats are dominated by two different oak species. Valley oak (*Quercus lobata*) is the predominant oak along streams and adjacent floodplains where it occurs with a wide variety of species associated with riparian areas in California's Central Valley. On drier uplands where shallow rocky soils predominate, blue oaks (*Quercus douglasii*) are the dominant species. In these habitats, blue oak co-occurs with a wide variety of other oak species such as interior live oak (*Quercus wislizenii*), canyon live oak (*Quercus chrysolepis*), oracle oak (*Quercus x morehus*), scrub oak (*Quercus berberidifolia*), valley oak, and black oak (*Quercus kelloggii*), as well as foothill pine (*Pinus sabiniana*) and a variety of shrubs such as toyon (*Heteromeles arbutifolia)*, *Ceanothus* spp., manzanita (*Arctostaphylos* spp.) and others. These communities are discussed in more detail within Chapter 2 of the Master Management Plan.

Bidwell Park's oak woodlands are highly valued both by people and by wildlife. People value oak woodlands for their beauty and for the opportunities they afford for relaxation and recreational activities. In more developed areas, such as those in Lower Park, valley oaks tower above grassy openings, playgrounds, and sporting fields providing shade on hot summer days and a chance for city residents to experience a semi-natural setting only minutes from their homes. At the relatively undeveloped eastern end of the Park, mixed oak woodlands and savannas provide opportunities for hiking, wildlife and wildflower viewing, picnicking, and other activities in a wildland setting equaled by few city parks. Many residents of Chico appreciate this fact and view Bidwell Park, and the habitats preserved within the Park, as a defining characteristic of the Chico community.

Oak woodlands are especially important to wildlife. Statewide, oak woodlands provide habitat for over 300 species of vertebrates (Gusti et al 1996) and upwards of 5,000 species of invertebrates (Pavlik et al 1991). At Bidwell Park, oak woodlands provide habitat for a wide variety of both common wildlife species as well as many that are considered rare, threatened, or endangered. For many of these species, oaks are the primary food source and they provide cover from predators, hunting perches, nesting habitat, and/or breeding habitat (Pavlik et al. 1991).

3.1.2 OAK WOODLAND MANAGEMENT OBJECTIVES

The oak woodland management program consists of three interrelated objectives:

- Ensure oak woodland sustainability by increasing recruitment;
- Protect existing oak woodlands from wildfire; and,
- Practice responsible oak landscape maintenance.

3.1.3 OAK MANAGEMENT ISSUES

The following section discusses factors that present potential management opportunities or challenges in meeting each of the oak woodland management objectives discussed above.

3.1.3.1 OAK WOODLAND SUSTAINABILITY

Many oak stands within Bidwell Park are even-age stands of mature trees with few young trees, saplings, or seedlings. The lack of young oak trees raises questions about the regeneration of these stands. The term "regeneration" refers to the net change in stand structure resulting from the loss of individual trees to mortality and the gain of individual trees through recruitment. Therefore, a lack of recruitment, as is commonly seen in many oak stands within Bidwell Park, is not necessarily indicative of an oak regeneration problem if there is little to no mortality within the stand. Still, the apparent lack of natural oak regeneration at Bidwell Park potentially poses a threat to the long-term viability of its oak woodlands.

A lack of natural oak recruitment is a concern across California. Numerous researchers have offered theories for the lack of natural recruitment within oak woodlands and savannas throughout California. Some of the factors commonly given for the observed lack of recruitment include: browsing of oak seedlings by domestic livestock (Hall et al 1992, Swiecki et al 1997, Muick 1997), browsing by rodents and grasshoppers (Tyler et al 2002), and competition from exotic annual grasses and forbs for soil moisture and light (Davis et al 1991, Danielson and Halverson 1991, Gordon and Rice 1993 and 2000). Researchers have also documented a close association between oak recruitment and wildfire (McClaran and Bartolome 1989), indicating that oak regeneration may be characterized by large flushes of recruitment after a wildfire followed by extended periods of little to no recruitment.

Sudden Oak Death (SOD) is another potential threat to oak woodland sustainability. It was first described in 1995 and is caused by the plant pathogen *Phytophthora ramorum*. Hundreds of thousands of oaks and other tree and shrub species have died since the introduction of SOD, creating a severe fire risk in some of California's parks and forests (Palmieri & Frankel 2004). Despite its name, symptoms of SOD have only been documented in four of California's 22 oak species, two of which, black oak and canyon live oak, occur in Bidwell Park. Blue and valley oaks seem thus far to be resistant to SOD. Trees with SOD generally have wilted faded brown foliage. Older leaves turn pale green and then brown within weeks. Some trees affected by the disease exude dark brown sap on the lower trunks (California Department of Parks & Recreation 2004). Removal of surface bark of an affected tree will reveal discolored brown tissue separated from the healthy bark by a distinct black zone line (University of California 2002). Currently, SOD has been confirmed in the following counties: Alameda, Contra Costa, Humboldt, Lake, Marin, Mendocino, Monterey, Napa, San Francisco, San Mateo, Santa Clara, Santa Cruz, Solano, and Sonoma (University of California 2005). SOD has also been reported, although not confirmed, in 17 additional counties, including Butte County (University of California 2005).

3.1.3.2 WILDLAND FIRE

California's oak woodlands have a long history of both "natural" wildfire (e.g., wildfire caused by lightning strikes) and human generated wildfire (e.g., fires set by Native Americans, Spaniards, and ranchers) (Keeley 2001a, 2001b, 2002; Blackburn and Anderson 1993). Generally, low to moderate intensity ground fires have limited impact on young oaks and oak seedlings, most of which are capable of resprouting following a fire, and studies have consistently documented resiliency among oaks to fires of all intensities (Griffin 1980, Plumb 1980, Tietje et al 2001, Fry 2002, Dagit 2002). In fact, some oak woodlands may even benefit from wildfire. Some researchers have suggested that the recruitment of new oak seedlings may increase after a wildfire, possibly because oak seedlings are better able to germinate and grow with the temporary reduction in competition from herbaceous plants (Davis et al. 1991, Gordon and Rice 1993, Gordon and Rice 2000).

While oaks have evolved various adaptations that allow them to cope with and, in some cases, benefit from periodic wildfires, it should be noted that all oaks are potentially sensitive to hot fires fueled by large accumulations of brush and grass that can permanently damage the oak's cambium layer. Trees suffering cambium damage may initially appear healthy but are more likely to die in subsequent years from drought, disease, and other factors (J. Mott, personal communication). Additionally, older, mature trees, such as those that characterize many foothill woodland communities around Bidwell Park, are much less likely to resprout from the

root crown following a severe wildfire. And, even though all oaks are capable of resprouting following wildfires, each species varies in its tolerance of fire and its root crown sprouting abilities. This is particularly true for valley oak, which tends to be the least tolerant of wildfire and the poorest root crown sprouter, relative to other oaks (Garrison et al 1996).

Section 5 of this NRMP discusses wildfire prevention and the use of fire as a management tool in more detail.

3.1.3.3 OAK LANDSCAPE MAINTENANCE

Within more urbanized areas of the Park, landscape maintenance can detrimentally affect oaks. Germination, growth and survival of oak trees are affected by mowing, soil compaction, and installation of impervious surfaces over and near their roots. The vast majority of oak roots occur in the top 2 feet of soil (Millikin and Bledsoe 1999) and thus are easily disturbed by these activities as well as by grading, trenching, and soil compaction.

Irrigation can also detrimentally affect oaks by potentially causing root crown rot. Crown rot is caused by *Armillaria mellea*, a common soil pathogen found in association with numerous plants and vegetation communities worldwide. Despite its widespread distribution throughout California, the fungus rarely infects native oaks because it requires warm temperatures and sufficient soil moisture to grow and reproduce. If, however, native oaks are provided with supplemental irrigation during the dry summer months, as frequently happens in gardens, parks, and other horticultural settings, the oak root fungus can infect native oaks and, ultimately, weaken and even kill the tree.

3.1.4 OAK MANAGEMENT GUIDELINES AND RECOMMENDATIONS

The management recommendations offered below are not meant to describe particular management implementation measures. Rather, they offer information and advice relative to specific aspects of oak management and provide a preliminary framework for oak woodland management. In many cases, more detailed technical assistance guides are available to guide each management action. These guides should be consulted when developing implementation measures.

3.1.4.1 OAK WOODLAND SUSTAINABILITY

Adequate regeneration within oak woodlands can be attained through numerous mechanisms. As a first step, the City should inventory existing oak stands and determine which stands have inadequate regeneration and, thus, are in need of additional management actions. The University of California Integrated Hardwood Range Management Program has developed a decision scheme to assist oak woodland managers in this process (Standiford and McCreary 1996). Stands identified as lacking sufficient regeneration to meet management goals should receive supplemental oak plantings and/or be prioritized for appropriate vegetation management techniques to decrease competition from nonnative grasses and forbs.

If supplemental planting of acorns is required to increase oak recruitment, acorns should be collected within the vicinity of the planting site to maintain the genetic integrity of the stand. Trees grown from locally collected acorns may be better suited to local site conditions, and thus are more likely to be healthy and vigorous than are trees grown from acorns collected in stands with different growing conditions. Two University of California publications (McCreary 1993 and 2001) provide a wealth of information concerning the growing and regeneration of oaks and should be consulted for more specific information.

Vegetation management within oak woodlands should employ various tactics to control invasive plants and improve germination and growing conditions for oak seedlings. Areas with dense infestations of invasive plants, such as periwinkle (*Vinca major*), English ivy (*Hetera helix*), and yellow starthistle *(Centaurea solstitialis)*, or with dense accumulations of nonnative grass thatch should be treated to improve germination conditions for oak seedlings. Specific treatment methods are covered in more detail in Section 4, Invasive Plant Management.

3.1.4.2 WILDLAND FIRE

A prescribed burning program within oak woodlands, including proper controls, documentation and monitoring should be initiated. Some mechanical removal of fuels, such as accumulations of brush and woody debris from the base of oaks, may be necessary to prevent damage to mature oaks during wildfires. Oak stands surrounded by or interspersed with dense or decadent shrublands and dead, downed wood should be treated first to reduce the probability of catastrophic wildfire. Other, less fire-prone stands can be treated over time as funding allows. The use of wildland fire to reduce fuel loads and manage vegetation is discussed in Section 5, Fire Management. Note that among sensitive resources to protect, Butte County checkerbloom (*Sidalcea robusta*) grows almost exclusively in blue oak and blue oak/foothill pine woodland, often under blue oak trees (within dripline or at base of trunk), as described in BPMMP section 2.3.2.2, Biological Resources.

3.1.4.3 OAK LANDSCAPE MAINTENANCE

As a general rule, the planting of turfgrass and other plants not adapted to periodic drought should be avoided within the dripline of oaks, as should pruning, trimming, supplemental irrigation (except during periods of chronic drought), and any sort of grading, trenching, or other similar activity. Areas of the park leased to CARD and the Bidwell Park Golf Course should also be monitored for compliance with best practices for oak landscape maintenance and, where necessary, changes made to bring them into compliance. Detailed guidance for maintaining oaks in parks and other more developed settings and landscaping around oaks can be obtained from several publications (Johnson 1995, Hagen et al. 2000). The City of Chico Best Practices Technical Manual (City of Chico 1998) also provides extensive guidance for oak landscape maintenance activities.

4 INVASIVE PLANT MANAGEMENT

4.1 OVERVIEW OF INVASIVE PLANTS

Invasive plants are plants that have the potential to cause environmental or economic harm, usually because they have undesirable attributes and can rapidly spread and become locally abundant. In California, most of these species have been recently introduced by people to California from other continents, either intentionally (e.g., ornamentals) or accidentally (e.g., agricultural contaminants). Though most nonnative horticultural plant species are noninvasive, horticultural introductions account for a substantial portion of nonnative invasive species. For instance, over 80% of invasive woody species in the U.S. were introduced for horticulture (Reichard 1997). Terms such as nonnatives, nonindigenous, exotics, pest plants and alien species are commonly used as synonyms for invasive plants. The following discusses some of the ecological characteristics of invasive plants and describes the potential effects of invasive plants on natural communities, users of Bidwell Park, and surrounding infrastructure.

4.1.1 INVASIVE PLANT ECOLOGY

Although there is not one set of characteristics differentiating potentially invasive from noninvasive plants, invasive plants are generally those plants that have morphological, reproductive, or other characteristics that allow them to grow and reproduce faster than other plants within the same plant community (Bossard et al. 2000). These advantages allow invasive plants to outcompete other plants for light, soil moisture, space, and nutrients. Numerous theories exist explaining why invasive plants become established at certain sites. One widely supported hypothesis is that plant invasions are tied to the disturbance of soils and existing vegetation. Assuming seed or propagule sources of potentially invasive plants already exist on the site or are introduced into the site coincident with the disturbance, the churning and scraping of the soil surface and the temporary lack of native vegetation can provide an opportunity for invasive plants to become established on the site. Once established, invasive plants can come to dominate the site and be extremely expensive and difficult to eradicate from the site due to either the sheer numbers of plants (e.g., nonnative grasses), the large number of seeds produced by the plant and seedbed longevity (e.g., yellow starthistle), or the wide variety of reproductive mechanisms employed by the plant, e.g., Himalayan blackberry (*Rubus discolor*), perennial pepperweed (*Lepidium latifolium*), and tree-of-heaven (*Ailanthus altissima*).

4.1.2 INVASIVE PLANT EFFECTS

The presence of invasive plants can cause a wide variety of ecological problems. In grassland and woodland habitats, invasive plants can modify fire intensities and fire cycles by causing hotter and faster burning fires and by shortening the interval between fires (D'Antonio and Vitousek 1992). In riparian and wetland habitats, invasive plants can use excessive amounts of water, increase sediment buildup, and reduce open water habitats (Brotherson and Field 1987). Invasive plants can also lead to erosion problems in riparian areas and modify flooding frequency and intensity. In any plant community, invasive plants, because of their often superior reproductive output, competitive abilities, and tolerance for disturbance, can dominate the community, decreasing available habitat, growth, and reproductive vigor for native plants. This is particularly problematic for native plants with limited distributions or native plants with narrow habitat requirements.

Aside from ecological effects, invasive plants can cause problems for users of Bidwell Park and residents of surrounding communities. Species such as Himalayan blackberry and yellow starthistle often form thickets and contain numerous thorns and spines. Other species block scenic vistas, modify the appearance of the landscape, or create security problems. Invasive plants may also provide habitat for pest and problem animals such as rats, feral cats, blackbirds, mosquitoes and other species.

Finally, invasive plants can also pose hazards to infrastructure such as homes, roads, and bridges by altering the timing or intensity of natural disturbance regimes such as fires, floods, and erosion resulting in costly losses of structures and increased maintenance to prevent those losses.

4.2 INVASIVE PLANT MANAGEMENT OBJECTIVES

Invasive plant treatment within Bidwell Park consists of four interrelated objectives:

- Reduce existing infestations of invasive plants,
- Prevent the spread of invasive plants from current infestation areas into adjacent uninfested areas,
- Reduce invasive plant infestations from Park neighbors by enacting an encroachment ordinance that covers both structures and vegetation, similar to the Lindo Channel Encroachment Ordinance, and
- Enhance and maintain sensitive/special status plant and animal populations by removing invasive plants.

Each of these objectives can be met through the development and implementation of a weed abatement program for Bidwell Park. The following sections describe factors to consider and list the basic steps to follow when implementing a weed abatement program.

4.3 INVASIVE PLANT MANAGEMENT ISSUES

4.3.1 INVASIVE PLANT POPULATION PROFILES

For planning purposes, all invasive plant populations may be characterized into one of three profile types based on the plant's distribution: incipient populations, widespread populations, and ubiquitous populations. Incipient populations are those presumed to have been recent introductions or those that have been relatively contained thus far. They are characterized by relatively few (less than 100 stems) or small (averaging less than 0.1 acre) infestations that cover only a small portion of the total Park area. Widespread populations are those which have spread throughout the Park, though each infestation is still relatively small. They are characterized by many (over 100 stems) small (averaging less than 0.1 acre) infestations that cover a larger portion of the Park, relative to incipient weeds. Ubiquitous weeds are those that have already spread and grown considerably in infestation size within the Park. They are characterized by few to many large (averaging greater than 0.1 acre) or continuous infestations that cover a sizeable portion of the Park. The significance of each profile type to invasive plant abatement efforts is discussed more in the following sections.

4.3.2 WILDLIFE HABITAT PROVISION

Even though many invasive plants are not as valuable to wildlife as native plants, many insects, birds and mammals have adapted to utilizing them and now rely upon them, especially in locations where the weed may be the only plant providing wildlife habitat. In particular, it has been noted in studies conducted by Point Reyes Bird Observatory in the Sacramento River area that invasive species such as Himalayan blackberry and California black walnut (*Juglans californica* var. *hindsii*) were important nesting substrate for a number of songbirds (Geupel et al. 1997). In situations such as this, it is advisable that populations of invasive trees and shrubs be assessed for wildlife habitat values and the presence of wildlife, within the context of the surrounding vegetation, before implementing invasive plant treatments. For instance, tall invasive trees that are taking over native riparian woodland may provide perches for raptors. If a large stand of such trees is removed during an invasive plant abatement effort, it may be an extended period of time before this habitat component is replaced within the riparian community. In this instance, it may be appropriate to implement a method of abatement that removes

pockets of these trees and replants that area over a longer period to allow some development of newly planted species before all trees are removed.

4.4 INVASIVE PLANT MANAGEMENT GUIDELINES AND RECOMMENDATIONS

Similar to the management guidelines and recommendations developed in Section 3, the guidelines below offer information and advice relative to the development of a weed abatement program. Although these interrelated steps can form the basis for a preliminary invasive plant treatment program, a comprehensive weed management and abatement plan should be developed at some point in the future.

4.4.1 POPULATION MAPPING AND BASELINE ASSESSMENT

A comprehensive assessment of invasive plants in Bidwell Park is needed. Mapping by hand is the most straightforward way of tracking invasive species and establishing a baseline to monitor future changes and track weed abatement program success as part of adaptive management. Invasive plant infestations, rare plant populations, or other conservation targets should be tracked on base maps such as U.S. Geological Survey quad maps, Park trails maps, or aerial photographs. Individual invasive species can be mapped on separate maps or they can all be mapped together (California Invasive Plant Council 2004). Information can be entered into a geographic information systems (GIS) database which can then be used as a tool in planning treatments, quantifying acreages to treat, avoiding sensitive resources, and tracking results over time. There are a number of mapping programs to consider, including The Nature Conservancy's Weed Information Management System (WIMS; http://tncweeds.ucdavis.edu/wims.html) program, the North American Weed Management Association standards, and others. The North American Weed Management Association has developed a complete set of weed mapping standards, protocols, and field forms that can be used by community groups and Park staff to map weed populations within Bidwell Park (www.nawma.org). The choice of mapping programs or protocols to follow depends on goals, objectives, resource availability, reception for geopositioning systems (GPS), available aerial images, GIS database capabilities, and other factors.

Before any mapping is started, review the entire list of invasive plant species to identify and prioritize plant mapping and removal projects. Identify plant populations that have the potential for explosive growth but which, for a variety of reasons (e.g., seed source only within the park, few mature plants, limited growing conditions, ease of removal) can be controlled or eradicated in a relatively short period of time (e.g., privets, puncturevine, bladder senna, tree-of-heaven).

4.4.2 PRIORITIZATION AND TREATMENT IDENTIFICATION

Once invasive species populations have been identified and mapped in the Park, these populations should be prioritized based on various factors. Some factors to consider include: protection of special status plants and animals, proximity to potential dispersal vectors, such as roads, and the availability, feasibility, and likelihood of success of various treatment methods relative to target weed species. Population profiles should also be considered when prioritizing weed populations for treatment. As discussed above, there are three main types of population profiles: incipient populations (I), widespread populations (WS), and ubiquitous populations (U). Incipient populations are frequently easiest to control because it is much easier and cheaper to eradicate a species that has not yet spread and established in great numbers (i.e., a "nip it in the bud" approach). Widespread populations are more problematic because they have already spread and without quick abatement action are likely to quickly expand and cause extensive ecological harm. Small infestations of widespread plants should be removed first before they expand and substantially spread propagules. Additionally, Infestations that would likely spread into reaches not yet infested or areas of high sensitivity (e.g., rare species habitat) should also be removed at the earliest opportunity, if feasible. Ubiquitous populations are the most difficult to control. In many cases these species may have already caused substantial habitat degradation or other damage and, though they may still be

expanding, control may be difficult or impossible and, accordingly, very costly. To be effective, a long term (e.g., 10 year) plan for containment will often be needed to control ubiquitous weed populations. Populations of ubiquitous weeds should generally be treated only when they pose significant threats to Park resources and long term control of that weed population is likely.

To aid in prioritizing weed populations for treatment, an evaluation matrix should be prepared. Such a matrix should list target weed species, the potential impacts of each species to ecosystems, people and infrastructure, the potential for invasiveness, the relative cost to control each species, and the population profile type. The matrix ultimately used by the City may build off the preliminary matrix presented in Table C.4-1. (This list may be modified with additional species and priority rankings based on public review and comment).

To create Table C.4-1, species ranked high priority by Friends of Bidwell Park (list available at: www.friendsofbidwellpark.org) were further prioritized. Though all of these species are invasive, cause detrimental effects, and are difficult to eradicate, they do differ in these attributes, and based on these differences, the species were triaged into three priority categories. Those species placed in the highest priority category have incipient or widespread distribution patterns and are either highly invasive in general or cause substantial impacts (Table C.4-1). In the absence of control measures, these are the species whose effects will increase the most in the near future. Species that are already ubiquitous, or that are less invasive and whose infestations cause lesser impacts, were placed in the moderate priority category; those species both with a relatively low level of invasiveness and causing relatively low levels of effects (in all effect categories) were placed in the lowest priority category. Distributions of the invasive species in Bidwell Park are estimates, based on current information available from the Friends of Bidwell Park. Future surveys and mapping will be needed to establish a baseline and may result in modifications to invasive species priority rankings.

4.4.3 PARK STAFF AND VOLUNTEER TRAINING AND EDUCATION

A Park invasive plant abatement training and education program should be developed that is within the capacity of available Park staff, volunteers, and funding. Invasive plant removal should be included in the day-to-day activities of Park maintenance workers. Training should be provided for all Park workers in invasive plant identification and removal techniques. A list of weed species should be developed that will be removed as time and resources permit, as part of routine maintenance (e.g., large thistle species, puncturevine, plants that are particularly poisonous, especially in children's play areas, and plants that have been targeted for control or eradication within the Park).

A list of invasive plants should be developed that can be removed by volunteer labor using mechanical methods (e.g., privets, bladder senna, puncturevine, pokeweed, broom, ivy, periwinkle) and identify specific removal project sites. Invasive plants (e.g., broomsedge bluestem, Italian plumeless thistle) that threaten specific small habitats (e.g., wetlands) should also be identified. Areas that have specific, easily recognizable boundaries should be identified, such as roads, trails, or the creek so that any major invasive plant removal work can be monitored without having to consider whether the removed species is creeping back in again from the edges. The worst invasive plants in Lower, Middle, and Upper Park should be listed to help focus the efforts of Park staff and volunteers on the most critical problems.

Table C.4-1
Attributes of Invasive Plants within Bidwell Park

Weed	Habitat[1]	Effects Physical-Biotic-Human[2]	Invasiveness[3]	Control Cost (per unit area)[4]	Profile Type[5]	Notes[1]
High Priority Species[6]						
American pokeweed *Phytolacca americana*	Riparian	M-H-M	H	H	WS	Spreading rapidly in Bidwell Park and becoming a fairly common weed in the Chico urban area.; mature plant is toxic
Algerian ivy *Hedera canariensis*	Riparian Woodland	M-H-L	H	L	I	Encroaching from neighboring properties
Arundo *Arundo donax*	Riparian	H-H-H	M	H	WS	Eradication efforts conducted since 2000
Bladder senna *Colutea arborescens*	Riparian, Valley Oak Woodland	M-H-M	M	H	WS	Eradication efforts conducted since 2003
Broomsedge bluestem *Andropogon virginicus*	Moist to wet soil along streams, seeps, ponds and in pastures	M-H-L	H	M	WS	Degrading Park wetlands
Edible fig *Ficus carica*	Riparian	L-H-L	H	L	WS	
English ivy *Hedera helix*	Riparian, Valley Oak and Foothill Woodland	M-H-L	H	L	I	Encroaching from neighboring properties
Fennel *Foeniculum vulgare*	Riparian	L-H-L	H	H	I	Also along disturbed road edges
French broom *Genista monspessulana*	Riparian, Valley Oak and Foothill Woodland	M-H-L	H	H	I	Also along disturbed road edges
Himalayan blackberry *Rubus armeniacus (R. discolor)*	Riparian, Valley Oak Woodland	M-H-H	H	H	WS	Can be confused with native blackberry; City of Chico uses Salt Creek Crews & goats for control; may be ubiquitous in many areas, but high priority for control in key areas for security, fuelload reduction, and habitat enhancement
Italian plumeless thistle *Carduus pycnocephalus*	Grassland, Oak Woodland	L-H-M	M	L	I	Currently perhaps only 1 infestation known in Park; should remove it before it spreads to other locations; Ecological Reserve removing their infestations
Japanese privet *Ligustrum japonicum*	Riparian, Valley Oak Woodland	H-L-M	M	M	WS	Planted extensively in the Park, as Chico street trees, and along Hwy 99; creates dense monocultures; eradication efforts conducted since 2003, at Five Mile and in Lower Park.
Olive *Olea europaea*	Riparian, Foothill Woodland	L-L-H	L	M	I	Remnant orchard in golf course and to south of course, spreading up canyon; can form very dense canopies; potential to harbor olive fruit fly pest.
Perennial pepperweed *Lepidium latifolium*	Riparian	H-H-L	H	H	I	Small infestation removed in 2003
Scotch broom *Cytisus scoparius*	Riparian, Valley Oak and Foothill Woodland	H-H-L	M	H	I	Also along disturbed road edges
Spanish broom *Spartium junceum*	Riparian, Valley Oak Woodland	H-M-L	M	H	WS	Eradication efforts have been conducted for about 10 years
Periwinkle *Vinca major*	Riparian, Valley Oak Woodland	M-H-L	M	H	WS	
Puncturevine *Tribulus terrestris*	Disturbed areas and trail edges	L-L-M	H	H	WS	Fruit can injure feet, puncture bicycle tires
Tamarisk *Tamarix* sp.	Riparian	H-H-H	H	H	I	
Tree-of-heaven *Ailanthus altissima*	Riparian, Valley Oak Woodland	L-H-M	M	H	WS	
Yellow starthistle *Centaurea solstitialis*	Annual grassland, openings in woodlands	H-H-L	M	M	WS	Has been treated with prescribed burning in Middle Park.

1 – Habitat locations are based on available literature, Friends of Bidwell Park 2005, data compiled for the BPMMP and professional judgment of EDAW ecologists.
2 – Physical process effects are based on Criterion 1.1 and biotic effects are based on Criteria 1.2-1.4 of the California Invasive Plant Council (CalIPC) plant assessment form (PAF) (CalIPC 2003), and, if available, existing CalIPC ratings; human effects are detrimental effects on infrastructure, buildings, agriculture, recreation or other human uses based on a review of available literature and the professional judgment of EDAW ecologists. Level of effects are categorized as low (L), medium (M) or high (H).
3 – Degree of invasiveness is categorized as low (L), moderate (M) or high (H) based on CalIPC criteria, scoring methodology for invasiveness and, if available, existing CalIPC ratings (CalIPC 2003).
4 – Control Cost Ratings are categorized as low (L) or high (H) based on costs per treatment and the likely number of treatments required for control. Species with persistent soil seed banks or spreading via below-ground stems were rated “High,” as were species requiring large amounts of biomass removal. Data sources included available literature (particularly the reviews in Bossard et al. 2000), data collected for the BPMMP, and the professional judgment of EDAW ecologists.
5 – Distribution profile types are: Incipient (I) - few small (< 0.1 acre) infestations, Widespread (WS) - many (> 100) small infestations, and Ubiquitous (U) - few to many large infestations; profile types are based on information from Friends of Bidwell Park.
6 – High priority species are species ranked high priority by Friends of Bidwell Park (list available at: www.friendsofbidwellpark.org) that also are I or WS species with either high invasiveness or a high rating for at least one effect type.
Sources: Friends of Bidwell Park, EDAW 2004

4.4.4 TREATMENT METHODS

Several commonly used invasive plant treatment methods are discussed below (See Table C-4.2 for a summary). This list is not exhaustive nor does it discuss every advantage and disadvantage associated with each method. Further, it should be noted that a single method of control is not likely to be completely effective in most circumstances and that invasive plant control is usually improved when two or more of these techniques are combined. However, this information can assist Park managers with developing a preliminary toolbox of techniques likely to be effective at treating invasive plants in Bidwell Park.

4.4.4.1 PRESCRIBED BURNING

Although fire is not always an appropriate method for some weeds (e.g., plants that are likely to resprout vigorously following fire or plants that are likely to benefit from germination conditions created by a fire), it can be useful in the control of many species, particularly nonnative grasses and other grassland weeds. Fire should be applied when sufficient fuel exists and satisfactory moisture and atmospheric conditions are present to carry a fire hot enough to burn the targeted weeds. This method requires trained burn crew personnel, prescribed burning and fire prevention equipment, and compliance with local and state regulations regarding burning. Approval from local and state fire agencies may also be necessary before applying this method. Section 5 of this document discusses prescribed fire in more detail.

4.4.4.2 GRAZING

Livestock such as cattle, sheep, and goats can be used to reduce invasive species populations. For invasive plant control and vegetation management, particularly for shrubs and other woody species, goats are usually most effective. Goats preferentially browse on woody species and can be fenced into treatment areas where chemical or mechanical methods are not feasible.

Success with this method usually depends on proper timing and intensive herd management. Timing is important to ensure that livestock are browsing target species at the time they are most palatable to the livestock and at the time when browsing is most likely to reduce seed output and deplete stored energy from the target plants. Herd management is important to ensure that animals will evenly browse target species, avoid non-target species, and cause minimal impacts to soils, water quality, and other potentially sensitive resources.

4.4.4.3 MOWING

Mechanical mowing is essentially an alternative to livestock grazing. Mowing may be desirable for small areas of herbaceous weeds such as medusahead or starthistle where grazing is not cost effective, feasible, or not likely to be effective. Mowing is particularly effective when combined with herbicide applications.

4.4.4.4 HERBICIDES

Chemical treatments used to remove invasive plants range from spraying herbicides on large areas to applying herbicides to selected weeds. All herbicides should be applied by licensed applicators and other personnel in accordance with herbicide label directions and in compliance with all state and local regulations. Herbicides should be selected based on their efficacy in controlling the invasive plant, their safety for applicators and members of the general public, and toxicity levels to other non-targeted organisms. Signs should be posted in areas planned for herbicide treatments at least 24 hours prior and following herbicide applications. These signs should list the chemicals to be applied, areas to be treated, potential public health risks, and steps the public can take to minimize exposure.

Specific chemical treatment methods include: foliar spraying, cut and squirt, cut-stump, and basal bark. Foliar spraying applications are most commonly used for herbaceous plants or small woody plants. The exact timing,

Table C.4-2
Comparison of Invasive Plant Treatment Methods

Method	Usefulness	Cost	Key Considerations
Prescribed burning	Can be used in grasslands, shrublands, and woodlands. Less applicable in valley oak woodlands; although still useful if properly planned. Most effective at controlling herbaceous plants.	Variable. Requires preparation of a prescribed burn plan, permits from local fire department and air quality management board. May require significant site preparation and staffing costs.	Fire is not selective (impacts both target and non-target species). Can be difficult to control and may be dangerous if not planned properly. May kill weed seeds and sterilize seedbed if hot enough. Some weeds may benefit from fire and become more common following burning.
Livestock grazing (goats)	Most useful in treating shrubby vegetation. Can also be used to treat starthistle and other thistles, blackberries, and similar vegetation. Most useful in treating small areas.	Moderate to high. Goat contractors typically charge from $5,000 to $20,000 or more to treat specific areas. Fencing and other necessary materials are supplied by contractor.	Generally selective but must be carefully managed to avoid browsing of non-target species. Treatments need to be timed so that target vegetation is most palatable to goats, which may or may not coincide with the time when vegetation is most effectively controlled with grazing.
Mowing	Most useful in treating herbaceous vegetation over small areas.	Variable depending on availability of suitable equipment and staff costs.	Not selective. Can be difficult to impossible over rough terrain, rocky soils, and step slopes.
Herbicides	Applicable to any vegetation type. Useful as a follow-up to other treatments.	Moderate to High, depending on herbicide used. Also requires trained and licensed applicators. Must be coordinated with local Ag Commissioner.	Selective to target plants if applied properly. Drift onto non-target plants possible. Some products (e.g., surfactant in commercial formulations of glyphosate) harmful to aquatic organisms (therefore, wetland-certified formulations should be used on or over water). Should be applied during periods of active growth. May pose public health concerns.
Mulching	Useful as a follow up to other methods. Generally of limited usefulness by itself.	Low to moderate depending on availability of mulching materials.	Mulch materials should be certified weed-free to avoid spread of invasive plants.
Mechanical	Most useful for small infestations.	Low to moderate depending on staff costs and availability of volunteers to staff projects.	Target plants should be readily removed by hand, weed wrenches, etc. Woody vegetation should not be capable of root crown sprouting.
Biological control	Useful as a temporary control or in combination with other methods. Rarely achieves complete eradication.	Low. Many agents already released (e.g., Klamath weed beetle, rusts for starthistle, etc.)	Only a small minority of invasive plants have biological control agents. Potential new agents must undergo extensive testing and be approved by state agencies.

concentration, and extent of applications depend on the plant species and the herbicide used. Foliar spraying can be advantageous when weeds dominate the site and native plants are lacking, including rare or otherwise sensitive native species.

The cut and squirt, cut stump, and basal bark methods are commonly used to treat trees and larger shrubs. These methods all involve cutting through the bark to expose the plant's vascular tissues and then applying undiluted or high concentration herbicide formulations either with a spray bottle, paint brush, or some other applicator. In using these methods, it is particularly critical to ensure that the herbicide remains in contact with the exposed vascular tissues for a sufficient amount of time and that the herbicide is applied during periods of active plant growth.

4.4.4.5 MECHANICAL METHODS

Mechanical removal of invasive plants includes all physical removal actions that are done by hand or machine. Some examples of mechanical removal are cutting, girdling, chaining, and pulling. Cutting, or removing the portion of the plant above the root crown, is only effective at controlling species that do not resprout from the root crown. Girdling involves removing the bark and underlying vascular tissues in a circle around the base of a tree destroying the tissue that is used to transport nutrients back and forth between the roots and above ground portion of the plant. This method can be beneficial when the objective is to leave dead snags in the area, such as for nesting birds and bats. Another example of mechanical removal is pulling. Pulling weeds can be very time consuming and costly and is only effective in cases where the entire plant, including the roots, can be removed. It is most effective for small infestations and for follow up treatments following the removal of the initial population.

4.4.4.6 MULCHING

Mulching involves placement of a weed barrier, such as landscape fabric, nylon, or plastic, and then placement of three to six inches of rice straw or wood chips. This method is effective for smothering small infestations of herbaceous weeds that are hard to control with other methods. Because it buries weed seeds and can create germination conditions unsuitable for many weed species, mulching can also help prevent the germination of new weeds.

4.4.4.7 BIOLOGICAL CONTROL

Biological control of invasive plants involves the use of native or introduced pathogens and insects to reduce an invasive weed's ability to reproduce and spread. Before biological control agents are approved for release, they are tested extensively on related non-target plants to ensure that the agent will cause no harm to them. Although biological controls aid in the reduction of reproduction and dispersal of targeted weed species, they are not considered effective for complete eradication. They are intended to control the population levels to a point where the targeted weed species can be cost-effectively managed.

4.4.4.8 THE BRADLEY METHOD

The Bradley Method is a grassroots approach to invasive plant eradication and it is generally appropriate for volunteer groups or small-scale restoration projects (Bradley 1971). The major principles of this method are hand-weeding areas using small groups of people and selecting small areas to work on so that each one will revegetate naturally without seeding or installing plants. The method allows native plants growing adjacent to or within the infestation to reestablish several small areas cleared successively over time. It gives native vegetation the edge to reestablish an area on its own. The method is designed for one person to follow, starting with the best stand of native vegetation and working towards the worst infestation of weeds. By keeping the sequence always the same, it can be followed by any number of people in any number of places.

4.4.4.9 HOT WATER-STEAM METHODS

These methods use propane-heated hot water or steam to destroy plant tissues and impede plant transpiration. As a result, the plant dehydrates, wilts, and dies within a period of hours to days. Originally developed for organic growers of winegrapes and tree crops, these methods are increasingly used by municipal parks and small-scale farmers as the equipment has become smaller and less costly and, therefore, more practical for a wider variety of applications. Although these methods have not been tested widely here in the United States, preliminary results indicate that they can be as effective as herbicides in controlling herbaceous weeds (Riley 1995); initial tests have shown this method to be less effective in treating woody weed species (Melendez and Kibble, cited in Jones and Stokes 1998). The chief disadvantage of these methods, relative to other methods, is their high costs and their inability to control woody species.

4.4.5 POST-TREATMENT RESTORATION

Invasive plant abatement efforts are usually more successful when coupled with follow-up plantings of native vegetation, when needed. Not all treated areas require post-treatment active planting. However, without supplemental seeding and planting of natives, treatment areas often revert to dominance by the same invasive plant or a different invasive plant that then requires additional treatment and management. Plantings can be done immediately after invasive removal or may be delayed in instances where additional invasive plant control measures will be necessary (such as herbicide treatments following a prescribed burn), or where additional site preparation is needed (e.g., to overcome changes in soil chemistry due to the invasive plant). Post-treatment monitoring (e.g., during the first 1–5 growing seasons following treatments) can help to determine whether or not a treated site will require active planting. Over time, monitoring will help guide future decisions on which types of areas, infestations, and treatments to follow with active planting. Lists of suitable native species for various habitat types within the Park should be prepared to guide post-treatment revegetation efforts. Plants chosen for revegetation should be species native to the area, or noninvasive nonnative (e.g., sterile hybrid) plants that have a quick growth rate, to prevent reinfestations by the removed weed or other weed species. As a guide for restoration efforts, the “Islands of Vegetation” concept developed in the 1990 Master Management Plan may be consulted as a guide. All restoration sites should be monitored on a regular basis to remove any new weed seedlings.

4.4.6 TREATMENT AND LONG-TERM MONITORING AND ADAPTIVE MANAGEMENT

For all infestations, efficient pre- and post-treatment monitoring should be conducted. Treatment monitoring results should be evaluated as part of an adaptive management process, to provide information on treatment efficacy and to help determine whether and how to modify treatments. Monitoring may include before and after photographs (ideally from established photo points) and mapped extent of infestation. It can also include, resources allowing, additional data collection on the type (e.g., stump/stem sprout, seedling, root sprout) and quantity of any regrowth. The regrowth can be quantified by methods such as estimating the percent of green canopy (i.e., green leaves and stems) out of the whole canopy (i.e., total leaf and stem layer); or estimating the approximate average number of live seedlings, stem sprouts or root sprouts per unit area (e.g., per square meter). Any native plants providing cover on the site should also be noted by species and quantity (e.g., percent cover in the entire treatment area or per square meter). Post-treatment monitoring is most efficient when combined with retreatment of the weed infestation. The number of years required for retreatment of infested areas varies by species, infestation size and other factors. Some infestations may only take a year to remove, while others may take 3 to 5 years or more. Monitoring should generally continue for a few years after the infestation was removed to ensure that regrowth or other unwanted species do not become established.

Over the longer term, Bidwell Park should have periodic surveys that continue to collect information on infestations by those species identified in this study as well as any other potentially invasive plants. Long-term monitoring results should be evaluated as part of an adaptive management process, to provide information on weed abatement program effectiveness and to help determine whether and how to modify priorities and

abatement strategies. During surveys, new weed infestations can be mapped and assessed, previously mapped weed infestations can be re-assessed, and other management issues can be addressed (e.g., illegal trash dumping, potential erosion problems). The monitoring should be closely tied to other resource monitoring, including wildlife and riparian habitat monitoring to determine which invasive plants are most problematic and to refine restoration and enhancement strategies (including invasive plant abatement) to provide the best results. The invasive plant surveys should also allow for a proactive approach so that new satellite populations of invasive plants are identified and removed while they are still small and easy to cost-effectively control.

5 FIRE MANAGEMENT

5.1 FIRE OVERVIEW

The following provides an overview of the ecological role of fire as well as a discussion of the history of wildland fire and the fire environment within Bidwell Park.

5.1.1 FIRE ECOLOGY

Periodic fire is a natural component of most all ecosystems in California and numerous efforts are underway across the state to re-introduce fire as a management tool in many vegetation types. Additionally, many communities are increasingly at threat from catastrophic wildfire since residential development is frequently interspersed with or adjacent to fire prone habitats. Understanding some of the ecological implications of fire in these situations is critical to developing an overall fire management plan.

5.1.1.1 ECOSYSTEM BENEFITS AND COSTS

Fire in California's oak woodlands, chaparral, and grasslands can be used to produce a variety of positive ecological benefits. Fire releases nutrients into the soil that are otherwise bound up in plant materials; it creates patches of early successional vegetation types, such as young shrubs and grasses, that provide valuable wildlife habitat; it encourages regeneration among many plant species that have evolved fire-adapted reproductive strategies; and, it creates habitat for many plant species that only grown in temporary gaps within woodlands or chaparral created by fires. Fire can also bring with it several ecological "costs" such as reductions in soil moisture, hydrophobic soil surface layers that prevent water infiltration and temporary destruction of wildlife habitat. Fires also create ideal germination conditions for many invasive plants and can lead to soil erosion and other water quality problems.

5.1.1.2 PLANT RESPONSE TO FIRE

Different plant habitats, and the individual species within those habitats, respond differently to fire. In chaparral habitats shrubs generally follow one of two different regeneration strategies; they either regenerate through seed or they resprout. Within the Bidwell Park area the dominant chaparral shrubs are a mostly seeders such (i.e., common manzanita *Arctostaphylos manzanita* and wedgeleaf ceanothus *Ceanothus cuneatus*). Most remaining shrubs that are components of chaparral vegetation, including toyon, redbud (*Cersis occidentails*), deer brush (*Ceanothus intergerrimus*), lemonade berry (*Rhus integrifolia*), mock orange (*Philadelphus lewisii*), poison oak (*Toxicodendron diversilobium*), California buckeye (*Aesculus californica*), mountain mahogany (*Cercocerpus betuloides*), Yerba santa (*Eriodictyon californicum*), blue elderberry (*Sambuccus mexicana*), scrub oak, and buckthorns (*Rhamnus* spp.), will readily resprout following wildfire. In woodland and savanna habitats, most oaks, with the notable exception of valley oak, are vigorous sprouters following wildfire; although, severe fires may damage the trees to the point that resprouting is not possible. Conifers such as foothill pine (*Pinus sabiniana*) regenerate entirely from seed. Finally, California's grasslands, both as open prairies and as an understory component in oak woodlands and savannas, are dominated by exotic grasses that evolved with a long history of burning and are well adapted to wildfires (Keeley 1981). Because nonnative grasses are so well adapted to fire and are able to quickly germinate following fire, these species frequently become the dominant component of chaparral and woodland communities following fire. With no further perturbation, the shrub and tree canopies recover and, over time, this exotic annual component drops out of the community. With repeated perturbation, however, these areas of chaparral and woodland can be type converted into grasslands or mosaics of grass and shrubs and woodland, something that has been advocated and practiced by Native Americans and Euro Americans alike over the past centuries (Keeley 2002a).

5.1.1.3 FIRE REGIMES

The historical fire regime for California's foothill woodland and grassland communities is a subject of considerable debate. While there is general agreement that most foothill vegetation communities are fire-adapted, at least to some degree, experts differ on the frequency and intensity of historic fires within these communities. Some believe that large wildfires are "unnatural" and an artifact of fire suppression policies (Minnich 1983, 1989, 1995, 1998) while others believe that these sorts of fires were not uncommon historically and are probably a natural component of foothill woodland and chaparral communities (Keeley and Fotheringham 2001a). Regardless of which position is correct, historically, crown-replacing fires generally required three coincident events: a lightning strike to ignite the fire, sufficiently high levels of ground and ladder fuels to feed the fire, and strong, dry, and hot easterly or north-easterly winds to fan the small fire ignited by the lightning strike into a massive conflagration. Absent these conditions, the majority of fires probably burned through relatively small areas before they either ran out of fuel or were extinguished by rain. The historic fire regime of these ecosystems, then, was likely characterized by regular to infrequent fires of low to moderate intensity and even less frequent crown-replacing fires of extreme intensity. Fire is particularly important in grasslands and oak savannas/woodlands since it is often required to maintain these systems and prevent encroachment by trees and shrubs (e.g., Axelrod 1985).

Whatever the natural fire regime was for these habitats, fire frequency has undoubtedly increased over the last several thousand years, first with settlement by Native Americans (Blackburn and Anderson 1993) and again over the last 200 years with European settlement (Bartolome 1989, Stephens 1997). Both of these cultural groups used fire extensively to encourage open tree canopies, more wildlife, better growing conditions for culturally significant plants, and/or better livestock grazing conditions.

Beginning in the 1900s, the use of fire became increasingly restricted and many resource management agencies began extensive fire suppression programs. It is widely assumed that current conditions in many of California's forest and woodland habitats are, at least partly, the result of these policies (Minnich 1983) and that fire hazards within chaparral and woodlands can be lessened through prescribed burning programs designed to maintain these habitats in a mosaic of different age classes (Minnich and Deazzani 1991, Minnich 1995, 1998). However, others have suggested that prescribed burning of chaparral and woodland habitats is largely a waste of time, money, and effort (at least as a method to reduce fuel loads and wildfire losses) and that large, wind-driven wildfires will burn through any age class of chaparral or woodland (Keeley 2002b). Furthermore, empirical evidence indicates that the current fire regime within chaparral and woodlands, at least in Southern California, approximates the historic "natural" fire regime fairly closely (Keeley and Fotheringham 2001a) and that these vegetation types are burned much more frequently than other types, even in the absence of prescribed burning programs, because these habitat types often characterize urban-wildland interface zone throughout much of the State (Keeley et al. 1999, Wells et al. 2004). Some researchers have suggested that fire suppression may be necessary in these habitat types just to approximate the natural fire regime, which was characterized by *fewer* fires than currently seen today (Conard and Weise 1998).

5.1.2 FIRE HISTORY OF BIDWELL PARK

Over the last 55 years, seven wildfires covering areas larger than 30 acres have been reported by the California Department of Forestry and Fire Protection (CDF) within Bidwell Park. The average fire return frequency interval is estimated at 6.5 years (CDF 2005a) for many areas of the Park. The majority of these fires have burned through oak woodlands and chaparral along the north canyon face above Big Chico Creek within the Middle and Upper Park areas. The largest wildfire in recent Park history was the Musty Buck Fire, which was started by lightning in August of 1999 and consumed 1,180 acres within the Park and nearly 17,000 acres within Butte County (CDF 2005a). Prior to 1950, the fire history of the Park is largely unknown; although, it is doubtless that portions of the Park burned on a regular basis due to numerous activities from indigenous peoples, miners, loggers, and ranchers in and around the Park vicinity.

5.1.3 BIDWELL PARK FIRE ENVIRONMENT

Three factors, weather, fuels, and topography, dictate the fire environment at any given location. Generally, hot dry days with persistent north winds create more extreme fire behavior than cooler days with higher humidity and little to no wind. Extreme fire behavior is also driven by high accumulations of dry and/or downed fuels and a high density of "ladder" fuels (i.e., shrubs, vines, grasses, and smaller trees that carry wildfire into the crowns of large trees), a condition often found in many of California's forests and woodlands and frequently exacerbated by prolonged periods of drought. Steep slopes, particularly slopes facing south and west, narrow canyons, ravines, and other landscape features with steep slopes and opposing slopes in close proximity to one another also create extreme fire behavior.

Because weather cannot be controlled and often not predicted with great accuracy, fire prevention plans and suppression efforts focus on understanding the distribution of fuels and topography within a fire planning area. As part of the California Fire Plan, CDF has developed 19 different fuel models based of dominant vegetation types (CDF 2005c), each of which describes a different set of fire behavior outputs such as rate of spread and flame length. These models are then coupled with local topography to develop basic understanding of wildfire threat and the potential for extreme wildfire behavior in specific locations. Given that many areas of Bidwell Park are characterized by high fuel loads and steep, irregular topography, it should not be surprising that many parts of the Park are ranked by CDF as having the potential for extreme wildfire events (CDF 2005b). These rankings are summarized in Table C.5-1.

Table C.5-1
Potential for Extreme Wildfire Within Bidwell Park

Potential for Extreme Wildfire	Lower Park	Middle Park	Upper Park	Park Wide
None	4%	5%	<1%	1%
Moderate	25%	59%	6%	16%
High	66%	30%	75%	67%
Very High	5%	6%	19%	16%

Source: CDF 2005b

5.2 FIRE MANAGEMENT OBJECTIVES

Fire management within Bidwell Park consists of two main objectives:

- Reduce the probability of wildfire within the Park that threatens Park visitors, Park facilities, and surrounding land owners and residents, and
- Safely use prescribed fire as a management tool to treat invasive plants and improve habitat for native plants and wildlife.

A framework for achieving these two objectives, as well as basic fire management implementation measures, is presented below.

5.3 FIRE MANAGEMENT ISSUES

The following discusses factors that potentially provide management opportunities or present management challenges in meeting the two fire management objectives listed above.

5.3.1 WILDLIFE HABITAT

Historically, many resource management agencies have focused on the potentially negative impacts wildfire can have on wildlife habitat. While catastrophic wildfire can cause long-term damage to wildlife habitat, particularly for species that have limited distributions or are only associated with particular habitat types (e.g., old-growth forests, mature oaks, closed-canopy chaparral) moderate to low intensity fires generally benefit wildlife. For example, fire generally increases the growth of grasses and forbs, encourages highly palatable shrub re-sprouts or seedlings, and opens up canopies in woodlands and shrublands. Fire is particularly important in shrublands dominated wedgeleaf ceanothus (also known as buckbrush), which is a primary food source for deer during the winter. In these habitats, fire encourages germination of new seedlings in old decadent stands that otherwise provide little food for deer both because mature plants generally produce fewer new shoots and because those new shoots that are produced are often at the top of the plant, above the deer's browse line. Fire also encourages succulent re-sprouts of most other chaparral shrubs, some of which like flannel bush and California buckeye provide excellent deer forage (Sampson and Jespersen 1963).

Deer habitat is particularly important within the Big Chico Creek Watershed, which comprises a portion of the winter range for the Eastern Tehama Deer herd, the largest migratory deer herd in California. This herd migrates some 100 miles from its summer territory around Lassen National Park to spend winter and spring in the Big Chico Creek Watershed and surrounding areas of Tehama and Butte County. Upper portions of Bidwell Park and adjacent areas act as the nursery for this deer herd since most fawning occurs during the winter and spring seasons. Formerly numbering some 69,000 animals (Longurst et al. 1952), population estimates places the herd size at roughly half that amount (Loft et al. 1998) and declining every year. Although numerous factors may be contributing to this decline, a lack of suitable winter and spring forage is doubtlessly a contributing factor.

5.3.2 COMBINED IMPACTS

Although prescribed fire can be a valuable management tool, resource managers should be mindful of the potential combined impacts of managed prescribed fire and unmanaged wildfire. Some researchers have demonstrated that the combined impacts of prescribed burning, which to date has had little impact on the annual acreage burned or the number of wildfires across much of California (Conard and Weise 1998, Keeley et al 1999, Keeley and Fotheringham 2001b), and periodic wildfire can damage shrubland and woodland ecosystems by facilitating invasions of nonnative plants (Keeley et al 2003) and extirpations of native plants (Zedler et al 1983, Haidinger and Keeley 1993, Keeley 1995). As discussed above, the mean fire return interval for many parts of the Upper Park and Middle Park have averaged around seven years over the last 55 years. Whatever the historic fire regime was for the region, it is likely that fire return intervals today are shorter than they would be in the absence of human settlement. Given continued population growth within Chico and the close proximity of the Park to the City, it is entirely likely that human-caused wildfires will remain common, if not increase, within the Park. While unplanned wildfire is not a substitute for carefully planned prescribed burns as a habitat management tool, widespread application of prescribed burning that does not consider the potential combined impacts of wildfire and prescribed fire together may result in a deterioration of resource conditions and a failure to meet management goals.

5.3.3 PUBLIC SAFETY

Many and increasingly more areas of Bidwell Park lie in close proximity to developed areas and are heavily used by Chico residents. The highest concentration of nearby residences and structures to the Park is in Lower Park, but new development has increased in areas adjacent to Middle and Upper Parks as well. Issues of concern include nearby homes with wood shingle roofs or dwellings and other structures that are very near the Park, especially in high fire risk areas such as hill slopes with highly volatile fuels such as chaparral. Even relatively remote areas of the Park are regularly used for swimming, hiking, biking, disc golf, and other activities. Since many portions of Bidwell Park have the potential for extreme wildfire behavior, any wildfire suppression or

prescribed burning effort that does not plan for public safety first and foremost can potentially have disastrous consequences.

5.4 FIRE MANAGEMENT GUIDELINES AND RECOMMENDATIONS

The management recommendations offered below are not meant to describe particular management implementation measures. Rather, they offer information and advice relative to specific aspects of fire management and provide a preliminary framework for the management of catastrophic wildfire and the development of a prescribed burning program. In many cases, more detailed technical assistance guides are available to guide each management action. These guides should be consulted when developing implementation measures.

5.4.1 WILDFIRE REDUCTION AND MANAGEMENT

Fire prevention and suppression are interrelated activities designed to first prevent the start of a wildfire and second, in the event that a wildfire starts or moves into the Park, prevent the spread of that fire into areas where sensitive natural resources could be damaged or where the lives and property of Chico residents could be threatened. Much of the following discussion draws from the Park's 1991 Wildfire Management Plan (California Fire Safe Consultants 1991), which should be considered during development of an updated wildfire management plan.

5.4.1.1 WILDFIRE PREVENTION

A basic wildfire prevention program should focus on several activities. First, the City should appoint a fire prevention officer whose duties should include increasing coordination and communication with local fire agencies as well as developing educational programs on fire safety for the public. Additionally, the City should place signs indicating fire danger status at key point within the Park. Such signs are widely used throughout the National Forests and are displayed at some CDF fire stations. Other fire prevention activities should include continued coordination with Pacific Gas & Electric's (PG&E's) efforts to clear vegetation around power transmission lines within the Park as well as ensuring vegetation within and around areas the public is likely to congregate, such as picnic areas and popular recreational spots, is not conducive to starting and spreading wildfire. Finally, the City may wish to consider instituting a policy of closing fire prone areas of the Park to the public on days where extreme fire behavior is likely (i.e., hot, dry, and windy days during the summer and fall).

5.4.1.2 FUELS MANAGEMENT

The Park Division should develop a fuels management program. An effective program may require funding beyond what is currently available within the Park Division's budget. Fuel reduction treatments should be prioritized, with highest priority given to treating those areas likely to pose significant risks to public safety, private property, or Park facilities. Fuels reduction treatments should also be considered for areas with dense infestations of nonnative invasive plants (e.g., Himalayan blackberry, tree of heaven, eucalyptus), areas with high concentrations of ladder like fuels like wild grape, areas where wildlife habitat could be improved or protected through fuels reduction, areas lacking natural oak regeneration, or areas where fuels reduction would benefit native plant communities or special status plant populations. Although prescribed burning is one method of fuels reduction (Section 5.4.2) other techniques may also be appropriate. Other techniques to consider include mechanical methods (e.g., chaining, mastication), biological methods (e.g., goat grazing), and chemical methods (e.g., herbicide applications).

Fuel management treatments designed specifically to protect oak woodlands should focus on removing fuels at the base of oak trees. (Note, however, that potential adverse effects to sensitive resources, such as Butte County checkerbloom which frequently grows around the base of oak trees, should also be taken into consideration) Some of the most problematic fuels are small-diameter dead wood not in contact with the ground and thick, waxy or

resinous leaves such as those of buckbrush, toyon, bay (*Umbellaria californica*), manzanita, scrub oak, interior live oak, and conifers (needles). These fuels generate enough quick heat to kill mature oak woodland trees, which, in the absence of those fuels, are seldom substantially damaged or consumed in a wildfire. An equally bad source of fire damage comes from slow-burning ground fuels like duff or dry logs that often accumulate on the uphill side of trees and generate localized heat for long periods after the passing of the fire front. Fuels management efforts should focus on removing these types of fuels from selected areas of the Park, subject to available funding.

Whenever possible, fuels treatments should be designed to produce multiple benefits (e.g., reduce wildfire risk, improve plant and wildlife habitat, remove invasive plants, protect sensitive resources). In general, the method, or combination of methods, selected should be the most cost effective treatment that poses the least amount of risk to public safety and Park resources.

5.4.1.3 WILDLFIRE DETECTION AND REPORTING

In large part, improved wildfire detection and reporting can be accomplished with improved public education. As more and more people spend time in the Park and with the growth in cellular phone usage, there is an increased opportunity for citizen reports of wildfires (cell phone coverage in upper Park is poor, however). A simple measure such as posting signs with instructions describing how to report a wildfire in various locations throughout the Park and/or developing pamphlets containing this information would help wildfire reporting. Additionally, Park employees should patrol remote areas of the Park more frequently on days with a high fire danger. The City may also wish to consider funding staffing of the Platte Mountain Lookout on high fire danger days.

5.4.1.4 WILDFIRE PRESUPPRESSION AND SUPPRESSION

Although City of Chico fire crews have primary responsibility for wildfire suppression activities within the Park, Park staff should be trained and equipped to respond to small fires when possible. Frequently, very small fires can be effectively suppressed with a minimum amount of equipment and training. Providing Park Rangers with the ability to extinguish these sorts of fires can prevent small fires from turning into large fires. What is more important is that Park staff be familiar with the Incident Command System used by all wildland firefighting agencies to prioritize and staff wildland fires and be trained in the proper procedures for reporting wildland fires to the Chico Fire Department. Park managers can further facilitate wildfire suppression by ensuring that sufficient water supply points are located throughout the Park and that a sufficient number of helispots are located within the Park. Finally, and most importantly, Park managers, in concert with the Chico Fire Department, should develop a basic wildfire evacuation and response plan that analyzes escape routes from various, potentially dangerous areas of the Park, such as the upper portion of Big Chico Creek, and that provides procedures for notifying and evacuating members of the public from these areas should they be threatened by wildfire.

The Chico Fire Department reviewed the Fire Management section and provided the following recommendations and comments:

- Need additional pull-outs on Upper Park Road.
- Need additional bridges to access south side of Big Chico Creek.
- Need Big Chico Creek crossing or bridge at Ten-Mile House Road for improved fire crew access and safety.
- Continue the ability to use Sheriff's Office helicopter for waterdropping in Park.
- Park Rangers should have Chico Fire Ultra High Frequency (UHF) radios for communications during emergencies.

- Park Department should assure that its tree watering trucks can also be used to fill fire engines during fires in Bidwell Park by having correct hoses and fittings.

- Problems in Butte County affecting safety of Bidwell Park, include 1) no funding for fire lookouts, 2) no funding for the four fire crews previously located in Magalia, and 3) the federal air tanker is no longer located in Chico.

5.4.2 PRESCRIBED BURNING

Despite its increasing use as a natural resource management tool, prescribed fire can frequently be costly to conduct, difficult to coordinate, of questionable value, and potentially dangerous, particularly in wildland-urban interface zones. In developing its prescribed fire program, the City should focus on the implementation of smaller-scale, strategically located prescribed burns. These burns should be designed to meet specific resource goals and objectives and implemented only when resource objectives cannot be addressed in a cost-effective fashion through other vegetation management techniques. Some examples of natural resource management objectives developed for Bidwell Park that can be addressed through prescribed burning include:

- Reducing the probability of extreme wildfire by creating fuel breaks that slow wildfires under less extreme weather conditions and permit access of fire suppression equipment and personnel to strategic locations (NRMP Section 5.2 Objective 1; NRMP Section 3.1.2 Objective 2);

- Increasing oak regeneration (NRMP Section 3.1.2 Objective 1);

- Improving wildlife habitat by encouraging new growth in decadent stands of chaparral (NRMP Section 5.2 Objective 2); and

- Removing or reducing populations of invasive plants (NRMP Section 4.2 Objectives 1, 2, and 3; NRMP Section 5.2 Objective 2).

While the below discussion provides a starting point for the development of a prescribed burning program, the City should ultimately prepare a detailed, programmatic level prescribed burning plan that analyzes and describes these topics in greater detail.

5.4.2.1 PRESCRIBED BURNING PRIORITIZATION

Similar to the procedures described for mapping and prioritizing invasive plant treatments, a procedure should be developed to map and prioritize prescribed burns. This effort can build off existing vegetation maps and geographic information systems technologies to model and map those areas most likely to benefit from prescribed burns. Ideally, the Park should establish fuel load guidelines to specify acceptable fuel load levels within various Park regions (e.g., urban interface areas, wildlands, developed recreation areas, etc.). Acceptable fuel loads can be developed to meet a number of resource management and public safety objectives such as improved oak regeneration and wildlife habitat, protection of Park buildings and recreation areas, creation of shaded fuel breaks (i.e., areas dominated by large trees with limited understory vegetation) to slow wildfire spread, and protection of adjacent property owners. Areas of the Park not meeting fuel load guidelines can then be prioritized for treatment based on the relative threats posed to public safety and ecological function by each site.

5.4.2.2 BURN PLANNING

After prescribed burn treatments have been prioritized, a project level prescribed burn plan should be prepared for each individual burn. At a minimum, this plan should describe the following:

- The location of the burn and the number of acres to be treated;

- Fuels, fire environment, and both best-case and worst-case scenarios for anticipated fire behavior at the treatment site;
- Justification for burning, i.e., why burning is necessary and preferred relative to other vegetation treatment methods;
- Proposed burn prescription detailing the timing of the burn, burning methods (heading or backing burn), control structures, etc.;
- Staffing and logistical issues;
- Potential impacts to neighbors from smoke and the potential for fire escape; Potential impacts to common plant and wildlife species, particularly ground nesting birds;
- Potential impacts to special status plants and wildlife; and,
- Potential impacts to water quality.

The Nature Conservancy has developed a website (www.tncfire.org) containing numerous resources to facilitate the development of prescribed programs and may be consulted for additional resources.

5.4.2.3 BURN IMPLEMENTATION

CDF operates a cost-share program known as the Vegetation Management Program (VMP). This program provides CDF with funds to enter into cooperative agreements with non-Federal partners to implement prescribed burn programs. Through this program, CDF assumes all liability and provides all permitting and staffing for prescribed burns, provided the proposed burn meets the goals and objectives of the California State Fire Plan (one of which is the reduction of hazardous fuels in wildland-urban interface areas). More information on the VMP is available on the Internet at www.fire.ca.gov/ResourceManagement/VegetationManagement.asp. Additionally, the Park can and should continue to use Chico Fire Department crews where possible to implement prescribed burns. In these situations, the City should ensure that it is covered by liability insurance for prescribed fire to indemnify it should a prescribed fire damage or injure third parties. Finally, numerous private contracting firms are located in Chico and surrounding areas that provide prescribed burn planning and implementation services. Such services typically cost several thousand dollars.

Fire breaks are often a necessary component of a prescribed burning or fire suppression effort. Although usually necessary, fire breaks should be constructed in ways that minimize environmental impacts and lessen the spread of invasive plants. For example, disking and other forms of soil disturbance can exacerbate erosion problems, unnecessarily disturb populations of native plants, and provide a mechanism for the dispersal and germination of weed seeds. Fire breaks should be sited to avoid impacts to special status species, wetlands, and riparian areas, and with a minimal amount of ground disturbance. When working in and around populations of invasive plants likely to be spread by seed, bulldozers, tractors, and other equipment used to construct fire breaks should be washed down before used in another location. Alternatives to new fire break construction, such as planning burns to utilize existing fire breaks or features such as roads and trials that can serve as fire breaks, should be explored whenever possible.

Finally, all prescribed burning in the Park, with the exception of prescribed burns carried out by CDF under the VMP program, must comply with CEQA and other applicable environmental regulations.

5.4.3 POST-FIRE REHABILITATION

Loss of vegetation and soil disturbance caused by wildfire and prescribed fire may increase the risk of soil erosion, flooding, and sedimentation which may threaten private property, water quality, and special status of plants and animals. Generally, burned areas should be investigated immediately post-fire to determine those areas in need of immediate attention. Park personnel should focus on severely burned areas, steep slopes, areas where water naturally channels, known locations of special status plants, animals, and cultural resource sites, and unstable slopes immediately adjacent to Park facilities and private property. Typical rehabilitation measures include the seeding of quick growing native species or sterile nonnative species, the application of various mulching materials, and the placement of rice straw wattles or logs perpendicular to slope lines to catch and retain sediments. It may also be necessary to modify culverts along roads to allow for increased water and sediment flow, installing drainage dips on dirt roads, and otherwise modifying roadways to account for increased water and sediment flows and prevent further damage to Park infrastructure.

6 ADDITIONAL RESOURCES

The websites and publications listed below can be consulted for additional information on the topics presented within this document.

Table C.6-1
List of Additional Resources

http://danr.ucop.edu/ihrmp/	University of California Integrated Hardwood Range Management Program – numerous articles and links to publications dealing with oak woodland management and ecology.
http://www.na.fs.fed.us/spfo/pubs/silvics_manual/volume_2/quercus/douglasii.htm	Good overview of blue oak ecology and management issues.
http://www.californiaoaks.org	California Oak Foundation – contains various articles and resources dealing with oak management and conservation.
http://phytosphere.com/coda/	A searchable database of diseases and pathogens that affect oaks in California.
http://www.wcb.ca.gov/Oak Woodlands/oak_woodland_program.html	State of California Oak Woodlands Conservation Program – provides grant funding and other resources for oak woodland conservation and management.
http://www.suddenoakdeath.org	Website of the California Oak Mortality Task Force – provides information and resources concerning sudden oak death.
http://www.weedcenter.org/index.html	Montana State University Center for Invasive Plant Management – information on ecology, distribution and treatment for selected species.
http://pi.cdfa.ca.gov/weedinfo/	California Department of Food and Agriculture, Encycloweedia – noxious weed data sheets, photographs, California weed laws.
http://www.CAL-IPC.org/	California Invasive Plant Council (CAL-IPC) – noxious weed list with ratings, publications, useful links.
http://calflora.org/	CalFlora database – botanical resource including pictures, and distribution and habitat information.
http://tncweeds.ucdavis.edu/	The Nature Conservancy, Wildland Weeds Management and Research Program – weed control methods, information weed documents, adaptive management techniques, photographs.
http://www.nps.gov/plants/alien/	Plant Conservation Alliance, Alien Plant Working Group. Weeds Gone Wild: Alien Plant Invaders of Natural Areas – fact sheets, useful links.
http://www.aphis.usda.gov/ppq/weeds/	U.S. Department of Agriculture, Animal and Plant Health Inspection Service (APHIS), Federal Noxious Weed Program – Federal Noxious Weed List, permitting regulations, eradication techniques.
http://wric.ucdavis.edu/	University of California, Davis Cooperative Extension Weed Research and Information Center – weed education, information and useful links.
http:///www.tncfire.org	Nature Conservancy Fire Management – links for fire training and fire planning
http://frap.cdf.ca.gov	State of California Fire and Resource Assessment Program – fire and related resource data and publications
http://www.fs.fed.us/database/feis/	U.S. Forest Service Fire Effects Information System – summarizes fire impacts on numerous species of plants and animals
http://gacc.nifc.gov/oncc/predictive/weather/index.htm	Northern California Interagency Fire Weather Center – provides detailed fire weather information and forecasts for Northern California

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