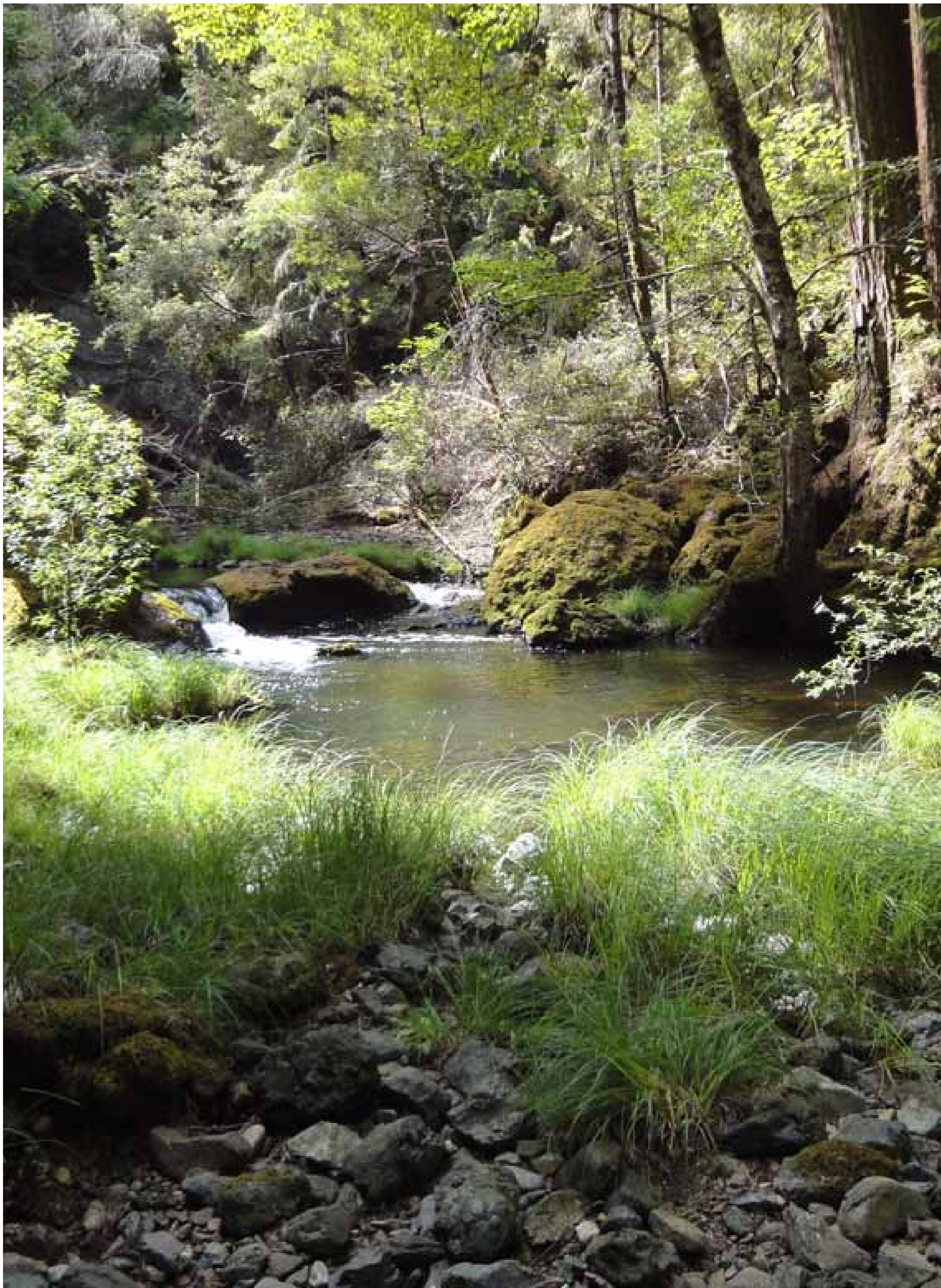
April 30, 2013
Administrative Draft

VEGETATION AND BIODIVERSITY MANAGEMENT PLAN



Marin County Parks

Marin County
Open Space District

MARIN COUNTY
PARKS
PRESERVATION · RECREATION

VEGETATION AND BIODIVERSITY MANAGEMENT PLAN

ADMINISTRATIVE DRAFT

Prepared for:

Marin County Parks
Marin County Open Space District

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The Need for a Plan

Overview of the Marin County Open Space District

The Marin County Open Space District (MCOSD) currently owns and manages 34 open space preserves across Marin County. The preserves are managed for both natural resource protection and recreation. They encompass some of the most ecologically sensitive resources within the county, and they are enjoyed by many thousands of county residents and visitors annually.

The MCOSD preserves contain outstanding examples of northern California's natural vegetation communities, including oak-bay woodlands, savannas, grasslands, and wetlands. As protected areas they support both a high diversity of plants and a large number of rare or locally endemic plants. The preserves are managed to protect, or possibly restore, their natural undeveloped character, while providing for a wide range of visitor uses.

The 34 preserves owned and managed by MCOSD encompass more than 14,650 acres. Additionally the district holds conservation easements on approximately 3,000 acres of private lands that provide important wildlife corridors, public access, and other connections to MCOSD preserves and other protected open space. Visitors and community members access the preserves through a system of more than 250 miles of unpaved roads and trails from more than 280 trailheads. The network of roads and trails lies primarily within the preserves, but MCOSD also holds numerous public trail easements across private lands that link preserves to surrounding communities.

The MCOSD preserves are not contiguous. They are generally situated throughout the southeastern portion of the county (figure 1.1). No preserves currently exist north of the Point Reyes-Petaluma Road. Most of the MCOSD preserves are located in or near population centers and major transportation corridors, reflecting their importance in connecting many of the county's communities with open space at the wildland-urban interface. Most MCOSD preserves are located within walking distance of neighborhoods. In some cases preserves adjoin other lands managed for public use, and in all cases preserves adjoin private property to some extent. MCOSD lands serve as boundaries between many of Marin's cities, towns, and communities.

Figure 1.1 Regional Map of MCOSD Preserves

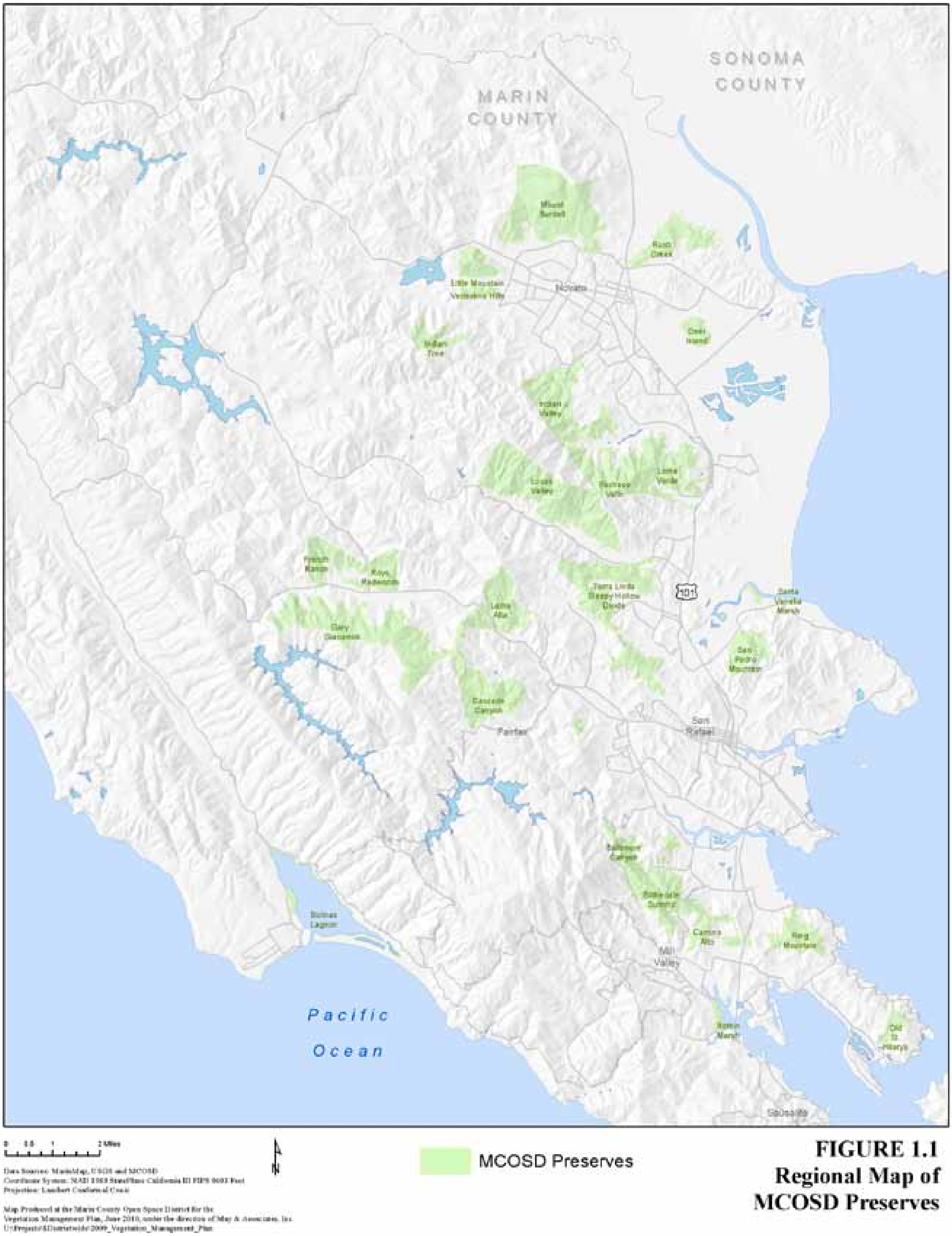


FIGURE 1.1
Regional Map of MCOSD Preserves

The Fundamental Problem Facing Preserve Managers Today

Since its founding, MCOSD has primarily focused on acquiring open space lands and protecting them from development and habitat loss. Vegetation management activities have been conducted primarily to provide emergency and public access and to reduce fire hazard and fire risk. Although MCOSD has long recognized the need to actively manage natural resources and to control and/or eradicate nonnative species on its preserves, such management has been a lower priority due to staffing and funding constraints. The vegetation management that has occurred has been focused on clearing fuelbreaks as impediments to the spread of potential natural or human-caused fires. This clearing has led to an unforeseen acceleration in the infestation of invasive nonnative plants, many of which are more aggressive challengers to access and more dangerous fuel sources than the native vegetation.

As a result, the preserves are now experiencing an accelerating rate of loss and degradation of natural vegetation, which is resulting in a loss of biological diversity, an increasing management burden to maintain roads and trails for emergency and public access, and a buildup of fuels, with an associated increased risk of fire and an increased management burden to reduce that risk.

The magnitude of this problem correlates with the establishment of fuelbreaks and other fuel modification zones within the preserves. Prior to 1994 an estimated 100 acres of fuelbreaks or other fuel modification zones were located on MCOSD lands. From 1995 to 2005 the number of acres of established fuelbreaks increased to 250 acres, and that figure more than doubled again between 2006 and 2010. Currently approximately 528 acres of established fuelbreaks exist within the preserves. The Marin County Fire Department (County Fire), in its 2008 *Marin County Fire Management Plan,* calls for the construction of an additional 70 miles of fuelbreaks, which would require an estimated 1,000 additional acres of fuelbreaks on MCOSD lands. If this plan was implemented by 2014, the result would be a ten-fold increase in direct loss of native vegetation, and in associated costs of maintaining access and managing fuel loads, in the Marin County preserves in less than 20 years. The new fuelbreaks would also open new areas to invasion by nonnative species, whose seeds could disperse from 70 miles along ridgetops to the slopes below.

THE PROBLEM

The MCOSD has experienced an increase of more than 500% in vegetation management responsibilities over the past two decades; including efforts to control fast growing invasive weeds (particularly broom), and impacts on native and special status plants. Most of this increase is related to the modification of native habitat along roads and preserve boundaries for a variety of purposes, including fire protection, maintenance and emergency vehicle access, and recreation. The result has been a degradation in the environmental quality and the biodiversity of the MCOSD preserves.

In resolving this critical problem, preserve managers and staff will need to address a number of issues related to local, regional, and global factors:

- Urban and suburban development is increasing around the MCOSD preserves, with the following consequences:
    - » increased potential for fire ignition, because human activity is the number one source of fire ignition in this climate
    - » additional opportunities for fire to spread from homesites to wildlands
    - » additional opportunities for nonnative ornamental vegetation to spread to wildlands
    - » additional opportunities for domestic animals, especially dogs and cats, to prey on native wildlife and damage or destroy native plants
    - » increased likelihood of high concentrations of recreational use of the preserves
- The use of preserve lands for primary fuelbreaks is increasing, and additional fuelbreaks and defensible space zones are proposed.
- Decades of wildland fire suppression may have increased the potential for more frequent and high-intensity wildfires.
- Native vegetation is being threatened and displaced by new invasive plant outbreaks and by the spread of existing infestations, both of which are occurring at accelerating rates.
- The prevalence and incidence of plant diseases (e.g., California oak mortality syndrome) and insect infestations are increasing and threatening to change the structure and overall health of native plant communities.
- Natural habitat and wildlife dispersal corridors are being fragmented by the loss of native vegetation.
- Global climate change has the potential to change the frequency, intensity, and duration of droughts, floods, heat waves, and cold spells; to cause a rise in sea level and an increase in the intensity and frequency of extreme high-water events; to change the water levels and flow regimes in creeks and streams; and to increase wildfire frequency and intensity.

A new approach to addressing these issues is warranted by the recent advances in the science of vegetation management, the severity of the threats facing natural resources on MCOSD lands, and the magnitude of environmental changes anticipated to occur over the next few decades due to climate change.

Purposes of the Vegetation and Biodiversity Management Plan

The primary purpose of this *Vegetation and Biodiversity Management Plan* for the Marin County preserves is to provide comprehensive, long-term guidance for a new science-based approach to vegetation management that will (1) maintain the natural biodiversity of the vegetation within the preserves, (2) maintain emergency and public access, and (3) manage fuel loads to reduce the threats of the spread of natural and human-caused fires. This comprehensive plan will replace existing preserve-specific vegetation plans, expanding the geographic scope of vegetation management to include all MCOSD preserves, and coordinating management actions based on shared goals and objectives. This plan is not prescriptive. Rather it is a vehicle for decision making about vegetation management projects on MCOSD lands.

PURPOSES OF THE VEGETATION AND BIODIVERSITY MANAGEMENT PLAN

- *Guide a science-based approach to vegetation management that will protect the natural biodiversity of the preserves, maintain public access, and manage fuel loads.*
- *Coordinate all aspects of vegetation management, including invasive plant control, needs for access, and fuel management, across all the MCOSD preserves, to improve program effectiveness and efficiency.*
- *Provide the foundation for a systematic approach to priority setting, budgeting, and staffing, to further improve program efficiency and effectiveness over the long term.*

Existing Guidance

Mission and Operation of the Marin County Open Space District

MCOSD is an independent legal entity and a special district operating pursuant to the *California Public Resources Code* to fulfill the following mission:

> *We are dedicated to educating, inspiring, and engaging the people of Marin in the shared commitment of preserving, protecting and enriching the natural beauty of Marin's parks and open spaces, and providing recreational opportunities for the enjoyment of all generations.*

A five-member board of directors oversees the operations of MCOSD. A seven-member Parks and Open Space Commission advises the MCOSD board of directors on policy matters related to acquisition, development, funding, management, and operation of MCOSD lands. A director oversees the day-to-day operations of MCOSD. MCOSD employs some 30 full-time employees and approximately 20 seasonal employees (seasonal numbers fluctuate annually). Of these employees, 4 work in natural resources, 13 work in maintenance and operations (including the volunteer coordinator), and 13 serve other functions within MCOSD.

Governing and Guidance Documents

This *Vegetation and Biodiversity Management Plan* is consistent with governing plans and policies for MCOSD, including the 2007 *Marin Countywide Plan*, the 2011 *Marin County Strategic Plan*, the 2008 *Marin County Department of Parks and Open Space Strategic Plan*, the 2005 Marin County Open Space Policy Review Initiative, and the 2009 Marin County Integrated Pest Management Ordinance. Table 1.1 summarizes these governing plans and policies as they relate to vegetation management. Additional information, including a summary of preserve-specific plans, is provided in appendix A.

Table 1.1 Summary of Governing Plans, Guidelines, and Policies Related to Vegetation Management

Systemwide Planning and Policy Documents, County Codes	Guidance Relevant to Vegetation Management	
Marin Countywide Plan (2007)	**Relevant Guiding Principles:**	
	1	A Preserved and Restored Natural Environment: Marin watersheds, natural habitats, wildlife corridors, and open space will be protected, restored, and enhanced.
	2	Collaboration and Partnerships: Marin public agencies, private organizations, and regional partners will reach across jurisdictional boundaries to collaboratively plan for and meet community needs.
	3	A Community Safe from Climate Change: Marin will be a leader in averting and adapting to all aspects of climate change.
	Pertinent Goals and Policies:	
	BIO-1	Enhanced Native Habitat and Biodiversity: Effectively manage and enhance native habitat, maintain viable native plant and animal populations, and provide for improved biodiversity throughout the County.
	BIO-2	Protection of Sensitive Biological Resource: Require identification of sensitive biological resources and commitment to adequate protection and mitigation, and monitor development trends and resource preservation efforts.
	BIO-4	Riparian Conservation: Protect and, where possible, restore the natural structure and function of riparian systems.
Marin County Strategic Plan (2001)	The *Marin County Strategic Plan* contains the basic framework for the mission statement, goals, and strategies for Marin County Open Space.	
Marin County Department of Parks and Open Space Strategic Plan (2008)	**Pertinent Fire Policies:**	
	Goal-1	Protect and Restore Our Lands: Protect, restore, and preserve the natural systems of the lands held in trust for current and future generations.
	Goal-2	Grow and Link the County's Systems of Parks, Trails, and Protected Lands: Complete the county's system of parks, open space, and trails. Support the efforts of other agencies, organizations, and communities to fulfill their land preservation and system goals.
	Goal-3	Foster Discovery, Learning, and Stewardship: Engage the community by providing volunteer and educational experiences for people to discover, learn about, protect, and restore their parks and open spaces.
	Goal-5	Lead, Innovate, and Partner: Cultivate partnerships, explore new approaches, and adopt best practices and technologies.
	Pertinent Fire Policies:	
	F-1	MCOSD shall strive to reduce fire hazards on its lands in partnership with local fire agencies and communities, in recognition of the importance of wildfire prevention to every Marin County resident.
	F-2	MCOSD shall strive to plan and conduct fire fuel reduction activities in a manner that protects natural resources.

Table 1.1 Summary of Governing Plans, Guidelines, and Policies Related to Vegetation Management

Systemwide Planning and Policy Documents, County Codes	Guidance Relevant to Vegetation Management	
	F-3	MCOSD shall participate in countywide fire hazard reduction planning.
	F-4	MCOSD shall assess fire hazard conditions when acquiring new lands and in land management planning.
	F-5	MCOSD shall determine annual fire fuel reduction priorities on its lands, in consultation with Marin County's fire agencies.
	F-6	MCOSD shall consider the use of prescribed burns, grazing, and other fire hazard reduction practices to reduce fire hazard and restore or maintain native ecosystems.
	F-7	MCOSD shall encourage adjoining property owners to create defensible space surrounding homes and other improvements.
	F-8	MCOSD shall strive to resolve issues of defensible space in cooperation with Marin County fire agencies, planning authorities, and communities.
	Pertinent Invasive Plant and Wildlife Policies:	
	NN-1	MCOSD shall strive to reduce populations of nonnative species for the benefit of native habitats and species.
	NN-2	MCOSD should collaborate with public agencies, nongovernmental organizations, and landowners in regional and countywide planning to reduce populations of invasive species.
	NN-3	MCOSD shall inventory populations of, establish control priorities for, and develop control strategies for nonnative species.
	NN-4	MCOSD should minimize the unintentional introduction of nonnative species.
	NN-5	MCOSD should support and participate in research concerning the control of nonnative species.
	NN-6	MCOSD shall accommodate remnants of nonnative species when they contribute to historic and cultural landscapes.
	Pertinent Special-Status Species Policies:	
	SS-1	MCOSD shall protect and enhance the habitats of indigenous plants and animals. Those whose survival is threatened, endangered, or tenuous, or whose regional presence is rare, shall be given special protection. Such plants and animals shall be referenced in the following policies as special-status species.
	SS-2	MCOSD should partner with public agencies, nongovernmental organizations, and landowners in regional and countywide efforts to inventory special-status species and to develop regional habitat conservation plans that protect special-status species, wildlife corridors, ecosystems, and biodiversity.
	SS-3	MCOSD shall develop strategies to protect special-status species and their habitats, including strategies to resolve conflicts between public use of District lands and the protection of special-status species and their habitats.
	Pertinent Public Outreach Policies:	
	PO-1	MCOSD shall conduct public outreach to inform Marin County residents and open space visitors of its mission, lands, resources, and programs; to enhance visitor appreciation and the educational value of open space; to encourage compliance with the Open Space District Code; and to promote good relations.
	PO-2	MCOSD shall encourage public participation in its decision-making processes and, specifically, encourage the participation of neighborhoods and communities in discussions of issues affecting their interests.
	PO-3	MCOSD shall direct its public outreach primarily to Marin County residents.
	PO-4	MCOSD shall accommodate non-English speaking visitors by providing outreach in multiple languages.
Marin County Integrated Pest Management Ordinance (2009)	The "Marin County Integrated Pest Management (IPM) Ordinance" (chapter 23.19 of the *Marin County Code*) directs IPM practices to be implemented by all county departments performing pest management. MCOSD, as a special district within the county, does not fall under the existing IPM ordinance; however MCOSD has voluntarily met the requirements of the ordinance for relevant projects on open space lands. The ordinance specifies the creation of the Integrated Pest Management Commission and requires reduction of pesticide use and established pesticide-free zones at playgrounds and landscape areas of health care facilities. The ordinance is amended to include several additional parameters on how to implement IPM practices and on how the public accesses information about pesticide use. The ordinance provides a partial list of pesticides intended for use on county lands that meet all criteria for IPM compliance, possibly expediting the approval process for projects that use these pesticides and herbicides and follow IPM procedures. Among the approved pesticide and herbicide list are plant family-specific herbicides. The ordinance defines the process by which other pesticides and herbicides, not identified on the list, will be evaluated and selected based upon future requests.	

Table 1.1 Summary of Governing Plans, Guidelines, and Policies Related to Vegetation Management

Systemwide Planning and Policy Documents, County Codes	Guidance Relevant to Vegetation Management
Marin County Fire Management Plan (2008)	The Marin County Fire Management Plan Identifies and describes countywide fire hazard management strategies. The plan recommends constructing 70 miles of additional fuelbreaks, including many on MCOSD lands; clearing stands of nonnative trees; and trimming roadside vegetation to reduce fuel loads. The plan includes fuelbreak construction guidelines and fuel-reduction strategies. It includes a fuel hazard assessment and ranking system, with supporting tables and maps. The plan specifies some invasive plant control requirements for broom, including the requirement that broom control be conducted using an integrated pest management approach. Suggested possible treatments include pulling, cutting, burning, and spraying, alone or in combination, for 1 to 3 years, followed by hand pulling of seedlings once general control is achieved.
Marin Sonoma Weed Management Area Strategic Plan (2003)	The Marin Sonoma Weed Management Area Strategic Plan outlines goals to (1) increase the effectiveness of invasive plant management programs, (2) increase public awareness, and (3) advance knowledge of good land stewardship and integrated pest management practices for noxious and invasive plant management, to be achieved through the collaborative efforts of the 18 partners, including MCOSD.
Memorandum of Understanding for the Establishment of a Weed Management Area for the Counties of Marin/Sonoma (2003, updated 2009)	The memorandum of understanding establishes a Marin/Sonoma Weed Management Area (MSWMA), which includes Marin County and southern Sonoma County watersheds. The memorandum proposes that members work cooperatively with willing landowners and managers to develop and implement an integrated, ecological approach to the management of noxious weeds and other invasive plants. It further proposes that members work together within the scope of their respective authorities toward a common goal of achieving sustainable, healthy ecosystems that meet the needs of signatory members and stakeholders.

Goals for the Vegetation and Biodiversity Management Program

Through the development and implementation of this plan, MCOSD will work to achieve five broad goals for the vegetation management program. These goals are intended to elaborate on existing policies, goals, and objectives already developed by Marin County (as illustrated in table 1.2), with a vision for strategically moving the vegetation management program forward into the future.

- **Goal 1**: Work with adjacent public landowners and partner agencies to create a consistent approach to vegetation management issues; establish, prioritize, and standardize vegetation management actions.
- **Goal 2**: Manage vegetation for the preservation and protection of native habitats and native species; ensure that MCOSD preserves can withstand environmental changes over time.
- **Goal 3**: Coordinate vegetation and fire management actions to reduce or eliminate priority invasive plant infestations, increase public safety, protect native habitats and native species, and reduce fire risk.
- **Goal 4**: Provide the public with opportunities to engage in stewardship of MCOSD lands through participation in volunteer vegetation management activities.
- **Goal 5**: Ensure the funding, support, and capacity necessary for the achievement of the other goals.

Table 1.2 How Proposed Vegetation Management Goals Relate to Existing Adopted Goals and Policies

Existing Adopted Goal or Policy	Vegetation and Biodiversity Management Plan Goals				
	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5
Marin Countywide Plan Goals					
Goal: A preserved and restored natural environment	X		X		X
Goal: A community safe from climate change		X			X
Goal: Collaboration and Partnerships … to reach across jurisdictional boundaries to collaboratively plan for and meet community needs	X		X	X	
BIO 1: Enhanced Native Habitat and Biodiversity BIO 2: Protection of Sensitive Biological Resources BIO 4: Riparian Conservation		X	X		
MCOSD Strategic Plan					
Protect and restore our lands.	X	X	X		X
Foster discovery, learning and stewardship.				X	
MCOSD Policies					
Policy NN1: Strive to reduce populations of non-native species for the benefit of native habitats and species. Policy NN7: Accommodate remnants of non-native (invasive) species when they contribute to an understanding of historic and cultural landscapes. Policy SS3: Develop strategies to protect special status species and their habitats, including strategies to resolve conflicts between public use of MCOSD District lands and the protection of Special Status Species and their habitats.	X	X	X		X
Policy F1: Strive to reduce fire hazard on its lands in partnership with local fire agencies and communities. Policy F3: MCOSD shall participate in countywide fire hazard reduction planning. Policy F5: Determine annual fire hazard reduction priorities on its lands, in consultation with Marin County's fire agencies. Policies F8: Strive to resolve issues of defensible space in cooperation with fire agencies, planning authorities, and communities.			X		X

Summary of the Planning Process and Document Overview

In mid-2009, MCOSD began work on preparation of this *Vegetation and Biodiversity Management Plan* with the assistance of many individuals, including MCOSD staff, consultants, technical experts, fire officials, community leaders, elected officials, and the public.

Throughout development of the plan, MCOSD sought input from this diverse group, and a technical advisory panel was used to review resource data and recommend some aspects of a comprehensive vegetation management approach. Public land managers were interviewed to ensure that state-of-the-art information was available to MCOSD staff.

Public outreach for the plan included a series of public workshops to keep the public informed about the progress of plan development, to present a variety of issues and topics during their early development stage, and to get public feedback. Public workshops conducted in support of this plan included the following:

Introduction to the Vegetation and Biodiversity Management Planning Process
June 23, 2009, Marin County Civic Center, San Rafael

Problem Statement and Program Goals
January 13, 2010, Novato; January 26, 2010, Woodacre; and February 3, 2010, Mill Valley

Introduction of Zoning and Public Input on Management Concepts
May 11, 2010, San Rafael; and May 12, 2010, Mill Valley

The planning process has included the following steps, which are reflected in the chapters of this plan, as follows:

Planning Process Step	Chapter
Project Initiation: • Determine the need for a plan. • Determine the purpose of the plan (plan goals). • Review existing guidance. • Recruit technical advisors.	*Chapter 1*
Preserve Conditions Inventory and Assessment: • Summarize existing information about biological resources found on MCOSD lands and the extent of invasive plant infestations and other threats to biological diversity.	*Chapter 2*
Assessment of Regional Trends, Practices, and Science: • Conduct a thorough literature review and contact knowledgeable land managers and technical experts to determine » what has and has not worked » costs associated with various techniques » associated risks and benefits of each technique » how vegetation management actions are accomplished (e.g., paid staff, contract labor, volunteer labor) » what strategies might work best for lands with resource values similar to MCOSD	*Chapter 3*

Planning Process Step	Chapter
Comprehensive, Long-Term Program for Vegetation Management: • Identify long-term objectives and strategies for » program coordination and prioritization » inventory and monitoring » natural resource management » invasive plant control and integrated pest management » fire risk management and fire hazard reduction » forest health management » management for climate change	*Chapter 4*
Plan Implementation: • Identify specific projects for implementing the plan. • Describe the processes to be used in project planning and priority setting. • Describe the role of volunteers in plan implementation.	*Chapter 5*
Assessment and Project Monitoring Protocols: • Establish assessment and monitoring protocols to support planning and adaptive management.	*Chapter 6*
Best Management Practices: • Standardize best management practices to be followed in all future vegetation management actions.	*Chapter 7*

2: PRESERVE CONDITIONS: INVENTORY AND ASSESSMENT

For the purposes of this *Vegetation and Biodiversity Management Plan*, the preserves have been grouped in geographic regions as listed below, and as shown in figure 2.1. These geographic regions reflect the natural clustering of the MCOSD preserves:

Region 1: Baltimore Canyon, King Mountain, Blithedale Summit, Camino Alto, Horse Hill, Alto Bowl

Region 2: French Ranch, Maurice Thorner Memorial, Roy's Redwoods, Gary Giacomini, Loma Alta, White Hill, Cascade Canyon

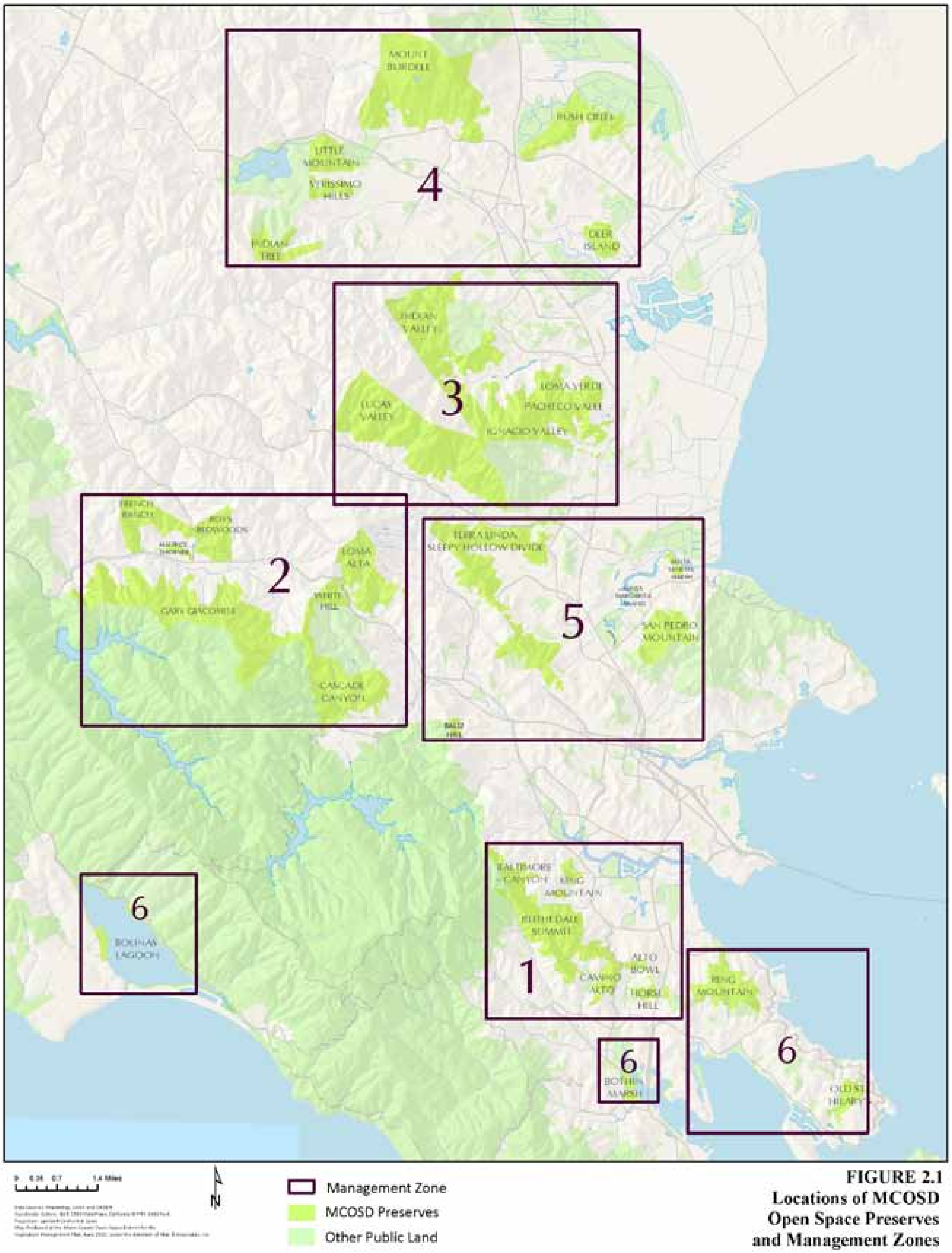
Region 3: Indian Valley, Lucas Valley, Loma Verde, Pacheco Valle, Ignacio Valley

Region 4: Mount Burdell, Rush Creek, Little Mountain, Verissimo Hills, Indian Tree, Deer Island

Region 5: Terra Linda/Sleepy Hollow Divide, Santa Margarita Island, Santa Venetia Marsh, San Pedro Mountain, Bald Hill

Region 6: Ring Mountain, Old St. Hilary's, Bothin Marsh, Bolinas Lagoon, Tiburon Ridge

Figure 2.1 MCOSD Preserves by Geographic Region



The MCOSD preserves range in size from 8 acres to more than 1,600 acres. They protect a great diversity of habitats—ranging from San Francisco Bay salt marshes on the east of the Marin peninsula to valley oak rangelands on Mount Burdell—and outstanding examples of northern California's natural vegetation communities, including oak-bay woodlands, savannas, grasslands, and wetlands. Redwood forests above San Geronimo Valley funnel precipitation to salmon-bearing creeks, and the coastal wetlands of Bolinas Lagoon nurture fish, which in turn support shorebirds and migratory waterfowl.

Special-status plants and wildlife and sensitive plant communities are typically found clustered in areas with unusual geology, soils, aspects, elevations, or combinations of these attributes, conditions that have contributed to the evolution of these unique species. For example, the portion of Mount Tamalpais that receives a marine influence (in the form of summer fog) contains maritime chaparral, a type of chaparral that is associated with several special-status plants. Likewise, areas with serpentine soils support unique serpentine grasslands and serpentine chaparral, both vegetation types that are strongly correlated with species-status species.

Several MCOSD preserves are important links in regional habitat corridors. For example, Blithedale Summit and the southern complex of preserves adjoin Marin Municipal Water District (MMWD), state park, and national park lands to provide a linkage between the waters of San

View from Lucas Valley Open Space Preserve

Francisco Bay and the Pacific Ocean. Mount Burdell and the northern complex of preserves serve to link San Pablo Bay with lands of west Marin and beyond. Figure 2.1 shows the adjacency of the MCOSD preserves with other protected public lands within Marin County.

Collectively, this impressive array of vegetation types provides an important place for hundreds of species to live, as well as a complex tapestry of experiences for visitors to explore. The preserves are managed to protect, or possibly restore, their natural undeveloped character, while providing for educational activities and visitor uses such as hiking, horseback riding, mountain biking, and viewing nature. The MCOSD preserves—together with the watershed lands managed by MMWD and extensive federal and state lands—contribute to Marin County's reputation as a highly desirable place to live and work.

Vegetation must be actively managed to reduce fire hazards and to protect biodiversity. The conservation of the rich variety of habitats and vegetation types within the preserves will help ensure the resiliency of these communities to adapt to environmental changes. Strategic vegetation and biodiversity management requires information about the distribution, affinities, and behavior of both native and invasive plants. This information can assist MCOSD staff with developing vegetation management approaches that protect sensitive species and sensitive natural communities, while restoring areas impaired by threats such as invasive plants and pathogens. Understanding the biological setting of individual preserves will help land managers make better decisions about vegetation management.

The preserves are characterized as having high biodiversity (Howell et al. 2007; Howell 1986). The full taxonomic richness of MCOSD lands is not well understood at this time, so many more species of wildlife, lichens, mosses, fungi, and insects are likely to occur than are currently known to occur on the MCOSD preserves. (More complete surveys conducted on MMWD lands have identified more than 900 species of vascular plants and at least 400 species of vertebrates; MMWD 2009a). A California Department of Fish and Wildlife Natural Diversity Database (CNDDB) records search identified at least 51 special-status plants, including six that are federally or state listed as rare, threatened, or endangered, on MCOSD lands. Additionally, MCOSD lands support at least 11 special-status wildlife species (Marin County Community Development Agency 2007; California Department of Fish and Wildlife 2009) (see table B.1 in appendix B). A preserve wide vegetation mapping survey (California Native Plant Society 2004) identified 107 native plant communities or vegetation associations/alliances, which are referred to in this *Vegetation and Biodiversity Management Plan* as "vegetation types."

The key characteristics of each preserve are identified in table 2.1. This table presents a summary of the best available data, as it is not possible to capture detailed characteristics for the thousands of acres of MCOSD lands in a single table. MCOSD will continue to collect information and to expand and fill gaps in its databases in order to refine future vegetation management actions (see "Inventory, Assessment, and Monitoring" in chapter 4).

Infestations of invasive plants are also found within the majority of the MCOSD preserves (Shelterbelt Builders, Inc. 2008). Invasive plants threaten the integrity of natural habitats and tend to be clustered in areas of disturbance such as along roads, trails, fuelbreaks, waterways, and utility corridors. They are also found in areas where soils are frequently disturbed (e.g., mowed, graded, or scraped areas) and in areas adjacent to developed lands. These clusters of invasive plants often become entrance points for the continued spread of invasive species outward from the existing infestation cluster and into the preserves. Many of these invasives are highly pyrophitic. A list of nonnative plants known to exist in the preserves is contained in table C.1 in appendix C.

Impacts on vegetation are most likely in areas of high human population density and high visitor use. Human impacts can include disruption of wildlife by domestic pets, introduction or expansion of invasive plants, and degradation of vegetation from human trespass and use (e.g., green waste dumping, trespass, creation of undesignated trails). Humans and homes are also the primary sources of ignition for fire. Undeveloped land is less available or common in more urbanized areas, and so the remaining patches of natural habitat tend to be smaller in size and have relatively large wildland-urban interfaces (defined as the area where developed lands adjoin undeveloped wildlands). Wildfire concerns are greatest along this wildland-urban interface, due to increased likelihood of human-caused ignition and the closer association of wildland vegetation with human structures. MCOSD preserves are an important buffer between developed lands and other protected lands managed by other public land management agencies. The preserves are often gateways to larger protected lands, and they often reduce the level of human use impacts on the more distant protected lands.

The protection of a diverse array of native and special-status species will help ensure that MCOSD preserves can withstand and be resilient to environmental changes. Specifically, areas of high biological diversity provide important ecological functions, such as food and shelter for wildlife species, natural water purification and filtration, storage of carbon in living plant tissue and in soils, and other essential ecological functions. Biologically diverse areas are more able to withstand and adapt to global warming, climate change, and other unknown future environmental changes. If managed for biological diversity, MCOSD lands likely can serve as a refuge and as a migratory corridor for a variety of native species, helping to ensure that those species and vegetation types are present for future generations to experience.

Table 2.1 Summary of Preserve Conditions

Preserve Name, Size, and Perimeter	Sensitive Natural Resources	Known Special-Status and Locally Rare Species	Management Challenges	History and Local Setting	Vegetation Management, Maintenance and Stewardship	Comments
Alto Bowl Area = 38 acres Perimeter = 2.1 miles	Sensitive Vegetation Type(s): • Madrone, California bay, tanoak (S) Wetlands: • Sutton manor creek		Uneven grazing with 20% of grassland overgrazed and 50% ungrazed. Important invasive plants include: • Genista monspessulana (French broom) • *Eucalyptus globulus* (blue gum eucalyptus) • Senecio mikanoides (Cape ivy)	Former dairy ranches - Tunnel Ranch and Alto Dairy - until 1940. Parcels acquired in 1974, 1985, and 1990.	The three springs were successfully enclosed in large grazing exclosures, and replanted with native species. No recent monitoring has been conducted but staff believes the spring fencing project was a success. Broom patch near PG&E tower was removed.	
Bald Hill Area = 31.4 acres Perimeter = 1.5 miles	Sensitive Vegetation Type(s): • Coyote brush alliance (F) • Madrone, California bay, tanoak (S) • Redwood, madrone (F)		Important invasive plants include: • *Hedera helix* (English ivy) • *Vinca major* (periwinkle) • Genista monspessulana (French broom)	Parcels acquired in 1994 and 1995. Shares a boundary with MMWD land.		No maintained trails.
Baltimore Canyon Area = 194 acres Perimeter = 5.2 miles	Sensitive Vegetation Type(s): • California bay, canyon oak (f) • California buckeye alliance (F) • Chamise, eastwood manzanita (G2) • Cliffs, rock outcrops (S) • Eastwood manzanita alliance (S) • Giant chinquapin alliance (F) • Interior live oak- eastwood manzanita (S) • Madrone alliance (S) • Madrone, California bay, tanoak (s) • Redwood, madrone (F) • Redwood, riparian (F) • Redwood-upland mixed hardwoods (S) • Redwood/chinquapin (G2) • Tanoak, California bay, canyon oak mixed forest (F) Wetlands: • Headwaters of Larkspur Creek. Numerous springs	Special-Status Plants: • Amorpha californica var. napensis (indigo bush), R • *Boschniakia hookeri* (coast ground cone), R • Eriogonum luteolum var. caninum (Tiburon buckwheat), R • Streptanthus glandulosus ssp. pulchellus? (Mt. Tamalpais jewelflower) Special-Status Wildlife: • *Onchorhynchus mykiss irideus* (central California coast steelhead), C • *Accipiter cooper* (Cooper's hawk), C • *Accipiter striatus* (sharp-shinned hawk), C • *Contopus cooper* (olive-sided flycatcher), C Locally Rare Species: • *Calandrinia breweri* (Brewer's redmaids), R • Ceanothus velutinus var. hookeri (Hooker's tobacco brush), R • *Strix occidentalis caurina* (northern spotted owl) nesting buffer R • Lupinus albifrons (host plant of mission blue butterfly, Icaricia icarioides missionensis, C	Contains dense infestations of broom, numerous acres/miles of proposed fuel breaks in mixed chaparral Important invasive plants include: • Genista monspessulana (French broom) • Acacia decurrens (green wattle)	Redwoods were logged in the mid-1800s, all in less than one decade. West property boundary is shared with MMWD.		
Blithedale Summit Area = 615 acres Perimeter = 8.1 miles	Sensitive Vegetation Type(s): • Chamise, eastwood manzanita (G2) • Douglas-fir, California bay/interior live oak (F) • Eastwood manzanita alliance (S) • Giant chinquapin alliance (F) • Interior live oak- eastwood manzanita (S) • Madrone, California bay, tanoak (S) • Redwood alliance (F) • Redwood, madrone (F) • Redwood, riparian (F) • Redwood-upland mixed hardwoods (S) • Redwood/tanoak (F)	Special-Status Wildlife: • *Strix occidentalis caurina* (Northern spotted owl) nesting buffer R or C • *Accipiter cooperi* (Cooper's hawk), C • *Accipiter striatus* (sharp-shinned hawk), C • *Contopus cooperi* (olive-sided flycatcher), C Locally rare species: • Rhododendron macrophyllum (coast rhododendron), R • *Arctostaphylos montana* expected to occur but not reported	Fuelbreaks are infested with broom, while recently cleared fuelbreaks are broom free but likely to be invaded. Must be actively managed. Contains miles/acres of proposed primary fuelbreaks along ridge top roads in mixed chaparral Important invasive plants include: • Ageratina adenophora (thoroughwort) • Genista monspessulana (French broom) • Cortaderia jubata (pampas grass) • Acacia decurrens (green wattle)	Shares property boundary with MMWD. Saved from development in the 1970s.		

Table 2.1 Summary of Preserve Conditions

Preserve Name, Size, and Perimeter	Sensitive Natural Resources	Known Special-Status and Locally Rare Species	Management Challenges	History and Local Setting	Vegetation Management, Maintenance and Stewardship	Comments
Bolinas Lagoon Area = 1064.2 acres Perimeter = 9.3 miles	Sensitive Vegetation Type(s)/Other Habitats: Wetlands: • Salt marsh (high, intermediate, low marsh) • Brackish marsh • Seasonal wetlands Monterey pines host important heron and egret colonies; even if the colony site becomes inactive, value of the trees to nesting herons and egrets should be protected for 10+ years before considering removal. High marsh ecotone at Kent Island is the only location in California that includes a zonation from Vancouver wildrye (*Leymus* x *vancouveriensis*), red fescue (*Festuca rubra*) to saltgrass, pickleweed.	Special-Status Plants: • Astragalus pycnostachyus var. pycnostachyus (marsh milk vetch), R • Castilleja ambigua ssp. humboldtiensis (Humboldt Bay owl's clover), R • Cordylanthus maritimus ssp. palustris (Point Reyes bird's beak), R Special-Status Wildlife: • *Strix occidentalis caurina* (northern spotted owl) nesting buffer R or C • *Accipiter cooperi* (Cooper's hawk), C • *Accipiter striatus* (sharp-shinned hawk), C • Contopus cooperi (olive-sided flycatcher), C: • *Rana draytonii* (California red-legged frog), C Locally rare species: • *Polygonum marinense* (Marin knotweed) may be present.	*Lepidium latifolia* occurrences recently detected along shoreline. Lagoon in adjacent seadrift is a regionally important source of invasive green crabs. Important invasive plants include: • Ageratina adenophora (thoroughwort) • *Ammophila arenaria* (European beach grass) • Carpobrotus edulis (iceplant) • Cupressus macrocarpa (Monterey cypress) • Lepidium latifolia (pepperweed) • *Pinus radiata* (Monterey pine) • Spartina alterniflora (smooth cordgrass)	Management turned over to MCOSD in 1988 from Marin County Parks Dept. Audubon Canyon Ranch owns a portion of Kent Island and has expressed interest in cooperating with restoration work. Adjacent properties owned by California Department of Parks and Recreation and National Park Service.	MCOSD collaborated with other agencies to obtain funding through the Marin-Sonoma WMA to remove invaders along the Hwy 1 shoreline. The Invasive Spartina Project removed a population of *Spartina alterniflora* by tarping and continues to resurvey the lagoon each summer. Proposal recently submitted for invasive plant removal on 23 acres of Kent Island; restoration of native woody shrubs (e.g., *Grindelia* or willows) near the colony might provide cover for fledging young.	The lagoon was the type locality of the rare *Astragalus pycnostachyus* ssp. *pycnostachyus*, where it has not been detected for many decades. Restoration potential
Bothin Marsh Area = 111.8 acres Perimeter = 3.1 miles	Sensitive Vegetation Type(s): Wetlands: • Salt marsh (high, intermediate, low marsh) • Brackish marsh • Seasonal wetlands	Special-Status Plants: • *Cordylanthus maritimus* ssp. *palustris* (Point Reyes bird's beak), R • *Plagiobothrys glaber* (hairless popcorn-flower): plants presumed extinct in California, last confirmed in 1954; Special-Status Wildlife: • *Phalacrocorax auritus* (double-crested cormorant) • Egretta thula (snowy egret) nests • *Numenius americanus* (long-billed curlew) • Pandion haliaetus (osprey)nests • Rallus longirostris obsoletus (California clapper rail) • *Reithrodontomys raviventris* (salt marsh harvest mouse)	Paved multi-use path may allow predators to access salt marsh harvest mouse habitat. Acacia trees may provide perches enabling raptor predation on mice. A large corner of the marsh has dense broom and fennel growing on fill. Important invasive plants include: • Foeniculum vulgare (fennel) • Carpobrotus edulis (iceplant) • *Acacia dealbata* (silver wattle) • *Salsola soda* (glasswort) • Genista monspessulana (French broom)	North and South Basins are essentially man made marshes. 1851 map shows tidal marshes extending to base of the hills. Dikes built in 1950s and 1960s. Shellmound in North Basin. Filling and building in 1970s. Acquired in 1976. Pathway (old railroad right of way) acquired in 1981 through Rails to Trails Program.	2008 grant-funded restoration project with Save The Bay removed invasive plants and replanted natives.	
Camino Alto Area = 164.5 acres Perimeter = 5 miles	Sensitive Vegetation Type(s): • Madrone, California bay, tanoak (S) • Redwood alliance (F) Wetlands: • Creeks, riparian woodlands	Special-Status Wildlife: • *Strix occidentalis caurina* (northern spotted owl) nesting R	Numerous social trails; major road erosion; fuelbreaks with long-term broom populations; heavy public use with dogs. Important invasive plants include: • *Cistus creticus* (pink rock rose) • Genista monspessulana (French broom) • Acacia	Northridge acquisition from 1970s City of Mill Valley did most of the vegetation management in this preserve until the late 1990s, when they were fined by the USFWS for ignoring spotted owl protection guidelines. This action caused MCOSD to implement its own spotted owl monitoring program and to take over vegetation management of the preserve, although Mill Valley Fire still provides fiscal support for projects.		

Table 2.1 Summary of Preserve Conditions

Preserve Name, Size, and Perimeter	Sensitive Natural Resources	Known Special-Status and Locally Rare Species	Management Challenges	History and Local Setting	Vegetation Management, Maintenance and Stewardship	Comments
Cascade Canyon Area = 497 acres Perimeter = 8.3 miles	Sensitive Vegetation Type(s): • Black oak alliance (F) • California bay, alder, big leaf maple, willow riparian forest (S) • Canyon oak alliance (F) • Chamise, eastwood manzanita (G2) • Chamise-serpentine chaparral (S) • Cliffs, rock outcrops (S) • Coyote brush alliance (F) • Eastwood manzanita alliance (S) • Interior live oak alliance (F) • Interior live oak- eastwood manzanita (S) • Leather oak, chamise, Mt. Tamalpais manzanita serpentine chaparral (F) • Madrone alliance (S) • Madrone, California bay, tanoak (S) • Mt. Tamalpais manzanita-chamise (G2) • Native temperate perennial grasslands (F) • Oregon oak alliance (F) • Rocky serpentine grasses (S) • Serpentinebalds (G2) • Upland serpentine grassland (G2) • Valley oak alliance (F) • Valley oak riparian mapping unit (F) • Valley oak/grass (S) • Wetland serpentine grassland (W) Wetlands: • Pine Mountain Creek • Cascade Falls Creek • Carey Camp Creek • Rush Creeks • Vernal pool • Numerous springs (including serpentine seep) • Riparian Woodlands	Special-Status Plants: • Amorpha californica var. napensis (indigo bush), R • *Amsinkia lunaris* (bent-flowered fiddleneck), • *Arctostaphylos hookeri* ssp. *Montana* (Mt. Tamalpais manzanita), • *Lessingia micradenia* var. *micradenia* (Mt. Tamalpais lessingia), R or C • *Streptanthus glandulosus* ssp. *pulchellus* (Mt. Tamalpais jewelflower), C Special-Status Wildlife: • *Contopus cooperi* (olive-sided flycatcher) • *Strix occidentalis caurina* (northern spotted owl) nesting • Onchorhynchus (central California coast steelhead), C • Accipiter cooper (Cooper's hawk), C • *Oncorhynchus tshawytscha* (chinook salmon), potential habitat, R • *Accipiter striatus* (sharp-shinned hawk), C • Antrozous pallidus (pallid bat), C • *Taxidea taxus* (American badger), C • *Elanus leucurus* (white-tailed kite), C • *Ammodramus savannarum* (grasshopper sparrow), C Locally Rare Species: • *Arctostaphylos manzanita* ssp. *manzanita* (common manzanita, southern range limit is in Marin), • *Aquilegia eximia* (common namexx), C • *Calandrinia breweri* (Brewer's claytonia), C • *Calamagrostis ophitidis* (serpentine reedgrass), R or C • *Calystegia collina* ssp. *oxyphylla* (St. Helena morning-glory), C • *Navarretia heterodoxa* (Calistoga navarettia), R • Piperia unalascensis, (few in Marin), C	Bike trails: vegetation in Cascade Canyon bottomlands along San Anselmo Creek has been displaced by the road system and the several recognized and non-recognized trails in the area. Extensive and large populations of French broom in existing fuelbreaks can spread and invade new fuelbreaks. Important invasive plants include: • Centaurea solstitialis (yellow starthistle) • Genista monspessulana (French broom)	Grazing - Bottini Ranch - until 1914. Hunting - "Elliot Nature Preserve" – from mid 1900s to 1970s. Parcels purchased in 1974, 1976, 1978, 1987, 1994, and 1995. Cascade Canyon Bottomlands and Cascade Canyon fire trail are very heavily used. Access and user group conflicts. Shares boundary with MMWD land.	MCOSD focus has been on treating small, isolated populations of French Broom in native vegetation. In 2009, broom was removed in one section of the lower WUI primary fuelbreak. Volunteers have removed areas of broom, but it is not adequately tracked. 2K/year, hand removal.	The 38-acre Elliott Nature Preserve is owned by the town of Fairfax and sits within the preserve.
Deer Island Area = 158.4 acres Perimeter = 2.2 miles	Sensitive Vegetation Type(s): • Estuarine marsh habitats (W) • Madrone aliance (S) • Poison oak alliance (F) • Temporarily flooded or saturated meadow edge (W) • Undifferentiated marsh (W) • Valley oak riparian mapping unit (F) • Valley oak, coast live oak (S) • Valley oak/grass (S) Wetlands: • Estuarine marsh habitats (W) • Novato Creek and Deer Island Channel Creek run outside preserve edges	Special-Status Plants: Locally Rare Species: • *Aster radulinus* (rough leaf aster), R • *Leptosiphon acicularis* (needle-leaved yellow linanthus), R • *Piperia elegans* (coast piperia), R	Important invasive plants include: • Centaurea solstitialis (yellow starthistle) • Hypericum perfoliatum (St. Johns wort) • Lepidium latifolia (pepperweed)	Island until late 19th century and diked and drained for pasture land. History of ranching since 1890. Parcels acquired in 1978 and 1983 (9-acre grazing lease ended). Property is surrounded by parcels owned by Marin Public Works Department/Flood Control, Novato Sanitary District, California Department of Fish and Wildlife, Marin Audubon Society.	Initial treatment of a large population of *Lepidium latifolia* cut and treated by Shelterbelt Builders, Inc. (2009)	

Table 2.1 Summary of Preserve Conditions

Preserve Name, Size, and Perimeter	Sensitive Natural Resources	Known Special-Status and Locally Rare Species	Management Challenges	History and Local Setting	Vegetation Management, Maintenance and Stewardship	Comments
French Ranch Area = 383.4 acres Perimeter = 5.2 miles	Sensitive Vegetation Type(s): • Chamise, eastwood manzanita (G2) • Chamise-serpentine chaparral (S) • Eastwood manzanita alliance (S) • Madrone, California bay, tanoak (S) • Mesic trending chaparral (S) • Mt. Tamalpais manzanita-chamise (G2) • Poison oak alliance (F) • Rocky serpentine grasses (S) • Upland serpentine grassland (G2) Wetlands: • Clear Creek • Riparian woodlands	Special-Status Plants: • *Arctostaphylos hookeri* ssp. *montana* (Mt. Tamalpais manzanita), R • *Eriogonum luteolum* var. *caninum* (Tiburon buckwheat), R • *Hemizonia congesta* ssp. *congesta* (hayfield tarweed), R • *Lessingia micradenia* var. *micradenia* (Mt. Tamalpais lessingia), R Special-Status Wildlife: • *Strix occidentalis caurina* (northern spotted owl) nesting buffer • *Accipiter cooperi* (Cooper's hawk), C • *Accipiter striatus* (sharp-shinned hawk), C • *Contopus cooperi* (olive-sided flycatcher), C • *Elanus leucurus* (white-tailed kite), C • *Ammodramus savannarum* (grasshopper sparrow), C • Antrozous pallidus (pallid bat), C • *Taxidea taxus* (American badger), C Locally Rare Species: • *Aspidotis californica* (California lace fern), R • *Calamagrostis ophitidis* (serpentine reed grass), R • Leptosiphon acicularis (bristly linanthus), R • *Sellaginella wallacei* (Wallace spike-moss, southern range limit is in Marin) • Zigadenus micranthus var. fontanus (marsh zigadenus), C	Dead vegetation from California oak mortality syndrome is prevalent in Douglas-fir-California bay vegetation. Important invasive plants include: • Cytisus scoparius (Scotch broom)		Broom removal prompted by removal of broom on neighboring property. Starting in 2008, annual cost has been 1K/year with 2K spent to date.	
Gary Giacomini Area = 1468 acres Perimeter = 20.6 miles	Sensitive Vegetation Type(s): • Bishop pine/eastwood manzanita (G2) • California bay, canyon oak (F) • California bay, tanoak (F) • California bay, alder, big leaf maple, willow riparian forest (S) • Canyon oak alliance (F) • Chamise, eastwood manzanita (G2) • Chamise-serpentine chaparral (S) • Coast live oak, douglas-fir (F) • Coyote brush alliance (F) • Douglas-fir, tanoak (F) • Douglas-fir (pure) (F) • Douglas-fir, California bay/interior live oak (F) • Eastwood manzanita alliance (S) • Giant chinquapin alliance (F) • Interior live oak alliance (F) • Interior live oak- eastwood manzanita (S) • Madrone alliance (S) • Madrone, California bay, tanoak (S) • Mesic trending chaparral (F) • Mt. Tamalpais manzanita alliance (G2) • Mt. Tamalpais manzanita-chamise (G2) • Mt. Tamalpais manzanita-\ with sparse Douglas-fir emergent (S) • Native temperate perennial grasslands (F) • Poison oak alliance (F) • Redwood, riparian (F) • Redwood-upland mixed hardwoods (S) • Redwood/tanoak (F) • Rocky serpentine grasses (S)	Special-Status Plants: • *Arctostaphylos hookeri* ssp. *montana* (Mt. Tamalpais manzanita), C • *Calochortus umbellatus* (Oakland star-tulip), R • *Cirsium hydrophilum* var. *vaseyi* (Mt. Tamalpais thistle), C • *Hemizonia congesta* ssp. *congesta* (hayfield tarweed), R • *Hesperolinon congestum* (Marin western flax), R • *Lessingia micradenia* var. *micradenia* (Mt. Tamalpais lessingia), R • *Navarretia rosulata* (Marin County navarettia), R • *Stebbinsoseris decipiens* (Santa Cruz microseris), R • *Streptanthus batrachopus* (Mt. Tamalpais jewelflower), R • *Streptanthus glandulosus* ssp. *pulchellus*??? (Mt. Tamalpais jewelflower Special-Status Wildlife: • *Strix occidentalis caurina* (northern spotted owl) nesting buffer C • *Oncorhynchus mykiss irideus* ((central California coast steelhead), C • Oncorhynchus kisutch (coho Salmon), C • *Accipiter cooperi* (Cooper's hawk), C • *Accipiter striatus* (sharp-shinned hawk), C • *Elanus leucurus* (white-tailed kite), C • *Ammodramus savannarum* (grasshopper sparrow), C • *Contopus cooperi* (olive-sided flycatcher), C • Antrozous pallidus (pallid bat), C	Dead vegetation from California oak mortality syndrome is very abundant in western portions of the preserve. Important invasive plants include: • Genista monspessulana (French broom) • Phalaris aquatica (Harding grass) • Silybum marianum (milk thistle) • Cytisus scoparius (Scotch broom) There is a large network of illegal trails in this preserve that cut through manzanita and other native plant communities.	Parcels purchased from developers in 1991 and 1995. MMWD shares the western boundary of preserve. Cortez Fire Road was converted from narrow trail trail to fire road in 2007 after pressure from local residents to provide an escape route in case of wildland fire.		

Table 2.1 Summary of Preserve Conditions

Preserve Name, Size, and Perimeter	Sensitive Natural Resources	Known Special-Status and Locally Rare Species	Management Challenges	History and Local Setting	Vegetation Management, Maintenance and Stewardship	Comments
	• Sargent cypress (F) • Sargent cypress alliance (F) • Sargent cypress/Mt. Tamalpais manzanita (G1) • Serpentine balds (G2) • Tanoak alliance (F) • Upland deciduous shrubs (F) • Upland serpentine grassland (G2) • Valley oak riparian mapping unit (F) Wetlands: • San Geronimo Creek • Montezuma Creek • Candelero Creek • Creamery Creek • Deer Camp Creek • Bates Canyon Creek • Woodacre Creek • Pine Mountain Creek • Riparian woodlands	• *Taxidea taxus* (American badger), C • *Syncaris pacifica* (California freshwater shrimp)[1] C Locally Rare Species: • *Aquilegia eximia* (Van Houtte's columbine), R (only 3 populations in Marin) • Arctostaphylos virgata (Marin manzanita), R • *Arabis blepharophylla*, (coast rock cress), R or C • *Calamagrostis ophitidis* (serpentine reed grass), R • *Ceanothus velutinus* (tobacco brush), R • *Elymus californicus* (California bottle brush grass), R • Fremontodendron californicum (California fremontia), R • *Leptosiphon acicularis* (bristly linanthus), R • *Navarretia heterodox* (Calistoga navaretia), R • *Sidalcea hickmannii* ssp. *viridis* (Marin checkerbloom) may be present, C • Zigadenus micranthus var. fontanus (marsh zigadenus), R				
Horse Hill Area = 49.4 acres Perimeter = 1.6 miles	Wetlands: • Three springs occur on the preserve	Special-Status Plants: • *Hemizonia congesta* ssp. *congesta* (hayfield tarweed), R	Horses have created numerous trails. Springs are grazed. Oak groves are suffering from soil compaction and poor regeneration. Brooms, *Cortaderia*, C*entaurea calcitrapa*, *C. solstitialis*, identified as priorities for control Important invasive plants include: • Dipsacus sativus (teasel) • *Oxalis pes-caprae* (Bermuda buttercup) • Genista monspessulana (French broom)	Horses have grazed Horse Hill for over 40 years. At least 3 prehistoric archaeological sites identified. Purchased in 1995. Privately owned horses (max. 14) are grazed over 60 acres, including land belonging to Mill Valley Meadows Homeowners' Association. It is assumed that equine use is the dominant use of Horse Hill and will remain so for the foreseeable future.	*Dipsacus* removal underway. Broom patch near PG&E tower removed.	
Ignacio Valley Area = 904.6 acres Perimeter = 15.1 miles	Sensitive Vegetation Type(s): • Black oak alliance (F) • California bay, buckeye (F) • California bay, alder, big leaf maple, willow riparian forest (S) • Chamise, eastwood manzanita (G2) • Interior live oak- eastwood manzanita (S) • Madrone alliance (S) • Madrone, California bay, tanoak (S) • Mesic trending chaparral (S) • Upland deciduous shrubs (F) • Valley oak riparian mapping unit (F) • Valley oak, coast live oak (S) Wetlands: • Arroyo de San Jose Creek • Two unnamed creeks. • Riparian woodlands	Special-Status Plants: • Streptanthus glandulosus pulchellus(Mount Tamalpais jewelflower) Special-Status Wildlife: • *Accipiter cooperi* (Cooper's hawk), C Locally Rare Species: • *Datisca glomerata* (Durango root)[2], C • Leptosiphon acicularis (bristly linanthus), C • *Lupinus albifrons* (silver lupine)[3], host plant for mission blue butterfly, C	Important invasive plants include: • Genista monspessulana (French broom)	Purchased in 1975.		

[1] Unverified but likely in lower Willis Evans Canyon
[2] Formerly known from a single specimen found at the adjacent Indian Valley Open Space (presumed to have been "imported accidentally". A substantial population of this species was subsequently discovered on this preserve
[3] Foodplant of mission blue butterfly, (*Icaricia icarioides missionensis), C*

Table 2.1 Summary of Preserve Conditions

Preserve Name, Size, and Perimeter	Sensitive Natural Resources	Known Special-Status and Locally Rare Species	Management Challenges	History and Local Setting	Vegetation Management, Maintenance and Stewardship	Comments
Indian Tree Area = 227.1 acres Perimeter = 4.7 miles	Sensitive Vegetation Type(s): • Chamise, eastwood manzanita (G2) • Madrone alliance (S) • Purple needlegrass (F) • Redwood, riparian (F) • Valley oak, coast live oak (S) Wetlands: • Vineyard Creek and one unnamed creek • Riparian woodlands	Special-Status Plants: • *Hemizonia congesta* ssp. *congesta* (hayfield tarweed), R Locally Rare Species: • *Arctostaphylos manzanita* ssp. *manzanita* (common manzanita), R southern range limit is in Marin • Leptosiphon acicularis (bristly linanthus), R	Important invasive plants include: • Phalaris aquatica (Harding grass) • Centaurea solstitialis (yellow starthistle)	Purchased in 1977. Previously part of French Ranch. Adjacent properties owned by Marin Agricultural land Trust and North Marin Water District.		No road access.
Indian Valley Area = 613 acres Perimeter = 5.2 miles	Sensitive Vegetation Type(s): • California bay, alder, big leaf maple, willow riparian forest (S) • Cattail alliance (W) • Chamise, eastwood manzanita (G2) • Madrone alliance (S) • Madrone, California bay, tanoak (S) • Small ephemeral ponds (W) • Tall temperate annual graminoids (F) • Valley oak, coast live oak (S) Wetlands: • Arroyo Avichi, south fork • One unnamed creek • Riparian woodlands	Special-Status Plants: • *Hemizonia congesta* ssp. *congesta* (hayfield tarweed), R Special-Status Wildlife: • *Accipiter cooperi* (Cooper's hawk), C • *Elanus leucurus* (white-tailed kite), C • Antrozous pallidus (pallid bat), C • *Taxidea taxus* (American badger), C Locally Rare Species: • *Arctostaphylos manzanita* ssp. *manzanita* (common manzanita), R southern range limit is in Marin • Leptosiphon acicularis (bristly leptosiphon), R • *Sellaginella wallacei* (Wallace spike-moss), R southern range limit is in Marin • *Stylomeccon heterophylla* (wind poppy), R unusual in Marin	Dead vegetation from California oak mortality syndrome is prevalent in lower elevation mixed broadleaf vegetation. Important invasive plants include: • Genista monspessulana (French broom) • Phalaris aquatica (Harding grass) • Centaurea solstitialis (yellow starthistle)	First parcel purchased in 1975. Previously part of the Back Ranch.		Golf course plant selection, dumping or some disturbance may have allowed invasive plants to establish on preserve.
King Mountain Area = 101.9 acres Perimeter = 6.4 miles	Sensitive Vegetation Type(s): • Madrone alliance (S) • Madrone, California bay, tanoak (S) • Redwood, madrone (F)	Special-Status Plants: • *Arctostaphylos hookeri* ssp. *Montana* (Mt. Tamalpais manzanita), • *Grindelia hirsutula* var. *maritima* (San Francisco gumplant) C • Historic site for *Pentachaeta bellidiflora (*whiteray pygmydaisy), thought to be extirpated from Marin, almost extinct Special-Status Wildlife: • *Strix occidentalis caurina* (northern spotted owl) nesting buffer	Important invasive plants include: • Genista monspessulana (French broom)	Ranching in late 1800. Goats grazing in early to mid-1900s. Parcels acquired in 1988 and 1990.	The volunteer program has been active in broom eradication efforts in this preserve for years, but there are still massive infestations present.	Potential reintroduction site for *Pentachaeta bellidiflora* (white ray pygmy daisy.
Little Mountain Area = 230.1 acres Perimeter = 3.2 miles	Sensitive Vegetation Type(s): • Mesic trending chaparral (S) • Valley oak, coast live oak (S) Wetlands: • Small vernal pool is at this site - R • Novato Creek runs along the preserve boundary • Riparian woodland • Undifferentiated marsh (W)		Important invasive plants include: • *Centaurea calcitrapa* (purple starthistle)	Previously part of E Ranch. Purchased in 1995. Adjacent residential community is essentially surrounded by MCOSD lands. NMWD lands are adjacent on west boundary.	*Centaurea calcitrapa* eradication project is ongoing. Since 2002, estimated 20K has been spent.	

Table 2.1 Summary of Preserve Conditions

Preserve Name, Size, and Perimeter	Sensitive Natural Resources	Known Special-Status and Locally Rare Species	Management Challenges	History and Local Setting	Vegetation Management, Maintenance and Stewardship	Comments
Loma Alta Area = 492.1 acres Perimeter = 6.2 miles	Sensitive Vegetation Type(s): • Chamise, eastwood manzanita (G2) • Madrone, California bay, tanoak (S) • Rocky serpentine grasses (S) • Seasonally or temporarily flooded meadow (W) • Upland serpentine grassland (G2) • Valley oak, coast live oak (S) Wetlands: • Fairfax Creek • Seasonal wetlands • Riparian woodlands	Special-Status Plants: • *Amsinckia lunaris* (bent-flowered fiddleneck), C • Calochortus umbellatus (Oakland star-tulip), C • Hemizonia congesta ssp. congesta (hayfield tarweed), R • Hesperolinon congestum (Marin western flax), C Special-Status Wildlife: • *Accipiter cooperi* (Cooper's hawk), C • *Eremophila alpestris actea* (California horned lark), C • *Elanus leucurus* (white-tailed kite), C • *Ammodramus savannarum* (grasshopper sparrow), C • Antrozous pallidus (pallid bat), C • *Taxidea taxus*, (American badger), C	Important invasive plants include: • *Centaurea calcitrapa* (purple starthistle)	History of grazing. Parcels acquired in 1988, 1989, and 1990.	*Centaurea calcitrapa* eradication project is ongoing. Initiated in 2004 with Conservation Corps North Bay Project ReGen grant. Estimated cost 1K per year, 10K.	
Loma Verde Area = 266.8 acres Perimeter = 4.5 miles	Sensitive Vegetation Type(s): • Blue oak alliance (F) • Valley oak, coast live oak (S)	Special-Status Wildlife: • *Accipiter cooperi* (Cooper's hawk), C	Important invasive plants include: • Genista monspessulana (French broom) • *Romulea rosea* (rosy sand crocus)	History of ranching.		
Lucas Valley Area = 1608.2 acres Perimeter = 10.5 miles	Sensitive Vegetation Type(s): • California sagebrush alliance (F) • Chamise, eastwood manzanita (G2) • Cliffs, rock outcrops (S) • Coast live oak, riparian (F) • Common manzanita (F) • Eastwood manzanita alliance (S) • Madrone, California bay, tanoak (S) • Mesic trending chaparral (F) • Mesic trending chaparral (S) • Native temperate perennial grasslands (F) • Valley oak, coast live oak (S) Wetlands: • Miller Creek and several tributaries • Riparian woodlands • Other locally rare habitats • Pristine coastal prairie is present. Several uncommon plants near or at top of ridge	Special-Status Plants: • *Calochortus umbellatus* (Oakland star-tulip), R Special-Status Wildlife: • *Oncorhynchus mykiss irideus* (central California coast steelhead), C • *Accipiter cooperi* (Cooper's hawk), C • *Elanus leucurus* (white-tailed kite), C • *Ammodramus savannarum* (grasshopper sparrow), C • Antrozous pallidus (pallid bat), C • *Taxidea taxus* (American badger), C Locally Rare Species: • *Erigeron foliosus* var. *franciscensis* (San Francisco leafy fleabane), R • *Salvia mellifera* (black sage), R, only known Marin location • *Eschscholzia caespitosa* (tufted eschscholzia), C • Leptosiphon acicularis (bristly linanthus), R • *Lessingia hololeuca*, (wooly-headed Lessingia), C • *Lupinus albifrons* (silver lupine), host plant for mission blue butterfly, C[4]	Important invasive plants include: • *Carthamus lanatus* (distaff thistle) • Foeniculum vulgare (fennel)	History of ranching since 1860. Parcels acquired in 1975, 1986, 1989, 1990, and 1996. Properties to the west are privately owned ranches, some by George Lucas. County lands to the east, managed by the Lucas Valley Homeowners' Association.	*Carthamnus lanatus* removal is ongoing. Initiated in 2005, cost estimated 3K.	
Maurice Thorner Memorial Area = 30.6 acres Perimeter = 1.3 miles.	Sensitive Vegetation Type(s): • Perennial grasslands (F) • Valley oak alliance (F) • Valley oak, coast live oak (S) • Valley oak/grass (S)		Important invasive plants include: • Genista monspessulana (French broom)	Acquired in 1981. Gold mining in late 1800s on slope south of the preserve.		

[4] Foodplant of mission lue butterfly (*Icaricia icarioides missionensis*)

Table 2.1 Summary of Preserve Conditions

Preserve Name, Size, and Perimeter	Sensitive Natural Resources	Known Special-Status and Locally Rare Species	Management Challenges	History and Local Setting	Vegetation Management, Maintenance and Stewardship	Comments
Mt Burdell Area = 1557.9 acres, Perimeter = 11.4 miles	Sensitive Vegetation Type(s): • California buckeye alliance (F) • Mesic trending chaparral (S) • Purple needlegrass perennial grassland (F) • Rocky serpentine grasses (S) • Sedge, rush, wet meadow (W) • Serpentine balds (G2) • Temporarily flooded or saturated meadow edge (W) • Upland serpentine grassland (G2) • Valley oak alliance (F) • Valley oak, coast live oak (S) • Valley oak/grass (S) • Wetland serpentine grassland (W) Wetlands: • Two small, unnamed creeks • Riparian woodlands • Hidden Lake, one of Marin County's few vernal pools	Special-Status Plants: • *Eriogonum luteolum* var. *caninum (*tiburon buckwheat), R • *Fritillaria liliacea* (fragrant fritillary), C • *Hemizonia congesta* ssp. *congesta* (hayfield tarweed), R • *Hesperolinon congestum* (Marin western flax), C • *Navarretia leucocephala* ssp. *bakeri* (Baker's navarretia), R Special-Status Wildlife: • *Rana draytonii* (California red-legged frog) C or R • Ammodramus savannarum (grasshopper sparrow) R • *Accipiter cooperi* (Cooper's hawk), C • Antrozous pallidus (pallid bat), C • *Taxidea taxus* (American badger), C Locally Rare Species: • *Asclepias fasicularis* (narrow leaf milkweed), R • *Erigeron biolettii* (streamside daisy), C • Leptosiphon acicularis (bristly linanthus), R • *Lessingia hololeuca* (wooly headed lessingia), C • *Navarretia cotulifolia* (featherleaf navarretia), C • *Monolopia major* (cupped monolopia), C, only Marin population • *Ranunculus lobbii* (Lobb's buttercup), R	An estimated 125 acres of grassland have been infested by yellow starthistle (*Centaurea solstitialis*). *Taeniatherum caput-medusae* (medusahead), *Aegilops triuncialis* (barbed goatgrass) are present. Goatgrass is currently being treated. Dead vegetation from California oak mortality syndrome is prevalent in valley oak-coast live oak vegetation. Recent grazing plan recommends some changes, including timing and intensity of grazing and changes in protection of rare plants. Important invasive plants include: • Aegilops triuncialis (barbed goatgrass) • Centaurea solstitialis (yellow starthistle) • Phalaris aquatica (Harding grass) • *Agrostis arvensis* (pacific bentgrass) • Mentha pulegium (pennyroyal)	Previously part of C Ranch. Purchased in 1977. California Department of Parks and Recreation owns Olompali property to the northeast. Northwest and west slopes are privately owned dairy ranches.	Crews are currently removing plants in a 15 acre stand of broom Herbicide, hand pulling, and weed whipping are being used to remove yellow starthistle plants: 45 acres have been treated and are being monitored; 95 acres are currently being treated; 45 acres remain to be treated. Completed 30% of Native Tree Revegetation Plan (1990) with volunteers. Several sensitive plant populations were previously protected from cattle grazing with exclusionary fencing. Some riparian areas have been fenced, but may need additional restoration. At least one social trail has been closed by ripping the trail bed. Volunteer-led tree planting project has been very successful. Current invasive removal includes: 45 acres of *Centaurea* have been treated and are being monitored; 95 acres are currently being treated. *Aegilops* treatment is ongoing. *Phalaris* is removed from Preserve and project discontinued.	
Old St Hilary's Area = 119.1 acres Perimeter = 2.8 miles	Sensitive Vegetation Type(s): • California buckeye alliance (F) • Mesic trending chaparral (S) • Purple needlegrass (F) • Rocky serpentine grasses (S) • Sedge, rush, wet graminoids meadow (W) • Serpentine balds (G2) • Temporarily flooded or saturated meadow edge (w) • Upland serpentine grassland (G2) • Valley oak alliance (F) • Valley oak, coast live oak (S) • Valley oak/grass (S) • Wetland serpentine grassland (W) Wetlands: • Preserve includes two unnamed creeks • Riparian woodlands Preserve contains "One of the most interesting and beautiful wildflower gardens in California, and thus in all the world." John Thomas Howell, author of *Marin Flora*	Special-Status Plants: • *Castilleja affinis* ssp. *neglecta* (Tiburon indian paintbrush), R • *Eriogonum luteolum* var. *caninum* (Tiburon buckwheat), C • *Hesperolinon congestum* (Marin western flax), C • *Streptanthus niger* (Tiburon jewelflower), C Special-Status Wildlife: • *Ardea herodias* (great blue heron)- nest sites • *Ardea alba* (great egret)- nest sites • *Egretta thula* (snowy egret) nest sites • Dendroica petechia brewsteri (yellow warbler) Locally Rare Species: • *Asclepias fasicularis* (narrow leaf milkweed), R • *Calamagrostis ophitidis* (serpentine reedgrass), R • *Erigeron foliosus* var. *franciscensis* (San Francisco leafy fleabane), R • *Monolopia major* (cupped monolopia), C, only Marin population • *Parnassia californica* (California grass of Parnassus), R • Phacelia divaricata – (unusual in Marin) C Zigadenus micranthus var. fontanus (marsh zigadenus), C	*Ageratina adenophora*,, *Cortaderia jubata*, and *Genista monspessulana* are present, but active control program shows successes. Dead vegetation from California oak mortality syndrome is prevalent in California bay-coast live oak vegetation. Important invasive plants include: • Ageratina adenophora (thoroughwort) • Cortaderia jubata (pampas grass) • Genista monspessulana (French broom)	Acquired parcels in 1993 and 1997. Marin County Parks owns adjacent land.	Since 2006, 1.5 acres of *Ageratina* controlled. Estimated cost 8K. Since 2002, dense populations of *Cortaderia* in and along creeks controlled. Estimated cost 25K. Since 2004, removed large forest of broom, with other scattered populations around preserve. Estimated cost 45K.	Invasive plant removal has been performed by a strong volunteer group. High habitat value, large volunteer contribution, separate, steady funding source made good work possible.

Table 2.1 Summary of Preserve Conditions

Preserve Name, Size, and Perimeter	Sensitive Natural Resources	Known Special-Status and Locally Rare Species	Management Challenges	History and Local Setting	Vegetation Management, Maintenance and Stewardship	Comments
Pacheco Valle Area = 443.1 acres Perimeter = 9.7 miles	Sensitive Vegetation Type(s): • Madrone alliance (S) • Madrone, California bay, tanoak (S) • Valley oak, coast live oak (S) • Valley oak/grass (S) Wetlands: • Pacheco Creek • Riparian woodlands	Special-Status Wildlife: • *Accipiter cooperi* (Cooper's hawk), C • *Ammodramus savannarum* (grasshopper sparrow), C • *Taxidea taxus* (American badger), C Locally Rare Species: *Lupinus albifrons* (silver lupine)[5], host plant for mission blue butterfly, C	Important invasive plants include: • Genista monspessulana (French broom)	Parcels acquired in 1975 and 1995.		
Ring Mountain Area = 374.1 acres Perimeter = 6.1 miles	Sensitive Vegetation Type(s): • Cliffs, rock outcrops (S) • Mesic trending chaparral (S) • Purple needlegrass perennial grasslands(F) • Rocky serpentine grasses (S) • Sedge, rush, wet graminoids meadow (W) • Serpentine grassland (F) • Temporarily flooded or saturated meadow edge (w) • Upland serpentine grassland (G2) • Valley oak, coast live oak (S) • Wetland serpentine grassland (W) Wetlands: • East Creek • West Creek • Three other unnamed creeks • Riparian woodlands Other: • Mineral lawsonite first discovered here in the 1890s. Geologically diverse and unique.	Special-Status Plants: • *Calochortus tiburonensis* (Tiburon mariposa lily), C • *Calochortus umbellatus* (Oakland star-tulip), C • *Castilleja affinis* ssp. *neglecta* (Tiburon indian paintbrush), C • *Eriogonum luteolum* var. *caninum* (Tiburon buckwheat), R • *Hemizonia congesta* ssp. *congesta* (hayfield tarweed), R • *Hesperolinon congestum* (Marin western flax), C • *Trifolium amoenum* (showy Indian clover), R was present before 1970, presumed extirpated • Trifolium buckwestiorum (Santa Cruz clover), R Special-Status Wildlife: • Accipiter cooperi (Cooper's hawk), C • *Ammodramus savannarum* (grasshopper sparrow), C • *Taxidea taxus* (American badger), C • Microcina tiburona (Tiburon micro-blind harvestman) C or R • *Elanus leucurus* (white-tailed kite), C • *Ammodramus savannarum* (grasshopper sparrow), C Locally Rare Species: • *Allium lacunosum* (pitted onion), R • *Calamagrostis ophitidis* (serpentine reed grass), R • *Triteleia peduncularis* (long-rayed brodiaea), C	*Foeniculum vulgare* (fennel) is increasing rapidly and threatens rare plant populations. Large stands of *Rubus armeniacus* on northern slopes and some drainages on southern portion of the site. Argentine ants may displace sensitive organism such as Tiburon blind harvestman. Tiburon buckwheat is severely threatened (LSA 2008). • Important invasive plants include: • Genista monspessulana (French broom) • Centaurea solstitialis (yellow starthistle) • *Elytrigia pontica* (tall wheatgrass) • *Maytenus boaria* (mayten) • *Centaurea calcitrapa* (purple starthistle) • Cortaderia jubata (pampas grass) Several significant encroachments have reduced available habitat for some rare species.	Earliest Miwok village dated to 370 BC. Part of Reed Ranch for 130 years until 1965. Army installed guns on summit in 1950s, deactivated in 1960s. Management turned over to MCOSD in 1995 from Nature Conservancy. Town of Tiburon owns several significant adjacent properties.	Staff has worked with volunteers to treat a long list of invasive plant species at several sites across the preserve. These ongoing efforts have been very successful.	
Roy's Redwoods Area = 271 acres Perimeter = 3.3 miles	Sensitive Vegetation Type(s): • Cliffs, rock outcrops (S) • Coast live oak, douglas-fir (F) • Madrone, California bay, tanoak (S) • Mesic trending chaparral (S) • Seasonally or temporarily flooded graminoids (W) • Temperate broadleaf cold season deciduous shrubland (F) • Valley oak, coast live oak (S) Wetlands: • Larsen Creek • Spirit Rock Creek • Riparian woodlands	Special-Status Wildlife: • *Strix occidentalis caurina* (northern spotted owl) nesting buffer C • *Contopus cooperi* (olive-sided flycatcher), C • *Accipiter cooperi* (Cooper's hawk), C • Antrozous pallidus (pallid bat), C • *Taxidea taxus* (American badger), C Locally Rare Species: • *Leptosiphon acicularis* (bristly linanthus), C • *Lessingia hololeuca* (wooly headed lessingia), • Ranunculus orthophyncus var. bloomeni (uncommon in Marin) C	Important invasive plants include: • Centaurea solstitialis (yellow starthistle) • Phalaris aquatica (Harding grass)	Purchased in 1978. Select-cut logging, Grazing in mid-1900s. Golf course along southwestern boundary. 463 acres - French Ranch		

[5] Foodplant of mission blue butterfly (*Icaricia icarioides missionensis)*

Table 2.1 Summary of Preserve Conditions

Preserve Name, Size, and Perimeter	Sensitive Natural Resources	Known Special-Status and Locally Rare Species	Management Challenges	History and Local Setting	Vegetation Management, Maintenance and Stewardship	Comments
Rush Creek Area = 472.2 acres Perimeter = 7.2 miles	Sensitive Vegetation Type(s): • Black oak alliance (F) • Blue oak, white oak (S) • Cattail alliance (W) • Estuarine marsh habitats (W) • Mesic trending chaparral (S) • Tall temperate annual graminoids (F) • Temporarily flooded or saturated meadow edge (W) • Undifferentiated marsh (W) • Valley oak/grass (S) Wetlands: • Rush Creek runs along boundary • Riparian woodlands • Seasonal wetlands • Wet meadow	Special-Status Plants: • Cordylanthus mollis ssp. mollis may occur in marsh Special-Status Wildlife: • *Pogonichthys macrolepidotus* (Sacramento splittail) C or R • *Ammodramus savannarum* (grasshopper sparrow), C • *Circus cyaneus* (northern harrier), C • *Geothlypis trichas sinuosa* (San Francisco common yellowthroat), C • Melospiza melodia samuelis (Samuel's song sparrow), C • *Elanus leucurus* (white-tailed kite), C • Rallus longirostris obsoletus (California clapper rail), C • Laterallus jamaicensis conturniculus (California black rail), C • *Reithrodontomys raviventris* (Salt marsh harvest mouse), C • *Taxidea taxus* (American badger), C	Important invasive plants include: • Ailanthus altissima (tree of heaven) • Genista monspessulana (French broom) • Dittrichia graveolens (stinkwort)	Chicken ranch in early 1900s. Received land in late 1990s. California Department of Fish and Wildlife owns adjacent properties.	Dense *Genista* populations have been reduced to hand pull follow up by volunteers. Early hand removal has prevented *Dittrichia* from becoming a problem at this preserve.	
San Pedro Ridge Area = 338.7 acres Perimeter = 3.9 miles	Sensitive Vegetation Type(s): • Madrone alliance (S) • Madrone, California bay, tanoak (S) • Native temperate perennial grasslands (F) • Valley oak, coast live oak (S) Wetlands: • One unnamed creek • Riparian woodlands	Special-Status Wildlife: • Haplotrema condinentis (land snail) C or R • *Aquila chrysaetos* (golden eagle) nest site, C	County Fire wants to construct a primary fuelbreak along ridge. City of San Rafael moving forward with defensible space along perimeter land. There are several major illegal trails and encroachments that have damaged madrone and oak communities. Important invasive plants include: • *Cistus creticus* (pink rock rose) • *Cistus ladanifer* (gum rock rose) • Genista monspessulana (French broom)	Dairy ranching since mid-1850s. Nike Missile site established in 1954. Parcels purchased in 1974-1977. Additional parcel purchased in 1999. Adjacent lands owned by City of San Rafael and California Department of Parks and Recreation.	French broom removal started in 2004, and several acres have been cleared.	Incipient broom occurrences should be eradicated.
Santa Margarita Island Area = 8.4 acres Perimeter = 0.5 miles	Sensitive Vegetation Type(s): • Estuarine marsh habitats (W) • Valley oak, coast live oak (S) Wetlands: • Preserve is surrounded by the South Fork of the Gallinas Creek • Riparian woodlands • Salt marsh • Brackish marsh • Seasonal wetlands	Special-Status Wildlife: • *Rallus longirostris obsoletus* (California clapper rail) C • *Reithrodontomys raviventris* (salt marsh harvest mouse) C • *Rallus limicola* (Virginia rail), C • *Elanus leucurus* (white-tailed kite), C	Important invasive plants include: • Genista monspessulana (French broom) • *Hedera helix* (English ivy)	Land used for soil disposal after WWII. Dumping of dredging spoils in 1969 and 1987. Purchased in 1974; marshland filled in and canals built, "thousands of rare and exotic plants brought in." Residents of Las Gallinas contributed to funding of this preserve.	Santa Venetia Marsh Restoration Project is removing several invasive plants and planting natives.	

Table 2.1 Summary of Preserve Conditions

Preserve Name, Size, and Perimeter	Sensitive Natural Resources	Known Special-Status and Locally Rare Species	Management Challenges	History and Local Setting	Vegetation Management, Maintenance and Stewardship	Comments
Santa Venetia Marsh Area = 31.4 acres Perimeter = 1.5 miles	Sensitive Vegetation Type(s): • Estuarine marsh habitats (W) Wetlands: • Preserve is surrounded by the South Fork of the Gallinas Creek • Salt marsh • Brackish marsh • Seasonal wetlands	Special-Status Wildlife: • *Rallus longirostris obsoletus* (California clapper rail) C or R • *Rallus limicola* (Virginia rail), C or R • *Elanus leucurus* (white-tailed kite), C • *Reithrodontomys raviventris* (salt marsh harvest mouse), C or R • *Melospiza melodia samuelis* (San Pablo song sparrow), C or R	Important invasive plants include: • Foeniculum vulgare (fennel) • Lepidium latifolia (pepperweed) • Tribulus terrestris (puncture vine)	Prehistoric archaeological site (California Archaeological Inventory CA-MRN-124). Residents remember goats on the island in the 1940s and 1950s, west side of island burned in 1974. Landfill on north end of island. Purchased in 1978.Handwritten note: land used for soil disposal, Santa Venetia Land Corp. Sold land to Trust for Public Land 1973, purchased in 1974; marshland filled in and canals built to sell lots for houses but none were built, "thousands of rare and exotic plants brought in." Residents of Las Gallinas contributed to funding of this preserve.	Upland buffer zone planting in 2007. Managing *Lepidium* and fennel	
Terra Linda/Sleepy Hollow Divide Area = 1043.9 acres Perimeter = 22.2 miles	Sensitive Vegetation Type(s): • California bay, alder, big leaf maple, willow riparian forest (S) • Cliffs, rock outcrops (S) • Coyote brush alliance (F) • Madrone, California bay, tanoak (S) • Purple needlegrass (F) • Rocky serpentine grasses (S) • Serpentine balds (G2) • Tall temperate perennial herbaceous (F) • Undifferentiated marsh (W) • Upland serpentine grassland (G2) • Valley oak alliance (F) • Valley oak, coast live oak (S) • Valley oak/grass (S) Wetlands: • Part of Miller Creek • Riparian woodlands	Special-Status Plants: • *Eriogonum luteolum* var. *caninum* (Tiburon buckwheat), C or R • *Hemizonia congesta* ssp. *congesta* (hayfield tarweed), R Special-Status Wildlife: • *Ammodramus savannarum* (grasshopper sparrow) • *Elanus leucurus* (white-tailed kite), C • Accipiter striatus (sharp-shinned hawk), C • *Aquila chrysaetos* (golden eagle) nest site, C • Athene cunicularia (burrowing owl), C • *Circus cyaneus* (northern harrier), C • osprey • *Accipiter cooperi* (Cooper's hawk), C • Pandion haliaetus (osprey) Department of Public Works has stated that Miller Creek is one of the best remaining habitats for steelhead in Marin County. Locally Rare Species: • *Lessingia hololeuca* (wooly headed lessingia), R • *Ranunculus lobbii* (Lobb's aquatic buttercup), R • Streptanthus glandulosus ssp. secundus (one sided jewelflower), R • purple martin	Terra Linda/Sleepy Hollow Divide Open Space Preserve has one of the only three known populations of barbed goatgrass (*Aegilops triuncialis*) in Marin. Purple starthistle, pampas grass, French broom, fennel, eucalyptus, Harding grass, yellow starthistle; erosion problems at multiple locations. New trail being constructed through goatgrass and onto adjacent private property and on to our Loma Alta preserve. Important invasive plants include: • Taeniatherum caput-medusae (medusa head) • Aegilops triuncialis (barbed goatgrass) • *Carthamus lanatus* (distaff thistle) • Centaurea solstitialis (yellow starthistle) • Cortaderia jubata (pampas grass) • *Eucalyptus sp*. (eucalyptus) • Genista monspessulana (French broom) • Mentha pulegium (pennyroyal)	Numerous parcel acquisitions from 1972 through 1989. Sheep grazing from 1981-1987 for fuel reduction.	A barbed goatgrass control project uses an integrated pest management approach to preserve native biological diversity and promote wildlife habitat. Fuel reduction in eucalyptus grove, no removal of eucalyptus greater than 13dbh unless hazard.	75 signed entrances.
Tiburon Ridge Area = 14.2 acres Perimeter = 0.8 miles	No Information	No information	Important invasive plants include: • Genista monspessulana (French broom)			
Verissimo Hills Area = 110.4 acres Perimeter = 3.2 miles	Sensitive Vegetation Type(s): • Valley oak, coast live oak (S) • valley oak/grass (S)	No information	Important invasive plants include: • Centaurea solstitialis (yellow starthistle)	Gift from Sanchez family in 1985. Adjacent residential community is essentially surrounded by MCOSD lands.		

Table 2.1 Summary of Preserve Conditions

Preserve Name, Size, and Perimeter	Sensitive Natural Resources	Known Special-Status and Locally Rare Species	Management Challenges	History and Local Setting	Vegetation Management, Maintenance and Stewardship	Comments
White Hill Area = 367.3 acres Perimeter = 5.9 miles	Sensitive Vegetation Type(s): • California bay, alder, big leaf maple, willow riparian forest (S) • California sagebrush alliance (F) • Chamise, eastwood manzanita (G2) • Chamise-serpentine chaparral (S) • Cliffs, rock outcrops (S) • Coast live oak, Douglas-fir (F) • Coyote brush alliance (F) • Douglas-fir (pure) (F) • Douglas-fir, california bay/interior live oak (F) • Eastwood manzanita alliance (S) • Interior live oak- eastwood manzanita (S) • Madrone alliance (S) • Madrone, California bay, tanoak (S) • Mt. Tamalpais manzanita-chamise (G2) • Rocky serpentine grasses (S) • Sedge, rush, wet graminoids meadow (W) • Sensitive manzanita alliance (F) • Serpentine balds (G2) • Upland serpentine grassland (G2) Wetlands: • Pine Mountain Creek • Cascade Falls Creeks • Riparian woodlands • Wet meadow (sedge-rush-wet meadow)	Special-Status Plants: • *Arctostaphylos hookeri* ssp. *Montana* (Mt. Tamalpais manzanita), C or R • *Lessingia micradenia* var. *micradenia* (Mt. Tamalpais lessingia), C or R • Streptanthus glandulosus ssp. pulchellus (Mt. Tamalpais jewelflower), C Special-Status Wildlife: • *Strix occidentalis caurina* (northern spotted owl) nesting buffer C or R • Oncorhynchus tshawytscha (winter-run chinook salmon) • *Accipiter cooperi* (Cooper's hawk), C • *Elanus leucurus* (white-tailed kite), C Locally Rare Species: • *Arabis blepharophylla* (coast rock cress), C or R • *Calamagrostis ophitidis* (serpentine reedgrass), C or r • *Monardella purpurea* (coyote mint, southern range limit is in Marin), C • Navarretia heterodoxa, C • Trifolium albopurpureum var. dichotomum (branched Indian clover), R • grasshopper sparrow • horned lark	Dead vegetation from California oak mortality syndrome is prevalent in madrone-California bay-tan oak vegetation. Important invasive plants include: • Centaurea solstitialis (yellow starthistle) • Genista monspessulana (French broom)	History of grazing, probably until the 1920s. Purchased from Boy Scouts of America in 1994 and 1997-1998. North Shore Railroad built tunnel (now Bothin Tunnel) through ridge north from White Hill. Shares western boundary with MMWD land.		
COMMENTS/NOTES:						
Area and perimeter estimates are from mcosd_preserves.dbf. When documents give different areas, these were noted.	Global rarity rankings from Natureserve 2009. Sensitive vegetation Type(s): G1= critically imperiled; G2 = imperiled; W = wetland, S = special; F = fewer than 10 occurrences on MCOSD lands. Uncommon vegetation types and habitats; species at the southern or northern edge of their ranges; notably well-preserved natural communities.	Plant information from, Calflora records, CNDDB records search, MCOSD GIS database, rare plant survey notes prepared by Doreen Smith, and preserve-specific plans and reports. Wildlife are from MCOSD GIS database, CNDDB records search, and from preserve-specific plans and reports. KEY: C=Confirmed by staff, R=Reported present.	Includes notes on invasive plants occurrences, forest pathogens, and other management issues such as erosion problems and other impairments as noted in preserve-specific management plans and other documents.	As noted in preserve-specific management plans and other documents.	As noted in preserve-specific management plans and other documents. Comments related to sensitive vegetation management projects, grant-funded invasive plant removal; implemented restoration plans; recent or large fuel breaks; trail and/or maintenance programs; volunteer activities.	General comments on the preserve that do not fit into the other categories.

3: ASSESSMENT OF REGIONAL TRENDS, PRACTICES, AND SCIENCE

This chapter identifies and synthesizes regional trends and evaluates current practices for various aspects of vegetation management. Information presented in this chapter was compiled through a review of published and unpublished vegetation management literature and through interviews with respected vegetation and fire management experts representing the following public agencies and private organizations:

- Audubon Canyon Ranch (ACR)
- California State Parks (CSP)
- East Bay Municipal Utilities District (EBMUD)
- East Bay Regional Park District (EBRPD)
- Golden Gate National Recreation Area (GGNRA)
- Marin Municipal Water District (MMWD)
- Marin County Open Space District (MCOSD)
- Midpeninsula Regional Open Space District (MROSD)
- Shelterbelt Builders, Inc. (SBI)
- Santa Clara County Parks (SCCP)
- Santa Clara Fire Safe Council (SCFSC)
- Santa Clara County Open Space Authority (SCCOSA)

These technical experts shared decades of experience, insights, and information. They represent organizations including large regional parks with strong public access mandates, small open space authorities with strong fire management mandates, and for-profit ecological restoration firms. In many cases, technical experts were able to share both published and unpublished information about their vegetation management programs. This included published management plans, published and unpublished (in-house) prioritized invasive plant threat lists, published and unpublished best management practices, published fire management strategies, and other resources that provided an exceptional opportunity to assess current practices in the field of regional vegetation management.

This chapter is organized according to the following sections:

- natural resource management (protection and restoration)
- invasive plant control and integrated pest management
- fire risk management and fire hazard reduction strategies
- forest health management
- management for climate change

Natural Resource Management (Protection and Restoration)

This section summarizes current natural resource management practices for vegetation, including inventory and monitoring, natural resource protection, and natural resource restoration.

Those interviewed reported on the scale and focus of natural resource management actions. The scale and focus are directly related to each organization's mission and available financial and staffing resources. For example, agencies whose primary mission is preservation of water quality, such as MMWD and EBMUD, tend to place stronger restrictions on any activity that could introduce contaminants into the watershed than do agencies whose missions combine the preservation of natural resource values with recreational use, such as EBRPD, GGNRA, MCOSD, SCCOSA, and CSP. Some agencies, such as MROSD, prioritize natural resource values.

None of the agencies interviewed has a comprehensive Vegetation and Biodiversity Management Plan that covers all of its lands or natural resource activities. However, MMWD and EBRPD are currently preparing environmental documents on natural resource and fire management activities. GGNRA has an approved vegetation management plan for the Presidio (Presidio Trust 2006) and an approved Fire Management Plan (GGNRA 2008) that integrates vegetation management. All agencies have policies outlining procedures, guidelines, and objectives for aspects of natural resource management. Some policies were developed by topic areas similar to those currently administered by MCOSD, while others provide more comprehensive and integrated guidelines to support land management.

The following summarizes regional trends, practices, and new science in the following three topic areas:

- inventory and monitoring
- natural resource protection
- natural resource restoration

Inventory and Monitoring

Inventories organize and document knowledge of a land's resources and establish baseline information from which to assess changes over time. Monitoring is the collection and analysis of repeated observations or measurements to evaluate changes in condition and progress toward meeting a management objective (Elzinga et al. 1998). Monitoring information is often used to help detect changes and trends in the health and function of natural communities.

All of the agencies interviewed have initiated, or are currently conducting, some variation of an inventory and monitoring program. However, some are operated with very limited resources and are more opportunistic, whereas others are linked to national protocols and methods and are conducted and updated regularly. Interviewees agreed that funding and staffing are the main limitations to completing detailed inventories and conducting ongoing monitoring.

The majority of the interviewees have undertaken the following:

- **Conducted a comprehensive inventory of vegetation types.** Most inventories use the standard California Native Plant Society protocols (i.e., Vegetation Rapid Assessment and Relevé protocols). The majority of agencies interviewed conduct their mapping work in accordance with the classification system in the California Terrestrial Natural Communities Recognized by the California Natural Diversity Database, as outlined in the Manual of California Vegetation (Sawyer et al. 2008). However, some agencies, such as EBRPD, name vegetation types differently to capture their locally distinct characteristics.

- **Initiated an early detection monitoring program for invasive plant management.** Monitoring programs are of varying scales, depending on resources and staffing. Some programs are opportunistic and unstructured, while others are well developed and supported.

- **Mapped dominant wetland features such as creeks, marshes, and lakes.** Several agencies, including GGNRA and MROSD, have mapped wetlands on a watershed scale: GGNRA has conducted watershed-level spring and seep inventories, while MROSD has completed preserve wide pond inventories.

- **Mapped threatened and endangered special-status plants.** The majority of the agencies interviewed have mapped easily accessible (i.e., via roads and trails) special-status population locations. Some agencies (e.g., EBRPD, MMWD, GGNRA) have detailed maps of all known special-status plant populations, typically prepared as a part of a vegetation or fire management plan. GGNRA also undertook a predictive habitat modeling project in 2006 and 2009 to identify lands where rare plants might be found in areas not previously surveyed or mapped, and to identify habitat for future establishment and restoration efforts (May & Associates 2004). This effort was successful in locating several previously unknown populations of special-status species.

- **Mapped priority infestations of known invasive plants.** Few agencies have undertaken a comprehensive mapping of invasive plants, due to limited funds and staffing. For most agencies, invasive plant mapping is conducted on a site- or species-specific basis as part of a grant-funded effort, a project, or an assessment of past fire management activities. Few agencies monitor invasive plants comprehensively, with the exception of MROSD and GGNRA. MMWD monitors several targeted invasive plants species (e.g., French broom, starthistle) and has recently hired staff to expand their invasive plant management and monitoring program. CSP also monitors several invasive species (e.g., *Helichrysum*, broom species, starthistle).

Few agencies have undertaken the following:

- **Developed clear goals and objectives for inventory or monitoring efforts.** Several interviewees indicated that they have collected data only to realize that it has limited application. Several interviewees identified limited access to professional support and lack of staff proficiency as limiting factors to developing clear goals and objectives. Those agencies that have larger scale monitoring programs are often able to allocate more staff time or resources to developing streamlined systems or to evaluating the efficacy of existing monitoring efforts. These larger programs are linked to national programs (GGNRA), have long-term affiliations with academic institutions (EBRPD), or engage staff and volunteers in monitoring efforts (MROSD).

- **Implemented standardized monitoring.** Most interviewees agreed that developing performance standards for projects is critical to evaluating project efficacy and ensuring that funds are spent efficiently; however, few have implemented monitoring based on performance standards. MMWD has identified the development and implementation of project-level monitoring as a recommended action in their *Biodiversity Management Plan* (MMWD 2009a). GGNRA often defines performance measures for invasive plant removal by contractors, then monitors control activities until performance measures are achieved. MROSD, GGNRA, and EBRPD perform monitoring after controlled burns to help determine if habitat restoration or invasive plant control performance standards have been achieved.

- **Conducted landscape-level monitoring.** Few agencies have conducted landscape-level monitoring as a means of tracking the condition of natural communities, primarily due to funding limitations. However, GGNRA works in partnership with the NPS servicewide inventory and monitoring program to monitor "vital signs," which are subsets of physical, chemical, and biological elements and ecosystem processes that have been selected to represent the overall health or condition of park resources and the known or hypothesized effects of stressors. Others, including MMWD, EBRPD, CSP, and MROSD, have identified both species and habitat monitoring as priority actions to help assess the condition of special-status species and high quality habitats. Most interviewees agreed that with the anticipated effects of climate change, and increasing development and access, this type of monitoring will become more critical.

Natural Resource Protection

This section emphasizes the importance of protecting natural resources before they are degraded. It presents three broad categories of methods used by interviewed agencies to achieve natural resource protection: (1) zoning, use-limitations, and physical protections; (2) volunteer participation in resource assessment and early detection programs; and (3) best management practices.

Interviewees agreed that natural resource protection (i.e., actions to prevent harm) is relatively inexpensive compared to active management (i.e., maintenance or restoration) to maintain manipulated vegetation or to repair damaged natural systems. Agencies indicated that effective natural resource protection includes two main elements: identification of priority high-value resources, and actions to protect and maintain these high-value resources in good condition into the future. Interviewees indicated that resources in good condition have a high level of resilience to ecological pressures, such as climate changes, droughts, diseases, or invasive plants, and therefore require less active management than resources that are degraded or otherwise in need of active management. This approach is articulated in numerous scholarly and strategic documents (e.g., Society for Ecological Restoration 2004; National Park Service 2009; MMWD 2009a; Marin County Community Development Agency 2007; Marin County Open Space District 2008).

The scale of protective actions varies between land managers. Some, including MCOSD, indicated that they are forced to manage reactively for issues such as forest disease, encroachment, trampling, invasive plant infestation, and other ecological pressures. Interviewees noted that, given limited resources, they often prioritize only the protection of endangered species or wetlands—resources that are protected by state and federal law and that are overseen by outside regulatory agencies. Other agencies, such as GGNRA, CSP, MROSD, and MMWD, apply a more landscape-level approach to protection, defining activities that are appropriate either on a preserve scale or within contiguous watersheds. All interviewees agreed that enforcement of protection measures is challenging and costly. The number of agency staff available for enforcement varies significantly, with agencies such as CSP having minimal staff to support this goal. Agencies described a number of systems that they use to promote proactive protection of biological diversity, including the following:

- **Zoning, use-limitations, and physical protections.** Several agencies use zoning as a tool to define priority areas for protection. For example, GGNRA uses the designation *special ecological area* to protect the most biologically intact and diverse representations of rare and unique vegetation types (presentation by GGNRA staff at the MCOSD 2010 Vegetation Workshop, and various personal communications with GGNRA staff). Additionally, natural communities are zoned on the Presidio for protection from other management actions (e.g., a no-mow zone). Some agencies do not define zoning boundaries, but instead outline protection practices for known special-status species populations, unique vegetation types, wetland, and riparian habitats. For example, MROSD has prioritized the protection of ponds within their preserves. Protection is also achieved by some agencies through limiting types of use and activities in high-value resource areas. For example, several agencies have guidelines limiting new trail construction, fuelbreak establishment, and facility development in areas supporting sensitive natural resources. Other protection strategies include limiting human access, fencing sensitive resources, installing regulatory signs, and/or designating protection areas on planning maps.

- **Volunteer participation in resource assessment and early detection programs**. All agencies have integrated varying levels of volunteer support into their resource protection strategies. One successful approach is the GGNRA Trail Keeper program. In this program, volunteers note issues such as vandalism, resource degradation, and formation of undesignated trails, while greeting visitors, addressing questions, and reporting emergencies. Early detection programs for invasive plants can also be conducted by trained volunteers who search for new occurrences of invasive plants before they become a problem.

- **Best management practices.** Surprisingly, few agencies have written best management practices for natural resource protection. Interviewees attribute this to the absence of standardized practices and lack of time to develop them. Others noted that their agencies have adopted best management practices, but that they are not standardized and are often inconsistent between projects or planning documents. Practices currently in use include equipment cleaning to reduce invasive plant introduction; mowing procedures; road grading techniques to reduce erosion; and stream maintenance procedures to prevent sedimentation into sensitive areas. For example, SCCP has identified invasive plant zones in which equipment must be cleaned before entering and leaving the zone, whereas GGNRA requires this practice throughout all of its parks. The MROSD enforces strict best management practices to treat California oak mortality syndrome (sudden oak death), whereas other agencies, such as the MCOSD, do not, because of the already extensive spread of the syndrome within their lands.

Natural Resource Restoration

This section acknowledges that, in addition to natural resource protection, natural resource restoration may be required when resources are degraded. Interviewees share similar approaches to priority restoration measures, such as invasive species removal, road and trail removal, and vegetation type conversion. The agencies differ in their responses to California oak mortality syndrome, management of special-status species, and ability to provide adequate staffing. This section also discusses implementation of large-scale projects and the importance of public support.

The agencies identify the need for natural resource restoration actions through varying mechanisms—existing plans, stakeholder concerns, staff observations, identification of failed protection measures, and monitoring results that indicate that management is required. Several agencies have clearly defined project-selection criteria and ranking systems to establish priorities, whereas others describe their management as “reactive to political pressures,” “ad hoc,” or “determined by funding sources.” The majority of interviewees stated that they employ an adaptive management strategy, but that their budgets do not provide for the necessary level of monitoring and evaluation to inform the associated decision making. All agreed that the development of goals, priorities, measurable indictors, and performance standards is critical for efficient, cost-effective, and ecologically appropriate management. However, few agencies have developed them for their natural resource management programs. Several agencies that have written goals and objectives, such as CSP, have limited funds for their implementation.

The interviewees agreed that the following are important natural resource restoration measures:

- **Invasive plant control.** The most common management action performed by agencies is removing and controlling invasive plant infestations. The majority of interviewees indicated that this is their department’s highest priority and, ultimately, where the majority of their resource management budget is applied.

- **Road and trail removal.** All interviewees consider the removal of roads and trails from sensitive natural areas to be an important tool to reduce habitat fragmentation, to limit the spread of invasive plants, and to reduce the inadvertent impacts on sensitive resources caused by visitors. While the approaches vary among agencies, all agencies map roads and trails and identify which roads and trails can be removed to improve the condition of their natural resources. In addition to mapping and assessment, GGNRA evaluates visitor destination routes via surveys or an onsite interview process and, where feasible, realigns trails to ensure that desired destination areas are accessible and that the closures of undesignated trails are sustainable. Both MMWD and GGNRA have launched programs to address the closure of undesignated trails. MMWD is ambitiously closing more than 50 miles of undesignated trails through a resource protection program. GGNRA is closing undesignated trails from Muir Beach to Pacifica as a part of its Trails Forever initiative.

- **Vegetation type conversion**. All agencies agree that management is needed to mimic the effects of disrupted natural processes (e.g., fire, grazing/browsing by large mammals) that would have originally sustained a dynamic mosaic of vegetation types. For example, MMWD and CSP have strategically converted coastal scrub to grassland habitats and removed young Douglas-fir saplings from coastal meadows. GGNRA is conducting similar management of coastal scrub on a smaller scale to provide habitat for the endangered mission blue butterfly. Depending upon the proximity of the management action to the wildland-urban interface, agencies have found that the conversion of vegetation types can also help achieve fire management goals.

The interviewees differed in their approaches to the following:

- **Forest pathogen and disease management.** All interviewees agreed that California oak mortality syndrome is a threat to the health of oak ecosystems and associated species; however, the level of management varies between agencies. Current management practices for this syndrome and other forest pathogens are discussed under “Forest Health Management,” below.

- **Special-status species management.** With the exception of GGNRA and EBRPD, most agencies do not specifically manage special-status species populations. Management actions undertaken by GGNRA and EBRPD include expanding the distribution and range of rare plants by direct seeding and planting and/or reducing threats to existing populations and appropriate habitat. Several interviewees indicated that while management of habitat for special-status species is not a specific goal, it is often achieved by auxiliary actions, such as invasive plant management or trail closures. All agreed that funding is the primary limitation for focused special-status species management. Grant funding for salmonid restoration and wetland projects is more readily available than funding for managing populations of rare plants.

- **Staffing.** Staffing for vegetation management actions varies across the agencies. Most agencies, including MMWD and MROSD, rely upon other in-house staff (e.g., rangers) working under the guidance, but not directly supervised by, a natural resource manager to accomplish actions. These agencies typically assign a number of hours to accomplish priority management activities. The remaining hours are often allocated to fire management, brushing roads and trails for access, and other traditional maintenance tasks. Interviewees indicated that timing and coordination is often challenging for maintenance and natural resource management activities when ranger staff is not directly supervised by natural resource managers. All agreed that it would be more efficient to have work crews directly supervised by natural resource staff. Additionally, volunteer programs are not typically prioritized and supervised by natural resources staff. In agencies with a larger natural resource staff, such as GGNRA, natural resource managers prioritize, supervise, and direct their own staff, contractors, and volunteer programs. Where natural resource managers direct their own programs, they typically do not receive additional support from the maintenance staff, which in those agencies tends to focus more on facilities and infrastructure.

In all agencies, funding for large-scale projects is tied to a particular initiative or a regional/national program, such as creek and stream daylighting, salmonid habitat restoration, and large-scale nonnative vegetation conversion projects (e.g., conversion of eucalyptus or other nonnative tree stands to native oak woodlands). Large-scale restoration is typically funded through grants or fire management programs. While a number of agencies, including MROSD, MMWD, GGNRA, CSP, and EBRPD, have undertaken creek restoration and eucalyptus-to-native forest stand conversion projects, they agreed that funding limitations impede their ability to achieve other important land management goals. Interviewees also acknowledged that there is rarely an increase in operational funds to maintain projects once completed—an issue all agreed must be addressed in the initial planning phases of a project. Staff also emphasized that it is unrealistic to assume that volunteers can maintain everything.

GGNRA has undertaken perhaps the largest number of restoration projects of all the agencies interviewed. This stems in part from access to multiple federal funding sources, and in part from the success of its nonprofit partner organization, the Golden Gate National Parks Conservancy, in raising significant philanthropic and state/federal funds. GGNRA also has successfully integrated restoration goals and opportunities into other types of projects, such as its Trails Forever program. For example, a recent multimillion dollar Trails Forever project at Mori Point in Pacifica was designed to include the creation of wetland and upland habitat for the California red-legged frog and San Francisco garter snake, the reconfiguration and improvement of a designated trail system, and the removal of undesignated trails. As a result GGNRA was able to integrate habitat restoration and transportation/trails funding into an umbrella project that addressed both sets of needs. GGNRA staff emphasized the importance of tying resource protection and restoration actions to visitor access improvements, especially given the strong link between trails and invasive plant infestations and continued public pressure for more public access and more diverse types of visitor use.

Several examples of large-scale ecological restoration planning and implementation projects undertaken by agencies that incorporate these types of recommendations and objectives are described below.

- The Presidio of San Francisco has a robust rare plant restoration program that has included the reintroduction of extirpated species, restoration and creation of habitat to expand the distribution and density of rare species, and large-scale removal of invasive tree stands to restore natural microclimates (Presidio Trust 2006).

- In 2009 EBRPD undertook the first phase of a four-phase project to reduce the number of invasive and introduced trees affecting 6 acres of rare serpentine prairie habitat that supports the federally endangered Presidio clarkia. This restoration project seeks to increase both the habitat size and population viability for the Presidio clarkia.

- The Bay Area Open Space Council's San Francisco Bay Area Upland Habitat Goals Project (also referred to as the Upland Goals Project) was initiated in 2004 to advance biological diversity conservation. This project is intended to recommend the types, amounts, and distribution of conservation lands to be acquired and actions needed to sustain diverse and healthy natural resources in the nine-county Bay Area (Weiss et al. 2008).

Public support for natural resource management projects is critical to balancing competing land uses and the trade-offs between improving natural resources and improving human well-being and access (Society for Ecological Restoration 2004). These challenges are particularly relevant within Bay Area parks—which have varying land use histories, agency missions, management mandates, and recreation and visitor use objectives. All agencies interviewed recognized that public interest and involvement in ecological restoration projects has increased significantly within the Bay Area over the past two decades. Several agencies have begun to recognize the importance of assessing and integrating public sentiment and public involvement into restoration planning. Agencies now assess community "readiness," impacts on community attitudes, and sentiments toward volunteerism as part of planning restoration projects (California Native Plant Society 2004). All agencies interviewed recognize that public perception of, and interest and involvement in, ecological restoration projects has significant bearing on a project's success. Public concerns typically stem from specific on-the-ground actions, such as invasive tree removal, herbicide application, and prescribed fire (Gobster 1997). GGNRA staff indicated that lack of information about such activities, lack of opportunities for the public to engage in decision-making processes, and insufficient planning are the primary reasons why community members object to restoration activities.

Summary of Findings: Natural Resource Management

Inventory and Monitoring

- Developing performance standards for projects, and monitoring to determine whether or not they are achieved and maintained over time, is critical to evaluating project efficacy.

- The anticipated effects of climate change, and increasing development and access, will make landscape-level monitoring more critical.

Natural Resource Protection

- Natural resource protection (i.e., actions to prevent harm) is relatively inexpensive compared to active management (i.e., restoration) to repair damaged natural systems. Resources in good condition have a high level of resilience to ecological pressures, such as climate changes, droughts, diseases, or invasive plants, and therefore require less active management than resources that are degraded or otherwise in need of active management.

- Effective natural resource protection includes two main elements: identification of priority high-value resources, and actions to protect and maintain these high-value resources in good condition into the future.

Natural Resource Restoration

- Natural resource restoration may be required when resources are degraded. The following are important natural resource restoration measures:
  - » invasive plant control
  - » road and trail removal
  - » vegetation type conversion
- The development of goals, priorities, measurable indicators, and performance standards is critical for efficient, cost-effective, and ecologically appropriate restoration management.

- It is more effective to have work crews directly supervised by natural resource staff.

- Operational funds to maintain projects once completed must be addressed in the initial planning phases of a project.

- Visitor access improvements should include ties to resource protection and restoration actions, given the strong link between trails and invasive plant infestations and continued public pressure for more public access and more diverse types of visitor use.

- Public support for natural resource management projects is critical.

Invasive Plant Management

This section summarizes invasive plant prevention, early detection, mapping and monitoring, and treatment practices as employed by leading agencies across the Bay Area.

The last two decades have seen a tremendous burst of innovation as invasive plant management has become a focus of essentially all land management entities and as thousands of practitioners have participated in invasive plant management actions. This period of innovation has generated new field tools and methods; new planning tools, such as evaluation systems and mapping technologies; and new database resources, such as invasive plant inventories and invasive plant watch lists.

Experts generally agree that an effective invasive plant control strategy requires the integration of several types of treatments (e.g., manual, mechanical, cultural) into a site-specific, multiyear treatment program. Effective control programs must consider the life history, physiology, and biology of the target species (e.g., plant family characteristics, plant physiology, flowering period, seed set, and seed germination characteristics). Control programs must also take into account site-specific conditions (e.g., slope, aspect, moisture, distance to sensitive resources, distance to human uses, soil characteristics). Furthermore, effective invasive plant control strategies are usually tied to specific conservation goals and conservation targets and must explicitly consider the effects of their proposed actions on the environment and on the health and safety of humans and other species.

These considerations are central to integrated pest management (IPM), which is a systematic approach to the control of pests that are considered problematic in a specific area or to a specific resource. IPM programs use current, comprehensive information to manage pest populations within acceptable limits, using the most economically feasible approaches that are least harmful to people, property, and the environment. Using this system, action thresholds (i.e., a predetermined measureable change in conditions, such as an increase in the size or density of an invasive plant infestation, which triggers a vegetation management action) are established, control options are identified and evaluated, and management tactics are selected and implemented. Using IPM, the choice of control options is based on a number of variables including worker and public health and safety, the life cycle and physiology of the invasive plants, environmental impact, effectiveness of the treatment alternatives, site characteristics, and technical and economic feasibility of the alternative treatments.

The following discussion of invasive plant control is organized according to the following topics:

- prevention
- early detection

- mapping and monitoring
- treatment

Prevention

This section addresses prevention as the most effective method for avoiding the harm associated with invasive species, and discusses various prevention methods used by the interviewed agencies.

The agencies agreed that the most effective approach for managing the harm caused by invasive plants is to prevent the invasion from happening. Numerous scholarly and strategic documents identify prevention as key to protecting ecosystem health (McNeely et al. 2001). Prevention is less costly than treatment, averts the harm that invasives cause, and avoids the use of intrusive treatments.

The interviewed agencies believe that preventing invasive plant infestations is the key to managing fuel loads and protecting biodiversity on their lands. Surprisingly, few agencies possess and use written BMPs related to the prevention of invasive plants, even though prevention is mandated in many of their strategic plans. Interviewees attribute this to the absence of existing standardized BMPs and the lack of staff time and funding to develop them.

However, most of the agencies do employ prevention measures. For example, most agencies strive to clean mowers and tractors, especially before moving equipment to new sites. Perhaps due to the absence of approved BMPs, cleaning is generally not required but is encouraged on most MCOSD preserves. One exception is SCCP; they have identified zones in which various invasive species are present, and they require that equipment be cleaned before moving between zones. At least one agency (ACR) is attempting to use mowing equipment that captures and bags debris to prevent the spread of invasives into noninfected areas; this is in response to the proliferation of several invasive plants along mowed trails.

Contractors and their equipment are a potential source of new invasive plant invasions, and agencies frequently attempt to control contractor actions by requiring that equipment be cleaned before arriving on site. For example, when crews from California Conservation Corps or other contractors work on SCCP lands, SCCP staff meet with crew leaders and ask them to clean their boots. They usually find invasive plant seeds and use this to impress the need for crew members to clean their boots whenever working at a new site. Some agencies write requirements to clean equipment, clothing, and boots into their contracts and agreements, and they report that overall compliance with these requirements has been good.

Restricting which plants can be planted on site or near preserves is a popular and effective prevention method. For example, GGNRA employs a “white list” that identifies species that can safely be used in landscaping and other planting projects. SCCP staff members attend meetings of neighborhood groups to discourage planting commercial wildflower seed mixes on SCCP lands, and they provide positive encouragement by providing neighbors with packets of seeds derived from SCCP lands.

Several of the interviewees also had rules intended to prevent the introduction of contaminated materials, such as soil or gravel, straw bales and other erosion-control material, and livestock feed. While one agency (SCCOSA) requires the use of weed-free hay by equestrians, another agency in the same county (SCCP) considered similar rules but then rejected them after finding that weed-free hay was not easily available. Both of these agencies require equestrians to keep parking and staging areas free of horse waste, and rangers and law enforcement personnel enforce these rules.

Early Detection

This section stresses the importance of early detection and describes the methods used by the interviewed agencies to detect invasive plants before they have a chance to spread.

All of our interviewees agree with the California Noxious and Invasive Weed Action Plan (California Department of Food and Agriculture 2005) that early detection is “the single most important element” for coping with invasive plants. Early detection and rapid response is highly cost efficient, yielding as much as a $34 benefit for every $1 spent (Cusack et al. 2009), and early detection is an official priority for almost all of the agencies that were interviewed. Almost all agencies interviewed engage in early detection actions. However, only a few of the agencies interviewed (e.g., GGNRA, ACR) have written materials to support early detection (e.g., invasive plant identification guides, priority invasive plant watch lists, training programs).

Most agencies interviewed maintain a “red alert” early detection plant list, some formally and some informally. All of the agencies interviewed are active participants in local weed management areas and attend conferences organized by the California Invasive Plant Council (Cal-IPC). Information from these sources is used as the basis of red-alert early detection plant lists, as is information obtained from The Nature Conservancy (which supports an invasive plant control research division) and other professional land managers working on similar invasive plant issues. For example, GGNRA early detection lists are developed in house by staff using Cal-IPC rankings combined with locally appropriate quantitative criteria. While all early detection lists are considered useful in managing invasive plants, locally developed lists are considered by the agencies interviewed to have the greatest management value for their lands. The cost of using existing red alert early detection lists is minimal, while the cost of developing red-alert lists in house can be considerable.

Early detection work is typically performed by natural resource staff; in some cases, rangers (EBRPD and SCCP) and maintenance staff are also trained to recognize invasive species and to report any new occurrences to natural resource staff. At least two organizations (ACR and GGNRA) train and engage volunteers for early detection. The cost of training staff to detect priority species is minimal. The cost of training and managing volunteers can be minimal when included in other volunteer training, or can be high, as in the case of highly trained volunteers such as GGNRA's Weed Watchers.

GGNRA and SCCP both regularly inspect high-risk locations, such as trailheads and parking areas. This is an efficient approach, which allocates detection effort to those sites most likely to be the source of new infestations. GGNRA also gives the highest priority to detection efforts at sites that contain high-value resources, such as special-status species populations, a strategy which allocates staff efforts where the cost-to-benefit ratio is greatest.

Many small infestations are removed at the time of detection, or in the course of treating other larger invasive plant infestations. However, in many cases infestations are not treated rapidly, or are not treated consistently over the several years required for eradication. The small scale of new infestations may make them prone to being forgotten, making it important to maintain treatment calendars (EBRPD, GGNRA, and MROSD). The cost of rapid response treatment varies, depending on the species, infestation size, and treatments used; however, the cost of a well-organized and routinely scheduled response is always less than the cost of a delayed response or an inconsistent response, which allows the infestation to increase.

MROSD has developed a novel cost-share program that encourages neighboring landowners to remove high priority invasive plants from lands adjacent to MROSD preserves. This program has been very successful and could provide a useful model for other agencies.

Mapping and Monitoring

This section concludes that mapping and monitoring invasive plants is key to successful control and presents methods used by interviewed agencies to conduct mapping and monitoring.

All of the agencies interviewed maintain Geographic Information System (GIS) databases to manage the locations of invasive plant occurrences. However, not all of these databases have up-to-date information or are actively maintained. In addition to GIS, some agencies use a program called GeoWeed to manage the collected data. ACR's more basic early detection program collects occurrence information as Global Positioning System (GPS) points, with a few key descriptors for each infestation, and then shares this information with the Calflora database (a collection of all plant occurrence information for California available at https://www.calflora.org). The cost for establishing a GIS database of invasive plant occurrences is relatively high, and can be prohibitive, and as a result, many agencies reported having incomplete or outdated invasive plant occurrence information. The cost of routinely adding to a database, once developed, can be minimal to moderate, especially when staff collect data as a course of other routine land management activities. The cost of developing protocols for what data to gather and how to map invasives is minimal, and such protocols greatly increase the usefulness of the collected data.

Mapping of early detections and existing infestations is typically performed using GPS, which uses satellite signals to determine coordinates for a location on the ground. Most agencies then integrate the GPS data into an in-house GIS database. For example, GGNRA collects invasive plant occurrence information as point occurrences and as polygons (areas of varying shape and size) using handheld GPS units. Accurate GPS units are affordable and widely used by many of the agencies interviewed. However, some agencies do not have an in-house GIS database mapping capability, preferring instead to use hand-mapping or even staff “institutional memory” of locations and conditions with no mapping.

Typically monitoring is used to assess the outcome of treatments, track the condition and size of known invasive plant occurrences, and/or monitor “hot-spots” where invasive plants typically enter preserves. Few of the agencies interviewed have clearly defined the objectives and methods of their invasive plant monitoring program. Few agencies perform consistent monitoring, and many agencies indicated that the data they collected was not sufficient to evaluate whether or not a project was successful. Commendable exceptions include MCOSD’s efforts to eradicate barbed goatgrass (*Aegilops triuncialis*), which includes an ongoing adaptive management monitoring program. While every agency interviewed has conducted some sort of performance monitoring, the results are often assessed informally by staff, and the results go unpublished and unknown to the general public.

Treatments

This section surveys the agencies’ implementation of the principles of integrated pest management (IPM) and discusses the components of their invasive plant treatment programs, including planning and prioritization, treatment methods, timing, and consideration of environmental and human health and safety issues.

Successful treatment of invasive plants on MCOSD preserves will require land managers to use a variety of treatments. The agencies interviewed expressed that the key to successful control is having the flexibility to select and adapt many treatment methods to a site-specific situation. Integrated pest management is a process that enables flexible decision making and requires agencies to carefully consider and balance the multiple objectives of protecting biological diversity, reducing fire risk, protecting and restoring native plant communities and special-status species, and ensuring environmental and human health and safety.

All interviewees recognized the value of an integrated IPM approach that considers all tools to manage vegetation. The scale and focus of IPM programs is directly linked to the organization’s mission, with water agencies (e.g., MMWD, EBMUD) eliminating or severely restricting use of chemical compounds and recreational activities near water supplies, and other agencies with a visitor use- or resource-based mission employing a combination of chemical and nonchemical control methods for priority invasive plants. Some agencies stated that their goal is to reduce or limit chemical pesticide use. Others stated that an effective program should offer nonchemical alternatives along with the judicious use of the most appropriate chemical herbicides.

Most interviewees agreed that any IPM plan must be adaptive to changing site and environmental conditions, and should be flexible enough to incorporate new research on treatment efficacy. All agreed that effective treatment requires multiple years and multiple types of treatment. Interviewees also agreed that many years of maintenance are needed following the initial control activity. All stressed that the efficacy of the initial treatment has a direct effect on the cost and level of effort required for any follow-up and/or maintenance treatments.

Additionally, interviewees indicated that realistic goals should be set before a project is initiated. They stressed that eradication of some well-established populations may not be feasible. In these instances, sustained control or containment may be more realistic goals than the goal of eradication. In addition, agencies noted that some invasive plant populations, such as pampas grass infestations that occur in inaccessible or dangerous locations, such as eroding sea cliffs, are best treated with methods that are lethal in a single treatment.

Interviewees offered the following additional comments on treatments, grouped below into four general categories: (1) selection and prioritization of treatments; (2) cost and effectiveness of various treatment types (i.e., manual and mechanical treatments, chemical treatments, cultural and other control treatments, biological control); (3) timing of treatments; and (4) health and safety considerations.

Selection of Treatment Methods and Prioritization of Treatments

In general, treatment approaches vary with the type and severity of the invasive plant infestation. Treatment project prioritization typically focuses on the maintenance of high quality natural communities, protection of public safety, and prevention of new invasive plant infestations. The land managers interviewed place a high priority on the following actions:

- eradication of new invasive plant infestations
- control of leading edge invasions (e.g., an established infestation that is spreading outward into wildlands from an adjacent property)
- treatment of state-ranked “noxious weeds,” as required by law
- eradication or control of invasive plant populations that affect special-status plant populations and other sensitive natural resources

Approaches to invasive plant prioritization have changed over time. The majority of interviewees indicated that they historically emphasized full eradication (elimination) of large established invasive plant infestations, but they have more recently recognized that this approach is not the most efficient use of time and materials. Instead, many have adopted a more strategic approach. For large and established infestations, some interviewees are now pursuing sustained control or containment of invasive plant infestations as a more feasible alternative to eradication.

There are distinct differences in priorities among agencies, depending on the agency's purpose and mandate. For example, MMWD, whose purpose is to provide municipal water supply, is primarily concerned with the protection of water quality; natural resource conservation and invasive plant control are often secondary priorities. Agencies with a recreational and public resource conservation purpose, such as CSP and MROSD, tend to give higher priority to resource protection and invasive plant control projects.

Manual and Mechanical Treatments

Manual control methods are those methods that use hands (pulling) or hand-held tools, such as hoes, saws, scythes, shovels, hatchets, rakes, and specialized tools like weed wrenches. Hand-held power tools include string trimmers with nylon line or polyblades (referred to as weed-whackers or brushcutters), chainsaws, and handheld power scythes. Manual tools are effective at all stages of growth and population size, but selection of the proper hand tool is important to the overall effectiveness of the control action.

Mechanical methods of control refer to the use of larger equipment, usually machinery that mows or mulches vegetation. This category includes high-speed flail mowers or rotary mowers mounted on tire or track skid steers; larger excavator-chassis equipment and equipment pulled behind farm tractors; and hydro-mechanical obliteration (an experimental method that uses a high volume of water under high pressure).

Several agencies utilize manual and mechanical control in invasive plant control efforts. In particular, MMWD has been a leader in developing alternative treatments and assessing efficacy. Interviewees presented the following findings related to manual and mechanical treatments:

- Manual control (i.e., hand-pulling) is effective for initial broom control, but is considered extremely costly compared to other methods. Interviewees caution that while hand pulling results in a high kill rate of between 85% and 95%, hand pulling also causes soil disturbance, exposing buried seeds, and often results in a longer-term increase in broom abundance if the treatment sites are not maintained. Secondary invasive plants, such as yellow starthistle and other thistle species, which may not have been present initially at the treatment site, can establish in the disturbed soil, causing further problems.

- Mechanical control (e.g., mowing, brush cutting) is less costly than manual control, but was reported to have much lower success rates and to cause even greater soil disturbance than hand pulling, and so was reported to be less appropriate for treating large and well-established invasive plant infestations. Mechanical control was reported to be highly effective and still low cost when integrated with other treatments (such as use of the cut-and-paint herbicide application method).

- Mechanical control followed by controlled burning (of brush piles or brush wind-rows) was reported by interviewees to be very cost effective and to possibly decrease the number of resprouts; however, it was noted that this technique can harm nontarget vegetation and can stimulate germination of broom seedlings. Interviewees suggested that, to be effective, this technique must be followed by actions to control resprouts and seedlings.

- Mechanical control followed by chemical control was reported to be very effective for treating large and well-established infestations. Cutting followed by some sort of localized herbicide application (e.g., cut-and-paint application, low-volume drizzle foliar application, low-volume basal bark application) is considered both low cost and highly effective. Several of the agencies interviewed consider this treatment to be the most cost-effective, safest, and most appropriate method for treating large infestations.

Chemical Treatments

Chemical control methods use chemical compounds to inhibit or prevent the growth of plants.

Several agencies interviewed are conducting, or have recently conducted site-specific pesticide toxicological reviews and risk assessments to preselect IPM procedures, including making decisions about when and where to use appropriate herbicides in their programs. For example, MMWD's vegetation management plan incorporates an extensive toxicological review of herbicides, a review of application methods and costs, and a list of herbicides proposed for use by MMWD. MCOSD has partnered with MMWD and funded part of this research, and it has stated its intention to incorporate MMWD's findings to the full extent feasible and to build upon the extensive knowledge base that MMWD has created. Several agencies suggest a need to research, evaluate, and apply new treatment techniques for new invasive plants and those invasives that have been found to be difficult to control.

While some agencies have maintenance staff experienced with herbicide application, others employ contractors to do their herbicide application work. Specifically for herbicide application, some agencies have designated IPM specialists, pest control advisors, and/or qualified pesticide applicators on staff, while others have not. Those without pest control advisors on staff rely heavily on independent consultants for advice regarding herbicide treatments. Most agencies interviewed have separate maintenance crews that perform a considerable amount of the chemical vegetation management work.

The agencies identified the following constraints that greatly influence the effectiveness of herbicides:

- wet conditions (which can dilute active ingredients or wash the herbicide off the target plant)
- periods of extreme heat (which can slow growth rates and affect the translocation of the herbicide from the leaves into the roots and/or cause herbicides to volatize)
- growth patterns of the target plants (some plants are best treated by cutting, allowing for new plant growth to emerge, then treating the new actively growing plant growth with much smaller amounts of herbicides that are applied directly to the growing shoots)
- wind speed (which can affect the ability of the applicator to accurately apply small amounts directly onto target plants)
- public use (which affects the selection of herbicides as a control method, and also requires methods that ensure human health and safety)

Cultural Control Methods and Other Treatments

Cultural control methods include social and operational practices that can directly or indirectly manage vegetation. This category is quite broad and includes the following practices:

- grazing or browsing by domestic animals to remove invasive plants
- prescribed burns
- timing of maintenance or vegetation management activities and/or treatments to reduce potential for spread of invasive plants
- conducting public outreach to prevent introduction of invasive plants from backyard gardens and green waste dumping
- habitat modification to increase resistance of natural plant communities to invasion (e.g., reducing soil disturbance, actively planting cover crops to shade out or out-compete invasive plants)
- buffering high-value natural resources from invasives through physical barriers (e.g., weed control matting, mulch barriers, solarization)
- early detection and response to new invasive plant infestations
- requiring footwear and/or equipment to be cleaned before and after entering infested areas to help prevent invasive plant spread, or restricting access to certain areas (either to contain invasive plant spread or to prevent spread into uninfested areas)

Cultural approaches that have been tested by the agencies interviewed include grazing and browsing using cattle and goats, prescribed burning, and covering or tarping invasive plants to solarize them. Grazing by cattle was reported by interviewees to be an effective treatment for removing some invasive plants, such as nontoxic thistles, from grasslands. Goat grazing and browsing was found to effectively reduce fuel loads and to selectively control some woody shrubs in grasslands. Grazing was not considered an effective treatment for large and well-established infestations of invasive plants such as broom. Cattle mostly consume grasses, so are less effective at consuming woody vegetation than are goats. Browsing by goats is moderately effective and moderately costly, but it was reported by interviewees to be destructive to nontarget plants and to leave many broom plants alive to resprout, so it is best to use goats to control invasives in combination with other methods. Interviewees also indicated that grazing is logistically difficult to manage in wildland settings.

Prescription burning can be used to control invasive plants in grasslands or other vegetation types with sufficient fuel to carry a fire, but it is difficult to apply in forested settings with significant ladder fuels. It is also difficult to permit and schedule due to air quality constraints, fire hazard, and wind restrictions. Prescription burning is reported to be effective at removing resprouting broom shrubs when applied sequentially over several years, but this treatment has very significant effects on community structure and is logistically difficult to employ.

Solarization has been attempted by interviewees on localized, small-scale invasive plant infestations, such as iceplant infestations in dunes and cape ivy infestations. For these situations, cutting and rolling the aboveground plant biomass, followed by composting the windrows onsite and tarping the exposed ground to solarize any remaining resprouts after removal was found to be effective at controlling the spot-infestations. Solarization was found to be ineffective at treating perennial grasses: in these instances, solarization was insufficient to kill the seed bank. The removal of the tarp triggered seed bank germination, effectively reversing any positive treatment effects. Tarping has also been used locally on cut tree stumps, such as eucalyptus and acacia, with varying degrees of effectiveness. In general, tarping was reported to be about 35% to 50% effective in preventing resprouting of these tree species.

Other treatments evaluated by interviewees included the Waipuna hot foam system and the hydromechanical obliteration system. Waipuna applies heated foam of corn and coconut extracts in aquatic solution, and was reported to be somewhat ineffective and relatively expensive. Hydromechanical obliteration uses very high pressure water jets to slice through biomass and soil. While it is effective at loosening individual plants so they can be pulled, it was reported to not be cost effective for treating large infestations. This treatment also was reported to cause soil erosion.

Biological Control Methods

Biological control agents are organism (parasites, predators, or pathogens) that are deliberately introduced into a pest vegetation population to reduce or eliminate it. Recognized biological methods include introduction of predatory insects, selective grazing, and in some cases, plant-specific pathogens. The agencies interviewed had for the most part not investigated biological control, so did not provide input on the efficacy or cost of this treatment method.

Timing

All interviewees agreed that the timing of treatments is crucial to successful control of invasive plant infestations. Timing must consider seasonal conditions (e.g., temperature, moisture, rainfall, wind); physiological characteristics of the target species (e.g., growth characteristics, timing of flower and seed set, volume and fertility of seed set, ability to crown or root sprout); and control objectives (e.g., eradication, control, containment). Variation in these parameters will result in timing adaptations.

Agencies emphasized that manual, mechanical, and biological control methods should be implemented prior to flowering or seed set of the target species in order to prevent new seed from entering the soil seed bank. Because these methods are relatively unaffected by weather, they can be implemented year-round depending upon the ecology of the invasive plants.

Preemergent herbicides are typically sprayed on the soil surface to kill plants as they germinate. A majority of the herbicide treatments used by the agencies interviewed are post-emergent, meaning that they work on plants after they have sprouted and grown stems and leaves. Post-emergent herbicide applications are most effective during a specific period of plant growth, for example, applying herbicide to woody plants when the plants are actively growing to expedite translocation of the herbicide into the belowground root system by the growing plant. Likewise, treatment timing for seedlings and grasses is typically in spring before flowering or seed set. Mature woody plants, such as broom species, are more susceptible to post-emergent foliar application when they are seedlings or when they set flower (but before seed set). However, spot treatment of woody plants such as broom using the cut-and-paint method can be done effectively virtually year-round.

Environmental and Human Health and Safety Considerations

Concern for environmental and human health and safety is critical to the IPM decision-making process regarding which vegetation management treatments are selected.

Interviewees indicated that the health and safety of vegetation workers and the public must be a high priority when selecting the appropriate treatment. All treatment methods have risks. For example, there is a high risk of injury entailed in manual and mechanical invasive species controls (e.g., acute and repetitive stress injuries from using hand tools, brushcutters, and chainsaws), as evidenced by high Workers Compensation Insurance rates for workers performing vegetation management using nonchemical tools. GGNRA reports that their number one source of compensation claims by vegetation management staff is exposure to poison oak and ticks. Chemical control also has short- and long-term risks. Some of these risks are not related to the herbicide itself, but are associated with injuries resulting from carrying heavy equipment across uneven terrain or with heat-related illness resulting from the need to wear protective clothing. Most agencies have made the professional assessment that when herbicides are carefully selected, appropriately applied, and used in moderation, they can significantly increase worker safety, reduce invasive plant infestations and related program costs, and reduce the need for long-term follow-up because the invasive plant infestations will be controlled or eliminated.

Environmental health and safety addresses factors such as erosion potential, fire danger, nesting bird protection, and air quality.

MMWD has conducted a thorough investigation of environmental and human health and safety considerations that are to be considered in their vegetation management program (MMWD 2009b, 2008a). The following list of "components of public health and environmental impacts to be considered (in alphabetical order)" is excerpted from MMWD (2008a):

- accidental ignition potential
- aesthetics
- air quality
- amphibians
- carbon emissions
- environmental persistence
- erosion and runoff
- nesting birds
- noise
- nontarget terrestrial and aquatic vegetation
- pollinators
- public health and safety
- salmonids
- soil productivity and microorganisms
- water quality

- worker health and safety

MCOSD will consider these factors in its decision making.

Examples of Invasive Plant Management Projects

Several examples of invasive plant management projects are provided below.

EBRPD focuses a great deal of effort on yellow starthistle control. They use a combination of fire, grazing, manual methods, and herbicide (including aerial applications) for vegetation management. Invasive plant population size and density, along with habitat and environmental constraints, typically dictate which methods EBRPD selects for initial treatment, follow-up treatment, and biomass disposal.

MMWD is most concerned with controlling broom species. Historically MMWD used herbicides effectively on this species. However, because of a moratorium on herbicide use, the agency currently uses a combination of manual and mechanical methods. MMWD is also experimenting with natural-compound-based herbicides (i.e., herbicides derived from naturally occurring compounds, such as clove oil). Mowing of broom is done to establish and maintain fuelbreaks and access roads, not primarily as an invasive plant control method.

MROSD is focused on the eradication of slender false brome. They have developed a species-specific IPM plan for slender false brome control that incorporates chemical methods, manual methods such a pulling and hoeing, and cultural methods such as mulching, with the goal of eradicating this species on MROSD lands. Because of the localized nature of the infestations, hand pulling is heavily used as a practical and low-cost treatment option. Larger populations are treated with a post-emergent foliar application of a glyphosate-based herbicide. MROSD recognizes that public support is key to the success of the project and has conducted extensive public outreach, including creating educational materials and conducting public meetings about their project. The results of this program will be instructive in developing future early detection and response programs.

Summary of Findings: Invasive Plant Management

- Preventing invasive plant infestations from occurring, thereby avoiding the harm associated with invasive species, is the key to managing fuel loads and protecting biodiversity.

- An effective invasive plant control strategy requires the integration of several types of treatments into a site-specific, multiyear treatment program.

- Effective invasive plant control strategies are usually tied to specific conservation goals.

- Effective invasive plant control strategies must explicitly consider the effects of their proposed actions on the environment and on the health and safety of humans and other species.
- Early detection is the single most important element for coping with invasive plants.
- The cost of a well-organized and routinely scheduled response is always less than the cost of a delayed response or an inconsistent response, which allows the infestation to increase.
- Mapping and monitoring invasive plants are essential to successful control.
- Effective treatment requires multiple years and multiple types of treatment. The efficacy of the initial treatment has a direct effect on the cost and level of effort required for any follow-up and/or maintenance treatments.
- Many agencies consider mechanical control followed by chemical control to be the most cost-effective, safest, and most appropriate method for treating large infestations.
- The timing of treatments is crucial to successful control of invasive plant infestations.
- When herbicides are carefully selected, appropriately applied, and used in moderation, they can significantly increase worker safety, reduce invasive plant infestations and related program costs, and reduce the need for long-term follow-up because the invasive plant infestations will be controlled or eliminated.

Fuel Management

This section outlines scientific trends, best management practices, and overall cost/benefits for various fire risk management and fire hazard reduction approaches. The term 'fire risk' refers only to the probability of ignition (in other words, the probability of either a human- or a lightning-caused fire being started). 'Fire hazard' refers to the ease of ignition and the resistance to control of fire within a particular fuel complex, defined by the volume, type condition, arrangement, and location of the fuel (NWCG 2011). In layman's terms, this is "the stuff that burns."

The information included below is not intended to replace the information in the existing county *Fire Hazard Management r*eport (MMWD 2008b), nor is it intended to be a comprehensive assessment of the existing fuelbreak system present or planned by County Fire on MCOSD preserves. Instead, this section attempts to capture the state of knowledge about fuel management strategies on open space lands so that the MCOSD can make informed decisions about how best to adapt or modify their fuel management approach based on what works for other agencies with similar goals.

All agencies interviewed agreed that reducing the risk of fires spreading to wildlands and wildfires impacting residential and commercial structures is an essential management objective. Also essential is providing safe access for evacuees and wildfire responders.

However, the agencies reported differences in the sizes of their program, the strategies used to achieve fuel reduction goals, and whether or not they maintain fire management jurisdiction responsibilities over their own lands. The agencies that have the most in common with the MCOSD include local agencies whose missions emphasizes the natural resource and recreational values of open space lands. EBRPD, by far the largest of these park districts, is completing a fuel management and resource management plan (EBRPD 2009a) with an accompanying environmental impact report (EBRPD 2009b). The plan's primary objectives are to minimize the loss of life and property from wildfire and to maintain or restore natural resource values associated with its mission. Proposed fire management treatments are generally localized to areas within 200 feet of structures on district borders, to areas around facilities at risk within the district, and to stands of trees that have the potential to support crown fires and spread embers long distances.

SCCOSA is one of the smallest park districts, consisting of 26 parcels ranging from 1 acre to 4,200 acres. While SCCOSA employees are trained to respond to wildfires on their land, the staff has no direct fire management responsibilities.

CSP in the Bay Area consists of 56 park units totaling 120,000 acres in 12 counties. CSP's goal is to "prevent all unplanned human-caused fires on its lands." However, due to limited resources, only the largest park in this system (Mount Diablo State Park, 20,000 acres), has a maintained fuelbreak system, ignition prevention actions, and defensible space zones.

Several of the other agencies interviewed have a relatively focused mission related to the delivery of water to their customers. For these agencies, fire management is secondary to water supply and delivery.

As noted above, EBRPD is currently completing a fuels management plan. MMWD has recently completed a comprehensive *Fire Hazard Management* report (MMWD 2008b) for its lands, many of which are adjacent to MCOSD preserves. Many of the fire risk management findings are directly applicable to MCOSD land, and are incorporated into this report wherever appropriate.

This section is organized according to the key components of fire risk management and fire hazard reduction strategies:

- fuel modification zones

- other fuel reduction strategies

Fuel Modification Zones

This section discusses the main types of fuel modification zones:

- defensible space zones
- ignition prevention zones
- fuelbreaks (primary, secondary, and wide area)
- ingress/egress zones

Each of these fuel modification zones is described in detail below. A preliminary overview discussion summarizes how some of the agencies are reassesing their approaches to fuel modification.

Overview

Agencies have varied in their approaches to constructing and maintaining fuel modification zones. For example, MMWD has established 100- to 200-foot-wide primary fuelbreaks in strategic locations (e.g., on ridge tops or next to roads or other low-hazard natural features that can impede the spread of fire). They also maintain secondary fuelbreaks, 60 to 100 feet wide, mostly next to roads. CSP creates fuel modification blocks of approximately 100 x 100 feet by crushing vegetation in place and then burning it in late winter to buffer areas with high fuel loads. MROSD discs the perimeter areas of their preserves to reduce vegetation cover and reduce fuel load and fire risk to adjacent properties (Mid Peninsula Open Space District 2008, 2009). EBRPD creates wide area fuelbreaks within eucalyptus or pine stands to reduce fire risk.

However, the interviewees overwhelmingly indicated that the most effective approach to reducing fire risk and protecting structures and adjacent communities is the establishment of defensible space zones along the wildland-urban interface (Cohen 2000, 1995, Dennis 2001). Interviewees stressed that defensible space zones are an important and often underutilized tool in helping slow the spread of fires from or onto preserves.

MMWD recently conducted an extensive review of the efficacy of the fuel reduction management actions recommended in their 1995 vegetation management plan (MMWD 2008b, 2009a) to determine the degree to which they provided protection of adjacent residences and watershed resources from wildfire, the cost of constructing and maintaining the fuelbreaks, and the effect the fuelbreaks have on watershed biodiversity. Based upon their findings, MMWD intends to shift its resources away from classic fuel management areas in the interior of their preserves and instead to emphasize fuel modification treatments along preserve perimeters—at the wildland-urban interface—where the risk to human health and safety is considered greatest. This change in management direction is consistent with current CSP and NPS management.

Respondents also noted that having trained natural resource and maintenance staff available to respond to large wildland fires enabled them to minimize wildland resource damage, minimize the costs of post-fire rehabilitation, and maximize the effectiveness of that rehabilitation.

A recurring theme during interviews about fuel modification zones was the need to address and minimize invasive plant spread and establishment within these zones. Most agencies indicated that they have had to redirect a large portion of their fuel management funding away from construction of new fuel modification zones to controlling or containing infestations of invasive plants, such as French broom, within already constructed fuel modification zones. Agencies recommended implementing an aggressive early detection and treatment program for controlling these invasive plants during and after construction, as well as treating infestations during maintenance activities. Interviewees noted that the inability to eradicate new invasive plant infestations early exponentially increases future operational costs. Additionally, agencies that were limited in using chemical control techniques (herbicides) as a part of their IPM strategy, expressed that this greatly increased overall costs, and for numerous invasive plants reduced control treatment effectiveness, thereby exponentially increasing future operational costs.

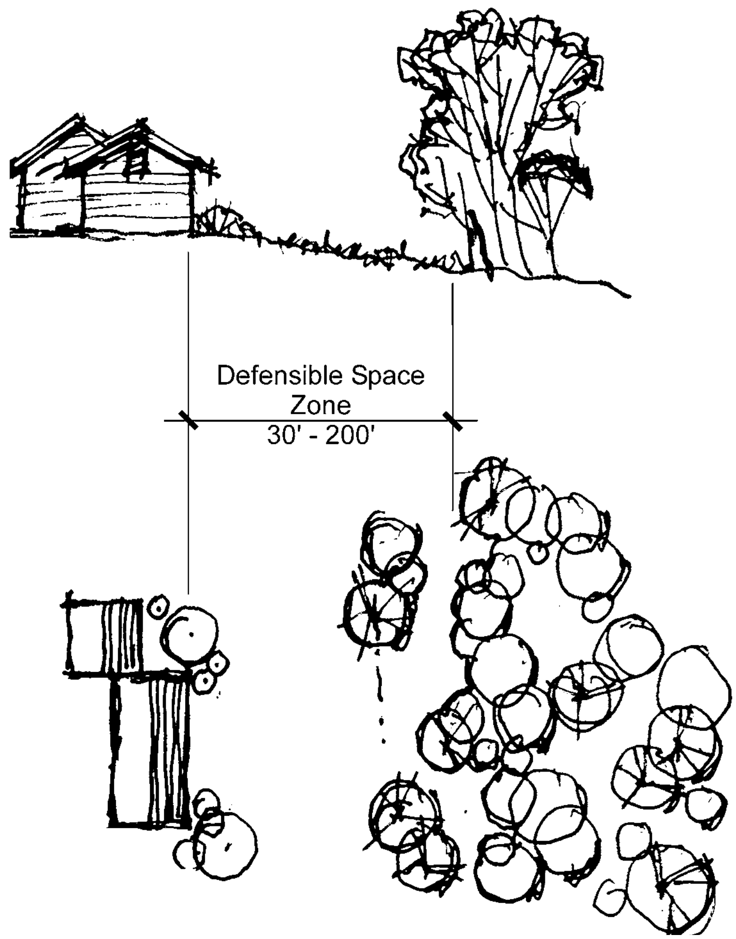
Defensible Space Zones

Defensible space zones are a type of fuel management zone that is established between a developed area and the surrounding undeveloped area for the purpose of reducing the potential for wildfires to spread between the two areas (see figure 3.1). The vegetation is modified and maintained to slow the rate of fire spread, and to slow the intensity of an advancing wildland fire due to radiant and convective heat. Wildfire may still spread due to the production of embers, which could land on a receptive fuel and result in the further spread of a wildfire.

Developed areas are the primary source of fire risk (the probability of ignition). Defensible space zones are the most effective approach to reducing fire hazard (fuel characteristics that support ease of ignition and resistance to control). Defensible space zones are typically regulated under state or local fire or building codes, which are enforced by a local fire department. The zones generally vary in width, according to topography and vegetation type and structure, from 30 feet to 200 feet (averaging 100 feet). Fuel modification plans (site-specific plans for fire prevention), rarely if ever require more than 200 feet, and they typically require a maximum of 150 feet of treatment area in the most combustible of California wildland fuels.

In most cases, defensible space zones are located along the perimeter of open space lands, at the wildland-urban interface. They protect both wildland and urban values by reducing the speed and intensity of fire spread and creating a relatively safe zone near structures from which firefighters can access and fight fires. For this reason, some experts are emphasizing creation of defensible space zones that completely separate the wildland-urban interfaces from high-value wildlands (Millar 2007).

Figure 3.1 Defensible Space Zone



The wildland-urban interface is interpreted differently by different land managers. MMWD, according to its 2008 fire hazard report, considers the wildland-urban interface to be residential areas within ½ mile of MMWD boundaries. EBRPD has assessed wildfire hazards on parklands within 200 feet of structures (EBRPD 2009a). CSP considers the wildland-urban interface to be those properties that share a common boundary with park wildlands (Gaidula 1976).

The utility of defensible space zones as a primary tool for reducing wildfire risk and protecting structures at the wildland-urban interface is further supported by the following excerpt from the MMWD *Fire Hazard Management* report (MMWD 2008b):

> *Fuel management to enhance the chance of structure survival entails reducing the fire intensity nearest the structure. In wildland fires, most structures are ignited by embers. Building an ignition-resistant structure is the most effective defense against structure ignition and loss, since there will almost always be numerous embers in a wildfire. The factor that can increase the probability of structure survival that can be managed*

> *through vegetation management is to reduce the intensity of the fire closest to the structure. The further from the structure, the less pertinent District fuel management is to structure survival. This is because a fire can flare up on wildlands on private properties or in an unmanaged landscaping near a structure even if there are managed fuels on surrounding lands.*
>
> *There are two aims in conducting fuel management to minimize structure damage. First, is to minimize the chance of fire spreading into and through tree crowns, which will reduce the number of embers nearest the structure. Second is to diminish the ability of the fuelbeds to create dramatic fire behavior after the inevitable embers ignite the fuels. The aim is to reduce potential fire intensity both high in the fuelbed and on the surface.*
>
> *Fuel management to reduce structure damage is done by mowing grass, eliminating pyrophytic vegetation (vegetation that easily ignites and/or burns intensely), and creating discontinuous fuels (both horizontally and vertically). Discontinuity is produced by pruning lower trees branches, and creating "clumpy" vegetation, where spaces of low fuel exist between specimen shrubs and short trees.*

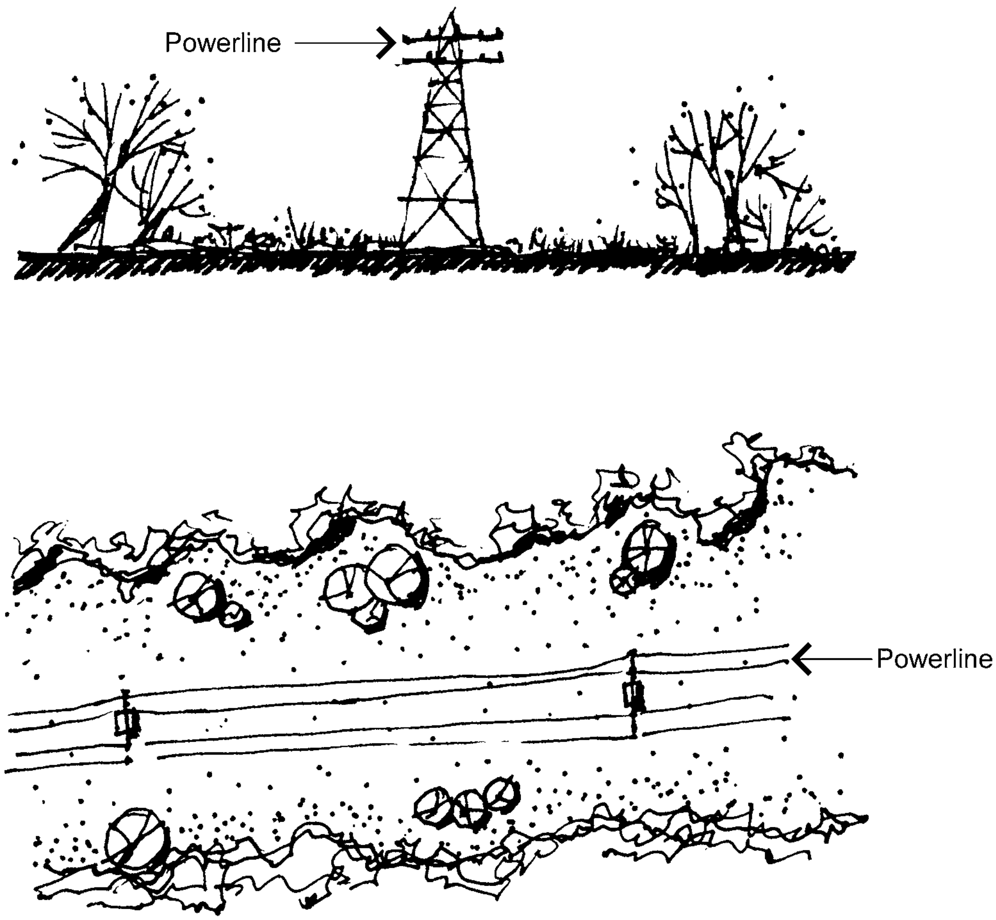
Although they define wildland-urban interface zones differently, the interviewed agencies generally agree on the specifications for defensible space zones. Most agencies have adopted the 100-foot defensible space specifications included in section 4291 of the *California Public Resources Code* and section 51182 of the *California Government Code*. (The *Public Resources Code* primarily directs the creation of defensible space in state responsibility areas, while the *Government Code* sets the fuel treatment requirements in local responsibility areas that are designated as very high fire hazard severity zones.) Both codes require a 30-foot-wide very low fuel zone called the "Lean Clean and Green Zone" and an additional 70-foot-wide reduced fuel zone. While this approach is easy to understand and interpret, interviewees acknowledged that it also has some disadvantages. First, the 70-foot reduced fuel zone may be too wide for some vegetation types, resulting in excessive disturbance and unnecessary vegetation management costs. Second, it may not be wide enough for some flammable vegetation types, such as dense chaparral, dense conifer-dominated forests, eucalyptus, and acacia groves. Finally, these codes do not incorporate natural resource management goals regarding which vegetation should be removed (e.g., invasive plants) or retained (e.g., special-status species, sensitive vegetation types). Fuel modification plans can and often do incorporate invasive and exotic species control and the removal of only target highly flammable species, while retaining less flammable species to maintain soil erosion capacity.

Defensible space zones are typically located on private property (not on public lands or preserves) and are therefore considered the responsibility of the landowners to install and maintain. There is general agreement among agencies that the neighboring landowners are the primary beneficiaries of the establishment and maintenance of these zones because they directly safeguard their structures. However, agencies agree that unless neighbors comply with building and fire codes to make structures and landscaping fire resistant, there is less benefit to establishing defensible space zones as a primary fuel modification strategy. Local fire agencies have the ability to enforce compliance. In other parts of the state, this typically includes a notice to comply; a follow-up notification of failure to comply, with consequences stated; and if compliance does not occur, charging the landowner for the needed work (which can be applied as a lien on the owner's property taxes) and having it performed. Some land management agencies are seeking partnership opportunities with neighbors. Some provide financial incentives to landowners to develop and maintain these zones, and others provide technical support (i.e., expert advice, tools, and sometimes work crews) to neighbors who want to create a defensible space around their structures. Most agencies require landowners to secure a permit to clear vegetation on preserves; the permits protect preserve resources by controlling how vegetation is cleared.

Ignition Prevention Zones

Ignition prevention zones are areas that are designed and managed to minimize and, if feasible, to reduce the chance of a fire igniting. Vegetation is typically reduced in volume and, in some situations, modified to increase its moisture (by replacing existing vegetation with species that retain more moisture in the leaves and the rest of the plant). These prevention zones are typically located near paved or dirt vehicular access roads, trailheads, campgrounds, and selected power transmission and gas lines (see figure 3.2). These zones are often as narrow as a 10-foot buffer on either side of a road, or as small as a 15-foot radius from a potential ignition source. Most agencies maintain ignition prevention zones in strategic locations based upon priorities and resources available for managing these zones.

Figure 3.2 Ignition Prevention Zone



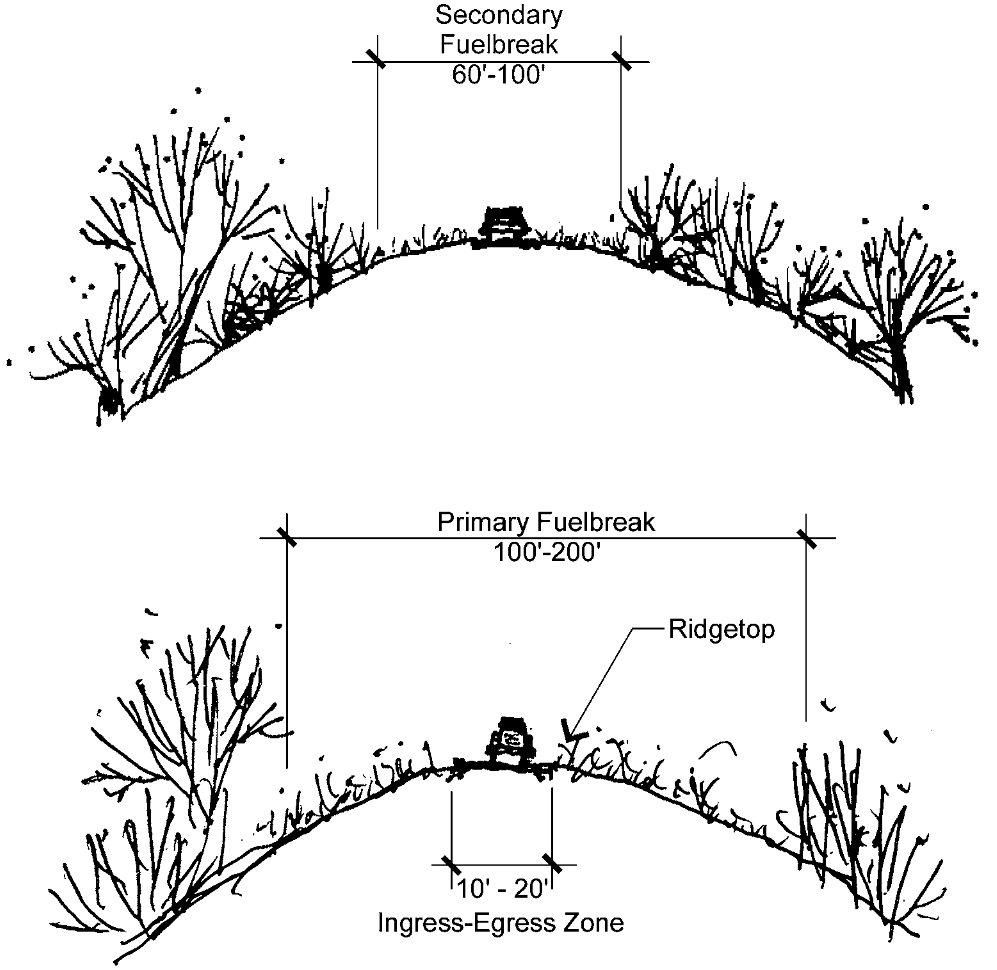
Fuelbreaks

Fuelbreaks are swaths or blocks of land in which vegetation and associated debris has been reduced to diminish the risk of fire spreading across the break. Fuelbreaks reduce the rate of fire spread, but without suppression effort they generally will not contain or control a wildfire. Fires have been stopped by fuelbreaks only in instances where fire intensity was low.

Primary and Secondary Fuelbreaks

Primary and secondary fuelbreaks are often located on ridgetops alongside roads (see figure 3.3). Primary fuelbreaks are typically 100 to 200 feet wide; these breaks are designed to control lower intensity fires or to control the edges of higher intensity fires to provide for firefighter safety. Secondary fuelbreaks are 60 to 100 feet wide and are primarily located next to roads. The most common method of fuelbreak creation is to use chain saws to thin or remove targeted vegetation, which is then piled to be burned at a later date, or chipped using a chipper. In other instances, large mowers and brush-cutting attachments are used to thin or remove vegetation.

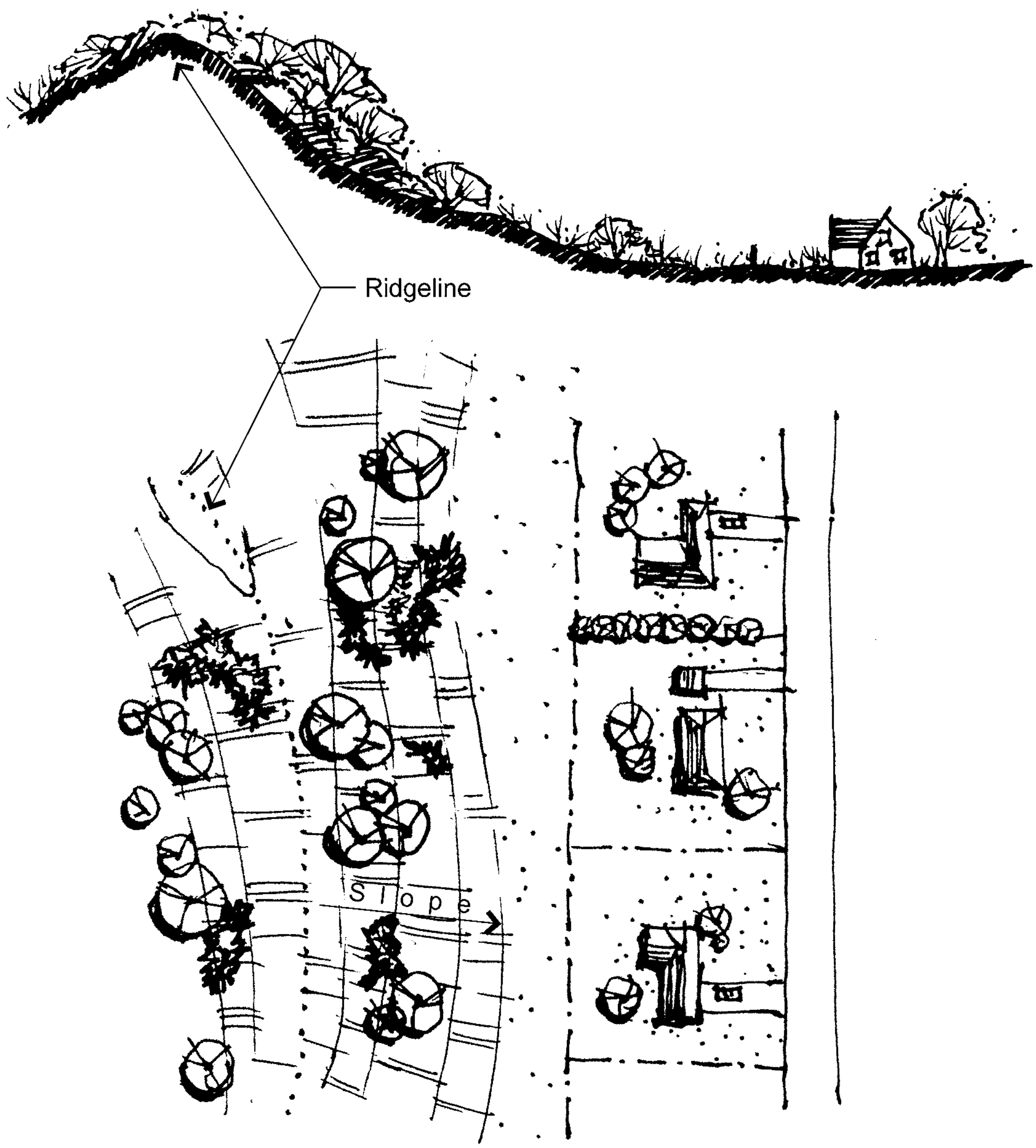
Figure 3.3 Primary and Secondary Fuelbreaks



Wide-Area Fuelbreaks

A number of interviewees also manage a third type of fuelbreak—a wide-area fuelbreak (see figure 3.4). These fuelbreaks cover large areas of land, not necessarily located next to roads. Wide-area fuelbreaks achieve multiple goals, including hazardous fuel and invasive plant reduction.

Figure 3.4 Wide Area Fuelbreak

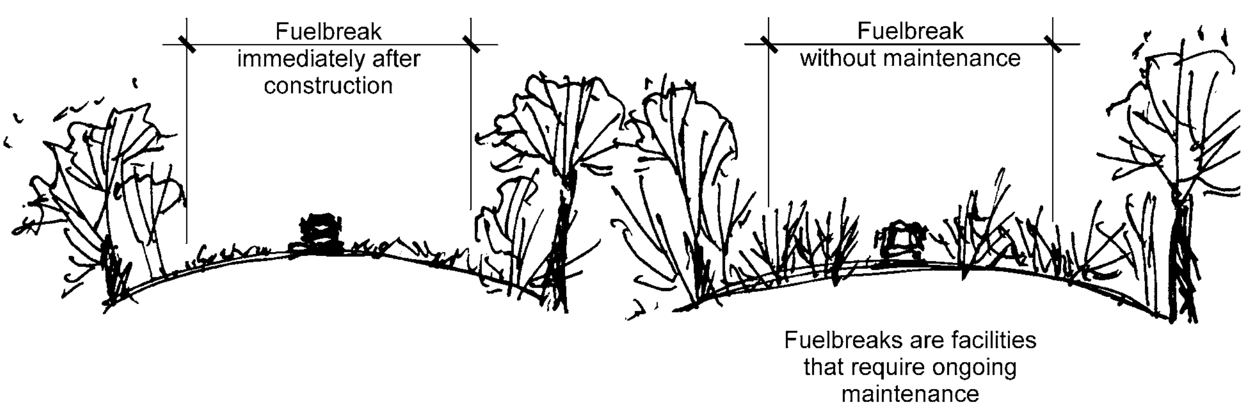


Fuelbreak Management

Several agencies concurred that while fuelbreaks are one tool for containing large wildland fires, ridgetop fuelbreaks typically have limited effectiveness for stopping the spread of fire during large fire events. Recent studies (Syphard et al. 2011a and 2011b) conclude that fuelbreaks primarily serve to facilitate fire management activities. Interviewees raised concerns that constructing and maintaining fuelbreaks is cost prohibitive and is a major cause of rising program costs for many land management agencies. All agencies noted that fuelbreaks are also strongly linked to the spread of invasive plants within their lands. For these reasons, interviewees strongly recommended that fuelbreaks be minimized, and resources reapplied to defensible space zones. At least one of the agencies interviewed (SCCP) enforces a policy of not allowing outside agencies (e.g., the California Department of Forestry and Fire Protection also referred to as CalFire) to maintain fuelbreaks on parklands. Recommendations from the agencies included the following:

- Fuelbreaks need to be planned like any other permanent facility requiring ongoing maintenance (see figure 3.5).
- Fuelbreak planning should take into account the locations of, and potential for invasion from, existing invasive plant infestations.
- No new fuelbreaks should be installed without securing sufficient funds to maintain the vegetation within the fuelbreak, control erosion over time, and treat invasive plant infestations before construction.
- Wherever possible, fuelbreaks should be downgraded and in some cases eliminated or placed on the edges of preserves to reduce costs and to limit effects on natural resources.

Figure 3.5 Fuelbreak Maintenance

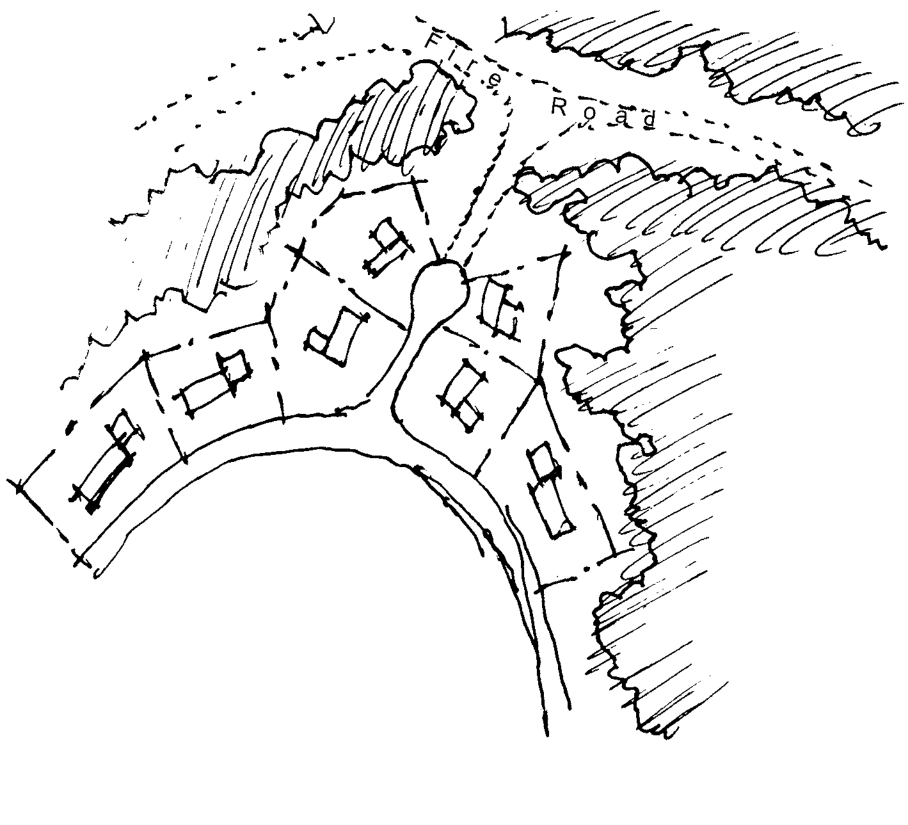


Ingress/Egress Zones

Many interviewees have established ingress/egress fuel management zones adjacent to roads that have been identified as fire roads, as a part of their fire risk reduction strategy. However, a number of land managers acknowledged that these zones have limited effectiveness for evacuation and for safe passage of firefighting equipment during a fire event. Several respondents noted that many access roads adjacent to their lands were not specifically designed to facilitate evacuation; they are congested and narrow and/or contain few turnouts or places to take refuge during a fire. Because of the limited effectiveness of the existing roads, agencies indicated that the best strategy for protecting life might be an early evacuation, well before a fire is in the vicinity, and that the deployment of firefighting aircraft would probably be the most effective way to fight large wildfires on their lands, not a ground-based operation from fire roads.

Fire roads, which are typically between 10 and 20 feet wide, are considered by most agencies to be relatively expensive to establish and maintain. Several agencies have assessed the condition of their existing fire roads (e.g., tread, associated erosion, maintenance costs, safety, location for firefighting purposes) to determine which should be downgraded to trails or eliminated completely to reduce both maintenance costs and impacts on natural resources, which can include habitat fragmentation, introduction or spread of invasive plants, disruption of wildlife travel corridors, and degradation of the visitor experience (Weaver and Hagans 1994). Similar assessments have been undertaken to determine optimal locations for any necessary fire roads—most of which probably would be relocated strategically to perimeter locations where they would connect primary access routes (see figure 3.6).

Figure 3.6 Optimal Fire Road Location



Other Fuel Reduction Strategies

This section discusses other strategies for reducing fuels—prescribed fire, grazing, and large-scale vegetation conversion/manipulation.

Prescribed Fire

Prescribed fires are intentionally ignited to meet specific resource and fire management goals and objectives under predefined fuel and weather conditions (GGNRA 2008). Prescribed fires are typically used to manage vegetation, strategically reduce hazardous fuel loads, and restore natural systems.

Prior to conducting prescribed fires, agencies must secure a number of permits and prepare a burn and smoke management plan. Respondents indicated that while prescribed burning is a useful tool, it requires a significant number of planning protocols, including burn permits or contracts, smoke management plans, incident action plans, contingency planning, public notification, public safety considerations, and exclusion of cultural sites and environmentally sensitive areas.

ACR, EBRPD, GGNRA, MROSD, and SCCOSA all conduct prescribed burning to manage sensitive vegetation, such as serpentine grasslands, to control invasive plant seedling flushes (e.g., French broom seedling flushes following initial removal), and to reduce overall fuel loads. EBRPD and GGNRA have full-time fire divisions that conduct prescribed burns on their properties and in cooperation with agency neighbors. SCCOSA conducts only grassland burns of less than 10 acres with their own staff and minimal equipment to maintain critical plant associations on serpentine soils. CSP staff travel statewide to conduct prescription burns on all vegetation types in cooperation with CalFire and the U.S. Forest Service.

Grazing

EBRPD, SCCOSA, and the National Park Service at Point Reyes National Seashore use livestock that feed on vegetation, such as cattle, sheep, or goats, as a means of fuel reduction. Respondents emphasized that animal behavior must be taken into account when selecting a grazing treatment, as cattle eat mostly grasses, sheep preferentially consume forbs, and goats typically selectively browse woody vegetation. Cattle require supplemental water and will tend to congregate around water troughs, creeks, and stock ponds, causing disproportionately more damage near these water features if not carefully managed. Interviewees indicated that cattle typically graze during winter and spring, then receive either supplemental feed or are moved to an irrigated pasture for summer and fall. Not all agencies employ grazing as a fuel reduction tool. Many agencies use standards for residual dry matter (defined as the dry vegetation biomass left onsite at the end of a grazing season) as a rough measure of ecological health, erosion potential, and intensity of grazing on grassland habitats.

Large-Scale Vegetation Conversion/Manipulation

The EBRPD fire plan recommends large-scale vegetation manipulation to reduce the production of burning embers in the air in order to protect residential structures and businesses. Vegetation manipulation is used to both reduce fire risk and to protect natural habitats. GGNRA conducts large-scale eucalyptus removal in areas where groves in wildlands are adjacent to residential communities. Some agencies, including MCOSD, undertake or are considering selective removal of Douglas-fir saplings, a tree that is invading meadows and grasslands and resulting in higher fire risk because the forest/shrub fuel types are more flammable than the low flashy grassland fuel types. Most other agencies interviewed do not undertake large-scale vegetation manipulation as part of their comprehensive fire management strategies.

Summary of Findings: Fuel Management

- MCOSD can reduce fire hazard (the ease of ignition and resistance to control of the fuel source) through the establishment of defensible space zones along the wildland-urban interface. Defensible space zones are the most effective approach to reducing fire hazard. Reducing fire hazard at the wildland-urban interface is protective of both wildland and urban values.

- Interviewees strongly recommended that fuelbreaks be minimized, and resources reapplied to defensible space zones, for the following reasons:

  - Recent studies show that fuelbreaks primarily serve to facilitate fire management activities by aiding firefighter access along existing roads.
  - Fuelbreaks are strongly linked to the spread of invasive plants.
  - Maintaining fuelbreaks is cost prohibitive for many land management agencies.

- Fire risk will only be reduced if private property owners comply with building and fire codes to make structures and landscaping fire resistant, since structures are often the locations of initial fire ignition. If private property owners do not reduce fire risk, then there is less benefit to establishing defensible space zones as a primary fuel modification strategy. Partnership programs with neighbors can encourage this compliance.

- Fire roads are needed for evacuation and for safe passage of firefighting equipment during a fire event. However, the historic roads that have been adopted as fire roads are rarely situated in optimal locations to achieve these objectives efficiently. The optimal locations for future fire roads are perimeter locations where the roads could connect primary access routes.

- Having trained natural resource and maintenance staff available to respond to large wildland fires enables agencies to minimize wildland resource damage, minimize the costs of post-fire rehabilitation, and maximize the effectiveness of that rehabilitation.

Forest Health Management

This section addresses forest health management issues, such as forest pathogens, forest type conversion, and forest fuel loads. It discusses measures that may be taken to maintain forest health and presents a brief overview of agency approaches to maintaining forest health.

The MCOSD preserves encompass many mature woodlands and forests. Some forested habitats are in a state of decline, from either natural causes (e.g., aging, disease, structural damage from natural causes) or human-induced causes (e.g., structural damage from human use, irrigation, soil compaction along roads and trails). Mature trees and dead and dying trees (known as *snags*), provide important wildlife habitat value and play an integral role in forest dynamics.

The challenge for land management agencies is to balance the need to maintain a biologically and structurally diverse forest (i.e., keeping a diverse forest full of trees of every life stage, including retention of snags, downed wood, and brush piles) with the need to provide safe and accessible trail systems for the public and to manage hazardous fuel loads.

Forest health is strongly influenced by weather and climate. Forest pathogenic fungi, bacteria, viruses, and other microorganisms are affected by temperature and moisture conditions. Extreme weather (e.g., drought, typhoons) can kill large expanses of trees directly by overwhelming tree physiological capability and structural strength.

Stress on the host can contribute to the severity and distribution of infection. Forests that are already stressed by disease or climatic conditions, such as drought, may not survive additional climatic stress (Winnett 1998). For example, in southern California, drought, in combination with stress induced by mistletoe infestations and root rot diseases, is thought to have made forests susceptible to bark beetle attack. In turn, the large tree mortality rates from these factors contributed to the severity of the 2003 wildfires, which caused over $2.5 billion in damage (Keeley et al. 2004, Kliejunas et al. 2008). A similar pattern might occur in Marin County forests.

This section is organized according to the following topic areas:

- overview of forest health maintenance programs
- management practices associated with specific threats

Overview of Forest Health Maintenance Programs

Most agencies interviewed did not maintain a separate forest health program. Instead, they addressed forest health issues along with other vegetation issues, such as fuel management or habitat restoration. Most agencies expressed concern that climate change will result in changes to forest functioning, composition, and diversity, but they do not have a comprehensive plan in place to manage their forests. Most agencies identify and remove hazard trees that threaten human safety and structures, remove downed trees that block roads and trails, and manage forests for fuel reduction/fire safety.

Numerous studies have shown a direct correlation between forest structure diversity and wildlife diversity (Maser et al. 1979, University of New Hampshire Cooperative Extension 1995). Forest structure diversity refers to the variations in vertical structure (e.g., variations in tree, shrub, and understory heights; presence of snags, downed wood, and brush piles), variations in horizontal structure and species diversity (e.g., diversity of tree, shrub, and understory species), and variations across the landscape (e.g., variations in patch size; differences in tree density; mixtures of open areas and closed tree canopy areas; microclimate variations, such as moist and cool shaded areas, and hot and dry nonshaded areas). In simple terms, the more types of microhabitats, food plants, and shelter in a forested system, the more the area is able to support many different species of birds, insects, mammals, and plants. The challenge is to maintain forest diversity while managing fuel load, visitor access and safety, and tree hazards.

In low-use areas, such as inaccessible forest interiors, a policy of limited active management (e.g., leaving snags and downed wood, not cutting unnecessary fire breaks, not actively planting trees and shrubs) will help maintain biologically and structurally diverse forest ecosystems. In areas where fuel loads or visitor access and safety require forest management, impacts on forest structure may be minimized by selectively thinning and/or planting trees and shrubs only as necessary.

Management Practices Associated with Specific Threats

This section discusses management practices for various forest health concerns, including diseases caused by forest pathogens, forest type conversion, and fuel loads in forested areas.

Diseases Caused by Forest Pathogens

California Oak Mortality Syndrome (Sudden Oak Death)

By far, the biggest forest health concern of agencies interviewed is the impact of California oak mortality syndrome on the composition and functioning of native oak ecosystems. California oak mortality syndrome is a forest disease, caused by the fungus *Phytopthora ramorum*, which has resulted in widespread dieback of several tree species and devastated Bay Area forests since the mid-1990s. There is no known cure for the disease. Tanoak (*Lithocarpus densiflorus)* appears to have little or no resistance to the disease, and prospects for persistence or replacement of tanoak forests are poor.

Agencies are employing various strategies to deal with the threat of California oak mortality syndrome. Some are simply monitoring infestations (as on MMWD and MCOSD preserves, which all reportedly have some level of infection). Some are actively revegetating after an area has been infected and trees have died. Revegetation typically includes planting replacement live oak (*Quercus agrifolia*) and black oak (*Q. kelloggii*), using acorns collected near California oak mortality syndrome outbreaks, with the hope that replacement seedlings may carry some resistance to the disease. Others are actively trying to contain the spread of the disease.

Agencies are taking the following actions to control the spread of California oak mortality syndrome:

- removing or felling in place the diseased oak and tanoak trees, as well as removing surrounding California bay laurel (*Umbelluria californica*), a tree that is thought to be a host for the plant pathogen that causes California oak mortality syndrome
- washing equipment, vehicles, and shoes with a mild bleach solution before leaving infected areas
- limiting public access to infected areas (e.g., temporarily closing trails or cordoning off areas), as needed, to reduce any potential spread by humans
- containing the diseased tree (i.e., felling the tree and leaving it in place), and monitoring surrounding trees until the disease has run its course in the area
- prohibiting the transport of leaf litter, soil, woody debris, firewood, or cut limbs from infestation areas, leaving woody debris at the site of the infestation

Most agencies are coordinating with the state-run California Oak Mortality Task Force, an organization dedicated to tracking and researching causes and cures for the disease. The California Oak Mortality Task Force is a clearinghouse for tracking the locations of infestations and sharing the current research and management actions being used by landowners to manage this devastating tree disease.

Diseases Caused by Other Forest Pathogens

Other notable insect infestations and diseases that are causing similar tree mortality in the region are described below.

Pitch canker is a disease affecting conifers (Monterey pine and other pine species) caused by the fungus *Fusarium circinatum* (*F. subglutinans, F*. sp. *pini*). In California, infections by *F. circinatum* enter the tree through wounds caused by insects. The fungal infestion generally eventually kills the infested tree; however, some trees recover. Outbreaks are clustered from Santa Cruz County to south Alameda County and Marin County. In some cases, after an initial outbreak of pitch canker activity, the incidence of new infections can decrease and eventually drop to an undetectable level, allowing tree recovery. Management of this disease focuses on containment to reduce the risk of spread to other trees, and generally follows the steps outlined above for California oak mortality syndrome. The Pitch Canker Task Force (2009), a research organization dedicated to tracking the spread of the disease and researching its cause and cure, has been created to track and limit the spread of pine pitch canker in California through management, research, consideration of regulatory actions, and education.

The bark and ambrosia beetles (*Monarthrum dentiger* and *M. scutellare*) typically attack only oak and tanoak trees. The abundance of trees killed by California oak mortality syndrome may be exacerbating the effects of beetle infestations which prey on trees already weakened by this disease.

Root rot, caused by oak root fungus (*Armillaria mellea*), is primarily associated with oaks and other hardwoods but also attacks conifers, especially in mixed conifer-hardwood stands. Oak root fungus infestations cause canopy thinning and branch dieback. Under conditions that favor disease, *A. mellea* can kill mature oaks. Trees with severe root rot also have an elevated risk of toppling due to root failure. Oak root fungus is normally a minor pathogen in oak woodlands, typically only attacking oaks that are in severe decline due to other factors. The abundance of trees killed by California oak mortality syndrome may be exacerbating the effects of root rot fungus in Marin County forests.

Velvet-top fungus (*Phaeolus schweinitzii*) is a root rot fungus affecting Douglas-fir and other conifers. Typically, a tree becomes infected when a spore enters at a wound. Soil compaction, flooding, fire, wounds, and other stresses seem to predispose a tree to this disease.

Forest Type Conversion

Many agencies are reporting that their native forests are converting from one type to another. This type conversion can occur because forests are becoming infested with invasive trees (e.g., eucalyptus, acacia), are experiencing large-scale native tree die-offs (e.g., loss of native oak and tanoaks as a result of California oak mortality syndrome), or are becoming invaded by native tree species (e.g., invasion of Douglas-fir is gradually converting mixed hardwood forests to conifer forests). The result is that the dominant trees are no longer the same as in the original forest and that the replacement sapling trees are smaller and denser. This effect results in concerns about fire safety as a result of accumulated fuels and creation of fuel ladders that could move a wildfire up into the forest canopy. Another concern is a reduction in overall forest biological diversity and forest health (Frankel 2008).

Some agencies are actively managing nonnative forests through targeted removal of eucalyptus, acacia, and other invasive trees. Others are actively removing understory saplings and brush around trees that were lost to California oak mortality syndrome to reduce fire hazard. Some agencies are actively removing Douglas-fir saplings as part of fire management projects. Very few agencies are able to monitor or manage for subtle forest type shifts, except in high-value resource areas.

Fuel Loads in Forested Areas

Interviewees indicated that forests require ongoing management for fire hazard reduction, but that such management also improves forest health. The General Accounting Office (Gorte 2006) emphasized the need for fuels management, concluding that:

> *the most extensive and serious problem related to the health of forests in the interior West is the over-accumulation of vegetation, which has caused an increasing number of large, intense, uncontrollable, and catastrophically destructive wildfires.*

Numerous options are available for managing fuel loads and maintaining healthy forest ecosystems, including controlled burns or flaming, physical removal of undergrowth and secondary tree growth, and prevention and control of invasive plants. Agencies interviewed have undertaken one or more of these actions, typically as part of a fire management project.

Summary of Findings: Forest Health Management

- The challenge for land management agencies is to balance the need to maintain a biologically and structurally diverse forest (e.g., keeping a diverse forest full of trees of every life stage, including retention of snags, downed wood, and brush piles) with the need to provide safe and accessible trail systems for the public and to manage hazardous fuel loads.

- By far, the biggest forest health concern of agencies interviewed was the impact of California oak mortality syndrome on the composition and functioning of native oak ecosystems. Agencies are employing various strategies to deal with the threat of this disease. The California Oak Mortality Task Force is a clearinghouse for tracking the locations of infestations and sharing the most current research and management actions.

- Forest type conversion is causing concerns about forest biological diversity and fire safety, as a result of accumulated fuels and creation of fuel ladders that could move a wildfire up into the forest canopy. Some agencies are actively managing nonnative forests through targeted removal of invasive tree species.

- Management to remove unnatural accumulations of fuel also improves forest health. Numerous options are available for managing fuel loads and maintaining healthy forest ecosystems, including controlled burns or flaming, physical removal of undergrowth and secondary tree growth, and prevention and control of invasive plants.

Management for Climate Change

This section summarizes current practices for managing vegetation and protecting biodiversity in an era of climate change, sea level rise, and increased atmospheric carbon dioxide (CO_2) and other greenhouse gas concentrations. Because it is a very new field, few regional land managers have developed practices for managing for climate change. Consequently, many of the practices listed below are recommended within the scientific and management literature.

Climate change impacts are already occurring and are certain to increase in coming years, as stated in the *Marin Countywide Plan*:

> *The 10 warmest years of the 20th century all occurred after 1985… The average of all global climate models suggests about a 3°F to 10°F rise in global temperature over the next 50 to 100 years. Global surface temperatures have increased about 1°F over the 20th century, with approximately 70% of that change occurring in the last 25 years… Globally, sea level has risen 4 to 8 inches over the past century.*

Expected environmental changes include altered climate and weather, higher temperatures and drier conditions, and increased frequency of uncommon weather events, such as drought, southern storms, and hard frosts. Other predictable changes include increases in average sea level, storm surge height, and frequency of extreme flood events.

These changes will have significant impacts on vegetation and biodiversity locally and across the globe. Expected effects of climate change include the following:

- loss of species in particular locations, as these species either move to track their preferred temperature or moisture conditions or are eliminated altogether by shifting climate, with some of these species likely to go globally extinct

- gain of some native species that are not currently present, some of which may become pests or may hybridize with related taxa

- increased abundance of forest pests and diseases due to range shifts, weakened native species, and changes in weather conditions (e.g., the increase in California oak mortality syndrome and insect pests associated with warm winters)

- increased incidence and severity of wildfires, due to a longer fire season, changes in vegetation composition, and increased fuel loads

- increased abundance of invasive species, due to range shifts, enhanced growth due to increased CO_2, and increased colonization opportunities brought on by disturbances such as fire

- changes in vegetation, including type conversion, caused by losses and additions of native species, invasive species, pests and disease, and fire
- loss of coastal habitats, as rising sea level and extreme flood events eliminate existing habitat
- changes to wetlands caused by altered precipitation, reduced groundwater recharge and overdrafting, altered in-stream flows, saltwater intrusion, and changes in water temperature and sedimentation
- changes in patterns and rates of wood decay caused by forest fungi, which will influence the ability of the forests to act as long-term carbon sinks or storage to offset the expected effects of climate change on atmospheric carbon levels (Cayan et al. 2006)

Scientists have a very high degree of confidence that climate change and sea level rise will occur (IPCC 2007) and that all systems will be affected as described above. However, the way in which natural systems will be impacted remains uncertain. This uncertainty comes from two sources.

First, species and ecosystems possess some resilience to extreme changes. For example, while models show that the climatic conditions for blue oak trees may be lost from the area, adults of these and other long-lived, stress-tolerant species may be able to persist for a century or two and then recover should conditions change in the future. Similarly, many California plants have long-lived soil seed banks. Seeds may remain dormant belowground during periods of inhospitable climate, then germinate en masse in a year with unusual weather conditions, and then be rare for another decade while buried seeds await that special combination of optimal recruitment conditions. Additionally, local-scale climatic variation may provide local refugia; species may be able to track their preferred temperature or moisture conditions by migrating up or down slope in a watershed, rather than migrating hundreds of miles north.

The second source of uncertainty in the severity of climate change impacts comes from the extent to which vegetation management practices that support and enhance existing natural resilience might be applied. Vegetation management actions will be critically important in determining the severity of negative impacts; wide vegetation management may ameliorate many of the impacts listed above, while unintentional mismanagement may exacerbate losses of species and ecosystems that the MCOSD is charged with protecting. To a large degree, persistence of species and ecosystems will be determined by the ability to rationally manage natural systems so that they can survive, adapt, and thrive.

Practices described in interviews and literature fall within two general categories: Mitigation actions seek to limit the future severity of climate change, either by reducing sources of greenhouse gas pollutants or by increasing factors that remove greenhouse gasses from the atmosphere. Adaptation actions respond to existing or expected climate change and seek to reduce the negative impacts of climate change.

This section is organized according to the following topic areas:

- mitigation practices to reduce greenhouse gases
- management to support natural resilience to climate change
- management to support natural resilience to sea level rise

Practices to Reduce Greenhouse Gases

This section provides a short summary of vegetation management practices that may be used to reduce greenhouse gasses.

Most mitigation strategies focus on decreasing the emission of CO_2 and other greenhouse gas pollution by improving transportation, energy use, construction, and facilities. This section does not review mitigation practices for reducing greenhouse gas emissions from these major emission sources. Such mitigation strategies are critical for averting the worst outcomes due to climate change, but they are better described within existing and developing county, state, and federal policies and regulations.

Mitigation actions based on vegetation management are predicated on the manipulation of poorly understood and highly complex biological systems and may entail multiple unknown potential secondary effects. Also, any reduction in greenhouse gases that could be achieved by manipulating vegetation is unlikely to be comparable to the reductions that could be achieved by even modest energy conservation actions. For these reasons, it is recommended that the application of such mitigation strategies be deferred until they are better understood and until Marin has fully realized the much greater and much safer benefits generated by investments in transportation, energy use, and infrastructure improvement.

The following discussion is provided to help MCOSD better understand the uncertainty of proactive vegetation management as a tool for reducing greenhouse gasses.

Fire Management and Greenhouse Gases

Wildland fires are an important source of natural CO_2 emissions. When forests or other ecosystems burn, living vegetation and dead plant material are transformed into CO_2, which is then released into the atmosphere. As climate change increases the incidence and severity of fires, managing fire regimes is likely to be an important strategy for reducing emission and increasing storage of CO_2.

Fire suppression in forests may reduce CO_2 emissions in the short-term; however, there is good evidence that fire suppression ultimately leads to larger fires, which release greater amounts of CO_2 than small fires (Hurteau et al. 2008). Unlike fire suppression, fuel management can be used to reduce the incidence of large fires. Allowing small-intensity fires to burn, conducting prescribed burns to reduce the risk of crown fires, or implementing thinning of understory fuels can all serve to decrease the potential for large fires. These actions can also increase long-term carbon storage by natural systems (National Wildlife Foundation 2006).

Vegetation Type Conversion and Greenhouse Gases

With some exceptions, actively growing coastal California forests typically store more carbon than do shrublands, and actively growing shrublands tend to store more carbon than do grasslands (Environmental Defense Fund 2009, Silver 2009). Thus, the succession of grasslands to shrublands, and shrublands to forests, generally increases carbon storage; while any conversion of forests to shrublands, or shrublands to grasslands entails a release of carbon dioxide and decreases carbon storage. Vegetation management actions can either impede natural succession, as occurs when Douglas-fir are prohibited from encroaching into meadows, or convert a higher successional stage to a lower one, as occurs when chaparral shrubland is converted to grassland for purposes of fuel reduction. Both types of actions can result in decreasing the ecosystem's capacity to store carbon (although other ecosystem benefits may be considered to offset this effect).

Wetland Restoration and Greenhouse Gasses

Another practice that may increase carbon storage is to restore coastal wetlands and other wetland systems. Many coastal wetlands accumulate peat or otherwise store carbon belowground, which can result in very carbon-rich soils. Management practices that restore these habitats help to increase belowground carbon storage. However, the creation of artificial wetlands to sequester carbon may also result in the concomitant generation of methane, a far more potent greenhouse gas.

Restoring coastal wetlands, however, has other conservation benefits. While the initial cost of coastal wetland restoration can be high, facilitating the buildup of coastal wetlands is an important vegetation management action that can assist in adaptation to sea level rise (see below) and provide significant long-term economic benefits.

Planting Trees and Greenhouse Gases

There is popular belief that planting all types of trees is a valuable method for sequestering (capturing) carbon, and for increasing oxygen production, thereby offsetting the effects of greenhouse gasses. However, planting trees that are not a part of a natural forested vegetation type can result in trees that are planted in inappropriate locations. These trees can adversely affect biological diversity, change the composition of native forest types, and may have higher or lower die-off or spread rates as compared with planting tree species that are already part of the native forest. Tree planting for carbon sequestering should only be undertaken as part of a larger habitat restoration effort, and should focus on replacement trees of the same species as are found in a natural vegetation type.

Farming Grasses and Greenhouse Gases

Similarly, farming grasses for carbon storage is a vegetation management practice that is being experimentally evaluated in Marin (Silver 2009) and that has generated much excitement. While grasslands store less carbon than forests or shrublands, grasses are faster and easier to grow and can still store significant amounts of carbon, especially in the belowground root system. Conceptually, either commercial farming or habitat restoration of native grassland vegetation types could be an important method for storing carbon, enhancing biodiversity, and increasing farm incomes (Environmental Defense Fund 2009). However, it is not yet clear which practices result in this win-win outcome; commercial grass farming could have additional adverse impacts, such as addition of nutrients and soil tilling methods. These additional impacts should be carefully evaluated to identify potential unintended consequences, such as increased nitrification, spread of invasives in disturbed soils, and possible loss of native grassland habitat to make room for tilled grass farmlands. Additionally, carbon farming must be evaluated to determine whether carbon storage is long-term or ephemeral. The costs of these practices are being evaluated in the study cited above.

Practices to Support Natural Resilience to Climate Change

This section reviews current practices for adapting to the effects of climate change, including a number of highly effective and cost-efficient practices that can be applied immediately. These practices are currently employed by the agencies interviewed, recommended in the scientific and management literature, or mandated in strategic documents and action plans (Aldous et al. 2008, Glick et al. 2009, Heller and Zavaletta 2008, California Natural Resources Agency 2009).

The focus on adapting vegetation management to address anticipated climate changes is driven by the certainty that, even if the most ambitious mitigation actions are successful, global warming pollution already emitted into the atmosphere has guaranteed that significant climate and environmental changes will occur; indeed, many important changes are already occurring. Consequently, interviewees agreed on the importance of planning to identify strategies and actions for managing vegetation and protecting biodiversity in the face of certain change.

The most effective practices for ensuring adaptation of natural systems to climate change have been grouped within the following categories: reduce stressors, protect biodiversity and ecological functions, protect species and vegetation types important to natural ecosystem resiliency, maintain or restore landscape connectivity, identify and protect key landscape features that provide refugia, implement proactive management and restoration strategies, and increase monitoring and adaptive management practices and apply lessons learned to improve management outcomes (National Wildlife Foundation 2006).

Reduce Environmental Stressors

Reducing environmental stressors not related to climate change is an important strategy to cope with the unique impacts of climate change (National Wildlife Foundation 2006). Environmental stressors include destruction or degradation of natural communities by invasive species, pests and disease, and altered fire and disturbance regimes. Without actions to reduce these environmental stressors, many species and ecosystems will be lost before the effects of climate change become pronounced. In addition, environmental stressors reduce the overall ability of native vegetation to naturally adapt to climate changes such as drought, localized flooding, and increased or decreased temperature and rainfall.

Many vegetation management actions intended to address such environmental stressors as invasive plant infestations and forest pathogens have already been described previously in this chapter. Taken together, these vegetation management practices also help vegetation resist the effects of climate change. For example, the relationship between climate change, fire, and invasive plant infestations can be anticipated and dealt with by developing plans for controlling invasive plants and managing fuel loads. Similarly, warmer winters and drier summers are likely to amplify the effects of forest pathogens, such as California oak mortality syndrome, which can result in increased rates of tree death and related changes in forest composition. Vegetation management actions that detect and contain forest pathogen outbreaks can prevent such outbreaks from harming MCOSD forests and other vegetation types.

Fire management also contributes to offsetting the effects of climate change. Actions that reduce fuel loads reduce the overall potential for large and intense wildfires or increases in fire frequency, both of which are anticipated to result from climate change.

Protect Biodiversity and Ecological Functions

Numerous studies demonstrate that biological diversity promotes ecosystem resilience (Kareiva et al. 2008). One review of adaptation practices refers to biological diversity as “natural climate insurance” (National Wildlife Foundation 2006) and cites two examples:

- Yellow starthistle growth is reported to be accelerated by increased levels of CO_2. This effect was not seen in high species-diversity grasslands.

- The presence of diverse fish populations was found to reduce the effects of coral reef bleaching.

In these and other cases, high biological diversity was found to help stabilize natural systems and offset the effects of climate change. Experts interviewed recommend that MCOSD should maintain biological diversity on its preserves wherever possible (e.g., diversity of vegetation types, microhabitats, elevational areas, moisture regimes). Based on available research, biologically diverse preserves with many types of vegetation may be able to better withstand climate changes, and to support and sustain native plant and wildlife species that may have to adapt or physically move to reach suitable temperature and moisture regimes or habitats (also referred to as range shifts).

Protect Species and Vegetation Types Important to Natural Ecosystem

Some vegetation types that are particularly important to either preserving existing ecosystem function or to supporting the natural readjustment of species ranges are described below.

Species and Vegetation Types at the Edge of Their Distribution

Experts identify two important reasons for protecting species and habitats that are at the edge of their distribution: First, it is likely that species that already live in marginal habitat may have developed genetic variations or other physiological adaptations that allow them to survive in a changed climate. Unique genetic variation could include traits such as drought tolerance, seedbank characteristics, and timing of reproduction. These genetic variations might help the larger populations persist in spite of climatic variability, help these species pre-adapt to future climate conditions, and possibly be sources of movement of populations of plants and wildlife to more suitable conditions (i.e. range shifts). For example, as Marin grows drier and warmer, the range of unusual occurrences (e.g., the single Marin population of black sage *(Salvia mellifera),* a species that is considered locally rare that grows on MCOSD preserves) could become a source population that could expand and replace more common species, allowing this plant to persist. Second, managing for species that are not yet considered special-status can help prevent more common species from becoming vulnerable to extinction, thereby slowing the decline in biodiversity in the region.

Creeks and Riparian Areas

Protecting and restoring creeks and riparian zones are cost-effective practices for maintaining important ecosystem functions and for enhancing landscape connectivity (Seavy et al. 2009). Because anticipated climate changes include increased drought, localized flooding, and changes in rainfall patterns, riparian vegetation types that live along rivers, creeks, and waterways are especially vulnerable to the effects of climate change. Riparian vegetation types provide important ecosystem functions, such as bank stabilization and flood control, water filtration and purification, and groundwater aquifer recharge. Riparian vegetation types also are habitat for numerous special-status and locally rare wildlife species. Riparian vegetation also creates cool shaded areas that provide a thermal refuge for a variety of terrestrial and aquatic organisms; this function is likely to become even more important in a warmer and drier climate-changed future. Since riparian corridors span elevation gradients and link a variety of ecosystems, protecting and restoring these systems is important to organisms that may need to relocate to a higher and cooler microclimate. A coalition of conservation groups and land managers in Sonoma County has recently identified riparian restoration as the county's primary climate change adaptation strategy (North Bay Climate Change Initiative 2009).

Large Trees and Forested Areas

Similarly, protecting and restoring large trees and forested areas ensures valuable ecosystem functions such as carbon storage, erosion control, natural water filtration and replenishment of natural aquifers, and shading and cooling effects that provide a variety of temperature and moisture microclimates (Heller and Zavaleta 2008). All of these ecosystem functions support the preservation of native species that are adapting to climate changes. Like riparian zones, large and mature trees in a functioning forest can tolerate a broader range of environmental variations (temperature, moisture, etc.) and are less sensitive to change (as compared to smaller and younger trees). The variety of temperature and moisture microclimates that forests provide can buffer climate change impacts on other species. Consequently, removing large trees or riparian areas will intensify climate change impacts, while restoration of these functional groups will slow the rate of change. MCOSD will have to balance these somewhat conflicting objectives when planning to remove nonnative invasive trees such as eucalyptus and acacia, and perhaps offset the effects of tree removal by planning to reforest tree removal areas with native trees, and/or phasing work to lessen the temporal effects of tree removal.

Maintain or Restore Landscape Connectivity

The practices described above will enable some species and habitats to persist in their current locations. However, the expected severity of climate change is such that some species and ecosystems simply will not be able to survive in their current locations. The review of practices found broad agreement that vegetation management must be conducted to enable the natural movement of species to new locations.

Eliminating barriers to movement is important to maintaining landscape connectivity. Fences and roads can be effective barriers for many wildlife species, and these barriers can be reduced by replacing fences with wildlife-friendly fencing or establishing crossing mechanisms where roads block known dispersal corridors.

As noted above, restoring creeks and riparian zones reestablishes the natural connectivity between major landscape units and tributaries within watersheds. Creeks and riparian zones comprise a network of linear corridors, which can maintain wildlife populations (Seavy et al. 2009). Corridors provide habitat for species crossing landscapes and escape routes for organisms fleeing predators.

Landscape connectivity is equally important in nonriparian terrestrial systems. MCOSD preserves are important links in connecting the wildlands of Marin County. Ideally, vegetation management on adjacent lands, including invasive plant removal and fuel management, will be coordinated with management of MCOSD preserves to facilitate the expansion of species and habitats onto adjacent lands.

Identify and Protect Key Landscape Features

Key landscape features that provide important microclimates and other places of refuge for native plants and wildlife should be identified and protected, both to protect special-status and locally rare species, and to protect overall biological and environmental site diversity to help ensure species persistence and range shifts by sensitive species. Key landscape features that increase overall environmental site diversity and serve as places of refuge include seeps and springs, which can provide refugia for species impacted by drying conditions; sheltered or north-facing slopes, which can provide refugia in a drying landscape; and rocky or infertile soils, which can support stress-tolerant species otherwise excluded by environmental conditions, invasive species, or increased fire frequency. All of these habitats have served as refugia in previous episodes of climate change and are likely to be critical in saving species that would otherwise be eliminated by a drier, warmer Marin County. Some important refugia can be identified based on evidence of past climate change. For example, ACR lands in Sonoma County contain an unusually moist habitat that is home to outlier occurrences of coast redwood (*Sequoia sempervirens*), false indigo (*Amorpha fruticosa* var. *napensis*), and redwood lily (*Lilium rubsecens*), all relicts of a wetter era. In addition to protecting the two rare species in this occurrence, ACR biologists are evaluating management actions, such as tree thinning, to ensure that it remains a moist refuge into the future.

Other key landscape features that should be identified and protected are areas of topoclimate and microclimate gradients, including cold air drainages. Topoclimates are determined by small-scale variation in solar exposure, wind, and cold air drainage, while microclimates are determined by vegetation cover and fine-scale surface features (Weiss et al. 2008). Variation in climate across these small scales can be large. Landscape features that are likely to be important include canyons and valleys; cold air drainages, including sites with unusually frequent frost; areas of strong fog drip; and areas of discrete vegetation composition that is distinct from surrounding vegetation.

Implement Proactive Vegetation Management and Restoration Strategies

There is strong consensus among interviewees and researchers that proactive vegetation management is the safest, most efficient, and most cost-effective way to address climate change (Kareiva et al. 2008). Natural resource management is one of the best understood tools for proactively managing vegetation for climate change. Natural resource management actions that expand ecosystems and habitats, enhance populations and population viability, and maximize genetic diversity and adaptive variation are all actions that help ensure that natural areas remain resilient to climate change. Some key natural resource management actions that help offset effects of climate change are described below.

Expand the Ranges of Special-Status and Locally Rare Species and Sensitive Vegetation Types

Managers are beginning to design restoration projects to increase the ability of species and ecosystems to shift with changing climate conditions. For example, managers conducting wetland restoration projects often plant saltwater-tolerant plants in zones that will be inundated by high tides. To increase the potential for adaptation, managers can also plant these same species just above typical high tide levels. Although die-off rates in nontraditional planting areas may be higher than in traditional tidal areas, some of the plantings in the new above-tideline areas may grow, expanding the overall distribution of vegetated tidal wetlands, and potentially acting as expansion areas for tidal wetland species that could offset losses of vegetated tidal habitat resulting from rising sea levels.

Increase Genetic Diversity

Restoration projects are likely to be more effective at promoting climate change adaptation if they include greater genetic diversity. For example, some researchers (Millar 2007) recommend increasing the genetic diversity of restoration plantings to increase the success of restoration under a range of possible future climate conditions, including wet-dry, warm-cold, and other gradients. Other researchers (Seavy et al. 2009) recommend that plant collection for restoration projects (which frequently only includes local plant sources) be expanded to include collection from an entire watershed or region and to include a wide variety of slopes, aspects, and microhabitats.

Relocate or Assist in Species Migrations

Interviewees and researchers identified a great deal of recent interest in species translocation, also referred to as assisted migration, managed species relocation, and assisted colonization. As climate zones and conditions shift, maintaining some populations in their current location may become impossible or impractical. Some species, such as trees or small invertebrates, that spread slowly from their existing locations may be incapable of dispersing and colonizing new areas rapidly enough to keep up with the rate of anticipated climate changes (e.g., temperature increases or moisture changes along an elevational gradient). These more slow-moving species may need to be actively relocated if they are to persist. However, relocation is considered risky and is not generally recommended on a large scale (Ricciardi and Simberloff 2009). Experts recommend that MCOSD not undertake relocations unless considered absolutely necessary for survival of a special-status species.

Manage for Natural Resilience

Some vegetation types are likely to be lost from a region as their climate zone moves northward and upslope. For example, it is predicted that the cooler climate of northern coastal areas such as Marin may warm to resemble slightly warmer coastal areas like Santa Barbara or Monterey. If such a change occurs there are three possible approaches available for vegetation management:

- Take intensive action to preserve the original (Marin) vegetation types.
- Manage to support the new (in this example, Monterey's or Santa Barbara's) vegetation types in the original (Marin) location.
- Manage the original (Marin) vegetation in a manner that allows it to adapt to change (i.e., allow the existing vegetation types to disaggregate and reassemble into unpredictable and novel vegetation types).

The first approach is likely to be expensive and infeasible for all but the most important of vegetation types. For example, MCOSD may elect to intensively manage some very rare or economically and culturally important vegetation types, but may determine that it is unrealistic to manage for the status quo for all vegetation types. The second approach, managing for a new vegetation type (e.g., duplicate Monterey vegetation types in Marin) may be appropriate under some circumstances. For example, Monterey cypress, a species native to Monterey may be appropriately established in Marin *if* it is found to be approaching extinction in its native range and can only persist in Marin. This scenario is unlikely at best.

For the most part, the third approach appears to be the most appropriate course of action for agencies like MCOSD. As vegetation types change, they can be monitored, and where such changes do not result in large-scale adverse impacts on special-status species, some common vegetation types may be allowed to become uncommon, and some common species to become rare, while new species are allowed to arrive. Under this kind of management, some species will be lost. The challenge facing land managers is to determine when to actively manage to preserve high-value conservation targets, while allowing for expected vegetation shifts to occur over time. Agencies interviewed recommend the common vegetation management activities that are already described in this report (e.g., reducing environmental stressors, maintaining habitat connectivity and movement corridors, selectively managing for target special-status species and sensitive vegetation types), while taking a wait-and-see approach to changes in more common natural resources.

Increase Monitoring and Adaptive Management Practices

Agencies interviewed suggested that MCOSD should increase the rapid assessment of its lands, and use adaptive management practices for specific restoration projects to adapt management to changing climatic conditions. This approach will allow MCOSD to both rapidly detect any unusual changes in its natural resources (e.g., loss of biodiversity or large-scale vegetation type conversions) before such changes become problematic, and to adapt its vegetation management approach in response to real-time changes in site conditions that may occur from climate change.

Practices to Support Natural Resilience to Sea Level Rise

This section reviews current recommendations for promoting adaptation to climate-induced sea level rise. Additional tools are likely to become available as the nation and state begin to cope with rising waters.

Sea level rise due to global warming is the most certain and inevitable consequence of climate change. Indeed, climate-change-induced sea level rise has been occurring for decades, with sea levels in California rising at rates almost exactly predicted by models (17–20 centimeters per century). It is estimated that sea level will rise up to 45 centimeters by 2050 and 140 centimeters by 2100 (Herberger et al. 2009, Callaway et al. 2007). These estimates are conservative, and current research suggests that the rises in sea level will likely be greater. For example, poorly understood phenomena (e.g., meltwater lubrication of polar ice sheet flows or removal of buttressing ice shelves) might result in rates of sea level rise far in excess of current estimates. In addition, models predict that tides will be higher, occur more frequently, and last longer, which will further exacerbate coastal erosion and other damage. Because Marin County is located between the Pacific Ocean and the San Francisco Bay, even relatively low amounts of sea level rise might have profound impacts on its human and natural communities. Agencies interviewed stressed that MCOSD should seek to prioritize restoration of coastal vegetation types wherever possible.

The following vegetation management strategies are suggested for MCOSD lands: protect existing coastal species, habitat connectivity, and functions; promote increasing coastal habitats; and promote the upslope migration of coastal species and vegetation. These strategies are described in more detail below.

Protect Existing Species, Habitat Connectivity, and Functions

Protecting existing coastal vegetation types, and maintaining these vegetation types in good condition, is important to helping ensure their ability to adapt to and persist under changed climatic conditions, such as rising sea levels.

It is likely that coastal areas will be developed with seawalls and other structures to protect developed areas from coastal flooding. Such developments may further fragment coastal vegetation types. Maintaining natural connectivity, such as habitat corridors, diverse habitat mosaics, and linkages between coastal areas of the MCOSD preserves and nearby wetlands, is important for ensuring that species and natural communities are able to migrate in response to a changing environment.

Human use and development can disturb coastal ecosystems in many ways. For example, public access trails at Bothin Marsh can also provide access to marsh habitat by cats and other domestic animals that threaten special-status species, such as the salt marsh harvest mouse. Native species are particularly vulnerable to predation by domestic animals when they are forced to retreat to upland areas during high tides. As sea levels rise and coastal vegetation is constrained by developed areas, suitable habitat for special-status species that depend on coastal vegetation types will become smaller and more limited, making it increasingly important to protect the remaining coastal habitats and related species from impacts associated with visitor use.

Another stressor that is not directly climate related is invasive plant infestations by nonnative coastal species, such as cordgrass *(Spartina)* and iceplant *(Carpobrotus* sp.*, Mesembryanthemum* spp.*).* Managing invasives will help ensure that coastal habitats persist over time. It is predicted by the experts interviewed that invasive species will increase as they take advantage of warmer conditions; of habitat disturbance caused by coastal development, such as seawall construction; and of changes in seawater composition as precipitation patterns are altered and upland toxins are mobilized by rising waters. Agencies interviewed stressed that MCOSD should seek to prioritize protection from invasive species wherever possible.

The full range of coastal vegetation types must be protected and managed to sustain biological and environmental diversity. Coastal wetlands include a heterogeneous mix of vegetation types arrayed in complex and dynamic combinations. While coastal salt marsh makes up much of Marin's existing wetlands, other important habitats include beaches, foredunes, tidal deltas, salt pannes, brackish marshes, estuaries, freshwater wetlands, and brackish or vernal pools. Maintaining this natural diversity will require an inventory of existing habitats, an assessment of threats to each habitat type, and planning actions to ensure that all types persist, even under changing environmental conditions.

The impacts of sea level rise are likely to be exacerbated by accompanying changes in temperature and precipitation, affecting some habitat types disproportionately. In particular, coastal habitats that are structured by freshwater sources, such as seeps and creeks, are threatened by diminished freshwater inputs due to decreased precipitation, groundwater withdrawals, and saltwater intrusion. For this reason, it is even more important that managers restore riparian habitat and promote water and watershed management practices that will maintain the ecological integrity of riparian ecosystems (San Francisco Bay Joint Venture 2008).

Promote Build-up of Coastal Habitats and Upslope Migration of Coastal Species

The anticipated losses of some coastal lands as a result of sea level rise may be offset in part by the natural process of building up coastal sand spits and other new coastal landforms through deposition of waterborne sediments. Where these new lands form, some vegetation types may be able to establish on them, allowing vegetation types to move and increase with changing conditions. Similarly, some vegetation types that require certain water regimes (e.g., permanent inundation, partial inundation) may be able to move into areas where they were previously unable to persist, because those areas would be experiencing a rise in water levels. While a variety of natural conditions influence the ability of coastal areas to build up landforms and for coastal vegetation types to migrate, active management that promotes these natural processes can have a tremendous influence on the outcome.

Rates of buildup of coastal lands are determined by a wide variety of environmental conditions, such as sediment deposition patterns, wave and wind patterns, substrate composition, sediment availability, and sometimes patterns of existing vegetation (which can stabilize soils, reducing erosion and sedimentation rates). It is very likely that in the future, agencies will develop local and regional guidelines for promoting the natural buildup of coastal lands. Until such time as better guidance and technical support is available, agencies recommend that MCOSD restore degraded coastal wetlands, particularly those that are eroding or are changing in elevation or extent (acres) due to wind or wave erosion or changes in tidal action.

Similarly, MCOSD should promote the expansion of coastal vegetation types upwards along elevational gradients. As mentioned previously, MCOSD restoration actions may include planting coastal plants just above their natural moisture or elevational ranges to promote establishment into new areas. Coastal plants typically occur in distinctive patterns corresponding to strong environmental gradients, such as moisture and salinity. These species established in new, nontraditional locations might expedite establishment of coastal vegetation upwards as sea levels rise. For other species that cannot naturally move upslope without assistance, MCOSD may wish to consider some selected active relocation for high-value resources, such as special-status species.

One potential complication of sea level rise is the accompanying increase in salinity, which will lead to shifts in dominant plants, especially in freshwater marshes. This will probably cause a reduction in overall diversity and result in vegetation types that are different from those found today (Callaway et al. 2007). However, in many of the coastal habitats managed by the MCOSD it may be possible to preserve most of the species, even if the structure and composition within a single vegetation type is changed. Restoration projects should plan to include a diversity of vegetation types, and include a wide variety of revegetation species planted across a range of microclimates and elevational variations. This will increase the ability of individual planted species to establish according to subtle environmental and ecological cues, and maximize the likelihood that the project will result in a diverse and stable vegetation type over time.

Most importantly, action must be taken to ensure that there are undeveloped open spaces available inland from existing coastal habitats (Herberger et al. 2009). In many locations, the amount of coastal wetlands are limited by the presence of upslope developed lands such as levees, roads, or other infrastructure that act as barriers to the movement of native species. In some locations, there is suitable land upslope, but the land is not protected and is subject to development pressures. Agencies interviewed suggest that MCOSD work with others to map all features upslope of its coastal preserves, and identify physical or use barriers to habitat expansion. Where adjacent undeveloped land is available, MCOSD should seek to promote its acquisition and protection. Finally, where coastal habitats are constrained upslope by high-value infrastructure such as roads or structures, the MCOSD should work with partners to seek ways for its natural vegetation resources to continue to function naturally to the fullest extent possible (e.g., continue to protect coastal areas from erosion, absorb tidal floodwaters).

Summary of Findings: Management for Climate Change

The challenge to land managers facing climate change is to determine when to actively manage to preserve high-value resources, while also allowing for expected vegetation shifts to occur over time. The agencies interviewed recognized that a large part of managing the vegetative response to climate change is the more basic vegetation management that is recommended independent of climate change, such as reducing environmental stressors, maintaining habitat connectivity and movement corridors, and selectively managing for special-status species and sensitive vegetation types. There is broad consensus that biologically diverse preserves with many types of vegetation will better withstand climate changes and better support and sustain native plant and wildlife species that may have to adapt or physically move to reach suitable temperature and moisture regimes or habitats (also referred to as range shifts).

Activities discussed in scientific literature include the following:

- Incorporate natural resilience to climate change into adaptive management practices. In adapting vegetation management to changes in site conditions that may be occurring primarily as a result of climate change, three possible approaches are available:
    - » Take intensive action to preserve the original vegetation types. This approach is most applicable to highly important vegetation types.
    - » Manage to support new vegetation types if they are becoming extinct in their original locations.
    - » Allow the original vegetation type to adapt to changing conditions. This approach is the most generally appropriate course of action for the MCOSD preserves, recognizing that some common vegetation types may become uncommon.
- Design restoration projects for sensitive resources to not only include diversity of vegetation types and species, but also to include genetic diversity and to encourage adaptation to a variety of microclimates within the restoration area. Some researchers recommend increasing the genetic diversity of restoration plantings, including expanding the collection area and including a wide variety of slopes, aspects, and microhabitats. They also recommend planting the gathered materials across a range of microclimates and elevational variations within the restoration area.
- Protect areas important to ecosystem resiliency:

» Species and vegetation types at the edge of their distribution may have developed genetic variations that allow them to survive in a changed climate and might help the larger populations persist in spite of climatic variability.

» Creeks and riparian areas provide a thermal refuge, which is likely to become even more important in a warmer and drier climate-changed future. Since riparian corridors span elevation gradients and link a variety of ecosystems, protecting and restoring these systems promotes connections, which are important to organisms that may need to relocate to a higher and cooler microclimate.

» Large trees and forested areas serve valuable ecosystem functions, such as carbon storage, erosion control, natural water filtration and replenishment of natural aquifers, and shading and cooling, all of which support the preservation of native species that are adapting to climate changes.

» Places of refuge during drier, warmer periods (including seeps and springs, sheltered or north-facing slopes, and locations that provide refuge for stress-tolerant species that might otherwise be excluded by invasive species or increased fire frequency) have served as refugia in previous episodes of climate change and are likely to be critical in saving species that would otherwise be eliminated by a drier, warmer Marin County.

Even relatively low amounts of sea level rise may have profound impacts on Marin County residents and natural communities. The following management activities that would specifically address the adaptation of coastal vegetation to rising sea levels were identified:

- Offset the loss of coastal wetlands to sea level rise by supporting replacement wetlands in new locations.

- Maintain linkages between coastal areas of the MCOSD preserves and nearby wetlands to support species migrations in response to environmental changes. Most importantly, take action to ensure that there are undeveloped open spaces available inland from existing coastal habitats.

4: FRAMEWORK FOR VEGETATION AND BIODIVERSITY MANAGEMENT PLAN

A Comprehensive Approach to Vegetation Management

The vegetation management program for the MCOSD preserves will place the greatest emphasis on protecting and improving the condition and resiliency of high-value resources. Vegetation types and habitats will be managed for diversity, richness, complexity, and connectivity across the MCOSD preserves, recognizing that adaptation to global climate change will be most successful for healthy natural systems. Management to reduce the threats to natural systems posed by invasive species, unnatural fire events, and pathogens that may take advantage of already stressed species will be an integral part of this management. Rather than reacting to threats as they arise, emphasis will be placed on proactively working to reduce the causes of these threats, based on the most current scientific information about effective procedures and on standardized best management practices.

Program Coordination and Prioritization

Zone the Preserves to Identify Areas of Particular Importance or Concern

To support the development and implementation of this *Vegetation and Biodiversity Management Plan*, lands throughout the preserves have been classified into four vegetation management zones based on the ecological and/or cultural importance of their vegetation types, the condition of their resources, and their proximity to urban or suburban areas. The four zones have been designated the legacy zone, the sustainable natural systems zone, the natural landscape zone, and the highly disturbed zone (see figures 4.1 through 4.6).

Zoning will help MCOSD staff differentiate areas with the highest biological value, which may require special management approaches. The preserves support more than 100 vegetation types, many of which are globally, regionally, or locally rare; numerous special-status species protected by state or federal laws; and other high-value resources, such as habitat corridors or clusters of habitat types that support high avian and other wildlife biodiversity.

Zoning will provide MCOSD with landscape-level tools to help prioritize management actions. *Landscape level* in this context means that zoning can provide an opportunity to view the preserves more holistically and to assess regional needs and priorities for assigning staff or resources to carry out projects and activities. Zoning can help MCOSD make decisions about where to implement specific vegetation management actions, by supporting a structure and framework for rapidly evaluating what actions are known to be compatible within a vegetation management zone, and what actions require more planning and review. Zoning can also support land use or resource management planning (e.g., evaluating proposed new infrastructure development).

The process used to develop and map the vegetation management zones is summarized in appendix D. The defining characteristics of each zone are described below.

Legacy Zone

The legacy zone includes lands that support unique or irreplaceable remnants of natural biological diversity, along with other vegetation types with high biological value. The habitats for plants that have been identified as threatened, endangered, or rare in the world, the nation, the state of California, or Marin County are included in this zone, along with wetlands and selected upland vegetation types, including redwood forest, serpentine grasslands, and chaparral. Also included are habitats and vegetation types that are at the boundaries of their geographic distributions and that may be important to detecting, and managing for adaptation to, the effects of climate change.

Native manzanita in the legacy zone

Native vegetation in this zone remains largely intact and free of invasion by nonnative plants. Because of their rarity and ecological importance, many species and vegetation types within this zone are protected by federal and state laws and regulations, or by other initiatives, such as the Upland Habitat Goals Project. The legacy zone will serve as a sanctuary for natural resources that otherwise could be permanently lost from Marin, California, and the world.

Sustainable natural systems zone at Mount Burdell

Sustainable Natural Systems Zone

The sustainable natural systems zone includes lands that are valuable for ensuring the ecological resiliency of natural systems and the associated character of Marin County. Lands in this zone, which generally form a natural buffer around lands in the legacy zone, include corridors supporting wildlife movements and potentially the movements of species adapting to climate change, areas of refuge for species living within or migrating through Marin County, and vegetation types that are not considered as biologically valuable as those included in the legacy zone, but that are still considered "hot spots" in terms of relatively high species diversity. Lands in this zone contain only minimal infrastructure, and the vegetation types are relatively free of invasive species.

Natural Landscape Zone

The natural landscape zone includes lands that support native plants and natural vegetation types that are typical of Marin County landscapes. These common vegetation types, while not legally protected or recognized as rare, provide valuable habitat for a diversity of local native species. They contribute to the beauty of Marin County landscapes and add to the ecologically rich natural communities and scenic vistas that define the MCOSD preserves. Vegetation within the natural landscape zone often provides important buffers between the wildland-urban interface and other zones and contains large tracts of grasslands, common oak and other woodland vegetation types, and coastal scrub. While this zone is more infested with

Natural landscape zone

invasive plants than the legacy and sustainable natural systems zones, it still provides valuable connectivity and important habitat for common wildlife and plants.

Highly Disturbed Zone

Homes adjacent to wildlands in the highly disturbed zone

The Highly Disturbed Zone includes lands that provide essential services, such as fire protection and access to MCOSD open space lands. While these lands are also important to the enjoyment and protection of the natural diversity of Marin County, their management is influenced by their role in preventing the movement of fire between residences and open space lands, transmitting utilities (e.g., power and water lines) to nearby communities, and facilitating visitor access. Due to high human use and disturbance, this zone is prone to invasive plant infestations; plant diseases and pathogen outbreaks; and neighboring land influences, such as trespass, predation by domestic pets, green waste dumping, and the introduction of garden plant escapees.

Figure 4.1
Vegetation Management Zones
Region 1

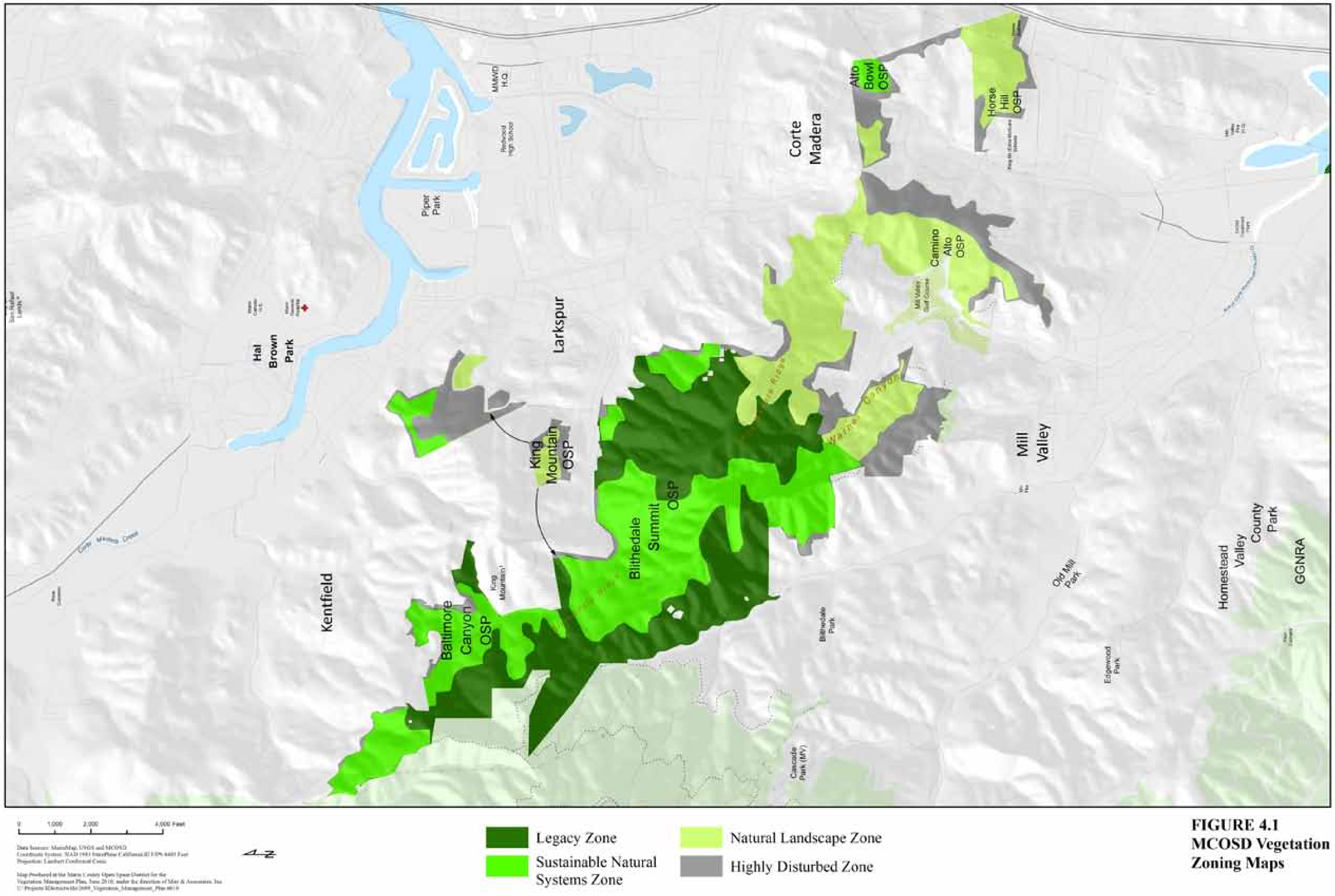


FIGURE 4.1
MCOSD Vegetation Zoning Maps

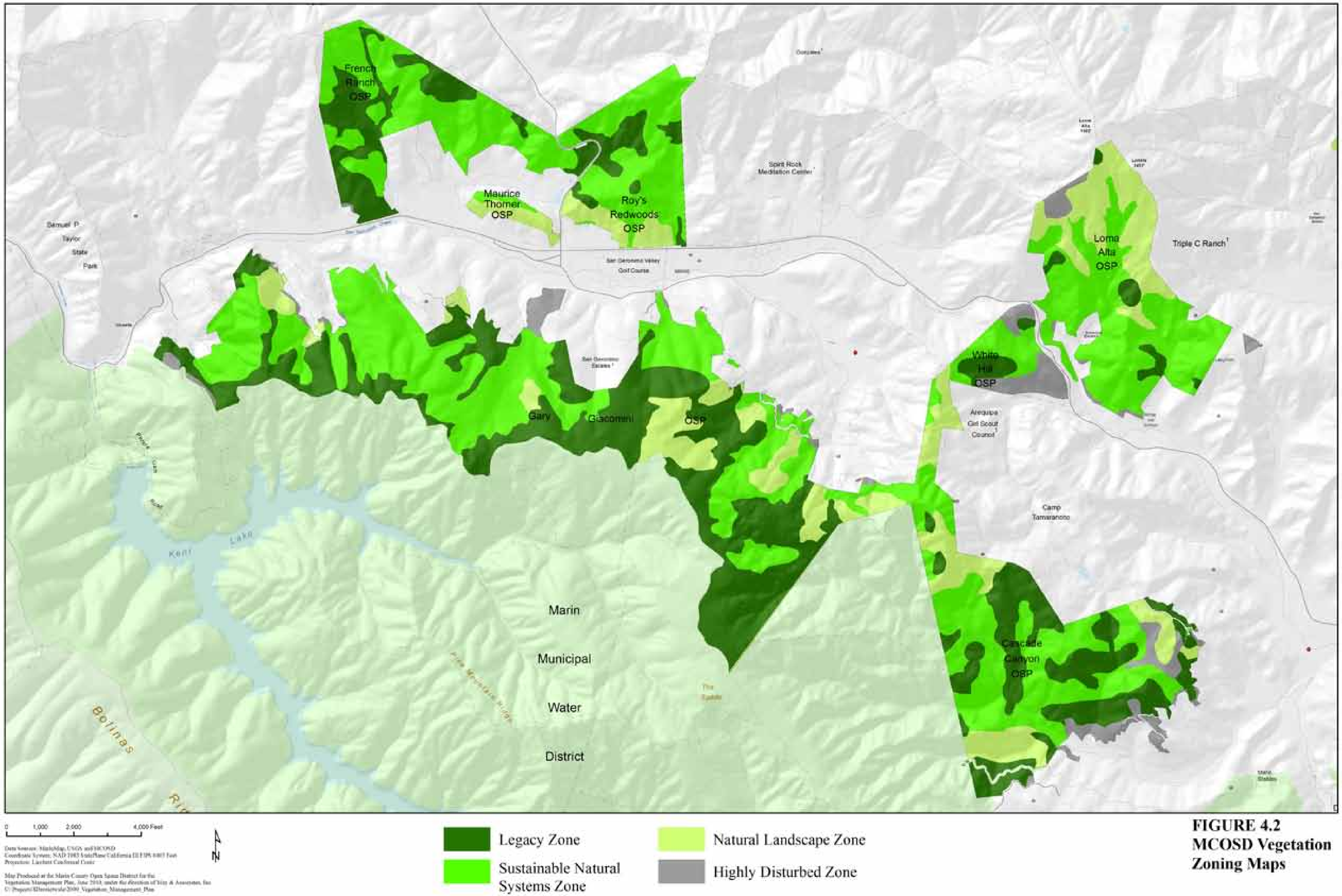


Figure 4.2
Vegetation Management Zones
Region 2

Figure 4.3
Vegetation Management Zones
Region 3

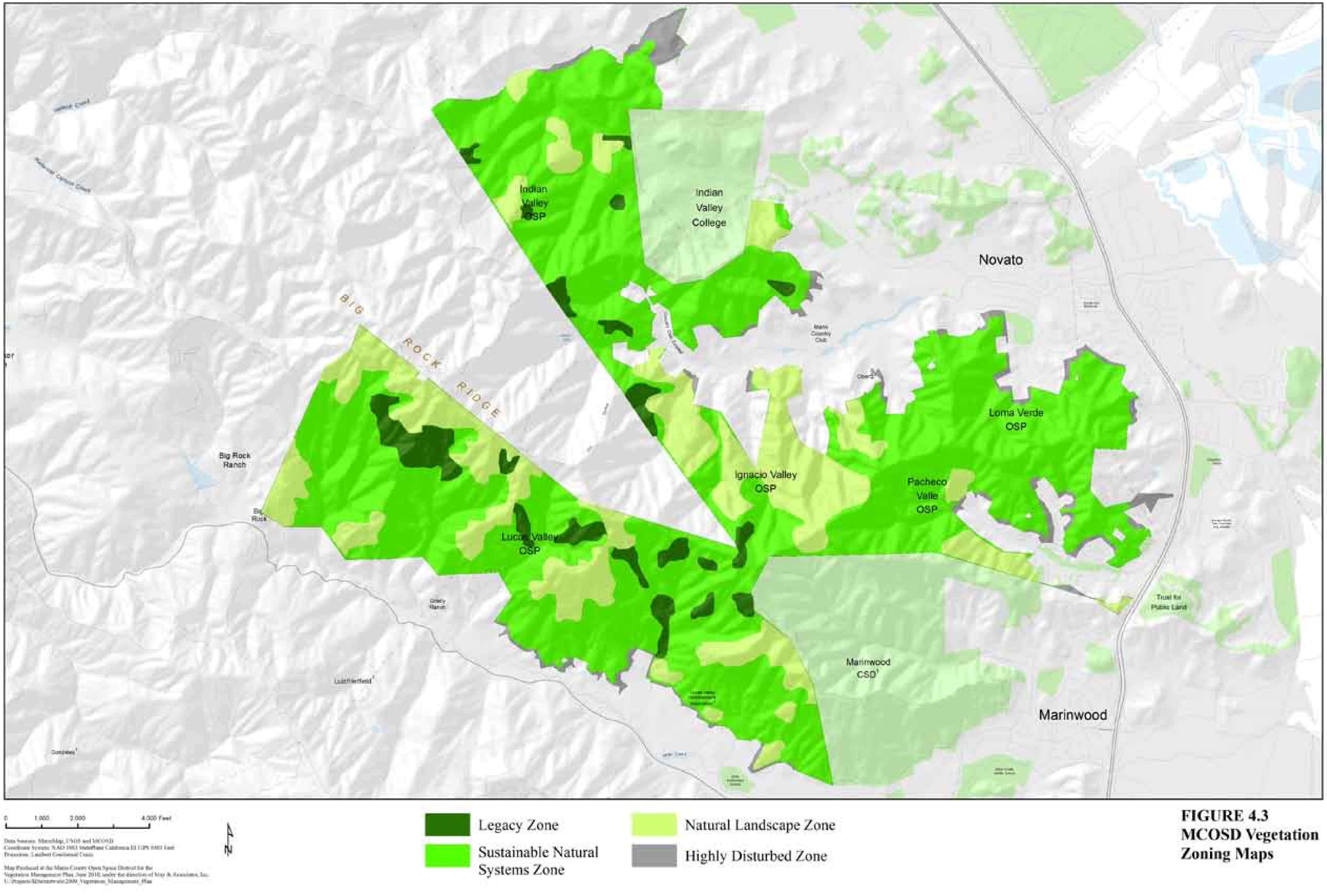


FIGURE 4.3
MCOSD Vegetation Zoning Maps

Figure 4.4
Vegetation Management Zones
Region 4

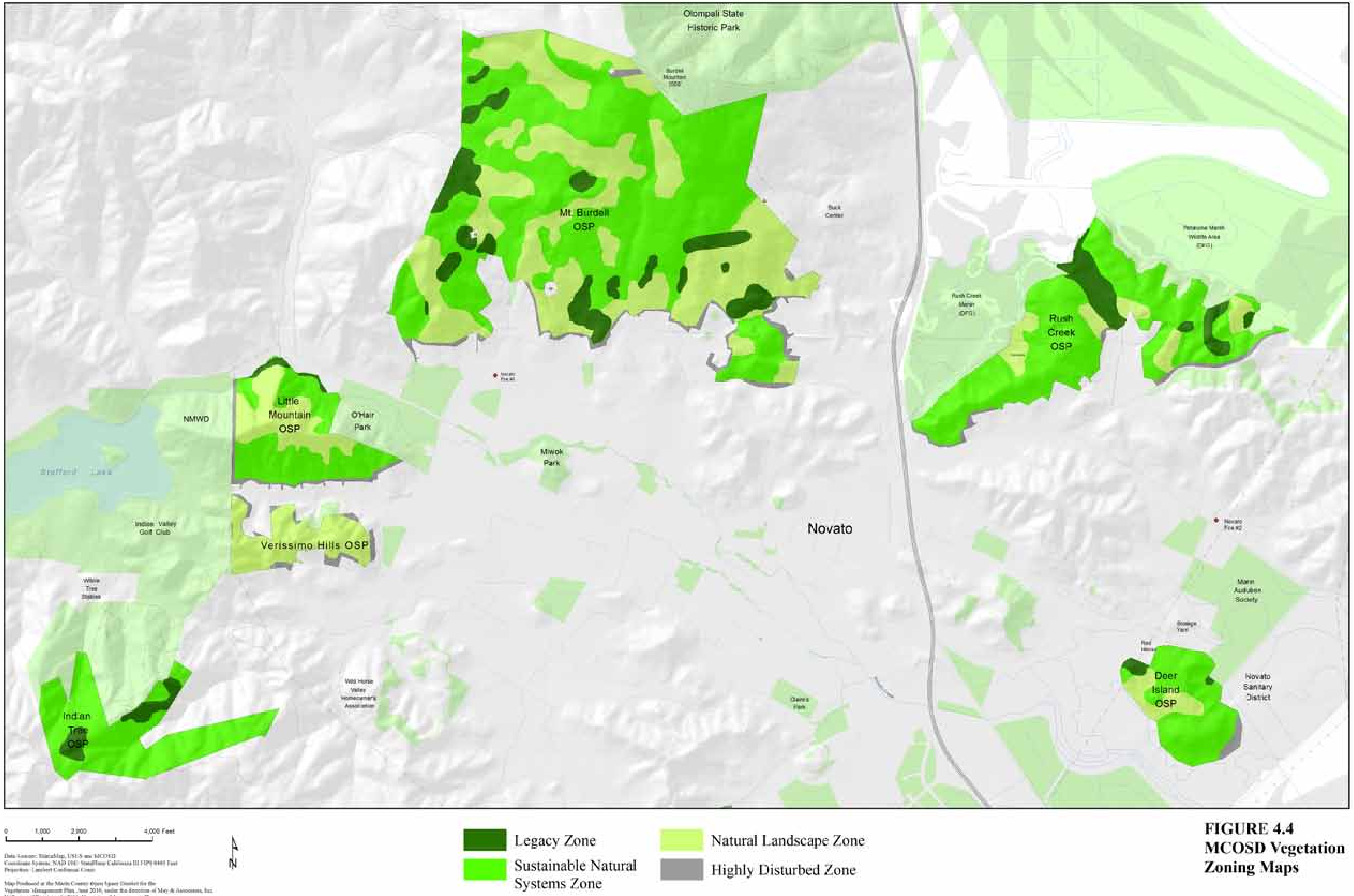


Figure 4.5
Vegetation Management Zones
Region 5

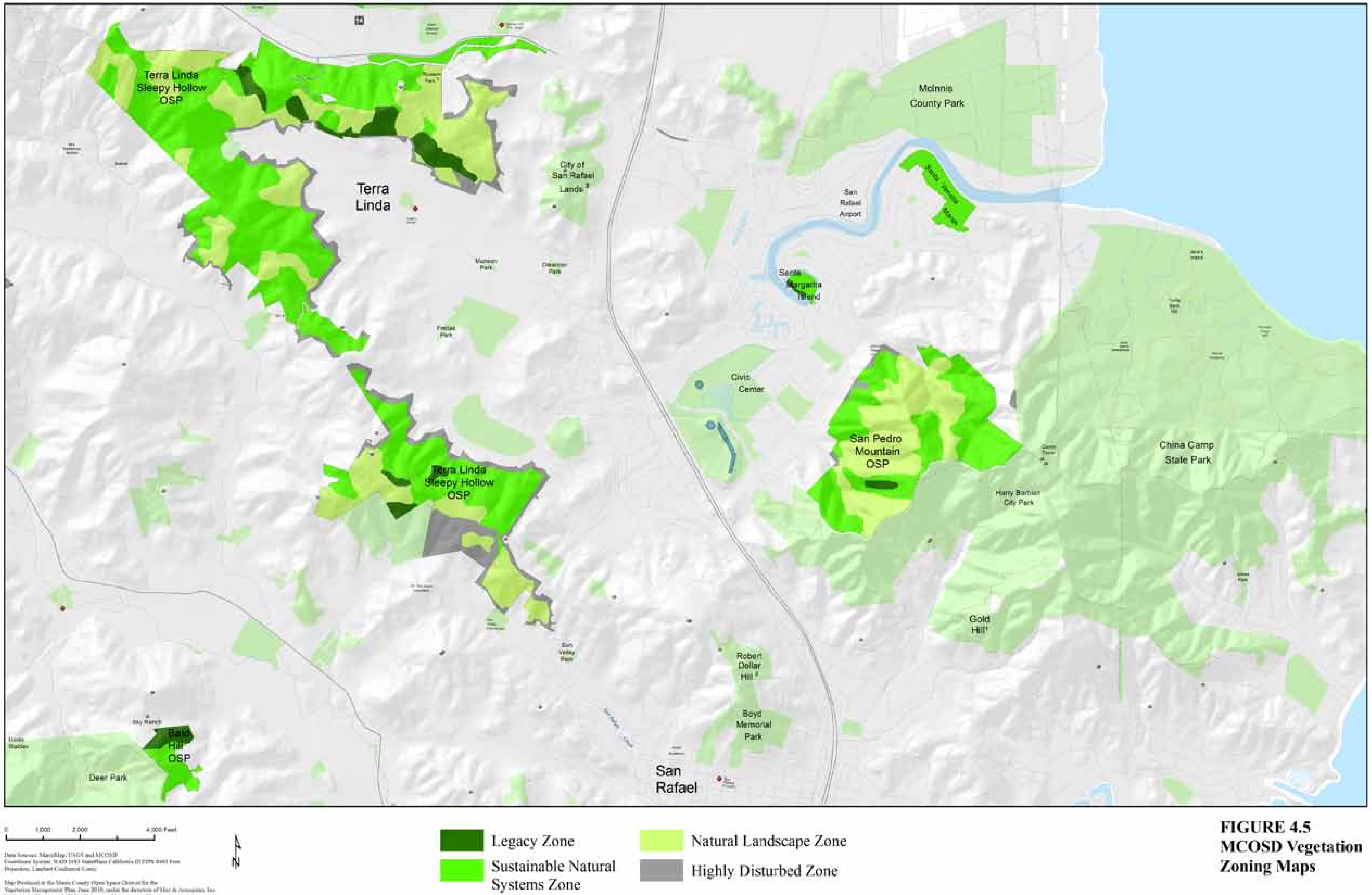


Figure 4.6
Vegetation Management Zones
Region 6

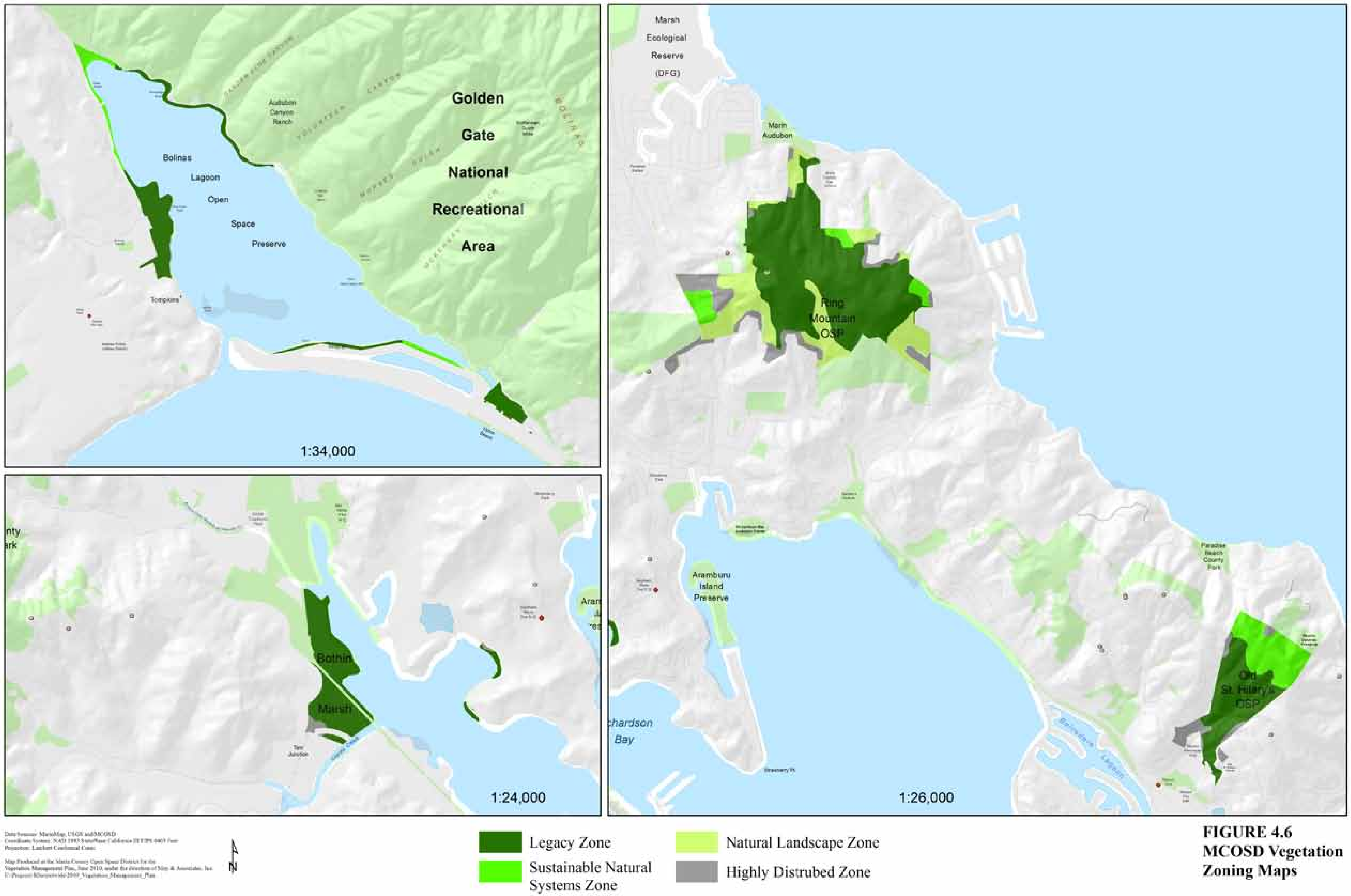


FIGURE 4.6
MCOSD Vegetation
Zoning Maps

Establish Vegetation Management Objectives Based on the Character of Each Zone

Vegetation management activities will be prioritized by zone, placing the highest priority on protecting and restoring species and habitats in the legacy zone. Management objectives have been established based on the biological importance of the vegetation and other concerns associated with each zone (table 4.1). Specific activities for achieving the management objectives are discussed in detail in this chapter.

Table 4.1 Vegetation Management Objectives by Zone

	Management Objective			
Activity	**Legacy Zone**	**Sustainable Natural Systems Zone**	**Natural Landscape Zone**	**Highly Disturbed Zone**
Natural Resources Management (Protection and Restoration)	Protect high-value resources before they are degraded.	Protect high-value resources before they are degraded.	Protect any new special-status or locally rare plant occurrences (may result in rezoning).	Protect any new special-status or locally rare plant occurrences (may result in rezoning).
	Proactively restore high-value habitat.	Increase habitat connectivity to create travel corridors through large blocks of native vegetation.	Increase habitat connectivity to create travel corridors through large blocks of native vegetation.	Regularly assess lands to detect threats to high-value resources in the preserves.
Invasive Plant Control and Integrated Pest Management	Prevent the spread of invasive species.	Prevent the spread of invasive species.	Prevent the spread of invasive species.	Prevent the spread of invasive species.
	Eradicate pioneer and other low cover or sparse cover invasive plant infestations.	Eradicate pioneer invasive plant infestations.	Eradicate pioneer invasive plant infestations.	Eradicate pioneer invasive plant infestations.
	Control any high or medium cover invasive plant infestations within and abutting legacy zones.	Control low or sparse cover invasive plant infestations within and abutting sustainable natural systems zones.	Control low or sparse cover invasive plant infestations within and abutting natural landscape zones.	
		Contain high or medium cover infestations.	Contain high or medium cover infestations.	Contain high and medium cover infestations.
Fire Risk Management and Fire Hazard Reduction Strategies	Manage the fire risk associated with use of the preserves.	Manage the fire risk associated with use of the preserves.	Manage the fire risk associated with use of the preserves.	Manage the fire risk associated with use of the preserves.
	Minimize the use of fuelbreaks as a fire hazard reduction strategy for wildfire control.	Minimize the use of fuelbreaks as a fire hazard reduction strategy for wildfire control.		Place a high priority on fire hazard reduction in defensible space zones.
			Locate fire roads and adjacent ingress/egress zones where they will efficiently support evacuations and safe passage for firefighting equipment.	Locate fire roads and adjacent ingress/egress zones where they will efficiently support evacuations and safe passage for firefighting equipment.

Table 4.1 Vegetation Management Objectives by Zone

Activity	Management Objective			
	Legacy Zone	**Sustainable Natural Systems Zone**	**Natural Landscape Zone**	**Highly Disturbed Zone**
	Restore nonessential fuelbreaks and fire roads to natural conditions.	Restore nonessential fuelbreaks and fire roads to natural conditions.		
	Maintain natural resource and maintenance staff capability to respond to large wildfires.	Maintain natural resource and maintenance staff capability to respond to large wildfires.	Maintain natural resource and maintenance staff capability to respond to large wildfires.	Maintain natural resource and maintenance staff capability to respond to large wildfires.
Forest Health Management				Manage hazards associated with weakened or diseased trees in high-use areas
	Selectively treat forest pathogens.	Selectively treat forest pathogens.	Selectively treat forest pathogens.	Selectively treat forest pathogens.
	Manage for a multi-aged, multistoried forest structure.	Manage for a multi-aged, multistoried forest structure.		
Management for Climate Change	Consider the effects of vegetation management on greenhouse gasses.	Consider the effects of vegetation management on greenhouse gasses.	Consider the effects of vegetation management on greenhouse gasses.	Consider the effects of vegetation management on greenhouse gasses.
	Expand monitoring and adaptive management to support response to climate change.	Expand monitoring and adaptive management to support response to climate change.	Expand monitoring and adaptive management to support response to climate change.	Expand monitoring and adaptive management to support response to climate change.
	Include actions to reduce effects of climate change in vegetation management practices.	Include actions to reduce effects of climate change in vegetation management practices.		
	Offset the loss of coastal wetlands to sea level rise by supporting replacement wetlands in new locations.			

Coordinate Vegetation Management Activities Needed to Accomplish the Objectives

The management activities that will achieve the above objectives are described in the remainder of this chapter. Specific projects related to these activities will be planned and prioritized following procedures outlined in chapter 5. Management activities will be timed to correspond to natural biological cycles and coordinated to make the most effective use of staff time over the course of the year, as shown in table 4.2.

Table 4.2 Integration of Management Activities Based on Biological Cycles

Action	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Plan												
Monitor rare plants												
Plant												
Initial mow												
Follow-up mow												
Foliar spray												
Collect propagules												
Monitor vegetation												
Photomonitor												
Map invasive plants												
Cut stump, basal bark, thinline												
Install erosion control												
Analyze data and prepare reports												

Inventory, Assessment, and Monitoring

The MCOSD staff will use three basic kinds of information about vegetation resources and threats to inform decision making and adaptive management.

- A comprehensive baseline inventory of high-value resources and threats: The inventory will include descriptions and maps of high-value vegetation types and habitats, and it will compile information about major threats to native vegetation, such as invasive plant infestations, high fire risk areas, and diseased and hazard trees.

- Periodic rapid assessments to detect emerging management issues: These assessments, which will generally be conducted on an annual basis, will track the abundance, distribution, and condition of high-value resources; the new occurrence or spread of invasive plants; the severity of fire hazards; and the presence of forest pathogens and hazard trees. Trained volunteers will contribute significantly to gathering this information, which will be used to identify the need for management action.

- Monitoring to assess the efficacy of specific projects: This monitoring will be conducted over a long enough time period to ascertain that the project is achieving its intended purpose. If a project is not producing the expected results, it will be reevaluated and modified as part of ongoing adaptive management.

Baseline Inventories

Baseline inventories will be completed by filling the following data gaps, beginning with high priority areas and as funds allow.

Wetland and Riparian Characterization and Map

Wetlands and riparian areas on and adjacent to the MCOSD preserves will be mapped and characterized as a separate GIS data layer. Information regarding the distribution and characteristics of wetlands and riparian areas will be used to assess the environmental impacts of proposed facilities, such as new fuelbreaks or roads, on these resources.

Updated Special-Status Plant and Wildlife Map

MCOSD will complete the inventory of special-status plants. Known special-status plant populations will be visited and their status assessed. (Inventory and monitoring of special-status wildlife species will be more challenging and will occur as feasible, with the exception of northern spotted owls, which are inventoried and monitored every year.) Natural plant communities with a high potential to support special-status species will also be visited and assessed to identify any additional special-status species. MCOSD staff has already begun this process and has assembled GIS data layers to display the information collected to date. However, additional information about the locations of these species is critical to their protection.

Marin dwarf flax

Life history and bloom periods will be considered when developing the schedule for conducting the inventory work. The MCOSD will complete the full inventory within no more than four years. The inventory will be updated every 5 to 10 years.

Special-status plant GIS data will be stored in a separate GIS dataset that will be linked to future monitoring data. Together, the two datasets will be used to evaluate shifts in distribution, changes in occurrences and population sizes, and the efficacy of special-status plant management actions on MCOSD preserves over time.

Locally Rare Plant and Wildlife Inventory

An additional inventory will be conducted to identify native plant and wildlife populations that are locally rare or unique, often because they are at the extremes of their geographic distribution. For locally rare species, the MCOSD will map and verify the general locations of the occurrences previously provided by the California Native Plant Society. The MCOSD will also work directly with other land managing agencies in the county to confirm the number of known occurrences of each locally rare species (defined as species with less than three known occurrences in Marin County), and to identify other species that may qualify as locally rare.

Cross-Reference Vegetation Mapping Data

Detailed vegetation mapping of most of the MCOSD preserves was completed in 2008, using signature identification of September 2004 aerial photography to classify vegetation polygons to alliances and associations. While the existing MCOSD vegetation mapping provides an invaluable inventory, it needs to be cross-referenced with other state and global vegetation classification systems to increase its usefulness.

The vegetation classification system used to map the preserves was based on the protocols established in the California Native Plant Society's *California Manual of Vegetation* (Sawyer et al. 2008). However, a variety of other vegetation classifications are commonly in use. For example, the Upland Habitat Goals Project uses a modified version of a vegetation classification system and map developed by the U.S. Forest Service. The California Department of Fish and Wildlife and the international inventories maintained by NatureServe also use different classification systems.

MCOSD will cross-reference other related classification systems with the current preserve classifications. Cross-referencing will allow MCOSD to identify vegetation types that have California rarity rankings (CDFW, CNPS), or global rarity rankings (NatureServe). While some of the MCOSD vegetation mapping categories are likely to be unique to Marin, use of a more standardized classification system will help to more rapidly identify high-value vegetation types.

Invasive Plant Inventory

The MCOSD currently collects and manages invasive plants data for multiple purposes, thereby making it difficult to correlate information and prioritize infestations for control. For example, the natural resource staff maintains a GIS-based dataset with the goal of identifying and tracking the size, location, and management actions and costs of controlling invasive plant infestations on MCOSD preserves. In contrast, maintenance staff maintains a separate working Access database to track the location of annual flashy fuels and fuel management treatment areas (several of which encompass invasive plant infestations). For some invasive species, mapping polygons in the GIS database represent carefully delineated occurrences of a species made over several sequential years and have a very high degree of spatial and temporal resolution. In other cases, mapping polygons in the GIS database represent preliminary assessment of the broad distribution of species and are more appropriate for indicating the presence of a widely distributed invasive species at a preserve.

To better support invasive plant management, a comprehensive, preserve-wide invasive plant mapping and data management system will be implemented. The system will build upon the partial mapping completed for priority fuel management areas (Shelterbelt Builders 2008) and use the methods outlined in the Shelterbelt Build 2008 report. Invasive plant infestations will be recorded and mapped using GPS coordinates. Data will include the estimated density and the leading edge (sparse and outlier plants) as well as the main population. Existing MCOSD datasets for invasive plants will be used in the interim period to guide management decisions while mapping updates are prepared.

MCOSD will take a phased approach to invasive plant mapping, based on the following priorities:

- Priority 1. Map within preserves supporting the highest percentage of legacy zones (Baltimore Canyon, Gary Giacomini, Ring Mountain, Roy's Redwoods, French Ranch, Cascade Canyon, Old St. Hilary's, Rush Creek, Indian Tree, and Bolinas Lagoon).

- Priority 2. Map within preserves supporting the highest combined percentage of legacy and sustainable natural system zones (Indian Valley, Lucas Valley, Ignacio Valley, Loma Verde, Mt. Burdell, and Santa Venitia Marsh).

- Priority 3. Map within areas identified in the current Fire Management Plan (Marin County Fire 2008) or by local fire departments as fuel management areas that were not included in previous invasive plant mapping efforts (Shelterbelt Builders 2008), and in areas of proposed new infrastructure projects.

- Priority 4. Map within preserves supporting the highest combined percentage of sustainable natural system and natural landscape zones (Terra Linda/Sleepy Hollow, Loma Alta, San Pedro Mountain, and Pacheco Valle).

- Priority 5. Map within preserves dominated by highly disturbed zones (Blithedale Ridge, Alto Bowl, and King Mountain).

Mapping data can be collected using GPS units or by hand mapping using topographic maps. One method does not preclude the other, and the selected method should be based upon mapping goal/purpose, resources available, and staff training. Regardless of the method used, the MCOSD will store and maintain the data within a GIS database.

The resulting updated invasive plant GIS dataset will be stored separately from, but linked to, the annual rapid assessment data, and the project-based vegetation management GIS data (i.e., alphanumerically numbered polygons where vegetation management actions are occurring). Collectively, the various datasets can be used to evaluate the rate of spread, shifts in distribution, and the efficacy of invasive plant treatments on MCOSD preserves over time.

Baseline information will be updated every 5 to 10 years.

Fuelbreak Assessment

A fuelbreak assessment was performed on existing and proposed fuelbreaks on 15 preserves in 2008 (Shelterbelt Builders 2008). This assessment will be expanded to include all 34 preserves. This effort will be undertaken in partnership with Marin County Fire for comparison with their fire management planning efforts.

High Fire Risk Areas Used by the Public

MCOSD staff will identify, with input from Marin County Fire and other fire agencies, those areas adjacent to development, used by the general public, or used for public utilities, where the potential for wildfire ignition is considered a high risk. These areas—which will generally include parking lots, trailheads, picnic areas, communication sites, power lines, and other areas in highly disturbed zones that are adjacent to hazardous fuels—will be mapped and described in a separate fire management GIS data layer.

Rapid Assessments

Three basic kinds of rapid assessments will be conducted on a recurring basis:

- annual trail-based rapid assessments to detect and categorize new or changing threats to resources
- systemwide early detection and rapid response to invasive plants
- assessments of high-value resources to detect any change in condition

These assessments are mentioned in the various management strategies presented in this chapter, and specific protocols for these assessments are provided in chapter 6.

Project Monitoring

Specific protocols for project monitoring to support adaptive management are provided in chapter 6.

Natural Resource Management (Protection and Restoration)

Protect High-Value Resources Before They Are Degraded

Resources in good condition have a high level of resilience to ecological pressures, such as climate changes, droughts, diseases, or invasive plants, and therefore require less active management than resources that are degraded or otherwise in need of active management. Natural resource protection (i.e., actions to prevent harm) is relatively inexpensive as compared to active management (i.e., restoration) to repair damaged natural systems. Effective natural resource protection includes two main elements: identification of priority resources, and actions to protect and maintain those resources in good condition into the future.

The highest priority for protective management will be given to vegetation in the legacy zone, including:

- federally and state-listed special-status species and their habitats
- locally rare species and their habitats
- globally rare vegetation types with rankings of G-1 or G-2
- wetlands, including sensitive wet meadows
- upland vegetation types recognized as most important (rank 1) by the Upland Habitat Goals Project
- vegetation types at the edge of their range

Protective management will also be applied to vegetation in the sustainable natural systems zone, including

- important wildlife travel corridors
- "hot spot" areas with relatively high biodiversity
- globally rare vegetation types with ranking of G-3
- upland vegetation types recognized as important (rank 2) by the Upland Habitat Goals Project
- creeks and riparian areas and other places of refuge for species inhabiting or traveling through Marin County

Should any new special-status or locally rare plant occurrences be discovered in the natural landscape or highly disturbed zone, they will be protected and managed as if they were included in the legacy zone. Where feasible, zone boundaries will be adjusted to include newly discovered habitats of special-status or locally rare species in the legacy zone.

Routinely Assess High-Value Vegetation Types

See "Inventory, Assessment, and Monitoring," above.

Protect High-Value Vegetation Types by Limiting Public Access

As a general policy, visitors will be directed away from areas of high-value vegetation types to prevent disturbance and adverse impact. This will be done through the appropriate placement of trails, by erecting fencing, or installing educational signs that provide information about the resource values being protected.

Incorporate Zone and Vegetation Sensitivity Designations into Project Planning

The overall objective for vegetation management will be to preserve large, unfragmented areas of natural vegetation and connectivity. The connection between and among zones will largely be addressed by wildlife travel corridors.

Time Maintenance Activities to Avoid Impacts on Sensitive Biological Resources

Maintenance activities will be timed to reduce potential impacts to special-status species and protected nesting birds. Table 4.3 identifies those months of the year when particular practices may need to be implemented (e.g., pretreatment nesting surveys, avoidance of nests or breeding habitat) to avoid adverse effects on special-status species or protected nesting birds. This table is intended to provide general guidance on sensitive periods for special-status species, but it will be adjusted to fit local conditions and used within the context of federal, state, and local laws and regulations that protect biological resources. The table is not meant to imply that treatments cannot be scheduled during the sensitive periods, but that best management practices described in chapter 7, such as bird nesting surveys, may need to be implemented prior to undertaking the work.

Regularly Assess Lands within the Highly Disturbed Zone to Detect Threats

Invasive weeds in the highly disturbed zone

MCOSD staff will assess lands in the highly disturbed zone on an annual or semiannual schedule, looking for trespass, garden plant introductions, green waste dumping, and target invasive plant spread. MCOSD will work with other county departments to conduct outreach and enforcement actions, if warranted, to correct problems that potentially threaten preserve resources. Joint efforts might include the preparation and distribution of educational materials, meetings with community groups and neighborhood watch groups, and installing signs and physical barriers to correct trespass issues. Efforts specific to invasive species management and fuel reduction are described in greater detail in other parts of this chapter.

Table 4.3 Suggested Seasonal Restrictions for Maintenance Activities Near Special-Status Species

BMP	Target	1-Jan	15-Jan	1-Feb	15-Feb	1-Mar	15-Mar	1-Apr	15-Apr	1-May	15-May	1-Jun	15-Jun	1-Jul	15-Jul	1-Aug	15-Aug	1-Sep	15-Sep	1-Oct	15-Oct	1-Nov	15-Nov	1-Dec	15-Dec	Buffer
SSWS 1	Nesting birds																									150 ft min active nests until young have fledged Published breeding period March 1-Aug 15, but locally may be as early as Jan 1 for some
SSWS 1	Raptors																									150-250 ft around active nest, until young have fledged Published breeding period March 15-Aug 15 but locally as early as Feb 15th for some
SSWS 2	Northern spotted owl																									100 ft around known habitat
SSWS 3	Double crested cormorant, heron, egret																									100 ft around nest or rookery, until young have fledged
SSWS 4	California clapper rail, California black rail																									100 ft around known nesting habitat
SSWS 4	Salt marsh harvest mouse																									100ft around occupied habitats
SSWS5	California red-legged frog																									At least 100 ft around potential upland aestivation habitat Avoid work in occupied aquatic habitat
SSWS6	Foothill yellow-legged frog																									100 ft for upland habitat Avoid occupied aquatic habitat
SSWS7	Northwestern pond turtle																									100 ft around aquatic habitat 500 ft around occupied upland
SSWS 8	Mission blue, San Bruno elfin, myrtle silverspot																									100 ft around occupied habitat
SSWS 8	Tomales roach, Ricksecker's water scavenger beetle																									100 ft around occupied habitat

Table 4.3 Suggested Seasonal Restrictions for Maintenance Activities Near Special-Status Species

BMP	Target	1-Jan	15-Jan	1-Feb	15-Feb	1-Mar	15-Mar	1-Apr	15-Apr	1-May	15-May	1-Jun	15-Jun	1-Jul	15-Jul	1-Aug	15-Aug	1-Sep	15-Sep	1-Oct	15-Oct	1-Nov	15-Nov	1-Dec	15-Dec	Buffer
SSWS 9	Coho and chinook salmon, steelhead trout																									Restrict work to dry season Jun-Sept, or 100 ft around occupied streams.
SSWS 10	Tidewater goby																									100 ft around occupied habitat
SSWS 10	Sacramento splittail																									100 ft around occupied habitat
SSWS 10	California freshwater shrimp																									Avoid work in occupied aquatic habitats.
SSWS 11	Woodrat																									25 ft around active woodrat nests
SSWS 12	Special-status bats																									100 ft around occupied habitat
SSWS 13	American badger																									100 ft around occupied habitat
SSPS 1	Plants																									100 ft around occupied habitat

Proactively Restore High-Value Habitat

Identify Declines in Vegetation Types or Habitats

A decrease of more than 20% of the original or most recent mapping acreage or population estimate will be considered a significant decline warranting management action, as will an observed degradation of the vegetation types that support high-value vegetation.

Manage Invasive Plants

Elimination or control of invasive plant infestations will be a high priority in all restoration areas where invasives are present. This activity is discussed in detail under "Invasive Plant Management," below.

Remove or Realign Roads and Trails Away from High-Value Biological Resources

Many of the existing roads and trails in the preserve are old ranch roads, which were never designed for, or located in places intended for, recreational or educational experiences or scenic viewing. Neither are they located optimally for use as fire roads.

The MCOSD *Road and Trail Management Plan* will include an existing conditions assessment of all of the roads and trails on the preserves. This assessment will assist MCOSD in determining which redundant, unnecessary, underused, or high-maintenance roads and trails can be decommissioned or rerouted. Special consideration will be given to roads and trails located within high-value vegetation types, including habitat for special-status species.

As a general policy, redundant and/or environmentally undesirable roads in the legacy zone will be evaluated to determine whether they should be decommissioned, or converted to trails, unless a legally binding agreement exists. As a general policy, redundant and/or environmentally undesirable trails in the legacy zone will be evaluated to determine whether they should be decommissioned or rerouted. In some cases, certain roads may be considered critical for emergency access and may need to remain if this access cannot be duplicated elsewhere on the preserve. Areas where roads or trails are removed will be restored to natural conditions.

Restore Native Vegetation

The following conditions will be considered when assessing a restoration site and strategy (Dawson 1984):

- Presence of one or more of the target vegetation types: Do target vegetation types occur either within or immediately adjacent to areas to be restored?

- Soil type and soil condition: Are site soils appropriate for the target vegetation types and are they largely intact, or have they been plowed, graded, or had topsoil removed?

- Hydrologic function: How disturbed are water features, diversions, and wells? Does the site still flood naturally?

- Site topography in context: Does the site fit with the topography of the surrounding landscape, or is it lower, higher, sloped, or leveled?

- Indicators of past land use: Are there indicators of past homesteading/human occupation (e.g., abandoned ditches, water control structures, old foundations, fig trees, or pepper trees)?

Based on the vegetation type and project objectives, a “planting palette” will identify the plants and the quantities that will be used in the restoration project. The palette will include all the characteristic dominant plants of the target vegetation type (Dawson 1984). The quantities of each plant selected will be based loosely on their percent relative cover in the target vegetation type; however, plant quantities will be adjusted to reflect species that are difficult to grow, grow slowly, are readily available from local nursery stocks, or are easily established through direct seeding. Plants that are difficult to establish from seeds or cuttings or that are not commercially available will not be included because the potential for success will be low. The potential for resiliency and adaptation to climate change will also be considered in the planting palette, as discussed later in this chapter.

Most revegetation plant materials will be collected, stored or germinated, and grown as container stock for approximately one year before being planted at a restoration site. Plant materials may include seeds, cuttings, or root stock divisions, depending on the species to be collected. Plants will usually be collected within the same watershed as the restoration site. Plants may be collected and grown by volunteers, MCOSD staff, or by a contract nursery that specializes in native plant propagation.

For most restoration projects, the following actions will be undertaken:

- Mark the edges or corners of the restoration site in the field. Mark ingress/egress routes, approved access roads, and staging areas in the field.

- Install protective fencing and signs around sensitive natural resources to be retained.

- Set up permanent photomonitoring locations and conduct baseline photomonitoring.

- Conduct any additional surveys or other site investigations (e.g., preconstruction bird nest surveys, woodrat nest surveys).

- Conduct any necessary invasive plant control actions (e.g., remove initial invasive plants, set up cleaning stations for equipment, install rumble strips).

- Conduct any necessary site preparation work. Site preparation work may include site grading, soil preparation (e.g., recontouring, aeration, compaction, raking, in some cases adding soil amendments), and installation of erosion control structures (e.g., weed-free straw bales, straw wattles, erosion control matting).

- Lay out plants at the planting site (if appropriate). Use color-coded flags to indicate plant installation sites for individual species. Check plant spacing and appropriateness of planting sites for individual species (i.e., make sure wetland plants are installed in wet area, shade-loving plants are installed under trees or shrubs, etc).

- Schedule delivery of planting materials and inspect plant materials for health and vigor. Reject root-bound, diseased, or otherwise unsuitable plant materials.

- Schedule plant installation and oversee work. MCOSD staff will oversee restoration work to help ensure that plants are properly installed, spaced correctly, and that site conditions match the approved plans.

- Water-in plants immediately after installation. Immediately following plant installation, water plants to help ensure good soil-to-plant contact. Plants can be watered by hand or with a water truck or hose. If required, irrigation systems can be used to water-in plants. A five-gallon bucket with a small pinhole can also be used to provide slow-release spot irrigation.

Restoration sites will be maintained for a period of 3 to 10 years following restoration. Volunteer-appropriate activities during this phase may include watering, weeding, replanting, invasive plant control, and staking or removing browse protection structures.

Project monitoring to support adaptive management will be initiated immediately following site restoration. Monitoring is discussed extensively in chapter 6.

Identify Opportunities to Reintroduce Extirpated Plants

Some of Marin's landscapes have been dramatically altered from their historical setting, leaving fragmented remnants of once vibrant ecological landscapes. One result of these changes is the extirpation of both plant and wildlife species—some lost over more than a century ago, others within the past decade. The MCOSD will work with other Marin County land managers and the California Native Plant Society to compile a list of extirpated species that were likely to be present in the past on MCOSD preserves (based on the historic range of the species and the presence of suitable plant habitat onsite). Information on historic range, plant habitat requirements, locations of last known occurrences, seed or propagule availability and locations, and any associated permit requirements will be compiled. Reintroductions of extirpated species will be undertaken in partnership with other agencies or as a part of a student or faculty research project.

Increase Habitat Connectivity to Create Travel Corridors

Wildlife movement corridors (large connected areas of habitat) help maintain wildlife species diversity and abundance (Noss 1987; Perault and Lomolino 2000). Such corridors allow wildlife (and plant) species to move between habitat patches, allowing recolonization of patches in which a local extinction event has occurred, and providing increased foraging area and escape areas for a wide variety of species. Further work has suggested that a network of small patches in proximity to one another (habitat stepping stones) can also increase wildlife population sizes and persistence (Webb and Thomas 1994; Schultz 1998). The general rule of thumb for maintaining wildlife corridors is “bigger is better”—i.e., the larger and more contiguous the area, the more likely that it will act as a wildlife corridor.

Minimize Intrusions into Larger Contiguous Habitat Areas

In considering the need for roads, trails, and fuelbreaks, MCOSD will strive to minimize their effects on large, connected areas of habitat. Roads and trails are discussed under “Proactively Restore High-Value Habitat,” above. Fuelbreaks are discussed under “Fire Risk Management and Fire Risk Reduction,” below.

Purchase or Obtain Easements on Lands that Will Help Connect Preserves

MCOSD will continue to seek opportunities to close gaps in connectivity through the acquision of land in fee or through the acquisition of trail easements.

Invasive Plant Control and Integrated Pest Management

The priority invasive plants targeted for management in the MCOSD preserves are listed in table 4.4. More comprehensive information about nonnative plants know to exist on the MCOSD preserves is provided in appendix C.

Table 4.4 Priority Invasive Plants

Scientific Name	Common Name	Preserves infested**	Total Acres Mapped**	State Noxious Weed Rating	Cal-IPC Rating	Status on MCOSD Lands
Acacia decurrens, Acacia melanoxylon, other *Acacia spp.*	Acacia, black wattle, blackwood acacia	5	0	N/A	Limited (*A. melanoxy-lon*), N/A	Limited distribution, high impacts
Aegilops triuncialis	Barbed goatgrass	4	147	B	High	Limited distribution, high impacts
Ageratina adenophora	Crofton weed, Thoroughwort, Eupatorium	4	4	Q	Moderate	Limited distribution, high impacts
Carpobrotus edulis	Highway iceplant, Hottentot fig	5	49	N/A	High	Limited distribution, high impacts
Carthamus lanatus	Woolly distaff thistle	5	10	B	Alert	Limited distribution, high impacts
Centaurea calcitrapa	Purple starthistle	12	252	B	Moderate	Abundant, high impacts
Cotoneaster sp.	Cotoneaster	6	10	N/A	Moderate	Limited distribution, high impacts
Centaurea solstitialis	Yellow starthistle	22	1,280	C	High	Abundant, high impacts
Cortaderia jubata	Jubata grass	17	33	B	High	Abundant, high impacts
Cytisus scoparius	Scotch broom	17	396	C	High	Abundant, high impacts
Delairea odorata	Cape ivy, German ivy	6	46	N/A	High	Abundant, high impacts
Dittrichia graveolens	Stinkwort	2	4	N/A	Alert	Limited distribution, high rate of spread
Eucalyptus globulus	Tasmanian blue gum	8	29	N/A	Moderate	Limited distribution, moderate impacts, high fire risk
Echium candicans	Pride of Madeira	5	4	N/A	Limited	Limited distribution, high rate of spread
Ehrharta erecta	Erect veldtgrass	3	9	N/A	Moderate	Limited distribution, high impacts
Foeniculum vulgare	Fennel	25	251	N/A	High	Abundant, high impacts
Genista monspessulana	French broom	28	706	C	High	Abundant, high impacts

Table 4.4 Priority Invasive Plants

Scientific Name	Common Name	Preserves infested**	Total Acres Mapped**	State Noxious Weed Rating	Cal-IPC Rating	Status on MCOSD Lands
Lepidium latifolium	Perennial pepperweed, Tall whitetop	4	5	B	High	Limited distribution, high impacts
Phalaris aquatica	Harding grass	22	116	N/A	Moderate	Abundant, high impacts
Rubus armeniacus	Himalayan blackberry	16	9	N/A	High	Abundant, high impacts
Spartina alterniflora	Cordgrass	1	2	N/A	High, Alert	Limited distribution, high impacts
Spartium junceum	Spanish broom	5	3	C	High	Limited distribution, high impacts
Taeniatherum caput-medusae	Medusa-head	2		C	High	Limited distribution, high impacts
Tribulus terrestris	Puncture vine	2	3	C	N/A	Limited distribution, high impacts

MCOSD invasive species management is guided by the Marin County Integrated Pest Management Ordinance. Integrated pest management takes advantage of all appropriate invasive plant management options, including but not limited to hand removal, mechanical removal, cultural practices, and the judicious use of herbicides. Integrated pest management is not a single invasive plant control method, but rather a series of invasive plant management evaluations, decisions, and controls.

As shown in table 4.5, the priorities for invasive species management (i.e., eradication, sustained control, or containment) vary depending on the zone in which the infestation occurs. MCOSD will maximize land stewardship by keeping the highest value habitat intact and free from invasive plants, and by prioritizing funding and resources towards early detection and rapid removal districtwide.

Table 4.5 Priorities for Invasive Species Management

	Legacy Zone	Sustainable Natural Systems Zone	Natural Landscape Zone	Highly Disturbed Zone
Priority 1	Eradication of pioneer and low-cover infestations			
Priority 2	Control of invasive trees and high- or medium-cover infestations of other species	Control of leading edges of infestations abutting legacy zones		
Priority 3		Eradication of pioneer infestations		
Priority 4		Control of invasive trees and low-cover infestations of other species		
Priority 5			Eradication of pioneer infestations	Eradication of pioneer infestations
Priority 6			Control low-cover infesta-tions	Contain high- and medium-cover infestations

Prevent the Introduction and Spread of Invasive Species

Avoid Land Disturbance to Prevent the Introduction of Invasive Species

Prevention is the most effective method for avoiding the harm associated with invasive species, and healthy stands of native vegetation are more resistant to being colonized by invasive species than are disturbed lands, which invite new colonization. Therefore, an important part of MCOSD's invasive species management program will be avoidance of new disturbance or manipulation of established native vegetation on preserve lands, particularly in legacy zones.

Implement Best Management Practices to Avoid the Spread of Invasive Species

Most invasive plant infestations on MCOSD preserves are spreading along fire roads and trail corridors, in and around utility corridors and facilities, and from the wildland-urban interface into the preserves. Best management practices such as the following will be implemented to keep invasive plants from spreading into new areas:

- Require staff and contractors to clean equipment and work in a manner that does not spread invasive plants to new areas.

- Require that materials brought into the preserves (i.e., fill, rock, straw and any other erosion-control materials) are certified to be weed free.

Encourage Adjacent Landowners to Help Control Invasive Plants

MCOSD will work in partnership with California Invasive Plant Council (CalIPC), Marin Sonoma Weed Management Area, and local land managers to distribute existing educational materials or to develop new site-specific materials for local residents, preserve users (e.g., equestrians, hikers), and other community stakeholders, with the goal of building support for preventing the introduction and spread of priority invasive plants.

Eradicate Pioneer Invasive Plant Infestations in All Zones and Low-Cover or Sparse-Cover Infestations in Legacy Zones

The survey of current management practices and scientific literature concludes that early detection and eradication is the single most important element in coping with invasive plants. Therefore, these activities will receive the highest priority of all invasive plant control activities in any particular zone.

Eradication means destroying every single plant in the infestation, not just most of them. Typically, even if caught in the early phases, eradication will require more than one treatment, with treatment periods often extending 3, 5, or even 10 years. The key is diligence. If the site is weeded thoroughly enough and often enough, the remaining seed bank (i.e., seeds left dormant in the soil) can be exhausted, and the eradication will be successful.

The key to eradication is:

- detecting early
- responding quickly
- monitoring carefully
- repeating as necessary until all pioneer plants and seedlings are gone

Implement an Early Detection and Rapid Response Program

An Early Detection and Rapid Response Team will be created to regularly inspect the preserves, using an established inspection schedule and route that gives highest priority to legacy zones, followed by common entry points to the preserves, such as trailheads, major trail intersections, and adjacent backyard areas where green waste dumping or trespass has occurred in the past. The team will immediately treat new invasive plant infestations and maintain the treated areas to prevent reinfestation.

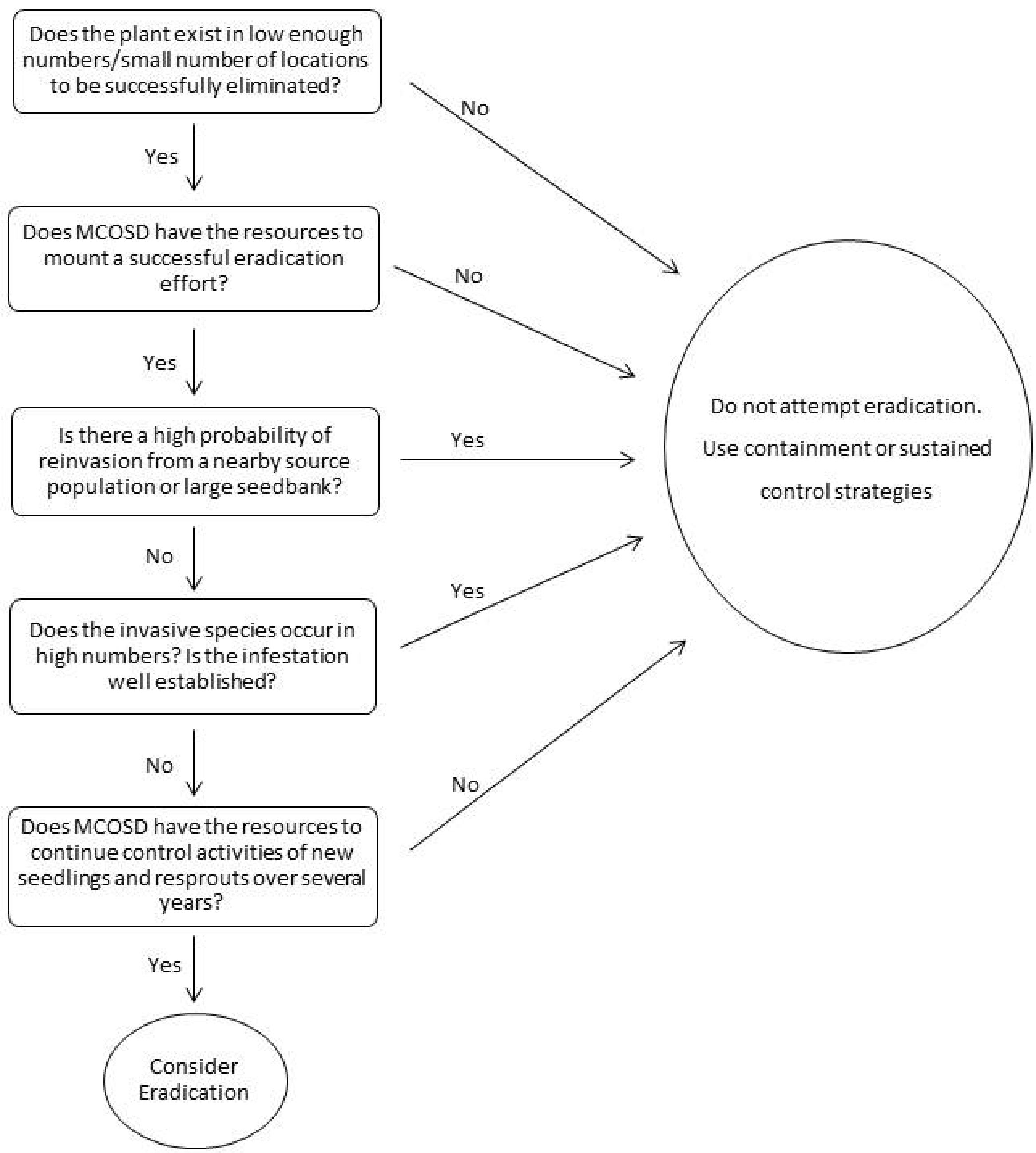
The volunteer program is described in detail in chapter 5. Volunteers will be expected to play a major role in early detection and treatment, whenever the following conditions are met:

- The activities can be performed using tools that are appropriate for volunteers.
- The activities can be performed safely by volunteers.
- There is community/stakeholder interest in performing the activities.
- The MCOSD volunteer program has the capacity to train and oversee the needed number of volunteers.
- Volunteers can clearly visualize the impact they have made through their volunteer contribution.

Control or Contain Established Plant Infestations

Eradication is successful generally only when the invasive plants exist in low numbers, making eradication a logistically and economically reasonable option. Figure 4.7 shows the criteria for choosing among the treatment options of eradication, control, or containment.

Figure 4.7 Decision-Making Flow Chart: Determining Eradication, Control, or Containment Strategy



Sustained control is the management of an invasive plant population to prevent its reproduction, while incrementally reducing its distribution over time (as funding and staffing allow) until it is eventually eradicated. Sustained control is accomplished by

- removing sparse areas and individual outlier plants around the edges of the infestation to reduce the overall size and rate of spread outward from the occurrence or population
- reducing overall plant density over time through ongoing treatments
- eliminating all or most mature plants, and preventing reproduction (i.e., flowering or seed set for invasives that spread via seeds; spread via rhizomes or underground root sprouts for plants that spread through vegetative means)

Containment is the management of an invasive plant population to keep it within a geographic boundary with no increase in population size. Containment usually involves establishment of a containment line (a cleared or mowed area) intended to physically separate the invasive plant infestation from other areas.

Inventory Invasive Plant Infestations

Invasive plant infestations will be recorded and mapped using GPS coordinates. Data will include the estimated density and the leading edge (sparse and outlier plants), as well as the main population.

Conduct Periodic Rapid Assessments of Known Infestations

MCOSD staff will conduct rapid assessments every one to three years of known infestations to detect changes from baseline conditions. The following criteria will be used to help assess and prioritize which invasive plants should be treated depending upon the resources available:

- Dispersal mechanism: Does the invasive plant disperse locally or is it widespread? Is the dispersal mechanism slow or rapid (e.g., a wind-distributed species, like pampas grass, is likely to spread faster than a plant that spreads from rhizomes, like bamboo)?
- Plant habitat requirements: Does the invasive plant have specific habitat requirements or is its colonization unrestricted (e.g., some invasive plants, such as cordgrass, can only grow in marsh habitats and therefore are not able to colonize as many locations as a plant that can grow in many habitat types, such as French broom)? Is colonization disturbance-dependent?
- Treatment cost per acre: How long does control take, and is the acreage high or low?
- Specialized skill required: Can the invasive plant be controlled by volunteers and staff or does successful control require contractor support? Is there a high number of treatment options for control, or only limited number?
- Probability for success: Is the probability of success high or low?

MCOSD staff will review invasive plant priorities on an annual basis and, using the above criteria, identify which infestations should be targeted for control and/or removal in the upcoming year. Table 4.6 is a sample plant evaluation worksheet to help MCOSD assess which invasive plant or populations should be prioritized for treatment. Use of this worksheet will help determine which species can be controlled by contractors, staff, or volunteers; which species will require a multiyear approach with sustained funding; and, which species have limited dispersal and will likely not spread significantly if left untreated for a period of time.

Table 4.6 Invasive Plant Treatment Decision-Making Matrix

Factors		Rank Range	MCOSD Weighting Factor	Rank Score	Weighted Score
Section 1. Containment and Control Benefits					
Likelihood of treatment effectiveness	Highly likely to eradicate	10	3		
	Moderately likely to eradicate or control	5			
	Low likelihood of success	1			
Proximity of invasive species to sensitive natural resources	Within population/habitat	10	3		
	Within 100 feet of population/habitat	5			
	Within 1,000 feet of population/habitat	1			
Initial treatment cost per acre	High - > $15,000	1	3		
	Moderate - $5,000-$14,999	5			
	Low - < $5,000	10			
Maintenance cost per acre (assume cost per year for 5 years)	High - > $3,000/ per year	1	3		
	Moderate - $2,999-$1,000/per year	5			
	Low - < $1,000/per year	10			
Density of invasive plants	Dense invasive plants	1	2		
	Moderate invasive plants	3			
	Sparse invasive plants	4			
	Little or no invasive plants present	5			
Possible dual benefit to fuel management	High benefit - located in a designated fuel management zone	10	2		
	Moderate benefit- outside but adjacent to a designated fuel management zone	5			
	Low benefit- not much benefit to fuel management efforts	1			
Need for specialized skills/ treatments	Can be accomplished with existing staff/volunteers, high # of treatment options	10	2		
	Requires specialized skills to control, low # of treatment options	1			
Potential impacts to rare, threatened and/or endangered species	High	1	3		
	Low/none	10			
Subtotal Containment and Control Benefits Score					

Table 4.6 Invasive Plant Treatment Decision-Making Matrix

Factors		Rank Range	MCOSD Weighting Factor	Rank Score	Weighted Score
Section 2. Environmental Concerns/Benefits					
Potential impacts to cultural resources	High	1	2		
	Moderate	3			
	Low/none	10			
Potential benefits to sensitive natural resources	High	1	2		
	Moderate	3			
	Low/none	10			
Erosion /visual impacts	Will not result in substantial soil disturbance, work not visible for roads or trails	10	2		
	Work may result in some localized soil disturbance work partially visible from roads or trails	5			
	Work likely to result in widespread soil disturbance, work site open and exposed	1			
Linkage to adjacent existing fuel management areas	Over 1 mile	1	2		
	Within 1 miles	2			
	Within 0.5 miles	5			
	Within less than 0.25 miles	10			
Subtotal Environmental Concerns/Benefits Score					
Total Project Score (section 1 score + section 2 score)					

Explanation of ranking and weighting factors:

Ranking:

240+	very valuable	100-149	valuable
200-240	highly valuable	<100	of little value
150-199	moderately valuable		

The above decision-making support matrix includes both rank range and weighting factors for various environmental, treatment effectiveness and budgetary factors. The rank range factors are on a scale of 1-10 for all factors. Various scores for measurements of distance, time, cost and related factors are shown. These numerical scores were based upon input from the MCOSD and other local natural resource managers. The MCOSD is not limited to using the ranking scores. For instance, the MCOSD may select to weigh or score a particular factor differently than shown.

The weighting factors range between a high of 3 for those factors that are of very high importance, a 2 for high importance and lastly those with a 1 for those of moderate importance. The weighting factor is the MCOSD assessment of the decision-making factors.

The scores are created by multiplying the ranking and weighting factors for each criteria and then adding the results together. This score is a relative ranking and a guide to decision making. It is understood that a single factor may create such an environmental or social concern that it may be eliminated from future consideration. An example of this would be the presence of an endangered species for which there is no mitigation measures.

Generally Utilize Multiple Types of Treatment over Multiple Years

The survey of current practices and scientific literature concludes that invasive plant infestations are most effectively controlled by using multiple types of treatment over multiple years, selecting the specific actions based on goals and objectives, the life cycle and physiology of the invasive plants, and specific site conditions and potential for environmental impacts. It also concludes that the efficacy of the initial treatment has a direct effect on the cost and level of effort required for any follow-up and/or maintenance treatments. Also, the timing of treatments is crucial to successful control of invasive plant infestations.

MCOSD staff will follow integrated pest management procedures when assessing each project and select the best available treatments for the target species. Assessments will include the following human and environmental health and safety factors:

- accidental ignition potential
- aesthetics
- air quality
- amphibians
- carbon emissions
- environmental persistence
- erosion and runoff
- nesting birds
- noise
- nontarget terrestrial and aquatic vegetation
- pollinators
- public health and safety
- salmonids
- soil productivity and microorganisms
- water quality
- worker health and safety

The recommended treatment options for invasive plants known to exist in the MCOSD preserves are discussed below and listed in table 4.7. For many species, mechanical control followed by chemical control is expected to be the most effective for treating large and well-established infestations. Cutting followed by some sort of localized herbicide application (e.g., cut-and-paint application, low-volume drizzle foliar application, low-volume basal bark application) is considered both low cost and highly effective.

Invasive Trees

Several invasive trees on MCOSD preserves are becoming problematic because they are displacing native vegetation and are spreading from landscaped areas into wildlands. Invasive trees that are problems on MCOSD preserves include

- blue gum eucalyptus (*Eucalyptus globulus*)
- Monterey cypress (*Cupressus macrocarpa*)
- Monterey pine (*Pinus radiata*)
- acacia (*Acacia decurrens*, *A. melanoxylon*, other *Acacia* spp.)

Criteria for controlling invasive trees are described under “Forest Health,” below. When the threshold for control is met, the following treatment will be conducted by MCOSD staff or contracted through a licensed and bonded professional aborist with experience working in wildland settings:

1. Mark trees and conduct any notifications required by county ordinance. Note: The MCOSD assumes that County Heritage Tree Ordinances do not apply to routine vegetation management conducted on MCOSD preserves.
2. Determine timing of tree removal to protect nesting birds.
3. Identify methods for minimizing the disturbance to surrounding vegetation and soils and the potential for erosion, such as
   » limbing-up the tree before the tree is felled to avoid damage to adjacent trees
   » using a pulley system or a crane to lift the tree from a steep slope, in sections or in its entirety, to a truck or staging area
   » netting the tree prior to transport to reduce the potential for slash and/or soil disturbance
   » special treatment of trees suspected of having a forest disease, such as California oak mortality syndrome, which will be felled and left in place, with no woody debris from such trees transported from the site
4. Flush cut stumps near ground level (no more than 6 inches above the ground surface). For trees, such as eucalyptus, that sprout from cut stumps, the cut stumps will either be stump-ground in place and/or immediately painted with an appropriate herbicide to prevent resprouts.

5. Collect and remove debris and restore the site. Unless the tree is diseased, all woody debris (slash, duff, wood chips) will be collected and removed from the site (unless otherwise directed by MCOSD staff), and the areas surrounding the removal site will be raked clean to the soil surface. If tree removal is conducted in an area with significant native species populations, existing natives will be protected prior to and during removal.
6. Reuse or dispose of green waste. Woody debris will be removed from the site to a nearby staging area or other site determined by MCOSD staff, or disposed of off-site. If off-site disposal is required, woody debris will be transported and disposed of at an approved disposal facility in accordance with MCOSD procedures and state and federal laws. Staff may elect to reuse some or all woody debris materials in future trail building and restoration activities, in which case it will be separated from the rest of the debris and stored on-site at an approved staging area. In some instances, and at the direction of MCOSD staff, the arborist may be required to chip, cut, or separate woody debris into piles of various sized debris.
7. Install erosion control material, such as certified seed-free straw, straw wattles, or other acceptable material that will decompose naturally over time and not introduce invasive plants into the preserves.
8. Monitor the site at least annually for five years and treat any secondary invasive plants that begin to establish in the treatment area.

Small Trees and Woody Shrubs

Small invasive trees and woody shrubs can be difficult to control because of their large distribution and density. The following invasive small tree and shrub species are considered problems on MCOSD preserves because they displace native species and can form a dense understory beneath forest canopies, resulting in increased fire risk and fuel load. In addition, these small trees and shrubs can spread into native forests, scrub, and grassland vegetation types, where once established they are even more difficult to eradicate.

Invasive small trees and shrubs known to be problematic on MOCSD preserves include

- cotoneaster (*Cotoneaster* spp.)
- French broom (*Genista monspessulana*)
- Scotch broom (*Cystisus scoparius*)
- Spanish broom (*Spartium junceum*)
- pride of Madeira (*Echium candicans*)

The most important principle for controlling small trees and shrubs is to prevent establishment


French broom creating ladder fuels as it invades a madrone-oak-bay forest

or expansion of the infestations, since the persistent seed bank means that infestations must be managed for many years. Seeds are easily transported on equipment, and populations can rapidly invade after soil disturbance, so preventing disturbance where shrubs are present, or removing shrubs before and after disturbance, can mitigate the need for expensive and ongoing treatment. For shrubs prone to resprouting after cutting, it is important to use techniques that kill the plant and do not allow resprouting plants to recover.

All of these species are perennials that reproduce primarily by seed; however, some also spread vegetatively by underground roots or canes (e.g., cotoneaster). Many of these species can also sprout from underground roots or stumps (stump-sprouting) after being cut (e.g., Scotch broom, Spanish broom, French broom, cotoneaster). Consequently, follow-up treatments are essential for successful control.

1. Qualifications to conduct work: Staff will conduct work, or will contract work through trained professionals under MCOSD supervision, or use a licensed and bonded professional landscaping or biological consulting firm with experience working in wildland settings.
2. Timing of removal to protect nesting birds: Small trees and shrubs will be removed outside of bird nesting season wherever possible.
3. Removal of vegetation: Small trees and shrubs will be removed and or trimmed in a manner that does not substantively disturb the surrounding soil surface and minimizes the potential for erosion.
4. Selection of treatment methods: Prior to the start of work, staff will select methods to be employed during small tree and shrub removal. Refer to table 4.6 for treatment options.
5. Flush cutting stumps: The remaining stumps will be flush cut to near ground level (no more than 6 inches above the ground surface). Cut stumps may be immediately painted with an appropriate herbicide to prevent resprouts.
6. Site clean-up/restoration: All woody debris (slash, duff, wood chips) will be collected and removed from the site (unless otherwise directed by MCOSD staff), and the areas surrounding the removal site will be raked clean to the soil surface. If vegetation removal is conducted in an area with significant native species populations, existing natives will be protected prior and during removal.

7. Treatment of green waste: Woody debris will be removed from the site to a nearby staging area, or to a site determined by MCOSD staff, or disposed of off site. If off-site disposal is required, woody debris must be transported and disposed of at an approved disposal facility in accordance with MCOSD procedures and state and federal laws. Staff may elect to chip, cut, or separate woody debris into various sized debris piles. If required, this material will be separated from the rest of the woody debris, and stored on site at an approved staging area.
8. Erosion control: Erosion control will be installed as necessary to prevent future soil erosion. Erosion control will follow best management practices, including use of certified seed-free rice straw, straw wattles, or other acceptable erosion control materials that will decompose naturally over time and that will not introduce invasive plants into the preserves.
9. Follow-up treatments for resprouts, seedlings: A series of well-timed follow-up control treatments are critical to controlling resprouting shrubs. Refer to table 4.6 for treatment options. Retreatments should be less intensive over time as the seed bank is exhausted, eventually resulting in either sustained control or full eradication of the species from the treatment area. Staff and volunteers have found the following follow-up treatment regime to be effective in treating resprouts and seedlings:
    - Conduct spot inspection of the treatment area and biomass control area two to three times during the first year following initial treatment.
    - Spot check these areas at least two times per year in years two to five.
    - Assuming these efforts are successful, reduce frequency of spot checking to once a year, until no more seedlings are detected, up to 30 years.
    - Treat any seedlings and resprouts by hand pulling or cutting and immediately painting with herbicide. New plants should not be allowed to flower or set seeds. If flowers or seed ponds are observed, increase frequency of follow-up treatments.
    - Consider using grazing during the maintenance phase to control regrowth. Grazing should be confined to larger areas where dense stands of shrubs have been removed.
10. Treatment of secondary invasive plants: Following initial removal, invasive plant control will focus on preventing secondary infestations between the end of removal and the start of any planned restoration of the site. If necessary, a containment line will be developed around treatment sites, and the site will be periodically monitored for invasive plants.

Vines and Cane-Producing Shrubs

Vines and cane producing shrubs, such as Himalayan blackberry, reproduce both vegetatively, through canes or runners, and sexually by seed. Several ivy species are present on MCOSD preserves, but only cape ivy (*Delairea odorata*) is considered problematic. In addition, Himalayan blackberry (*Rubus armeniacus*) is considered a target invasive, cane-producing plants.

1. Qualifications to conduct work. Staff will conduct work, or will contract work through trained professionals under MCOSD supervision, or use a licensed and bonded professional landscaping or biological consulting firm with experience working in wildland settings. Volunteers should not attempt blackberry removal.
2. Timing of removal to protect nesting birds. Vines and cane-producing shrubs will be removed outside of bird nesting season wherever possible.
3. Selection of control methods. Prior to the start of work, staff will select methods to be employed during vine and cane removal. Successful removal methods can include cutting back canes and digging out roots, brushcutting, and cutting and treating with herbicides. Refer to table 4.6 for treatment options.

Thistles

Thistles are plants in the sunflower family. Invasive thistles that are known to be problematic on MOCSD preserves include

- yellow starthistle (*Centaurea solstitialis*)
- purple starthistle (*Centaurea calcitrapa*)
- wooly distaff thistle (*Carthamus lanatus*)
- stinkwort (Dittrichia graveolens)

Thistles generally grow in a basal rosette of leaves for one or more years, then bolt (i.e., produce a vertical stalk with flowers and a seed head), then die after flowering. Thistles tend to rapidly colonize disturbed areas and are capable of infesting undisturbed sites once established in a disturbed area nearby. The most important principle in treating thistles is to avoid creating soil disturbance. Other land managers observed that their largest and fastest growing thistle infestations are associated with fuelbreaks, fire roads, and trails that are scraped, disked, or otherwise disturbed (refer to findings in chapter 3). Preventing disturbance where thistles are present, or removing thistles before and after disturbance, can mitigate the need for expensive and ongoing controls and can prevent the creation of thistle seed sources with can harm adjacent vegetation types and properties.

1. Qualifications to conduct work: Staff will conduct work, or will contract work through trained professionals under MCOSD supervision, or use a licensed and bonded professional landscaping or biological consulting firm with experience working in wildland settings. Volunteers can undertake small-scale thistle removal.
2. Timing of removal to protect nesting birds: Thistles will be removed outside of bird nesting season wherever possible.
3. Selection of control methods: Prior to the start of work, staff will select methods to be employed during thistle removal. Refer to table 4.7 for treatment options.

Invasive Perennial Grasses

Invasive perennial grasses are grasses that live for many years, infesting surrounding areas by reproducing via seeds or vegetative growth (rhizomes). Invasive perennial grasses that are problematic in the greater Bay Area include grasses in the genera *Aegilops, Ehrharta*, *Festuca, Holcus, Cortaderia*, and *Phalaris*. Invasive perennial grasses have expanded rapidly in Marin over the past decade, and several species now threaten some of the MCOSD's most vulnerable ecosystems.

Target perennial grasses that are problematic on MCOSD preserves include

- barbed goatgrass (*Aegilops triuncialis*)
- jubata grass/pampas grass (*Cortaderia jubata*, sometimes *C. selloana*)
- erect veldtgrass (*Ehrharta erecta*)
- harding grass (*Phalaris aquatica*)
- medusahead (*Taeniatherum caput-medusae*)
- cordgrass (*Spartina alterniflora*)

An important principle for successfully treating perennial grasses is that treatments must kill the seed heads as well as the shoots and meristems that are clustered just above or below the soil surface and which can reproduce vegetatively. To ensure control, sites must be revisited for follow-up treatment at regular intervals for the first two to four years. Although most perennial grasses do not have persistent seed banks, grass seedlings are so small that they can elude detection for several years. The undetected seedlings can then mature and set seed to reestablish infestations that were thought successfully controlled.

1. Qualifications to conduct work: Staff will conduct work, or will contract work through trained professionals under MCOSD supervision, or use a licensed and bonded professional landscaping or biological consulting firm with experience working in wildland settings. Volunteers can also undertake small-scale perennial grass removal.
2. Timing of removal to protect nesting birds: Perennial grasses will be removed outside of bird nesting season wherever possible.
3. Selection: Prior to the start of work, staff will select methods to be employed during perennial grass removal. Refer to table 4.7 for treatment options.

Other Invasive Species

Several invasive plants that are problematic on MCOSD preserves do not fit in the above broad treatment categories. These plants include

- thoroughwort (*Ageratina adenophora*)
- highway iceplant or Hottentot fig (*Carpobrotus edulis*)
- fennel (*Foeniculum vulgare*)
- perennial pepperweed or tall whitetop (*Lepidium latifolium*)
- puncture vine (*Tribulus terrestris*)

For all target invasive plants that do not fall into a broad treatment category, MCOSD staff will contact California Invasive Plant Council (CalIPC), other land management agencies, and the Agricultural Commissioner’s Office to determine an appropriate course of treatment, based on population size and density, location, proximity to sensitive biological resources and human populations, and efficacy of available treatments. Refer to table 4.7 for recommended treatment options. In most cases, more than one treatment type will be required to fully eradicate or control the species.

Table 4.7 Recommended Treatment Options for Target Invasive Plants

Scientific Name (Common Name)	Recommended Treatments Options for Target Invasive Plants
Invasive Trees	
Acacia spp. (acacia, black wattle, blackwood acacia)	**Hand and Machine Control Methods** • Pulling seedlings or saplings by hand or with weed wrench. Must remove entire plant, especially roots. Effective on small plants (typically less than 1" in diameter) but not feasible for mature plants. **Chemical Control Methods** • Cut-stump application of Aquamaster or Garlon 3A.
Eucalyptus globulus (Tasmanian blue gum)	**Hand and Machine Control Methods** • Pulling seedlings or saplings by hand or with weed wrench. Must remove entire sapling. Effective on small saplings (typically less than 1" in diameter) but not feasible for mature plants. • Cut trees and use stump grinder to grind cut stump to a depth of 1.5 – 3 feet below soil surface. **Chemical Control Methods** • Cut-stump application of Aquamaster or Garlon 3A. • Low-volume application of Garlon 3A applied via hack-and-squirt. • Low-volume application of Garlon 4 applied via thinline, or basal bark.
Pinus radiata [6] (Monterey pine) *Cupressus macrocarpa* [7] (Monterey cypress)	**Hand and Machine Control Methods** • Flush cut trees to ground level.
Invasive Small Trees And Shrubs	
Cotoneaster sp. (cotoneaster) *Cytisus scoparius* (Scotch broom) *Genista monspessulana* (French broom) *Spartium junceum* (Spanish broom)	**Hand and Machine Control Methods** • Seedlings or very small saplings can be effectively removed by hand pulling or with weed wrench. • Pulling individual mature plants by hand or with weed wrench. [8] **Chemical Control Methods** • Cut-stump treatment with Garlon 3A. • Basal bark and cut-stump applications of Habitat or Stalker. • Low-volume basal application of Garlon 4 via thinline treatment or low-volume basal bark application. • Foliar application of Roundup Pro or Aquamaster (for seedling flushes and follow-up treatments), or cut-stump application (for mature plants, small infestations, and follow-up treatments). **Other Treatment Methods** • Machine removal using large machinery (excavator) with various attachments (masticator, combo-bucket, roto-excavator or brush-hog)[9] to cut and pull mature vegetation, followed by a) repeated hand pulling for small areas, or b) spot-application of herbicides, (usually Roundup) • Fall cutting, followed by propane flaming or controlled burning in spring when seedlings are very small. • Propane flaming (most effective on carpets of seedlings, ineffective on small seedling flushes and larger plants). Treatment must be conducted during the rainy season to reduce risk of wildfires. Treatment must be exceedingly thorough to ensure efficacy.
Echium candicans (Pride of Madeira)	**Hand and Machine Control Methods** • Individual adult plants are effectively removed by cutting or breaking branches and then digging root ball with shovel or Pulaski. Green waste must be disposed of properly since cut plants are capable of continued seed production. **Chemical Control Methods** • Foliar application of Roundup Pro is reportedly effective in controlling adults. • Cut-stump treatment may be effective, but more research is needed.

[6] While these trees are not listed as priority invasive species in this document, the MCOSD is likely to need to treat them occasionally; therefore, treatment options were included in this table.
[7] While these trees are not listed as priority invasive species in this document, the MCOSD is likely to need to treat them occasionally; therefore, treatment options were included in this table.
[8] Method is feasible only for small or sparse infestations, typically less than ½ acre due to cost.

Table 4.7 Recommended Treatment Options for Target Invasive Plants

Scientific Name (Common Name)	Recommended Treatments Options for Target Invasive Plants
Vines And Cane-Producing Shrubs	
Delairea odorata (Cape ivy, German ivy)	**Hand and Machine Control Methods** • Manual removal requires clearing away native and invasive plant material to gain visual and physical access to locations with Cape ivy stems emerging from the ground. Roots and stems must be teased out of the ground using a pointed tool to loosen the soil. Removed Cape ivy should be piled under firmly secured plastic tarps to eliminate all light and facilitate decomposition of material. Frequent follow up with manual or chemical methods is critical. **Chemical Control Methods**[10] • Foliar application of Roundup Pro or Aquamaster post-flowering reportedly results in high mortality for uncut Delairea. Mortality is lowered by pre-treatment cutting of Delairea vines. • Foliar application of Milestone + Aquamaster mix is reportedly highly effective at controlling species in riparian systems. **Other Treatment Methods** • Use of water high-pressure washer (hydro-mechanical obliteration)[11] reduces biomass of Cape ivy but has limited application, with greatest efficacy in riparian areas.
Rubus armeniacus (Himalayan blackberry)	**Hand and Machine Control Methods** • Plants can be effectively removed by cutting stem with loppers, brush cutters, or McLeods and then digging out root balls. Effectiveness of this manual approach depends on removing woody root fragments. Effective for small infestations. **Chemical Control Methods**[12] • Low concentration foliar, low-volume foliar, or cut-stump application of Roundup Pro or Aquamaster. • Low concentration foliar, low-volume foliar, or cut-stump application of Garlon 3A.
Thistles	
Carthamus lanatus (woolly distaff thistle) *Centaurea calcitrapa* (purple starthistle) *Centaurea solstitialis* (yellow starthistle)	**Hand and Machine Control Methods** • Small or sparse infestations may be effectively managed by hand pulling or chopping the entire plant after bolting but before flowering. The most effective chopping method involves severing the root 4-6 inches below ground with the blade of a shovel or hoe then pulling the severed plant out of the ground without disturbing the soil. • With manual, mechanical, or cultural techniques, plants should be removed before 1% of flowers have opened. All stalks with flowers should be bagged and removed from site, as flowers can develop into seed after being cut. • For yellow starthistle, mowing is best when conducted at a stage where 2 to 5 percent of the seed heads are flowering. **Chemical Control Methods** • Foliar application of Roundup Pro before flowering of adult plants. • Foliar application of Transline or Milestone on adult plants before bolting.
Perennial Grasses	
Aegilops triuncialis (barbed goatgrass)	**Hand and Machine Control Methods** • Hand pulling is reportedly effective for eliminating small or sparse infestations, but has limited applications (expensive, time- and labor-intensive). • Mowing using string trimmers can be effective. However, timing is critical. Mowing should occur after flowering, but before goatgrass seeds reach the soft boot stage. Early mowing will result in new tiller growth and late mowing will only spread viable seed. • Recommend MCOSD natural resource staff work with work crews to make sure treatment timing is optimal. **Chemical Control Methods** • Foliar application of Envoy in spring after germination and before seed heads emerge. • Foliar application of Fusilade in spring after germination and before seed heads emerge (less successful than use of Envoy). Site-specific conditions may be responsible for variable outcome. • Foliar application of Roundup Pro effective in spring after tillering but before flowering.

[9] Limited application: This is an expensive treatment, disturbs soils, and is limited to sites with access (i.e., near roads).
[10] Herbicide effects on non-target plants may be minimized by making treatments during winter when many other plant species are physiologically dormant.
[11] This treatment is relatively costly and is limited by access.
[12] Cutting canes to remove fruiting stems before applying herbicide is reportedly effective at preventing public consumption of contaminated berries.

Table 4.7 Recommended Treatment Options for Target Invasive Plants

Scientific Name (Common Name)	Recommended Treatments Options for Target Invasive Plants
	Other Treatment Methods • Two consecutive late spring prescribed burns[13] can significantly reduce abundance of barbed goatgrass. • Early summer burn but only before grass joints disarticulate to ensure seed kill has resulted in some success.
Cortaderia jubata (jubata grass) *Cortaderia selloana* (pampas grass)	**Hand and Machine Control Methods** • Hand tools (shovels, Pulaskis) can be used to cut up large plants and split, dig, and remove root ball. This is very labor intensive and results in soil disturbance. All root fragments must be removed to be effective as this plant can sprout from tiny root fragments left in soil. **Chemical Control Methods** • Cut-stump application of Roundup Pro is effective, but pre-treatment cutting is labor intensive; however, cutting excess biomass significantly reduces the amount of herbicides necessary for control. Consider cutting, allowing regrowth to four feet, and then applying herbicides to fresh growth to promote translocation of herbicide from actively growing tissue to root system (increases success of treatment). • Foliar application of Habitat, Aquamaster or Roundup Pro, Fusilade, or Poast is effective at controlling adult plants. • Rope wick application of Aquamaster or Roundup Pro is effective at controlling adult plants.
Ehrharta erecta (erect veldtgrass)	**Hand and Machine Control Methods** • Hand pulling every 3 months for two years is effective at eliminating small or sparse populations. Germination[14] is stimulated by soil disturbance so follow-up removal is critical. **Chemical Control Methods** • Low- concentration foliar application of Roundup Pro or Aquamaster is effective at controlling adult plants and can be used to eliminate dense populations but will require frequent follow-up treatments. • Foliar application of Fusilade is reportedly effective at controlling adult plants. **Other Treatment Methods** • Covering with black landscape fabric is reported to be an effective control method for small infestations over the short term. Tarping is thought to kill seedlings and adults but does not eliminate seed bank (buried seeds). Follow-up spot treatment will be required when tarps are removed. • Mulching with 4" deep sterile rice straw is reportedly effective at eliminating small infestations. Mulching may not eliminate seed bank (buried seeds). Follow-up spot treatment will be required when mulch breaks down.
Phalaris aquatica (harding Grass)	**Hand and Machine Control Methods** • Removing individual adult plants by digging root ball with shovel or Pulaski is reported moderately effective. Small plants may be removed with hand pick or hoe. Soil disturbance may promote germination of seeds so requires follow-up treatment. **Chemical Control Methods** • Foliar application of Roundup Pro, Aquamaster, or Fusilade in late spring/early summer. **Other Treatment Methods** • Use of water high-pressure washer (hydro-mechanical obliteration)[15] reduces biomass but has limited application, with greatest efficacy in riparian areas.
Spartina alterniflora (cordgrass)	**Hand and Machine Control Methods** • Individual plants or small infestations can be eliminated by digging with shovel to remove plants and root ball. **Chemical Control Methods** • Foliar application of Aquamaster is reportedly effective at controlling plants and eliminating infestations. However, this treatment is constrained by seasonality, timing of tides (e.g., low or receding low tides in the morning), and presence of mud on plant leaves. • Foliar application of Habitat to actively growing shoots in mid-July is reportedly an effective treatment for controlling plants and eliminating infestations. This treatment is more effective than Aquamaster.

[13] Burning will not effectively control seeds on the soil surface. Dormancy studies of jointed goatgrass indicate seed may be viable in the soil for up to five years. Goatgrass germination may also increase the year after burning due to increased fertility and light penetration. Therefore, a second year management strategy must be incorporated, and the population should be monitored for several years. It is critical that sufficient fuel is available to carry a fire; burning must be timed to occur after other grasses have matured and can carry a fire, but must occur before goatgrass seed has matured and fallen to the ground. Burning is reportedly not effective at sites with low fuel load (such as serpentine soils).

[14] Ehrharta has a short-lived seed bank but a very high reproduction rate and short generation time, so short return interval removal in a manageable area is key to eliminating infestations.

[15] This treatment is relatively costly and is limited by access.

Table 4.7 Recommended Treatment Options for Target Invasive Plants

Scientific Name (Common Name)	Recommended Treatments Options for Target Invasive Plants
Taeniatherum caput-medusae (Medusa-head)	**Hand and Machine Control Methods** • Mowing alone, or in combination with grazing, was found to be effective in reducing infestations. **Chemical Control Method**s • Small infestations can be controlled by foliar application of glyphosate products or imazapyr in fall and/or spring. **Other Treatment Methods** • Intensive grazing has been shown to reduce small populations, however the timing window is narrow and the stocking rates are high.
Other Invasive Species	
Ageratina adenophora (croftonweed, thoroughwort, eupatorium)	**Hand and Machine Control Methods** • Hand pull seedlings[16] where they occur at low density (i.e., during later stages of eradication effort). **Chemical Control Methods** • Foliar application of Roundup Pro, Aquamaster or Garlon 3A can control seedlings. • Foliar application of Garlon 3A can control mature plants after fruits turn brown. • Low-volume foliar application of Aquamaster or Roundup Pro can control mature plants after fruits turn brown.
Carpobrotus edulis (highway iceplant, Hottentot fig)	**Hand and Machine Control Methods** • Individual plants or small patches can be removed by hand pulling. • "Carpet roll" extensive patches by manually severing roots, cutting iceplant carpet into segments, rolling segments and removing biomass. In many cases, biomass must be removed to prevent secondary invasions. Biomass may be piled and composted, but is very heavy and can be extremely labor-intensive. **Chemical Control Methods** • Foliar application of Aquamaster or Roundup Pro is very effective at eliminating highway iceplant where biomass can be left in place.
Dittrichia graveolens[17] (stinkwort)	**Hand and Machine Control Methods** • Hand pulling can effectively remove individual plants but is not effective for eliminating large infestations. Oils from this plant are toxic and may cause headaches and itchiness, so care should be employed when handling. **Chemical Control Methods** • Effective control of adults is reported using foliar application of Aquamaster or Roundup Pro. Herbicide must be applied during early summer AND late summer, to completely control late-bolting plants.
Foeniculum vulgare (fennel)	**Hand and Machine Control Methods** • Effective elimination of small or sparse infestations can be accomplished by removing plants (including 3-6 inches of crown and root) using shovels, Pulaskis, and other tools. **Chemical Control Methods** • Foliar application of Roundup Pro or Aquamaster, Garlon 3A, or Garlon 4 is reportedly effective.
Lepidium latifolium (perennial pepperweed, tall whitetop)	**Hand and Machine Control Methods**[18] • Effective elimination of small (less than approximately 25 plants) or sparse infestations can be accomplished by removing plants (including 3-6 inches of crown and root) using shovels, Pulaskis, and other tools. **Chemical Control Methods**[19] • Foliar or wick application of Aquamaster is reported moderately effective at removing adult plants and may be able to eliminate infestations when applied repeatedly. • Foliar or wick application of Habitat is effective at removing adult plants and may be able to eliminate infestations when applied repeatedly.

[16] For eradication efforts, some clearing of vegetation (mowing grasses and shrubs to near ground level) facilitates locating and treating small plants.
[17] Additional research is required to identify effective techniques for eliminating populations: existing techniques are effective at removing individual plants.
[18] Hand pulling of isolated plants can reduce abundance by 50% in subsequent years, but infestations rapidly recover.
[19] Additional research is required to identify effective techniques: existing techniques are not sufficient to eliminate infestations. Effectiveness of herbicides is reportedly increased by mowing or cutting plants, allowing plants to resprout, and then applying herbicide to resprout stems.

Table 4.7 Recommended Treatment Options for Target Invasive Plants

Scientific Name (Common Name)	Recommended Treatments Options for Target Invasive Plants
Tribulus terrestris (puncture vine)	**Hand and Machine Control Methods** • Small infestations can be eliminated by hand pulling plants and sweeping, raking, or otherwise collecting all seeds. **Chemical Control Methods** • Foliar application of Roundup Pro is reportedly effective at removing plants and eliminating infestations. **Other Treatment Methods** • Biological control agents are available that can effectively control puncture vine populations, and these can be obtained from county agricultural commissioner offices. • Puncture vine is reportedly easily displaced by other plants, and so promoting competition by other plants is reportedly effective at preventing reestablishment once puncture vine plants have been removed.
NOTES: This table summarizes current successful invasive plant management treatments for managing the invasive plants that pose the greatest threat to MCOSD preserves at this time. Invasive plant management treatments selected are those already in use by leading agencies across the Bay Area that were identified via interviews and literature review as described in chapter 3. This table does not include treatments that have been deemed ineffective or less effective by these agencies. This table presents an overview of current practices and does not evaluate the relative efficacy of the various treatments. Selection of a particular treatment MUST be conducted on a case-by-case basis by MOCSD staff using IPM procedures	

Develop and Maintain a Treatment Schedule

Currently, the majority of MCOSD's invasive plant treatment work is conducted as a part of maintenance. Some additional invasive plant work is conducted as a component of specific natural resources projects, and some invasive plant treatments are conducted through the volunteer program.

Successful invasive plant treatment is usually dependent on conducting follow-up treatments on a schedule that does not allow the target plant to resprout, flower, or produce seeds, or for seedlings to establish in the treatment area. Therefore, maintaining a treatment calendar for each project, as well as for all invasive plant projects collectively, is important to the success of invasive plant control efforts.

MCOSD will establish a GIS dataset for all invasive plant treatment sites (see chapter 6). Using the database, MCOSD staff will develop and maintain an annual invasive plant treatment schedule. This annual treatment schedule will help ensure that follow-up treatments of invasive plant infestations are integrated with other vegetation management work into annual workloads.

A suggested treatment calendar for priority invasive plants is provided in table 4.8, below.

Monitor Plant Control Projects

The effectiveness of invasive plant control projects will be monitored to determine if performance measures have been met, and if not, the treatment will be adapted until the performance measures are met. Monitoring as it relates to vegetation management in general is discussed extensively in chapter 6.

In many cases, volunteers may be used to assist with the site monitoring. MCOSD staff will meet with the volunteer coordinator to determine if and how volunteers can be included in the work.

Table 4.8 Treatment Calendar for Priority Invasive Plants

Target	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Comments
Invasive Trees													
Acacia decurrens (black wattle), *Acacia melanoxylon* (blackwood acacia), other *Acacia* spp. (acacia), *Eucalyptus globulus* (Tasmanian blue gum)													
• Hand pull	1	1	1	2	2	2	2	2	2	2	2	1	1= easiest when soil is moist 2= effective at other times (if root removal possible)
• Cut stump	2							1	1	1	2	2	1= after bird nesting season, before rainy season 2= herbicide may be difficult due to rain
• Basal bark, hack and squirt	2							1	1	1	2	2	1= after bird nesting season, before rainy season 2= herbicide may be difficult due to rain
Invasive Small Trees And Shrubs													
Cotoneaster spp. (cotoneaster)													
• Hand pull	1	1	1	2	2	2	2	2	2	2	2	1	1= easiest when soil is moist 2= effective at other times (if root removal possible)
• Backhoe/excavator									1	1	1	1	1= most effective in fall and winter; not sure if effective at other times
• Foliar									1	1	1	1	1= most effective in fall and winter; not sure if effective at other times
• Cut stump									1	1	1	1	1= most effective in fall and winter; not sure if effective at other times
• Basal bark, thinline									1	1	1	1	1= most effective in fall and winter; not sure if effective at other times
Genista monspessulana (French broom), *Cytisus scoparius* (Scotch broom), *Spartium junceum* (Spanish broom)													
• Hand pull	2	2	1	1	3	3	3	4	4	4	2	2	1= best time 2= pulling is easier, but many seedlings have either not yet germinated or are large enough so that they can be easily pulled 3= risk of seed dispersal 4= seeds dispersed, effective if soil is not too dry and compacted
• Propane flame	2	1	1	3								2	1= best time 2= effective, but not all seedlings have germinated 3= effective if still small, but entering dry period
• Foliar spray			2	2	1	1	3	3					1= most effective after flowering and before seed dispersal 2= may be still flowering 3 = seeds may be dispersed
• Cut stump, basal bark, thin line	4	4	2	2	1	1	3	3	4	4	4	4	1= most effective after flowering and before seeds disperse 2= may still be flowering 3= seeds may have dispersed 4= not ideal, but often effective
• Machine remove								1	1	1			1= most effective in fall
Echium candicans (Pride of Madeira)													

Table 4.8 Treatment Calendar for Priority Invasive Plants

Target	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Comments
• Hand dig	3	1	1	1	1	2	2	2	3	3	3	3	1= best prior to flowering, most likely effective after bolting, before flower production 2= can be pulled anytime but risk seed dispersal 3= can be pulled but seeds likely to disperse
• Foliar spray			1	1	1								1=most likely effective after bolting, before flower production
Vines And Cane-Producing Shrubs													
Delairea odorata (Cape ivy, German ivy)													
• Manually remove	1	1	2	2	2	2	2	2	2	2	2	1	1= best time due to dormancy of many species (e.g., willows, poison oak, thimbleberry, etc.) which improves worker safety, increases target visibility, and reduces biomass needing to be tarped 2= manual control is effective anytime
• Foliar spray	2	2	1	1	1	1						2	1= best time during period of rapid growth after flowering, 2= best time to avoid non-target impacts due to dormancy of many species (e.g., willows, poison oak, thimbleberry, etc)
Rubus armeniacus (Himalayan blackberry)													
• Hand dig									1	1	1	1	Most likely easiest when soils are moist
• Brushcut or trim					1	1	1	1					1 = best time is after flowering but before fruiting
• Foliar spray					1	1	1	1					1= reported to be more effective in summer than winter
• Cut stump					1	1	1	1					1 = similar to foliar
Thistles													
Centaurea calcitrapa (purple starthistle), *Carthamus lanatus* (woolly distaff thistle), *Centaurea solstitialis* (yellow starthistle)													
• Hand pull or chop	1	1	1	1	1	2	2	2	2				1= best before 1% of flowers have opened 2= likely that > 1% of flowers have opened, all cut inflorescences should be removed from site
• Mow				1	1	1							1= most effective when 2-5% of flowers have opened
• Foliar spray Roundup					1	1							1= most effective after bolting, before flowering
• Foliar spray Transline or Milestone	1	1	1	1								1	1= most effective before bolting
Perennial Grasses													
Aegilops triuncialis (barbed goatgrass)													
• Hand pull			1	1	1	1	1						most effective before seeding
• Mow					1	1	1						1= most effective after flowering, before seeding
• Prescribed burn				1	1	1							1= most effective in late spring or early summer before joints disarticulate

Table 4.8. Treatment Calendar for Priority Invasive Plants

Target	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Comments
• Foliar spray			1	1	1								1= most effective in spring before flowering
Cortaderia jubata (jubata grass)													
• Hand dig	2	2	2	2	2	2	1	1	1	3	3	3	1= easiest to find when flowering, best to remove before seed dispersal 2= effective, but harder to find isolated plants without plumes 3= effective, but past seed dispersal
• Foliar spray							1	1	1	2	2		1= most effective in fall, but treat in late summer to limit seed dispersal, easiest to find when flowering 2= most effective, but seeds likely dispersed
• Cut stump							1	1	1	2	2		2=similar to foliar timing
Ehrharta erecta (erect veldtgrass)													
• Hand pull	1	1	1	1	1	1	1	1	1	1	1	1	1= effective year round, remove every three months
• Mulch	1	1	1	1	1	1	1	1	2	2	2	1	likely effective year round
• Foliar spray	1	1	1	1	1	1	1	1	2	2	2	1	1= effective anytime grass is green and growing 2= effective if grass is still green
Phalaris aquatica (harding grass)													
• Hand pull				1	1				1	1		1	1-likely most effective when soils are moist and removal likely not to be effective unless all the topsoil is also removed to get all the root fragments
• Foliar spray				2	1	1			3	3			1= easiest to find when in flower, best before seed set and when leaves are still green 2= effective in late spring, early summer, but harder to find prior to flowering 3= success also reported in late fall, but plants must not be water stressed and often are at this time
Spartina alterniflora (cordgrass)													
• Hand dig				1	1	1	1	1	1				assume easiest during growing season Apr. through Sept. Dies back in Oct.
• Foliar spray				1	1	1	1	1	1				more research necessary-conflicting research information 1= most effective in late spring/early summer per Bossard. However, the Spartina Project webpage shows control occurring June through September
Other Invasive Plants													
Ageratina adenophora (Crofton weed, thoroughwort, eupatorium)													
• Hand pull		1	1	1	1				1	1			1= most effective in spring and early fall, plants are easiest to find when in bud or bloom. Plant has been documented blooming 2-3 times per year

Table 4.8. Treatment Calendar for Priority Invasive Plants

Target	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Comments
• Foliar spray			1	1		2	2	1	1	1	2		most effective when treated 2x per year, once in spring, once in fall 1= spring treatment while flowers are still in bud 2=fall treatment after seed heads have turned brown
Carpobrotus edulis (highway iceplant, Hottentot fig)													
• Hand pull	1	1	1	1	1	1	1	1	1	1	1	1	1= effective any time
• Foliar spray	1	1	2	2	2	2	2	2	2	2	2	1	1= winter removal can help avoid impacts to dormant natives 2= no information but treatment likely effective anytime
Foeniculum vulgare (fennel)													
• Hand dig	1	1	1	1	2	2	2	2	2	3	3	3	1= effective, but plants harder to find 2= plants easy to find when in flower, best before seed dispersal; plants easy to find in fruit, risk of seed dispersal 3= control effective year round but seeds dispersed or harder to find
• Foliar spray			1	1	1	1							1= control reported effective but plants must have sufficient foliage
Lepidium latifolium (perennial pepperweed, tall whitetop)													
• Hand pull				1	1	1							assume best before seed production
• Foliar spray				1	1	1							1= most effective at the flower bud stage and worst at the rosette or early bolting stage. If herbicide cannot be applied at the flower bud stage, mow plants and apply the herbicide to regrowth.
Tribulus terrestris (puncture vine)													
• Hand pull			1	1	1	1	1	1					1= most effective before seeding
• Foliar spray			1	1	1	1	1	1					1= most effective before seeding
Dittrichia graveolens (stinkwort)													
• Hand pull						1	1	1	1				1 =assume most likely prior to flowering in fall
• Foliar spray						1	1	1	1				1= treat in earl y and late summer

Fire Risk Management and Fire Hazard Reduction Strategies

This *Vegetation and Biodiversity Management Plan* addresses all types of vegetation management on MCOSD lands; the management of vegetation in fuel modification zones is one aspect of the overall program. (See chapter 3 for a description of the main types of fuel modification zones, including illustrations in figures 3.1 to 3.6.)

Place a High Priority on Fuel Reduction in Defensible Space Zones

The survey of current practices and scientific literature related to fuel modification zones, conducted in support of this *Vegetation and Biodiversity Management Plan* and contained in chapter 3, finds that the establishment of defensible space zones along the wildland-urban interface is the most effective approach to reducing fire risk and to protecting structures and adjacent communities, as opposed to the construction of primary or secondary fuelbreaks. Given the most current information about the effectiveness of various fuel risk reduction practices, and the impacts associated with primary and secondary fuelbreaks (including invasive species infestations) in high-value resource areas, MCOSD is shifting its fuel reduction strategy away from classic fuel management (such as primary and secondary fuelbreaks in the wildland interior) and toward defensible space zones at the wildland-urban interface. Working with local residents, County Fire, and local fire agencies to establish and maintain effective defensible space zones is of particular interest to the MCOSD because so many of the preserves are surrounded on all or most sides by residential neighborhoods.

Under the current *Marin County Fire Code* all homeowners in wildland-urban interface areas are required to maintain a minimum of 100 feet of defensible space around structures to reduce the potential for fire to spread away from natural areas into built areas, or away from built areas into natural areas.This is referred to as a defensible space zone. In most cases, 100 feet of treated area between any structure(s) and hazardous fuels is considered sufficient to reduce the impacts from radiant heat or direct flame.

The first 30 feet of the defensible space zone is the area around a structure (front, back, and side yards) (see figure 4.8). That area should be free of all combustible construction and materials, planted with drought tolerant and fire resistant lawns and native plantings, usually less than 18 inches in height. However, this 30 foot area may contain occasional fire resistant trees and single well-spaced shrubs up to 48 inches in height, intermixed with ground cover and lawn. Shrubs and ground cover may be located as close as 5 feet from the structure, provided these plants will not carry fire to the structure. Plants in the first 30 feet should be fire resistant and should not include any pyrophytes that are high in oils and resins, such as pines, eucalyptus, cedar, cypress, or juniper species. Thick, succulent or leathery leaf species with

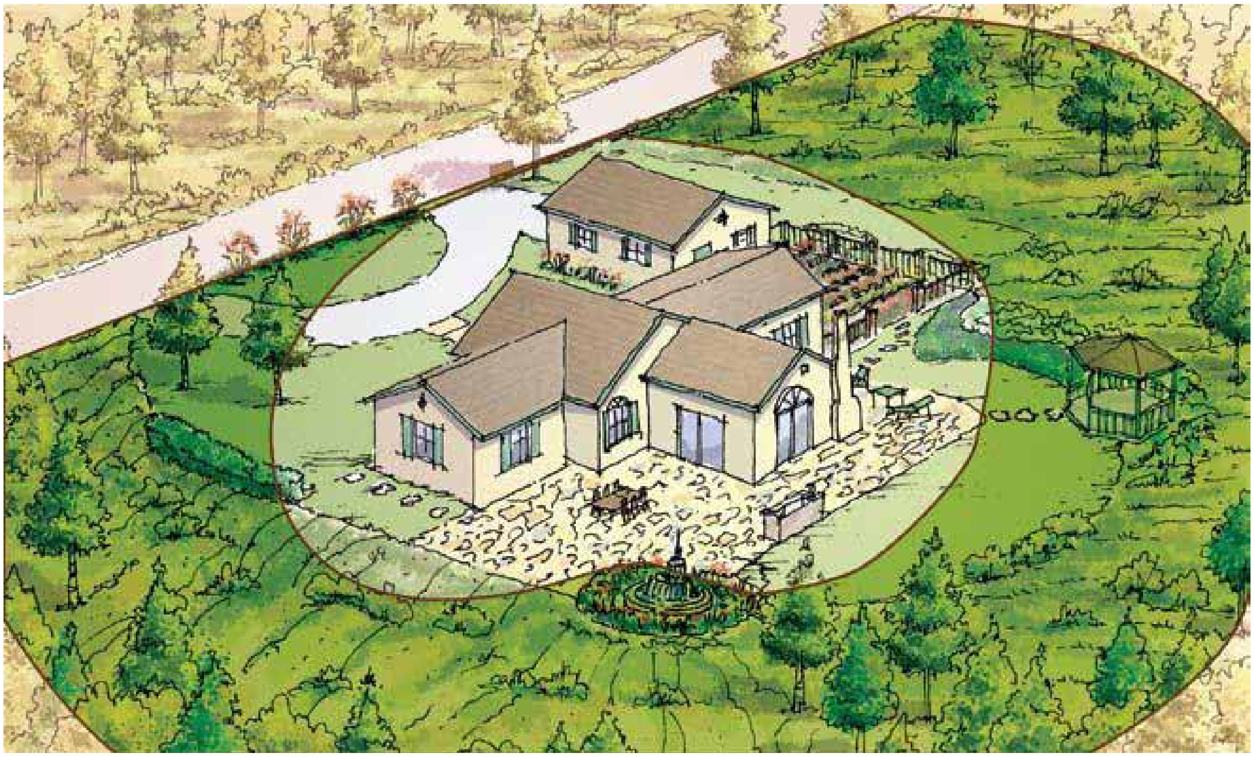


Figure 4.8 Parts of a Defensible Space Zone

The first 30 feet of a Defensible Space Zone is shown in light green, and the remaining 70 feet is shown in darker green.

high moisture content are the most fire resistant. Trees must be planted so that when they reach maturity, the tips of their branches are at least 10 feet away from any structure and 20 feet away from any other tree; a minimum of 6 feet of vertical separation must be maintained between the low-growing vegetation groundcover and the lower limbs of all trees. Nonflammable concrete patios, driveways, swimming pools, walkways, boulders, rock, and gravel can be used to break up fuel continuity within this area.

The remaining 70 feet of the defensible space zone is often referred to as the *thinning area*. In this area, the goal is to achieve and maintain an overall 50 percent reduction of the canopy cover spacing, a 50 percent reduction of the original fuel loading, and the 100 percent removal of all dead and dying plant material (see figure 4.9). Highly flammable native and invasive plants should be removed. The 70 feet of thinned area should contain low-growing (maximum 18 inches in height) and low- fuel-volume groundcover vegetation, or native grasses and occasional well- spaced (crowns separated by a minimum of 20 feet) fire-resistant trees. On steep slopes tree crown separation should be increased under direction of the local fire authority.

Figure 4.9 Thinning Area

Note brush piled in the foreground has been removed and will be chipped, burned or otherwise removed.

How Defensible Space Zones Relate to MCOSD Preserve Management

Most defensible space zones exist solely on private property, where compliance is the responsibility of the property owner. However, in many cases homes are immediately adjacent to MCOSD lands, and situated so close to a preserve boundary that the maintenance of a 100-foot defensible space zone surrounding such properties cannot be achieved without encroaching on MCOSD land. Where defensible space zones encroach onto the MCOSD preserves, MCOSD will coordinate with County Fire and local fire agencies and maintenance crews to determine an appropriate course of action. It will assist County Fire with contacting residents adjacent to MCOSD lands and advising them of their reponsibility to maintain their defensible space zones. Further, MCOSD will work with property owners that need to perform fuel reduction on MCOSD lands within their defensible space zones to determine treatments that will be protective of preserve values.

In the case of new construction on private property adjacent to MCOSD preserves, MCOSD is working collaboratively with Marin County fire agencies and the Community Development Agency on their review of Vegetation Management Plans required by ordinances adopted by several Marin County fire agencies (and implemented per Fire Protection Standard 220) where a portion of the required defensible space zone would be built on MCOSD lands.

Manage Defensible Space Zone Treatment Areas on MCOSD Lands

MCOSD staff, in cooperation with local fire agencies, will identify MCOSD lands within the required defensible space zones that pose a wildfire threat due to an accumulation of fuel. These areas will be documented in databases, on GIS layers, and/or on maps that will be made easily accessible to MCOSD staff and local fire agencies.

Treatments may include pruning trees and shrubs to remove dead branches that can act as a fuel ladder, and thinning heavy forest ground and understory vegetation. The following standards for fuel treatments for the thinning area (30 to 100 feet from a structure) should be achieved and maintained:

- Shrubs and trees will be free of dead material. Trees will be spaced so that their crown covers are at least 10 feet from any structure and at least 20 feet from each other. A separation of 6 feet will exist between the ground fuels (shrubs and groundcovers) and the lower limbs of all trees. All trees will be maintained to the current national standards for tree, shrub, and other woody plant maintenance (ANSI n.d.).

- Low-growing plants and groundcovers will be maintained to a height of 18 inches or less. Native annual and perennial grasses will be allowed to grow and produce seed during the winter and spring. As grasses begin to cure (dry out), they will be cut to 4 inches or less in height.

Initial treatment of these areas will be followed by annual maintenance to ensure that the standards are maintained over time.

MCOSD staff will seek to collaborate with County Fire and local fire agencies on inspections of the defensible space zones on and adjacent to MCOSD lands. Such inspections can assist in identifing changes in fuel loads; the relative effectiveness of previous treatment actions used to reduce fire hazards; the potential for a fire risk (i.e., potential to ignite); the dumping of trash; additions of new structures, such as patios with covers and outdoor barbecues/kitchens; changes in flammable species from fire resistant to easily ignitable; recent disease or insect outbreaks; and increased growth of highly flammable or invasive vegetation. If a problem is detected, MCOSD, County Fire, and local fire agency staff can then work with the property owner to resolve the issue.

Develop Partnership Programs to Encourage Compliance with Building and Fire Codes in Defensible Space Zones

Unless private property owners comply with building and fire codes to make structures and landscaping fire resistant, there is less benefit to establishing defensible space zones as a primary fuel modification strategy. To encourage compliance, MCOSD will work with County

Fire, local fire agencies, community organizations, homeowner associations, and individual property owners to encourage this compliance.

Use Ignition Prevention Zones to Manage Fire Risk Associated with Use by Agencies and the General Public

Identify High Fire Risk Areas for Management as Ignition Prevention Zones

MCOSD staff will identify those areas, adjacent to development, used by the general public, or occupied by agencies, such as public utilities and private communications companies, where the potential for wildfire ignition is considered a high risk. These high-risk areas—which will generally include trailheads, communication sites, and powerline canopies—will be managed as ignition prevention zones, and may require up to 50 to 100 feet of fuel treatment to protect the facility from radiant and convective heat. Vegetation in these zones will be managed in consultation with MCOSD staff.

These zones will be mapped and described in a separate fire management GIS data layer. They will be inspected annually, prior to the onset of the fire season, and information about the potential for wildfire ignition will be shared with MCOSD staff, County Fire, and local fire agency officials. MCOSD staff will use this information to inform potential temporary closures or public use restrictions during periods when fire risk is high, or to help identify areas where fuel reduction is warranted to prevent ignition.

MCOSD will construct and manage ignition prevention zones in areas that are at high risk from public activities. Areas that do not receive public use but that contain property with high social value (e.g., mountaintop repeaters or cell sites) may also require ignition prevention zones. This work will be accomplished by the utility, with oversight by MCOSD staff. Power lines are often a source of fire ignition, especially during windy days. MCOSD will consult with public power providers whose electrical transmission lines cross MCOSD lands to reduce the risk of limbs from trees falling onto power lines within utility rights-of-way.

Control or Restrict Access to High Risk Areas during Periods of High Fire Danger

Appropriate actions will be taken to minimize the risk of wildfire ignition during periods of high fire danger. These actions may include prohibiting vehicle access, closing trails and picnic areas, or closing entire areas to all human activities until the fire danger has subsided. The public will be informed of the reasons why such actions are being taken, and areas will be patrolled to ensure compliance.

Identify and Prioritize Locations for Fuelbreaks

The survey of current practices and scientific literature summarized in chapter 3 concludes that the use of primary and secondary ridgetop fuelbreaks in conservation areas should be minimized for the following reasons:

- Recent studies show that they serve mainly to slow, but not stop, the fire, and to facilitate fire management activities by providing firefighter access (in which case they serve the function of ingress/egress zones, see below).
- They create opportunities for the spread and invasion of nonnative pyrophytic plants into intact native habitats.
- The long-term maintenance costs—in terms of both time and expense—associated with these facilities are cost-prohibitive for land management agencies.

French broom rapidly invades a fire road, resulting in long-term, costly maintenance

For these reasons, MCOSD will not focus its fuel modification efforts on the establishment and maintenance of new primary and secondary ridgetop fuelbreaks in the interiors of the preserves, or on the reestablishment of old primary ridgetop fuelbreaks that have not been maintained. Rather, MCOSD will focus on the reduction of invasive species and fuel build-up in existing fuelbreaks, and on the establishment and maintenance of defensible space zones and wide-area fuelbreaks on the borders of preserves near residential communities. Wide-area fuelbreaks offer the opportunity to achieve multiple goals, including reductions in both hazardous fuels and invasive plants.

Fire behavior modeling throughout the state has illustrated the utility of constructing fuel modification zones close to structures and high fire hazard areas, which also tend to be areas of high property value. By placing fuel modification zones nearest structures, where fires are more likely to start, MCOSD can target the locations that are most effective in reducing damage from wildfire. By deemphasizing primary fuelbreaks in the interiors of preserves, MCOSD can reduce the spread of broom and other aggressive nonnative invasive plants in these areas where habitat value is higher. In interior areas of preserves, where MCOSD will focus primarily on the protection of high-value resources, ingress/egress fuel modification will be the preferred treatment for any fuel modification zones that cannot be relocated to the periphery of the preserve.

The existence and use of fuel modification zones (e.g., defensible space zones, ignition prevention zones, fuelbreaks, and ingress/egress zones) are all important tools for ensuring firefighter safety when fighting large wildland fires. Therefore, MCOSD will coordinate with County Fire to identify and prioritize efforts to maintain and construct both old and new fuelbreaks by evaluating individual projects against a comprehensive set of environmental, firefighting effectiveness, and budgetary factors. Projects will be scored using a decision-making matrix that identifies a range of possible values for each factor and weights each factor based on its relative importance (see table 4.9). Total project scores will be used to identify which fuelbreaks, both old and new, are critical to wildfire control and which fuelbreaks no longer serve their intended purpose. In the latter case, those fuelbreaks could be altered to provide for firefighter access (i.e., ingress-egress zones), or they could be restored to native habitat. The decision to restore these areas will depend in part on the vegetation management zone, the corresponding value of the vegetation type, and the presence of invasive plants. The decision to construct a new fuelbreak will also consider locations of, and potential for invasion from, existing or new invasive plant infestations, the frequency and cost of long-term maintenance of the facility, and the corresponding need for road maintenance.

Table 4.9 Fuelbreak Decision-Making Matrix

Wildfire Containment and Control Benefits Factors		Rank Range	Rank Score	MCOSD Weighting Factor	Weighted Score
Enhancement to defensible space zones	adjacent to homes	10		X 3	
	within 1,000 feet	7			
	half a mile plus from homes	1			
Location effectiveness for wildfire control	ridge top	10		X 3	
	canyon bottom	8			
	midslope	1			
Proximity to very high fire hazard severity zone	within zone	10		X 3	
	within 1,000 feet of zone	5			
	over 1,000 feet from zone	1			
Establishment cost	high	1		X 3	
	moderate	5			
	low	10			
Orientation to fire weather wind	perpendicular	10		X 2	
	parallel	3			
Minimum width to be of benefit for wildfire containment and control	200 plus feet	1		X 3	
	150 -199	4			
	100-149	7			
	50-99	10			
Flame lengths in feet during typical summer day weather	20+	10		X 3	
	8-19	5			
	<8	1			
Maintenance return frequency to maintain fuelbreak effectiveness	Yearly	1		X 2	
	2-3 years	5			
	4-5+ years	10			
Wildfire Containment and Control Score					

Environmental Concerns/Benefits Factors		Rank Range	Rank Score	MCOSD Weighting Factor	Weighted Score
Presence of invasive exotic vegetation Possible dual benefit to treatment	heavy invasive exotic vegetation	10		X 3	
	moderate invasive exotic vegetation	6			
	low invasive exotic vegetation	2			
	little or no invasive exotics present	1			
Potential impacts to rare, threatened and/or endangered species	high	1		X 3	
	moderate	7			
	low/none	10			
Potential for spread of invasive exotic species	high	1		X 3	
	moderate	3			
	low	10			
Potential impacts to cultural resources	high	1		X 3	
	moderate	3			
	low/none	10			
Fuel break type - visual impacts	shaded inc. roadway	10		X 2	
	shaded	8			
	Open and exposed	1			
Maintenance costs	high	1		X 3	
	moderate	5			
	low	10			
Linkage to adjacent fuel break or natural fire barrier	over 1 mile	1		X 2	
	within 1 mile	2			
	within 0.5 mile	5			
	within less than 0.25 mile	10			
Fire history – No. of fires in last 100 years of more than 100 acres within 1 mile of the proposed fuelbreak	2	10		X 3	
	1	5			
	0	1			
Environmental Concerns/Benefits Score					
Total Project Score – Fire and Environmental					

Explanation of Ranking And Weighting Factors:

Ranking Factors: The ranking range for all factors is a scale of 1-10. The highest possible rank score a project can receive under any factor is 10 and the lowest is usually 1. Depending on the factor, the ranges capture differences in distance, time, cost, or other variables, and the values assigned within the range are based upon input from MCOSD and County Fire. MCOSD is not limited to assigning only the values included in the matrix. For example, regarding the factor of presence of invasive vegetation, MCOSD is not limited to the values 10, 6, 2, or 1; it may assign a score of 4 if that value is more representative of what occurs on the ground.

Weighting Factors: Each factor is weighted according to its relative importance, as follows:

3 factors of very high importance

2 factors of high importance

1 factors of moderate importance

The scores are created by multiplying the ranking and weighting values for each factor, then adding the results together. This score is a relative ranking and a guide to decision making (see above). It is understood that a single factor might represent such an environmental or social concern that it could eliminate the project from future consideration. An example of this would be the presence of an endangered species if the effect of the project on the species could not be mitigated. Total project scores are intended to be used to determine the relative value of individual projects, as follows:

255+ extremely valuable

235-254 highly valuable

215-234 moderately valuable

195-214 marginally valuable

<194 of little value

Strategically Locate Ingress/Egress Zones

Ingress/egress zones are areas adjacent to fire roads where vegetation is modified to allow for passage of firefighting and rescue vehicles, in the case of an emergency, and maintenance and enforcement vehicles at any time. Ingress/egress zones are typically 16 feet wide, including the width of the road and the roadside areas where vegetation has been modified. Vegetation in these zones is typically managed to the same standards as vegetation in defensible space zone thinning areas.

Some existing roads (in most cases, old ranch roads) cause environmental damage, adversely affect native species, fragment habitat and disrupt wildlife corridors, and encourage the spread of nonnative invasive species (Weaver and Hagans 1994). In some cases, these roads could be decommissioned or converted to trails; or they could be more strategically located along the perimeters of the preserves, in the wildland-urban interface (see figure 3.6 in chapter 3). Roads relocated to perimeters of the preserves could connect to primary access routes, allowing them to efficiently support evacuations and safe passage for firefighting equipment, while avoiding adverse effects on natural systems in the interiors of the preserves.

Constructing an ingress/egress zone

Treat Fuel Modification Zones

Planning for fuel management projects in defensible space zones, ignition prevention zones, fuelbreaks, and ingress/egress zones will ensure that the treatment methods are most appropriate to the site conditions and specific project goals (see "Project Planning" in chapter 5). Planning for all projects will also ensure that early detection and elimination of invasive plants occurs prior to construction, and that post-construction maintenance and monitoring requirements are included.

The following treatments may be used individually or in combination with each other. All treatments will be implemented using the best management practices described in chapter 7.

- prescribed burning
- hand cutting and either piling and burning material, or chipping and spreading material
- mechanical removal (e.g., mowing, weed-whipping, mastication)
- herbicide application
- grazing

Restore Nonessential Fuelbreaks and Fire Roads to Natural Conditions

The fuelbreak decision-making matrix will be used to evaluate existing, as well as proposed, fuelbreaks. Those fuelbreaks located in the interior of preserves that are determined to be nonessential will be restored to natural conditions to increase habitat connectivity and reduce the potential for invasive species, following the guidance for restoring high-value habitat, described above. The roads associated with those fuelbreaks will either be converted to trails or restored to natural conditions.

Maintain Staff Capability to Respond to Large Wildfires

Should a wildland fire occur on or threaten MCOSD land, staff will be available to support fire suppression authorities. Should the wildfire burn MCOSD lands, MCOSD staff will assist in the planning of suppression efforts, provide information to help reduce natural resource damage, and provide input to the incident management team. Should the incident become multiday, MCOSD staff will become part of the incident management team.

MCOSD typically should have no additional costs for fire activities, other than staff costs, as these costs are generally incorporated into and borne by the fire agencies. If an incident becomes significant enough that the state declares the incident a disaster, costs may be recoverable, with federal as well as state funding likely to be available. The Natural Resources Conservation Service and State Office of Emergency Services will be consulted for possible grants or cost-share programs to limit the cost borne by MCOSD. MCOSD will maintain good records regarding staff positions utilized, hours worked, and all incident-related expenditures.

Upon containment/control of a wildfire incident, MCOSD will maintain coordination activities, including input for conducting both fire rehabilitation and Burned Area Emergency Response (BAER) Team mitigation efforts. MCOSD will ensure that all suppression-related materials are removed from MCOSD lands. Fire rehabilitation should not be limited to the repair of damages to roadways and fences and installation of water bars on tractor lines when there is a concern for soil erosion. At the end of the rainy season, MCOSD will conduct an assessment of the BAER Team's erosion and debris flow mitigation efforts, especially in the defensible space zones and along roadways, where lives or property are threatened by erosion and debris flows. MCOSD may have recoverable costs for BAER Team treatment actions.

Following a wildfire event, areas will be inspected to determine whether the defensible space zones, fuelbreaks, and other treatment areas functioned as planned. The review will include local fire authorities to help determine if the fuel treatments, suppression tactics, weather conditions, or other factors resulted in the failure of a fuel treatment to contain or control the wildfire. Treatment effectiveness will be documented for future reference, with recommendations regarding future hazardous fuel reduction activities. There are likely to be many agencies, such as utilities, public works, and similar departments, impacted by a large fire event. Reviews will be performed cooperatively, with MCOSD making recommendations regarding future treatments and actions to further protect natural resources.

Forest Health Management

Manage Hazards Associated with Weakened or Diseased Trees in High-Use Areas

Inspect Preserves Regularly To Identify Hazards and Pathogen Infestations

MCOSD staff, including natural resource staff, maintenance staff, and rangers, will routinely inspect high-use areas (e.g., roads and trails, trailheads, entrances) for trees that exhibit symptoms associated with pathogens and diseases, or that may pose a risk to human health or to structures.

Remove or Treat Priority Hazard Trees

Where detected, hazard trees will be mapped and the hazard described and reported to natural resource and maintenance staff. The MCOSD staff will treat (e.g., prune, trim, cable) or remove priority hazard trees, including hazard trees that are in defensible space zones surrounding private property, if the tree is on preserve land. Other diseased or weak trees will be treated or removed as staffing and resources allow.

All hazard trees will be recorded and tracked in a GIS database until treated. If high numbers of hazard trees are identified within one geographic area over time, further investigation as to any potential contributing factors will be conducted.

Selectively Treat Forest Pathogens

Insects and fungi that attack trees occur naturally in MCOSD forests. Insect and fungal infections can typically kill the infected tree, but some trees recover after being infested. Pathogens become problematic when forests are already diseased or weak, such as oak woodlands that are fighting California oak mortality syndrome, or when forests experience drought conditions. Not all forest pests or pathogens require control. In many instances, there is no reliable treatment for forest pathogens except to monitor the situation and let the disease run its course. Problem insects and fungi are typically transported from tree to tree through many pathways (e.g., wind, water, physical transport by insects, birds, and humans). Treatment of adjacent trees to contain the infestation by maintaining a sufficiently high concentration of a pesticide or fungicide on all susceptible surfaces of a tree is problematic and often prohibitively costly.

For these reasons, forest pathogens will be treated selectively in the MCOSD preserves. When forest pathogens are detected in the legacy zone, the MCOSD staff will assess the effects of possible spread of the disease or pathogen on the surrounding sensitive vegetation types and special-status species. If forest pathogen spread would significantly affect sensitive vegetation types or special-status species (e.g., species that are dependent on forest vegetation types) in these zones, integrated pest management procedures will be followed to determine the appropriate treatment.

When forest pathogens are detected in other zones, the infestation will be monitored and MCOSD staff will assess the effects of possible spread of the disease or pathogen into the legacy zone. Where spread would significantly affect sensitive vegetation types or if impacts could affect infrastructure, public safety, and/or fire risk in the areas adjacent to residential development, integrated pest management procedures will be followed to determine the appropriate treatment.

Monitor Pathogens and Set a Threshold for Triggering Pest Control

The MCOSD will maintain a GIS database containing occurrence locations and work with other agencies and researchers to standardize the type of monitoring data collected as a part of each occurrence (e.g., estimated density, cover of infestation). MCOSD land managers will identify the forest pathogen, the location of the infestation, and the severity of the infestation before deciding to undertake active management.

The level at which a pest will either become an economic or environmental threat is generally the action threshold that will trigger active pest control. Resource management staff will use monitoring information to determine a point at which action will be taken.

Implement Control Actions

MCOSD staff will work with a knowledgeable forester or researcher to evaluate and prescribe the proper integrated pest management control that balances effectiveness and risk.

Control of California Oak Mortality Syndrome

California oak mortality syndrome is caused by the plant pathogen *Phytophthora ramorum*.

Infected trees have been reported from all MCOSD preserves. There is no reliable cure for the infected tree; therefore, treatment of outbreaks will focus on containment, then preventative treatment of nearby trees. The following suggestions have been provided by local arborists and forest ecologists. MCOSD staff will periodically contact the Agricultural Commissioner's office and the California Oak Mortality Task Force to obtain up-to-date information.

- Thin or remove trees to interrupt disease pathways. The disease spreads from tree to tree and persists in wet and damp places. The pathogen can accumulate on other tree species, such as California bay laurel, which often traps moisture on its broad leaves; the pathogen then spreads via water, wind, or leaves or is transported by animals or humans to trees such as oaks, where it causes infection. Some land managers thin oaks and/or remove California bay laurel trees near infected trees to slow spread.

- Wash equipment, vehicles, and shoes in a mild bleach solution before leaving infected areas.

- Limit public access. This will be accomplished by temporarily closing trails or cordoning off areas as needed to reduce potential spread by humans.

- Contain outbreaks as possible. Often, because it is cost prohibitive and possibly ineffective to treat a large area of possible infection around one diseased tree, the best treatment is containment of the diseased tree (i.e., cut and leave in place), and monitoring of surrounding trees until the disease has run its course in the area. Other treatments that have been tried include spraying the nearby trees with a fungicide and treating acidification of soils under affected stands (although the effectiveness of this treatment is unknown).

- Do not transport infected material. Infested material will be cut and left in place. No leaf litter, soil, woody debris, firewood, or cut limbs will be transported from infestation areas.

Control of Other Forest Pathogens

For other forest pathogens (e.g., pine pitch canker, bark beetle, root rot fungus, velvet top fungus), the following information has been provided by local arborists and forest ecologists. MCOSD staff will consult the Agricultural Commissioner's Office and related resources to get up-to-date information on treatments. Many of the actions are the same as described above for treating California oak mortality syndrome.

- Wash equipment, vehicles, and shoes in a mild bleach solution before leaving infected areas.

- Limit public access.

- Contain outbreaks as possible. Treatment is typically felling the dead tree in place, then monitoring and possibly thinning or treating nearby trees to help prevent spread. Chemical controls might be exploited under nursery conditions, but for larger trees, maintaining a sufficiently high concentration of a pesticide or fungicide on all susceptible surfaces of a tree is problematic and prohibitively costly. Pruning infected limbs does not seem to reduce mortality of infected trees and is mostly cosmetic.

- Do not transport infected material.

Continue to Cooperatively Track and Research Treatment Options

MCOSD staff will participate in regional efforts to control and treat forest pathogens by contributing to and supporting tracking and research efforts being conducted by the California Oak Mortality Task Force, Agricultural Commissioner's Office, Pine Pitch Canker Task Force, and others.

Manage to Achieve a Multiaged, Multistoried Forest Structure

Manage Forest Type Conversion in Legacy and Sustainable Natural Systems Zones

The invasion of native forests (in particular native oak, mixed oak and conifer, redwood, and other old growth forest types) by nonnative trees will be managed in legacy and sustainable natural systems zones to ensure that they do not (1) substantially change the dominant tree types, (2) alter or reduce functions (e.g., shade, cover, forage), or (3) alter the structure (e.g., characteristic overstory, midstory, understory layers) of the forest type.

Invasive nonnative trees of primary concern include blue gum eucalyptus, Monterey cypress, Monterey pine, acacia, and cotoneaster. In legacy and sustainable natural systems zones MCOSD staff will implement the following steps to control these nonnative invasives:

- Identify and map stands of invasive trees greater than ¼ acre in size. Record dominant species, absolute cover of invasive trees, and life stage (mature tree, sapling, seedling). Enter information into a GIS database.

- Monitor the size and density of invasive tree stands every 5 to 10 years to assess the rate of spread from the original mapping boundary. During each visit, also monitor surrounding vegetation types for invasive seedlings and saplings that might be spreading from the original mapping boundary. If spreading is observed, remove new seedlings/saplings immediately (e.g., hand pull, cut) where possible, or map the spread and record whether ongoing treatment is necessary to control the invasive tree back to its original mapping boundary.

- Set an action threshold at which the invasive trees must be actively controlled. For example, action may be required if a known invasive tree stand increases in size by more than 10 percent, or if more than 25 percent of a native forest type is infested by the target invasive tree; or action may be required if a forest type that supports a special-status species is affected by a nonnative tree species. This would be accomplished by comparing baseline vegetation mapping with monitoring data.

- Implement control actions identified under "Invasive Plant Control."

In addition to the spread of nonnative invasive trees, land managers and MCOSD staff have indicated that the spread of native Douglas-fir seedlings and saplings into priority forested areas is threatening the functioning of the original vegetation type and is significantly increasing the risk of fire in these areas. Douglas-fir is an especially flammable ladder fuel because it forms dense stands of sap-rich midstory saplings that allow fires to reach the forest canopy. Because of this, Douglas-fir stands will be contained within the footprint of the existing mature stands and not allowed to spread into surrounding forest and grassland areas. To control this native species MCOSD staff will take the following management actions:

- Track and record new Douglas-fir seedling/sapling invasions into other forest types and also into native grasslands and other vegetation types.

- When Douglas-fir seedling/sapling density in the understory or midstory of other forest types reaches 20 percent or more, it will be controlled by hand or mechanical removal of saplings and seedlings.

Limit Active Management in Low-Use Areas

Management activity will be limited in low use areas, such as inaccessible forest interiors. Leaving snags and downed wood, not cutting unnecessary fuelbreaks, and not actively planting trees and shrubs will help maintain biologically and structurally diverse forest ecosystems.

Management of Vegetation Responses to Climate Change

Many of the strategies for supporting the adaptation of natural systems to climate change are integral parts of effective vegetation management independent of climate change and have already been addressed in previous sections of the plan. These are (1) reduce stressors (invasive species, large and intensive wildfires, threats to forest health); (2) protect biological diversity and ecological functions (including restoration of sensitive species and habitats); and (3) maintain or restore landscape connectivity. Five additional strategies specific to climate change are addressed in this section: (1) expand monitoring and adaptive management to address climate change, (2) include actions to reduce effects of climate change in vegetation management practices, (3) offset the loss of coastal wetlands to sea level rise by supporting replacement wetlands in new locations, (4) protect places of refuge and other areas important to ecosystem resiliency, and (5) cooperate with other agencies and researchers to understand and address the effects of climate change.

Consider the Effects of Vegetation Management on Greenhouse Gasses

With some exceptions, actively growing coastal California forests typically store more carbon than do shrublands, and actively growing shrublands tend to store more carbon than do grasslands (Environmental Defense Fund 2009, Silver 2009). Thus, the conversion of forests to shrublands or shrublands to grasslands entails a release of carbon dioxide and decreases ecosystem carbon storage. These effects will be considered, along with other factors, when making vegetation management decisions.

Expand Monitoring and Adaptive Management to Support Response to Climate Change

MCOSD will increase the rapid assessment of its lands to improve its capability to rapidly detect any unusual changes in natural resources (e.g., loss of biodiversity, large-scale vegetation type conversions). As part of the adaptive management process, it will seek to determine the possible cause of the change and to what extent it is related to climate change. If climate change is determined to be a major factor, MCOSD will adapt its vegetation management approach to manage for natural resilience. This management will vary based on the value of the vegetation type and species being affected. Intensive management action will generally be taken to preserve special-status or other sensitive species. However, if the detected changes are not expected to result in large-scale adverse impacts to special-status species, MCOSD will generally allow shifts to occur, recognizing that some common vegetation types may become uncommon. In rare instances where Marin vegetation types are transitioning into types that would support one or more species that is becoming extinct in its native range (which might or might not be within the MCOSD preserves), the new type may be managed to support those threatened species.

Design Restoration Projects to Facilitate Vegetation Shifts in Response to Changing Climate Conditions

The MCOSD will seek to include actions in restoration projects for special-status and locally rare species that will increase the ability of species and vegetation types to expand their ranges in response to topographic or elevational changes in temperature, moisture, salinity, or other factors.

Increase Genetic Diversity in Restoration Plantings

Restoration projects are likely to be more effective at promoting climate change adaptation if they include greater genetic diversity. The MCOSD will therefore seek to collect plant materials for use in restoration projects from an entire watershed or region, and collect plant materials from a variety of slopes, aspects, and microhabitats.

Plant across a Range of Microclimates and Elevational Variations

Vegetation will be planted across a range of microclimates and elevational variations with the restoration area. This will increase the ability of individual planted species to establish according to subtle environmental and ecological cues, and maximize the likelihood that the project will result in a diverse and stable vegetation type over time.

Offset the Loss of Coastal Wetlands to Sea Level Rise by Supporting Replacement Wetlands in New Locations

Promote Expansion of Coastal Vegetation Types

Many coastal wetlands accumulate peat or otherwise store carbon belowground, which can result in very carbon-rich soils. Management practices that restore or expand these vegetation types help to increase belowground carbon storage. While the initial cost of coastal wetland restoration can be high, facilitating the buildup of coastal wetlands is an important vegetation management action that can assist in adaptation to sea level rise and provide significant long-term economic benefits.

As part of projects to restore degraded coastal wetlands, particularly those that are eroding or are changing in elevation or acreage due to wind or wave erosion, MCOSD will incorporate actions that promote the expansion of coastal vegetation upward along an elevation gradient. For example, restoration actions might include planting coastal plants just above their natural moisture or elevational ranges to promote expansion into new areas, which might expedite establishment of coastal vegetation upwards as sea levels rise. Also, saltwater-tolerant plants might be planted in areas that will be inundated by high tides.

Manage New Coastal Depositional Areas for Expansion of Coastal Wetland Vegetation Types

The anticipated losses of some coastal lands as a result of sea level rise may be offset in part by the natural process of building up coastal sand spits and other new coastal landforms through deposition of waterborne sediments. MCOSD will monitor and detect new coastal depositional areas within the preserves and actively manage them for coastal wetland vegetation types.

Seek to Acquire and Manage Additional Undeveloped Coastal Lands

Maintaining linkages, or creating new ones, between coastal areas of the MCOSD preserves and nearby wetlands and inland areas will be important for ensuring that species and natural communities are able to migrate in response to a changing environment. Most importantly, action must be taken to ensure that there are undeveloped open spaces available inland from existing coastal habitats. In many locations, the amount of coastal wetland is limited by the presence of upslope developed lands such as levees, roads, or other infrastructure that act as barriers to the movement of native species. Where undeveloped land is available, MCOSD will seek to promote its acquisition and protection.

Cooperate with other Agencies and Researchers to Understand and Address the Effects of Climate Change

Because climate change is a relatively new phenomenon, it is likely that new research into the effects of climate change on biological resources will occur in the next decade, altering some or all of the strategies described above. To ensure that it is utilizing the most recent information during adaptive management of its lands, MCOSD will undertake the following to the greatest extent feasible.

Cooperate with Other Agencies to Promote Climate Change Research

The MCOSD may consider offering preserves for research projects or other types of assistance.

Coordinate with Other Agencies, Researchers, and Educational Institutions to Keep Up with Current Research

The MCOSD will coordinate regularly and share information with adjacent landowners such as MMWD.

5: PLAN IMPLEMENTATION

Projects

This *Vegetation and Biodiversity Management Plan* will be implemented through specific projects that will be planned and prioritized following standard procedures outlined in this chapter. Projects that are either ongoing or that have been planned or proposed to date are listed in table 5.1. This table will be updated as the plan is implemented over time.

Table 5.1 List of Potential Projects to be Implemented

Project Title	Preserve(s)	Description	Estimated Acres Treated
District-Wide Early Detection/ Rapid Response Program Implementation	All - on rotational 3-year cycle as described in Chapter 6	(1) Finalize /update annual list of priority invasive. (2) Train staff on identification of selected priority species. (3) Consider developing outreach program for adjacent landowners who have source populations of invasives that affect MCOSD preserves. Research cost-sharing, concurrent treatment, or providing technical support for offsite control. (4) Develop EDRR watch list for each preserve, update annually. (5) Develop a volunteer-based plant watch program as part of EDRR. (6) Patrol selected preserves as part of a 3-year cycle. (7) Implement control. (8) Update GIS. (9) Continue to monitor treated incipient infestations until either full control or eradication achieved.	15,067
District-Wide Invasive Plant Rapid Assessment	All - focus on invasive plant control projects that are implemented as a part of annual work plan	(1) Update (but not replace) the GIS attribute table for invasive plant infestations being treated. (2) Compare infestation distribution data and density/cover estimates to prior and baseline data layer. (3) Determine hotspots where changes in infestation distribution or density either warrant a change or more aggressive IPM-based action. (4) Update rapid assessment list with any new hotspots and, when appropriate add new priority invasive plant control projects to list.	15,067
District-Wide Barbed Goatgrass Control	Focus control in preserves listed below, adjust locations if new priority locations are identified as a part of the District-wide Target Invasive Plant Mapping Project currently underway	(1) Reassess barbed goatgrass control actions to date using the methods outlined in Chapter 6 within the preserves listed below. Remap and reassess distribution relative to ongoing mowing, fuel management, road/ trail locations, and vegetation management zones, and if applicable grazing. Determine if any of these other actions are affecting spread of the grass and if so, modify methods to reduce potential for spread (example, change mowing schedule to reduce inadvertent spread of goatgrass or discontinue, restrict vehicle access, change grazing leases timing, etc.). (2) Establish a volunteer-based weed watch program to complement control actions- conduct ongoing volunteer EDRR patrol and hand pull throughout the year. (3) Implement maintenance and monitoring program for remaining grass until eradication and/or control is achieved.	60+
	Mount Burdell	Treatment was initiated in 2006; several methods have been investigated to control and eventually extirpate barbed goatgrass from the site. Follow-up treatments have been conducted annually since 2006, but full control has not been achieved.	1.35
	Terra Linda/Sleepy Hollow	Treatment was initiated in 2006; several methods have been investigated to control and eventually extirpate barbed goatgrass from 60 acres of the site. Follow-up treatments have been conducted annually since 2005, but full control has not been achieved.	60
District-Wide Invasive Broom Control	Focus control in preserves listed below, adjust locations if new priority locations are identified as a part of the District-wide Target Invasive Plant Mapping Project currently underway	(1) Reassess French broom (and other broom species) control actions to date using the methods outlined in Chapter 6 within the preserves listed below. Remap and reassess distribution relative to ongoing mowing, fuels management, road and trail locations and if applicable grazing. Determine if any of these other actions are affecting spread of brooms and if so, modify methods to reduce potential for spread (example, change mowing schedule to reduce inadvertent spread, expand wide-area fuel break boundaries to capture infestation edges, or discontinue/alter land use practices (e.g. restrict vehicle access, etc.). (2) Assess if current control/containment locations are highest priority locations for control as outlined in Chapter 6 - add or delete control locations following assessment. (3) Meet with MCFD and other fire agencies to discuss opportunities to conduct dual fuel reduction/invasive plant control projects for broom. (4) Establish a volunteer-based weed watch program to complement control actions- conduct ongoing volunteer EDRR patrol and hand pull throughout the year. (5) Implement follow up maintenance and monitoring program for remaining brooms until eradication and/or control is achieved.	481
	Alto Bowl/Horse Hill	Treatment was initiated in 2003 for this approximately 4.5 acre infestation. The project was initiated by and follow up treatments have been conducted annually by volunteers. Research partnerships with county and local fire departments to cost-share Wide Area Fuelbreak project that includes volunteer opportunities.	4.5
	Cascade Canyon	This project site was initially cut as part of a grant funded fuel reduction effort to install a series of primary fuelbreaks throughout the preserve in 2006. This multi-year project will divide existing broom infestations into containment zones, Wide Area Fuelbreaks, restoration zones (eradication), and volunteer removal sites. Develop a restoration plan that manages fire risk and natural resources. This project requires and IPM-based approach to be successful.	88
	French Ranch	Treatment was initiated in 2008 for this approximately 3 acre infestation. The project was initiated by and follow up treatments have been conducted annually by MCOSD staff. Continue to work with neighbors to control broom on adjacent properties (source population for preserve) b) assess, map, develop project scope and treat scattered patches of Scotch broom (*C. scoparius*) and large mixed stands of Scotch and French broom.	3
	Old St. Hilary's	An ongoing volunteer-based broom control program has been conducted since 2004 resulting in containment of many large site populations. Scattered individuals and follow up patches remain and are treated regularly by both staff and volunteers. Included in the overall broom control assessment process: (1) Assess location of remaining French broom relative to serpentine grasslands and special-status plants. (2) Coordinate with adjacent landowners- possibility of cost-sharing control efforts and/or coordinating control on preserve and in adjacent areas. (3) Evaluate priorities for this species in comparison to other for funding as a part of the $18K annual endowment. (4) Work directly with Broom Busters to assess priorities and volunteer capacity.	7.5
	Pacheco Valle	An ongoing broom control program has been conducted since 2006 on 4-5 populations (approximately 10 acres total), located along fire roads and in and near a primary fuel break. The project was initiated by MCOSD because MCFD was constructing a primary fuelbreak along ridge. Follow up treatments have been conducted annually by MCOSD staff. Our goal is to reduce the density of this population to a hand pull site, but because this population is so large and dense, an integrated approach of spot application herbicide will be used for the next season and we will assess seedbank and treatment effectiveness to determine the next treatment cycle.	10
	Rush Creek	Treatment began in 2004 for this approximately 5.5 acre infestation. The project was initiated by MCOSD staff and volunteers and follow up treatments have been conducted annually by MCOSD staff and volunteers. Include the following as part of the overall broom control assessment process: (1) Reassess distribution of tree of heaven and French broom, especially along newly constructed trail and confirm priorities; (2) Analyze treatment data from 10/2011 to implement best treatment this year. Potential follow-up treatment could include select stump treatment of herbicide.	5.5

Table 5.1 List of Potential Projects to be Implemented

Project Title	Preserve(s)	Description	Estimated Acres Treated
District-Wide Invasive Pampas Grass Control	Focus control in preserves listed below, adjust locations if new priority locations are identified as a part of the District-wide Target Invasive Plant Mapping Project currently underway	(1) Assess and prioritize known and newly mapped locations of Pampas grass and identify IPM-based treatment methods within the preserves listed below and within newly identified infestations using methods outlined in Chapter 6. Evaluate infestations relative to high value resources, to ongoing mowing, fuels management, road and trail locations and if applicable grazing. Determine if any of these other actions are affecting spread of pampas grass and if so, modify methods to reduce potential for spread (example, change mowing schedule to reduce inadvertent spread, expand wide-area fuel break boundaries to capture infestation edges, or discontinue/alter land use practices (e.g. restrict vehicle access, change grazing leases timing etc.). (2) Assess if current control/containment locations are highest priority locations for control as outlined in Chapter 6 - add or delete control locations following assessment. (3) Coordinate with adjacent landowners- possibility of cost-sharing control efforts and/or coordinating control on preserve and in adjacent areas. (4) Establish (or continue) a volunteer-based weed watch program to complement control actions- conduct ongoing volunteer EDRP patrol and hand pull throughout the year. (5) Develop and implement maintenance and monitoring program for remaining pampas grass infestations until eradication and/or control is achieved.	32
	Blithedale Summit	Assess and prioritize additional known and newly mapped locations of Pampas grass within this preserve and identify IPM-based treatment methods using Chapter 6. Evaluate infestations relative to high value resources, to ongoing mowing, fuels management, road and trail locations. Determine if these actions are affecting spread of pampas grass and if so, modify methods to reduce potential for spread (example, change mowing schedule to reduce inadvertent spread, expand wide-area fuel break boundaries to capture infestation edges, or discontinue/alter land use practices); Conduct targeted removal along road/trail system, including the 1-acre infestation along S. Marin/Mainline Fire Road in coordination with MCFD and Kentfield Fire Department.	1
	Old St. Hilary's	A pampas grass (*Cortaderia jubata*) control program has been ongoing since 2002 removing dense population in and along main creek through preserve. Both MCOSD staff and volunteers currently conduct follow up detection and treatment. Small populations still exists along the drainages in the northern border of the preserve. Include the following as part of the overall pampas grass control assessment process: (1) Assess location of remaining pampas grass relative to serpentine grasslands and special-status plants. (2) Coordinate with adjacent landowners - continue cost-sharing control efforts and/or coordinating control on preserve and in adjacent areas. (3) Evaluate priorities for this species in comparison to other for funding as a part of the $18K annual endowment.	<1
	Ring Mountain	Pampas grass control was initiated in 2004 as part of a grant funded project to remove large dense populations of this species, totaling approximately 17 acres. MCOSD staff conducts follow up treatments. Include the following as part of the overall pampas grass control assessment process: (1) Assess location of remaining pampas grass relative to serpentine grasslands and special-status plants. (2) Coordinate with adjacent landowners - possibility of cost-sharing control efforts and/or coordinating control on preserve and in adjacent areas; target remaining infestations with an IPM approach with the goal to reduce the populations to a hand-removal maintenance site, and eventual eradication.	17
District-Wide Invasive Perennial Pepperweed Control	Focus control in preserves listed below, adjust locations if new priority locations are identified as a part of the District-wide Target Invasive Plant Mapping Project currently underway	(1) Assess and prioritize locations of known and newly mapped perennial pepperweed and identify IPM-based treatment methods within the preserves listed below and within newly identified infestations using methods outlined in Chapter 6. Evaluate infestations relative to high value resources, to ongoing mowing, fuels management, road and trail locations and if applicable grazing. Determine if any of these other actions are affecting spread of pepperweed and if so, modify methods to reduce potential for spread (example, change mowing schedule to reduce inadvertent spread, expand wide-area fuel break boundaries to capture infestation edges, or discontinue/alter land use practices (e.g. restrict vehicle access). (2) Assess if current control/containment locations are highest priority locations for control as outlined in Chapter 6 - add or delete control locations following assessment. (3) Coordinate with adjacent landowners- possibility of cost-sharing control efforts and/or coordinating control on preserves and in adjacent areas. (4) Establish (or continue) a volunteer-based weed watch program to complement control actions- conduct ongoing volunteer EDRP patrol and hand pull throughout the year. (5) Develop and implement maintenance and monitoring program for remaining pepperweed infestations until eradication and/or control is achieved.	1.75
	Deer Island	This 1.6 acre project was initiated 2009 by MCOSD and follow up treatment in 2010 was conducted by MCOSD staff. Assess 2011 treatment effectiveness and chose best IPM strategy to combine perennial pepperweed control with priority control actions for poison hemlock at this same location.	1.6
	Santa Venetia Marsh	Treatment was initiated in 2005 for this approximately .15 acre infestation. The project was initiated by MCOSD and follow up treatments began again in 2009 and again in 2011. 1) Assess effectiveness of 2011 treatment and continue to focus on an IPM based strategy until population is eradicated. Special considerations for this preserve: As part of the 2005 San Venetia Marsh Restoration Project, fennel was treated for three consecutive years, then has been maintained annually. Likewise, a small patch of puncture vine was removed near the sand bins installed by DPW. Control of these two species and other priority target species should be combined into larger preserve-wide EDRR and invasive nonnative plant control program (preferably in coordination with adjacent landowners and DPW, and utilizing volunteers).	.15

Table 5.1 List of Potential Projects to be Implemented

Project Title	Preserve(s)	Description	Estimated Acres Treated
District-Wide Invasive Purple Starthistle Control	Focus control in preserves listed below, adjust locations if new priority locations are identified as a part of the District-wide Target Invasive Plant Mapping Project currently underway	(1) Assess and prioritize locations of known and newly mapped purple starthistle and identify IPM-based treatment methods within the preserves listed below and within newly identified infestations using methods outlined in Chapter 6. Evaluate infestations relative to high value resources, to ongoing mowing, fuels management, road and trail locations and if applicable grazing. Determine if any of these other actions are affecting spread of purple starthistle and if so, modify methods to reduce potential for spread (example, change mowing schedule to reduce inadvertent spread, expand wide-area fuel break boundaries to capture infestation edges, or discontinue/alter land use practices (e.g. restrict vehicle access, change grazing leases timing etc.). (2) Assess if current control/containment locations are highest priority locations for control as outlined in Chapter 6 - add or delete control locations following assessment. (3) Coordinate with adjacent landowners- possibility of cost-sharing control efforts and/or coordinating control on preserves and in adjacent areas. (4) Establish (or continue) a volunteer-based weed watch program to complement control actions- conduct ongoing volunteer EDRP patrol and hand pull throughout the year. (5) Develop and implement maintenance and monitoring program for remaining purple starthistle infestations until eradication and/or control is achieved.	26
	Little Mountain	Treatment was initiated in 2002 for this approximately 7 acre infestation. The project was initiated by MCOSD as a part of a WMA grant and follow up treatments have been conducted annually by MCOSD staff and volunteers. The population is located along the preserve boundary and on adjacent NMWD land. Following hand removal, the site has continued to receive periodic (sporadic) treatment (mostly hand pulling purple starthistle). Continue to monitor site and hand remove any above ground plants. Special considerations for purple starthistle control on this preserve: Coordinate future actions with NMWD to ensure on and offsite populations treated to eradication.	7
	Loma Alta	Treatment was initiated in 2004 for this approximately 17 acre infestation. The project was initiated by MCOSD and follow up treatments have been conducted annually by MCOSD staff and volunteers. The population is located along the preserve boundary with the Lucas property and was treated as a containment site (Lucas property population dense and widespread). MCOSD also mows this boundary, potentially adding to spread of purple starthistle. Special considerations for purple starthistle control on this preserve: 1) coordinate actions with Lucas to ensure both on and offsite populations are treated simultaneously; 2)reassess purple starthistle location relative to annual mowing- discontinue mowing, or change mowing timing to avoid inadvertent spread of purple starthistle; 3) consider switching containment strategy to eradication if this goal can be achieved through coordinated effort between Lucas and MCOSD. If not, establish (map and mark) containment zones in the field and limit vehicle travel over containment zone and/or install cleaning stations; 4) develop and implement purple starthistle control, working from uninfested areas inward towards designated containment zone.	17
	Lucas Valley	Treatment was initiated in 2002 for this approximately 2 acre infestation. The project was initiated by MCOSD and follow up treatments have been conducted annually by MCOSD staff and volunteers. Continue to monitor and hand remove above ground plants at both populations (one along the Luiz Ranch Fire Road and the new population discovered in 2010 along the Big Rock Trail).	2
District-Wide Invasive Spartina Control	Focus control in preserves listed below, adjust locations if new priority locations are identified as a part of the District-wide Target Invasive Plant Mapping Project currently underway	(1) Partner with the Invasive Spartina Project (ISP) to map, assess and prioritize invasive *Spartina* infestations and hybrid infestations for control; (2) Work in coordination with ISP to identify and implement an IPM-based control treatment; (3) Work with ISP to complete any genetic testing as determined; (4) Establish (or continue) a volunteer-based weed watch program to complement control actions. (5) Develop and implement maintenance and monitoring program for remaining *Spartina* infestations until eradication and/or control is achieved.	<1
	Bolinas Lagoon	Treatment was initiated in 2003 by MCOSD and ISP for this approximately .75 acre infestation. Continue to coordinate with ISP as a part of the larger Bay Area Invasive Spartina Control Project. Additional populations were found in 2011 as part of an annual monitoring program for this species. Treatment will include tarping one population and spot treating the additional 3-populations with imazapyr (see ISP environmental review documents for more information on this strategy).	.75
	Bothin Marsh	Treatment was initiated for this approximately approx. 1 plant infestation. Control efforts were coordinated with ISP as a part of the larger Bay Area Invasive Spartina Control Project. Continue to monitor marsh for any reintroduction and/or hybridization with native species. Develop treatment strategy with ISP if new populations are found.	.05
District-Wide Invasive Stinkweed Control	Focus control in preserves listed below, adjust locations if new priority locations are identified as a part of the District-wide Target Invasive Plant Mapping Project currently underway	(1) Assess and prioritize locations of known and newly mapped stinkweed and identify IPM-based treatment methods within the preserves listed below and within newly identified infestations using methods outlined in Chapter 6. Evaluate infestations relative to high value resources, to ongoing mowing, fuels management, road and trail locations and if applicable grazing. Determine if any of these other actions are affecting spread of stinkweed and if so, modify methods to reduce potential for spread (example, change mowing schedule to reduce inadvertent spread, expand wide-area fuel break boundaries to capture infestation edges, or discontinue/alter land use practices (e.g. restrict vehicle access, change grazing leases timing etc.). (2) Assess if current control/containment locations are highest priority locations for control as outlined in Chapter 6 - add or delete control locations following assessment. (3) Coordinate with adjacent landowners- possibility of cost-sharing control efforts and/or coordinating control on preserves and in adjacent areas. (4) Establish (or continue) a volunteer-based weed watch program to complement control actions- conduct ongoing volunteer EDRP patrol and hand pull throughout the year. (5) Develop and implement maintenance and monitoring program for remaining stinkweed infestations until eradication and/or control is achieved.	3
	Rush Creek	Control of the approximately 3 acre Stinkweed (*D. graveolens*) infestation was initiated in 2004 and tied to a CDFW project Ongoing treatment has been sporadic and conducted by MCOSD staff only as needed. Continue to monitor this site for any re-infestation and develop an IPM based treatment strategy is new populations occur.	3

Table 5.1 List of Potential Projects to be Implemented

Project Title	Preserve(s)	Description	Estimated Acres Treated
District-Wide Invasive Thoroughwort Control	Focus control in preserves listed below, adjust locations if new priority locations are identified as a part of the District-wide Target Invasive Plant Mapping Project currently underway	(1) Assess and prioritize locations of known and newly mapped thoroughwort and identify IPM-based treatment methods within the preserves listed below and within newly identified infestations using methods outlined in Chapter 6. Evaluate infestations relative to high value resources, to ongoing mowing, fuels management, road and trail locations and if applicable grazing. Determine if any of these other actions are affecting spread of thoroughwort and if so, modify methods to reduce potential for spread (example, change mowing schedule to reduce inadvertent spread, expand wide-area fuel break boundaries to capture infestation edges, or discontinue/alter land use practices (e.g. restrict vehicle access, change grazing leases timing etc.). (2) Assess if current control/containment locations are highest priority locations for control as outlined in Chapter 6 - add or delete control locations following assessment. (3) Coordinate with adjacent landowners- possibility of cost-sharing control efforts and/or coordinating control on preserves and in adjacent areas. (4) Establish (or continue) a volunteer-based weed watch program to complement control actions- conduct ongoing volunteer EDRP patrol and hand pull throughout the year. (5) Develop and implement maintenance and monitoring program for remaining thoroughwort infestations until eradication and/or control is achieved.	.10
	Old St. Hilary's	An ongoing thoroughwort (*A. adenophora)* control program has been conducted since 2006 with follow-up treatments conducted regularly since 2007. The infestation is approximately 0.5 acres. The population is not fully controlled and currently there are scattered individuals and small patches in sensitive serpentine habitats which are patrolled and removed mostly by staff. Include the following as part of the overall thoroughwort control assessment process: (1) Assess location of remaining outliers and source infestations relative to serpentine grasslands and special-status plants. (2) Coordinate with adjacent landowners- possibility of cost-sharing control efforts and/or coordinating control on preserve and in adjacent areas. (3) Evaluate priorities for this species in comparison to other for funding as a part of the $18K annual endowment.	0.5
	Blithedale Summit	Treatment was initiated in 2007 for this approximately 0.5 acre roadside infestation. The project was initiated by MCOSD and follow up treatments have been conducted annually by MCOSD staff and volunteers. Consider the following as part of the overall thoroughwort control assessment process: control oblong spurge (Euphorbia oblongata) in and adjacent to this population (near entrance of Old Railroad Grade).	0.5
District-Wide Invasive Yellow Starthistle Control	Focus control in preserves listed below, adjust locations if new priority locations are identified as a part of the District-wide Target Invasive Plant Mapping Project currently underway	(1) Assess and prioritize locations of known and newly mapped yellow starthistle and identify IPM-based treatment methods within the preserves listed below and within newly identified infestations using methods outlined in Chapter 6. Evaluate infestations relative to high value resources, to ongoing mowing, fuels management, road and trail locations and if applicable grazing. Determine if any of these other actions are affecting spread of yellow starthistle and if so, modify methods to reduce potential for spread (example, change mowing schedule to reduce inadvertent spread, expand wide-area fuel break boundaries to capture infestation edges, or discontinue/alter land use practices (e.g. restrict vehicle access, change grazing leases timing etc.). (2) Assess if current control/containment locations are highest priority locations for control as outlined in Chapter 6 - add or delete control locations following assessment. (3) Coordinate with adjacent landowners- possibility of cost-sharing control efforts and/or coordinating control on preserves and in adjacent areas. (4) Establish (or continue) a volunteer-based weed watch program to complement control actions- conduct ongoing volunteer EDRP patrol and hand pull throughout the year. (5) Develop and implement maintenance and monitoring program for remaining yellow starthistle infestations until eradication and/or control is achieved.	114
	Mount Burdell	Since 2005, control has been conducted on approximately 110 acres of yellow starthistle, including several large, dense populations and smaller, insipient populations. Work was initiated by MCOSD and follow up treatment has occurred by MCOSD staff and volunteers since 2005, but YST has not yet fully been controlled. Consider the following as part of the overall yellow starthistle control assessment process: include eradication strategy for isolated Harding grass, and any other target invasive nonnative plants that are intermixed with yellow starthistle infestations. This information will inform the 2012 IPM-based strategy for this species.	110
	Ring Mountain	Treatment was initiated in 2000 for this approximately 3.7 acre infestation. The project was initiated by MCOSD and follow up treatments have been conducted annually by MCOSD staff and volunteers. The infestation density has been reduced (isolated population (no other pop's known in preserve). Volunteers will continue to focus hand removal efforts at this site as necessary.	3.7
Invasive Plant Control (Other Species Not Listed Above)	Focus control in preserves listed below, adjust locations if new priority locations are identified as a part of the District-wide Target Invasive Plant Mapping Project currently underway and future EDRR and Rapid Assessment results	(1) Review target invasive plant mapping results from 2010-11 and prioritize eradication, control, and containment projects using process identified in Chapter 6. (2) Identify IPM-based treatments, funding and resources required to complete priority projects and select projects based upon available and projected resources. (3) Assess list of existing projects in comparison with larger priority list to determine annual list of projects. (4) Implement priority actions and integrate into larger EDRR/Rapid Assessment monitoring program; (5) Develop maintenance strategy and determine if sustained control can be accomplished by volunteer program.	-
	Baltimore Canyon	Treatment has not been initiated for this approximately 0.25 acre infestations of pride of Madeira (*Echium* sp.) near gate on southern Marin mainline. Assess whether initiating control efforts should be a priority using the larger prioritization effort outlined above. If deemed high priority, identify most effective IPM-based treatment methods and continue to implement and monitor (through EDRR and Rapid Assessment) efficacy of treatments.	0.25
	Blithedale Summit	Treatment was initiated for this approximately 0.5 acre infestations of sweet fennel in 2010 to prevent spread across fuel breaks. (1) Assess whether continuing control efforts should be a priority using the larger prioritization effort outlined above. If deemed high priority, identify most effective IPM-based treatment methods and continue to implement and monitor (through EDRR and Rapid Assessment) efficacy of treatments. (2) Evaluate infestations relative to high value resources, to ongoing mowing, fuels management, road and trail locations and if applicable grazing. Determine if any current vegetation management actions are affecting spread of this population and if so, modify methods to reduce potential for spread (e.g. - change mowing schedule to reduce inadvertent spread, expand wide-area fuel break boundaries to capture infestation edges, or discontinue/alter land use practices. Coordinate work with MCFD and MVFD.	0.5
	Bothin Marsh	Treatment of iceplant has been ongoing as part of a SCC grant using volunteers. Assess whether initiating control efforts should be a priority using the larger prioritization effort outlined above. If deemed high priority, identify most effective IPM-based treatment methods and continue to implement and monitor (through EDRR and Rapid Assessment) efficacy of treatments.	
	Mount Burdell	An ongoing Harding grass control program of approximately 3.5 acres has been conducted since 2004, with follow-up treatments conducted sporadically since 2005 by MCOSD staff and volunteers. The population is not fully controlled and is currently scattered, but continuous along fire road near gate. Assess the continuation of the current control efforts as a part of the larger prioritization effort outlined above. If deemed high priority, identify most effective IPM-based treatment methods and continue to implement and monitor (through EDRR and Rapid Assessment) efficacy of treatments.	3.5

Table 5.1 List of Potential Projects to be Implemented

Project Title	Preserve(s)	Description	Estimated Acres Treated
Invasive Plant Control (Other Species Not Listed Above), Cont'd.	*Little Mountain*	An acacia removal project was initiated in 2010 by MCOSD, with follow-up treatment scheduled for 2011 by MCOSD staff. Assess the continuation of the current control efforts as a part of the larger prioritization effort outlined above. If deemed high priority, identify most effective IPM-based treatment methods and continue to implement and monitor (through EDRR and Rapid Assessment) efficacy of treatments.	.05
	Old St. Hilary's	An ongoing pride of Madeira control program of approximately 0.4 acres has been conducted since 2009, with follow-up treatments conducted by MCOSD staff and volunteers. This species is spreading onto the preserve from adjacent properties. (1) Hand remove any above ground plants. (2) Monitor (through EDRR and Rapid Assessment) the efficacy of treatment. (3) Coordinate with adjacent landowners of the possibility of cost-sharing control efforts and/or coordinating control on preserve and in adjacent areas. Additionally, a 0.9 acre population of Acacia was mapped by MCOSD and initial treatments of pioneer trees were conducted by MCOSD staff in 2011. (4) Develop a long-term project plan based on overall invasive priorities and adjacency to sensitive habitat to control and eventually eradicate this species from the preserve. Note: Thoroughwort is addressed in project # 11 above.	0.4
	Ring Mountain	Since 2002 numerous invasive weed control programs have been initiated on the Ring Mountain Preserve. Both MCP staff and volunteers have been working to remove high priority weeds such as tocalote (0.75 acres), tall fescue (0.2 acres), fennel (3 acres), and pampas grass (4 acres) using an integrative pest management (IPM) approach. MCOSD staffs are now planning on expanding many of these project footprints in order to protect high value habitat. (1) Develop a control effort for Chilean mayten (12 acres), another high priority weeds, and seek partnership of other organizations such as BAEDN and CalFlora. (2) Continue mapping and monitoring efforts with the goal of detecting new threats, and assessing the efficacy of control techniques. The most effective IPM-based treatment methods will be adopted for the remaining high priority sites in order to ensure success.	19.95
	Rush Creek	An ongoing tree of heaven (*A. altissima*) control project consisting of approximately 0.3 acres has been conducted since 2005, with follow up treatments undertaken by MCOSD staff and volunteers. Assess the continuation of the current control efforts as a part of the larger prioritization effort outlined above. If deemed high priority, reassess distribution of tree of heaven and French broom, especially along newly constructed trail and identify most effective IPM-based treatment methods and continue to implement and monitor (through EDRR and Rapid Assessment) efficacy of treatments.	0.3
	Terra Linda/Sleepy Hollow	Control of two dense patches (totaling approximately 2 acres) of Oblong spurge behind homes was initiated by hired contracted crews in 2010. MCOSD followed up with hand removal in 2011. (1) Continue hand removal of all above ground plants, monitor, and follow up removal if needed. (2) A dense population (approximately 0.15 acres) of pennyroyal surrounding a vernal pool along preserve boundary has been treated annually by MCOSD since 2007. MCOSD staff and volunteers will continue follow up hand removal until population is eradicated. (3) Treatment (hand removal) of approximately 0.25 acres of Himalayan blackberry (*R. armeniacus*) was initiated in 2007 from seeps above Wintergreen Terrace by MCOSD volunteers. MCOSD will monitor and hand remove any remixing re-sprouting plants at this site. Continue to implement and monitor (through EDRR and Rapid Assessment) efficacy of treatments. (4) Several patches of medusa head, (totaling approximately 0.3 acres) have been observed along border of preserve, near a DPW street maintenance transfer/storage area along Miller Creek. Reassess this population and identify if it is a priority site. If so, determine most effective IPM-based treatment methods and (through EDRR and Rapid Assessment) efficacy of treatments. (5) Treatment for a pampas grass population (totaling approx. 1 acre) was initiated in 2000. This site has been successfully reduced to a hand pull site of scattered re-sprouting plants. Continue to hand pull all above ground plants and monitor (through EDRR and Rapid Assessment) efficacy of treatment.	3.7
District-Wide Wide-Area Fuel Break Assessment - Existing And Future	All preserves with existing and proposed wide-area fuel breaks	(1) Review and assess current and FMP-proposed fuel break locations with recommendations within Chapter 4. (2) Determine priorities for continued and new treatments - to include an assessment of all existing fuelbreaks and invasive plant occurrences and determine which breaks need broom containment zones, and which fuel breaks should be converted to wide-area fuel breaks to minimize potential spread of broom. (3) Identify target invasive species within all proposed wide-area breaks and assess where fuelbreak boundaries should be located to prevent continued spread of target invasive species. (4) Identify resources and treatment techniques required to initiate and sustain wide-are fuel breaks. (5) Develop monitoring cycle and long-term treatment cycle for each priority break based upon desired conditions. (6) In coordination with MCFD and other fire agencies provide recommendation about which locations are priorities for MCOSD for continued treatment, and what resources are required to sustain breaks. (7) Prepare agreements with fire agencies for prioritizing, resourcing, maintaining and monitoring work.	-
Wide Area Fuel Break Vegetation Management - *(Worn Springs Fire Road)*	*Bald Hill*	A 30-acre wide-area primary fuel break was initially cut in 2009. (1) Review and assess this break location with recommendations within Chapter 4. (2) Determine priorities for continued and new treatments, and assess invasive plant occurrences and determine if this break should be converted to a wide-area fuel break to minimize potential spread of broom.	30
Wide Area Fuel Break Vegetation Management - *Crown To Coronet*	*Baltimore Canyon - Crown Fire Road*	A 4.3 acre wide-area fuel break was established in 2010 by MCFD, MCOSD, Kentfield Fire Dept., and PG&E. Initial actions included the mechanical treatment of all invasive plants (French broom, acacia, etc.). (1) Follow up treatment in 2012 will include spot treating re-sprouting broom with herbicide. (2) Reassess distribution and control treatments of target invasive plants within fuel break, and continue to implement and monitor (through EDRR and Rapid Assessment) efficacy of treatments. (3) Meet with county fire to discuss opportunities to conduct dual fuel reduction/invasive plant control projects for broom/acacia in area as well as sustain fuel break.	4.3
Wide Area Fuel Break Vegetation Management *Hillside*	*Blithesdale Summit (Summit-Hillside)*	A 14.2-acre wide-area fuel break was established in 2010 by MCOSD and MVFD and is maintained by both agencies. Initial actions included the mechanical treatment of 14 acres of French broom and other species (Cotoneaster, pampas grass, pride of Madeira, etc.). (1) Follow up treatment in 2012 will include spot treating re-sprouting broom with herbicide. (2) Reassess distribution and control treatments of target invasive plants within fuel break, and continue to implement and monitor (through EDRR and Rapid Assessment) efficacy of treatments.	14.2
Wide Area Fuel Break Vegetation Management - *Camino Alto*	*Camino Alto Fire Rd.- Camino Alto Avenue*	A 15-acre wide-area fuel break was established in 2010 by MCOSD and MVFD and is maintained by MCOSD and MVFD. Initial actions included the mechanical treatment of 15 acres of French broom and pampas grass. Assess the continuation of the current fuels management efforts as a part of the larger prioritization effort outlined above. If deemed high priority, reassess distribution and control treatments of target invasive plants (e.g. French broom, etc.) within fuel break, and continue to implement and monitor (through EDRR and Rapid Assessment) efficacy of treatments. Meet with county fire to discuss opportunities to conduct dual fuel reduction/invasive plant control projects for broom/eucalyptus in area as well as sustain fuel break.	15
Wide Area Fuel Break Vegetation Management - *Camino Alto Ii*	*Del Casa Fire Road*	A 15-acre wide-area fuel break was established in 2011 by MCOSD and MVFD and is maintained by both agencies. Initial actions included the mechanical treatment of 15 acres of French broom and pampas grass. (1) Follow up treatment in 2012 will include spot treating re-sprouting broom with herbicide. (2) Reassess distribution and control treatments of target invasive plants within fuel break, and continue to implement and monitor (through EDRR and Rapid Assessment) efficacy of treatments.	15

Table 5.1 List of Potential Projects to be Implemented

Project Title	Preserve(s)	Description	Estimated Acres Treated
District-Wide Flashy Fuels Management	All - with focus on Zone 4: Urban Interface Vegetation Management Zone	(1) Assess current flashy fuels control program. (2) Determine priorities for continued and new treatments based on property lines, revised definition of fire threats (in coordination with MCFD). (3) Identify special-status species and target invasive plants within proposed flashy fuel treatments and change treatment timing so as to not impact special-status species, including nesting birds, and to not spread invasives, and to increase invasive treatment effectiveness. (4) Develop a rotating mowing and monitoring schedule based on bird nesting and invasive treatment calendars. (5) Prepare agreements with fire agencies for prioritizing, resourcing, maintaining and monitoring flashy fuels clearing.	-
District-Wide – Special-Status And Locally Rare Plants Inventory	All preserves that were not completed as a part of 2009 protocol-based surveys. Complete in order of priority set in Chapter 5	(1) Identify all preserves where special-status and locally rare species mapping has not completed using protocol-based survey methods. (2) Using priorities set in Chapter 5, complete inventory and mapping of special-status and locally rare plants. (3) Update GIS database.	-
District-Wide Vegetation Management Of Road And Trail Corridors For Access	All	(1) In coordination with Roads and Trails Management Planning effort, and using condition assessment and vegetation data collected as a part of the roads and trails planning effort, access requirement needs for projects 15-23, and District-wide plans for visitor access, review and evaluate which roads and trails require vegetation management for maintaining access. (2) Identify target invasive species within all proposed road and trail corridors and assess where vegetation management should be located to prevent continued spread of target invasive species.(3) Determine the frequency (e.g. annual, biannual etc.), optimal timing (e.g. late winter, etc.), and type of treatment (e.g. mechanical brushing, hand pruning, etc.) for treating priority roads and trails corridors. (4) In coordination with MCFD and other fire and land management agencies provide recommendation about which roads and trails corridors are priorities for MCOSD for continued treatment.	-
District-Wide Removal Of Priority Redundant, Under-Used/ Un-Necessary And/Or High Maintenance Roads And Trails, Related Restoration Of Native Vegetation Types	All	(1) In coordination with the current road and trail planning effort, MCOSD staff, MCFD, and other local fire agencies will jointly evaluate the conditions assessment for existing roads and trails and determine any redundant, unnecessary, underused, and high-maintenance roads and trails (special consideration given to roads and trails located within sensitive vegetation types and special-status species habitats (e.g., Legacy and Restoration zones). (2) Assess, determine and prioritize which roads and trails should be realigned, downsized (in part or entirety), or removed in order to protect sensitive biological resources and help reduce overall vegetation maintenance costs. (3) Prepare obliteration/habitat restoration strategy for each road/trail system prioritized. (4) Develop signage, public engagement materials and monitor closure.	-
Assistance With Implementing Recovery Plans For Federally-Listed Plant Populations		Contact USFWS to discuss how best to implement Recovery Plans for federally endangered species on MCOSD lands (e.g., Ring Mountain, Bothin Marsh). Coordinate funding, protection and enhancement actions, and implementation responsibilities with USFWS, DFW, and other agencies who oversee recovery plan implementation.	-
Rotational Grazing & Habitat Enhancement Program	*Alto Bowl/Horse Hill (Mesa Area)* *Mount Burdell*	(1) Per recommendations of the Alto Bowl/Horse Hill Resource Survey (2009), Grazing Recommendations for Mt. Burdell (2008) and the Mt. Burdell Management Plan (1990), review current best practices for managing livestock in sensitive open space areas. (2) Implement management strategy - consider rotational grazing, fencing to ensure livestock impacts are reduced such that actions support habitat restoration objectives (e.g. reduce invasive plant infestations, promote oak seedling recruitment and establishment, protect sensitive resources, etc.). (3) Revise grazing leases to reflect revised grazing management plan. (4) Develop and implement a maintenance and monitoring program for grazed areas. (4) Monitor results and adaptively manage.	1,724
Complete And Validate Wetland, Riparian Woodland And Grassland Classifications	All preserves that support these vegetation classifications.	(1) Grassland and riparian vegetation data in the current vegetation GIS dataset is incomplete. Conduct a targeted inventory of riparian woodland and grassland vegetation types (especially those that could support special-status species) using protocols consistent with existing vegetation classification data. (2) Update GIS database.	-
Riparian And Stream-Side Habitat Restoration	*Cascade Canyon* *Roy's Redwoods*	(1) Per recommendations in the Cascade Canyon & White Hill Land Management Plan (2005) and the Land Management Plan for Roy's Redwoods and Maurice Thorner Memorial Open Space Preserves (1989), assess riparian area condition and associated natural resource values, to include identifying threats and impacts (invasive plant infestations, erosion, non-designated access/use; infrastructure, etc.) to riparian and woodland corridors. (2) prioritize actions and develop a strategy to implement, including creating more shaded aquatic stream habitat and improve habitat function by removing nonnative trees and interplanting native trees over creek channels. (3) Design and implement monitoring and maintenance strategies for this developed plan.	-
Alto Bowl Oak Seedling Protection	*Alto Bowl*	(1) Install oak protection (grazing) around oak seedlings (especially around NE edge of oak woodland). (2) Monitor seedling development and protection efficacy, removing or replacing protection as goals are achieved.	<1
Kent Island Restoration Plan	*Bolinas Lagoon (Kent Island)*	(1) Per recommendations of the Kent Island Restoration at Bolinas Lagoon (2009) report, remove targeted invasive plants from Kent Island. (2) Implement MOU with Audubon to remove identified understory vegetation in a manner not to impact rookeries. (3) Implement monitoring program and develop maintenance plan.	23
Bothin Marsh Special-Status Plant And Wildlife Habitat Restoration Project	*Bothin Marsh*	See #13 District-Wide Target Priority Invasive Plant Control (Other Species) above. Follow recommendation in Bothin Marsh Enhancement Plan 2004: (1) Conduct annual invasive plant surveys of known salt marsh birds-beak and clapper rail habitats and targeted removal invasive plants. (2) Conduct EDRR for entire marsh initially targeting iceplant, fennel, acacia species and Russian thistle (note that *Spartina* and perennial pepperweed control are addressed in projects 7 & 9). (3) Monitor bird's beak population annually. (4) Continue enhancement of upland cover along outer levy and paths (initiated by volunteer program under a Conservancy grant). 5) Monitor and adaptively manage.	94.5
Bothin Marsh South Basin Excavation Project	*Bothin Marsh*	(1) Consider partnering with DPW to excavate 0.5 acres of fill at west end of South Basin (potential mitigation for DPW's Coyote Creek dredging project). (2) Develop a joint dredging and restoration plan with DPW. (3) Complete necessary permitting and environmental review. (4) Implement restoration and dredging actions. (5) Develop and implement mitigation and monitoring program.	0.5
Cascade Canyon Grassland Type Conversion & Meadow Restoration - Pilot Project	*Cascade Canyon*	(1) Based on Cascade Canyon Management Plan (2005), assess and select one invaded/disturbed meadow area to convert to native grassland habitat. (2) Identify targeted threats and control/removal treatments to achieve restoration/conversion objectives (e.g. conduct Douglas fir sapling removal, control priority invasive plants, etc.). (3) Implement maintenance and monitoring program until eradication and/or control is achieved.	-

Table 5.1 List of Potential Projects to be Implemented

Project Title	Preserve(s)	Description	Estimated Acres Treated
Gary Giacomini Serpentine Grassland/Scrub Protection & Enhancement	*Gary Giacomini*	(1)Using existing data and data collected as a part of project #1 prioritize targeted invasive plants either invading or established within serpentine grassland and scrub habitats using the methods outlined in Chapter 6. (2) Identify appropriate control treatment strategies. (3)Assess distribution relative to ongoing mowing, fuel management, road/trail locations and future proposed access. Determine if any of these other actions are affecting spread of the grass and if so, modify control strategy to reduce potential for spread (e.g. discontinue or restrict vehicle access etc.). (4) Establish a volunteer-based weed watch program to complement control actions- conduct ongoing volunteer EDRR patrol and hand remove resprouts throughout the year. (5) Implement maintenance and monitoring program until eradication and/or control is achieved.(6) Work with MMWD to simultaneously control Harding grass on adjacent MMWD lands.	-
Lucas Valley Distaff Thistle Control And Removal	*Lucas Valley*	Initial treatment of a small 0.75 acre population of distaff thistle *(C. lanatus)* began in 2002. MCOSD staff has reduced this site to a hand-removal site. 1) Assess the continuation of the current control efforts as a part of the larger prioritization effort outlined in Project 13 above. If deemed high priority, identify most effective IPM-based treatment methods and continue to implement and monitor (through EDRR and Rapid Assessment) efficacy of treatments. Coordinate with adjacent landowners of the possibility of cost-sharing control efforts and/or coordinating control on preserve and in adjacent areas.	0.75
Roy's Redwoods Oak Woodland And Native Grassland Restoration	*Roy's Redwoods*	(1) Based on the Land Management Plan for Roy's Redwoods and Maurice Thorner Memorial Open Space Preserves (1989) assess and select one each of the following: (a) an invaded/disturbed grassland habitat to convert to native grassland, (b) an oak woodland exhibiting poor health (impacts from SODs and/or disturbed understory/poor recruitment). (2) Identify targeted threats and control/removal and/or habitat restoration treatments to achieve restoration/conversion objectives (e.g. control SOD spread, protect sapling establishment, control priority invasive plants, etc.). (3) Determine if revegetation is required, as outlined. (4) Implement restoration actions. (5) Establish a maintenance and monitoring program until restoration objectives are achieved.	32
Mt Burdell And Terra Linda/ Sleepy Hollow Vernal Pool Habitat Enhancement	*Mount Burdell* *Terra Linda/Sleepy Hollow*	(1) Control targeted invasive plants and remove direct threats from sensitive habitats (based on the Grazing Recommendations for Mount Burdell Open Space Preserve - 2008). Since 2009, a dense, 1.3 acre population of pennyroyal has been treated along the edges of vernal pools that support rare species. MCOSD staff and volunteers continue management of this species on an annual basis. (2) Assess the continuation of the current control efforts as a part of a larger prioritization effort, including creating GIS-based files of current rare plant distribution and population size. If deemed high priority, identify most effective IPM-based treatment methods and continue to implement and monitor (through EDRR and Rapid Assessment) efficacy of treatments. (3) Implement maintenance and monitoring program until eradication and/or control is achieved.	1.3
Terra Linda/Sleepy Hollow Eucalyptus Containment, Fuel Reduction And Type Conversion To Native Grassland And Scrub	*Terra Linda/Sleepy Hollow*	In accordance with the Terra Linda Land Management Plan (1991), eucalyptus have been thinned on approximately 5 acres since 2001. The Plan recommends full removal over time, however places dbh size restrictions (<10"). (1) Assess current stand size and configuration, develop strategy to systematically control the leading edges of the stand and remove sections where stand density is low, intact grassland and scrub remnants remain, and other sensitive habitat persists. (2) Reassess eucalyptus forest thinning in coordination with MCFD and San Rafael Fire and discuss opportunities to conduct dual restoration/fire risk reduction/ invasive plant control, as well as sustain fuel break. (3) In conjunction with #1, prepare an overall timeline and strategy for fully converting the eucalyptus stand to a mixture of grassland, scrub and woodland habitats that provide increased wildlife habitat, reduced fire risk, and provides aesthetic values to adjacent residents. (4) Obtain project permits. (5) Determine if revegetation is required. (6) Develop and implement a public awareness program. (7) Implement both sapling containment and staged forest stand conversion coupled with overall fuel reduction. (8) Establish a maintenance and monitoring program until restoration objectives are achieved.	5

Project Planning

This section provides an overview of how to prepare a plan for restoration, invasive species treatment, and fuel reduction projects.

Actions covered in this section include:

- Analyze the site.
- Establish project-specific objectives.
- Identify and address issues and regulatory requirements.
- Determine the appropriate management approach.
- Develop appropriate success criteria and site-monitoring procedures.
- Engage local communities and implement outreach strategy.
- Prepare draft implementation plan.
- Finalize the plan, budget the funds, and schedule the work.
- Obtain permits and agreements.

Analyze the Site

Identification of constraints and opportunities presented by an individual site can be the basis for a go/no-go decision. Therefore, constraints and opportunities will be evaluated early in the project planning process.

Determine Past Site Conditions

Historic site conditions in many ways dictate the range of vegetation types and habitats that the site can sustain (Chainey and Mills 1989, Dawson 1984). Determining past site conditions increases the potential for successful vegetation type or habitat establishment and persistence. For example, if the site historically supported freshwater marsh, it is likely that freshwater marsh could be restored at the site if the natural processes that originally created it are restored. Conversely, a site that historically supported freshwater marsh probably would not be suitable for establishment of upland vegetation types such as oak woodland or native grassland without substantial grading, filling, or recontouring.

Some of the historic site conditions that are important to consider when planning a vegetation management project are:

- topography
- floodplain geomorphology (e.g., channel incision and sinuosity, sediment load, flow velocity)
- hydrologic functions (e.g., flood flow patterns, drainage patterns, channel plan form)
- past disturbance regimes and disturbance recurrence intervals (e.g., flooding, fire, grazing, erosion)
- soils characteristics and ecology
- historic climatic conditions and historic rainfall patterns (i.e., climatic conditions that were present historically that allowed historic vegetation to establish at the site)

Assembling a good historic picture will often require gathering and synthesizing many types of data. A variety of sources can yield historic information about a site, including historic maps and aerial photographs; written accounts of site conditions and site uses; rainfall logs and stream gauges from nearby areas; geologic maps; soil surveys; and other sources of information on site geology, landforms, and landform processes.

Evaluate Current Site Conditions

Current site conditions can provide important clues to past site conditions and to what vegetation types or habitats the site can currently support. The site should be visited to gather additional clues about past and present conditions and to confirm the validity and applicability of recorded historic information.

Dawson (1984) identifies existing conditions that are important when assessing a restoration site:

- presence of one or more of the target vegetation types
- presence of invasive species
- soil type and soil condition
- hydrologic function
- site topography in context

- indicators of past land use (e.g., abandoned ditches, water control structures, old foundations, fig trees, or pepper trees)

Existing conditions that are important when assessing a site for treatment of invasive species:

- accidental ignition potential
- aesthetics
- amphibians
- erosion and runoff
- nesting birds
- nontarget terrestrial and aquatic vegetation
- pollinators
- salmonids
- soil productivity and microorganisms

Existing conditions that are important when assessing a site for fuel reduction:

- affected habitat type
- proximity of invasive species infestations

Identify Other Constraints

Some items that can pose constraints:

- easement restrictions
- locations of trails or access points
- utility easements and physical locations of utilities (e.g., access agreements that restrict vegetation growth within the easement area, locations of underground utilities, especially old petroleum pipelines or fragile fiber optic cables that may require repair or special site treatment)
- fuel management and emergency access requirements

- property access agreements (formal and informal) with adjacent landowners
- hazardous materials (e.g., old farm buildings, underground tanks, hazardous substances)
- adjacent land uses (e.g., herbicide use, proximity to residential developments and structures, water flow patterns)
- size and configuration of parcel

The presence of one or more of these factors will not necessarily stop the project. It is merely something to be evaluated during the site selection process. MCOSD natural resource staff will determine the go/no-go threshold for constraints as well as the relative weight of a given constraint when compared to the goals for the project. For example, the presence of a buried natural gas pipeline at a potential site may highly constrain a portion of the site for the restoration of a live oak woodland. However, should the site be targeted for grassland restoration, it might be possible to easily incorporate the utility easement in the restoration project.

Establish Project-Specific Objectives

Once baseline conditions are well-understood and potential constraints and opportunities are considered, the planning team can develop objectives specific to the project. The development of objectives can greatly aid in focusing team discussions and planning efforts for larger and/or more-complex sites or projects. Clear and concise objectives can also help other parties (e.g., the public, regulatory agencies) understand what is envisioned for the project.

At a minimum, the objectives for a vegetation management project will include the following items:

- target vegetation types
- total area to be treated
- relationship with the surrounding landscape
- project timeframe (i.e. number of years to implement the plan and number of years until the project is considered successful)

An example objective statement is “The objectives for this project are to establish 120 acres of live oak woodland over a span of five years, resulting in a nearly continuous high-quality coastal live oak vegetation type in 25 years.”

Identify and Address Issues and Regulatory Requirements

Identify and Address Site-Management Issues

In some instances, the difficulty and life-cycle cost of a project can be significantly increased by unforeseen management issues, such as invasive plant infestations, trespass, influences associated with adjacent agricultural or residential land uses, or erosion. Potential management issues need to be determined and addressed to the extent possible early in the planning process so that surprises are minimized.

For example, a site that currently has a significant invasive plant problem will most likely continue to have an invasive plant problem until the restored vegetation type is well established. Management actions to control the invasive plant may require a considerable amount of time and energy during the first few years of site establishment, and the expenses associated with this control may be significant.

Similarly, a site that has traditionally had problems with visitor trespass and use of unauthorized trails, will likely continue to experience those problems; therefore, law enforcement and use of fencing may become significant management issues.

Identify and Address Regulatory Requirements

Overview

Environmental regulations that may influence projects:

- Federal Endangered Species Act
- Federal Migratory Bird Treaty Act
- Clean Water Act, sections 401, 402, and 404
- Porter-Cologne Water Quality Control Act
- Rivers and Harbors Act, section 10
- Executive Order 11990 – Protection of Wetlands
- Executive Order 13112 – Invasive Species
- California Fish and Game Code, section 1602 (Streambed Alteration Agreement)
- California Fish and Game Code - Fully Protected Species

- California Fish and Game Code, sections 3503 and 3503.5 – Protection of Birds and Bird Nests and Raptors and Raptor Nests
- California State Wetlands Conservation Policy
- California Native Plant Protection Act (California Fish and Game Code, sections 1900 to 1913)
- Marin County General Plan (2007)

Compliance with these regulations may require a substantial planning or permitting effort when wetlands or endangered species are involved. Because special-status species and wetland issues are likely to be the most significant regulatory constraints during restoration at the preserves, they are discussed in more detail below

Local planning ordinances and local permits may also be required for conducting flaming or controlled burns, removing heritage or other protected trees, resolving encroachment or lease issues, or applying pesticides. Early determination of what permits are needed, and early submittal of permit applications, can greatly expedite a project.

Determine Effects on Special-Status Species

The presence of special-status species and the potential to affect these species may influence how a project is planned and implemented. In general, species listed under either the state or federal Endangered Species Acts require consideration of possible effects during the planning process. If a listed species is present at, or adjacent to, the site, complete avoidance of the species and its habitat is recommended. Avoidance measures will be developed with the appropriate regulatory agency (i.e., U.S. Fish and Wildlife Service and/or California Department of Fish and Wildlife). If complete avoidance is not possible it will be necessary to secure the necessary permit (Federal Endangered Species Act section 7 or section 10 permit) or agreement (California Fish and Game Code section 2081 management agreement) authorizing disturbance or take of a listed species or its habitat. Refer to chapter 7 for best management practices intended to eliminate or reduce impacts on special-status species, and incorporate them as necessary into project design and implementation.

Determine if Wetlands or Other Sensitive Vegetation Types Are Present

In many instances, wetlands will be adjacent to, or within, restoration sites, and minor modifications (e.g., grading, filling, recontouring) of onsite wetlands may be necessary to fix erosion, stabilize stream channels, repair culverts that are causing sedimentation, increase flood capacity, or promote site drainage. In these instances it may be necessary to obtain a Section 404 (wetland fill) permit (from the U.S. Army Corps of Engineers) for the placement of dredged or fill material into jurisdictional waters of the United States. The U.S. Army Corps of Engineers has a streamlined permit process (the Nationwide Permit Program) for restoration projects. Specifically, Nationwide Permit 27 (NWP 27) authorizes activities in waters of the United States associated with the restoration of former waters, the enhancement of degraded tidal and nontidal wetlands, and riparian areas, the creation of tidal and nontidal wetlands and riparian areas, and the restoration of nontidal streams and open water areas. Authorization of a project under NWP 27 will require notification of the U.S. Army Corps of Engineers through submittal of a preconstruction notification package.

Rivers or streams, including riparian areas, up to the edge of the 100-year floodplain may also be under the jurisdiction of the California Department of Fish and Wildlife, and projects may require a section 1603 streambed alteration agreement with the Department of Fish and Wildlife and/or the Regional Water Quality Control Board. The execution of these agreements may also require compliance with the California Environmental Quality Act.

Determine if Additional Environmental Documentation or Permits Are Required

Some projects will require additional environmental documentation of permitting. For example, projects involving prescribed fire or herbicides may require a county burn permit or a pesticide recommendation, respectively. Planning checklists will be used to help determine what additional environmental documentation and permits will be required.

Determine the Appropriate Management Approach

The guidance for determining the appropriate approach to specific kinds of management activities and projects is addressed in detail in chapter 4.

Develop Success Criteria and Site Monitoring Procedures

Specific success criteria and monitoring procedures will be developed for each project. Success criteria may be set on a species-by-species basis or for a site as a whole.

Examples of success criteria for different types of projects:

- Restoration project: By the end of the fifth year 80% of the planted material will be alive and vigorous, tree canopy cover at the site will be more than 20%, and natural recruitment of riparian-associated native plants will be occurring on over 50% of the recontoured stream bank.

- Invasive species treatment project: By the end of the fifth year, all adult invasive plants will be reduced by 100%, with newly emerging plants reduced by at least 80%.

- Fuel reduction project: By the end of the fourth year, invasive plant density within the fuelbreak will be reduced by at least 80% and future follow-up treatments can be managed by hand.

Monitoring procedures will be developed so that they, in the most direct and effective way possible, illustrate whether or not a site is progressing towards, or has met, its success criteria. Refer to chapter 6 for project monitoring protocols.

Engage Local Communities and Implement Outreach Strategy

Public support for natural resource management projects is critical to balancing competing land uses and the trade-offs between improving natural resources and improving human well-being and access (Society for Ecological Restoration 2004). These challenges are particularly relevant to MCOSD preserves— many of which have varying land use histories and management mandates and recreation and visitor use objectives.

MCOSD will assess and integrate public sentiment and public involvement into restoration planning by implementing an outreach strategy that may include the following:

- Develop project-specific informational materials to be posted at the proposed project site.
- Post project-specific information on MCOSD website.
- Hold a public meeting to inform communities, answer questions, and gather project feedback.
- Speak directly with adjacent neighbors on site (e.g., in coordination with local fire agencies, MCOSD has visited neighbors who live immediately adjacent to a project site to discuss details).

Prepare the Draft Implementation Plan

Implementation plans for specific projects will include the following items in roughly the order listed below:

- executive summary (optional, but useful when applying for permits with regulatory agencies)
- project need and objectives, including success criteria (annual and overall)
- site conditions
- environmental compliance and permitting (if needed)
- selected approach and how it will be implemented
- invasive species control plan

- monitoring and adaptive management
- references
- supporting exhibits and plans

Finalize the Plan, Budget the Funds, and Schedule the Work

A budget and schedule will be prepared to accompany the draft plan through review by MCOSD natural resource, planning, and operations staff. Plan approval will include a decision that adequate funding and staff time will be available to implement the project as planned.

Obtain Permits and Agreements

Ideally, this step starts one year or more ahead of project implementation. Assuming proper implementation of best management practices (see chapter 7), the proposed project should not affect special-status species or high-value vegetation types. However, on the occasions that a project, even with best management practices, might affect a listed special-status species or high-value vegetation type, such as a wetland, permit compliance will be required before the project can be implemented.

Project Prioritization Process

Many methods exist to prioritize and rank projects. Prioritization systems usually fall into one of two categories: numerical ranking systems, or flow-chart-type sieving systems. There is no ideal method for a given program or project, and every system has its shortfalls and biases. The system that will be used by MCOSD was developed by the National Park Service, an organization that must deal with diverse resources, interest groups, and stakeholder groups, similar to MCOSD.

Apply Modified Delphi Technique

The prioritization process described below, referred to as a Modified Delphi Technique (Delphi Technique) allows staff, stakeholders, and external experts to collectively discuss, refine, and produce a prioritized list of vegetation management actions for MCOSD lands. The Delphi Technique was developed by the RAND Corporation in the late 1960s as a forecasting tool. Later, the U.S. government enhanced it as a group decision-making tool in which a group of experts could come to consensus when the decisive factors were subjective, rather than knowledge-based. The Delphi Technique is particularly appropriate when decision-making is required in the context of a political or emotional environment, and it works formally or informally, in large or small contexts. It reaps the benefits of group decision making while insulating the process from a variety of limitations, such as over-dominant group members, skewing results towards one interest, or lobbying. This approach has the added advantage of working as an informal, subjective model when the decisions are based on opinion, and it can be directly converted to a formal model when the data is more knowledge-based. For the purposes of assessing MCOSD vegetation management priorities, this methodology can be combined with a numerical project scoring system to allow for the inclusion of both subjective and objective information.

Using the Delphi Technique will require the recruitment of a group of knowledgeable individuals who know MCOSD resources intimately, and who have differing backgrounds. For example, participants could be a natural resources staff member, a maintenance staff member, a county planner, a CNPS or Audubon representative, and a local resident (homeowner association representative, recreationist, or naturalist). Alternatively, participants could be limited to county employees. In either scenario, once the group is selected, it is tasked with assessing potential projects. The current list of potential projects is provided in table 5.1.

The group will conduct planning sessions and to freely discuss the objectives, importance, and possible results of a vegetation management action. Maps and aerial photography are important tools when discussing the location and the size and scope of a proposed action. Having a broad base of experts can help determine critical issues and help the group reach consensus on issues of concern before a project moves towards implementation.

It is recommended that MCOSD implement the Delphi Technique as follows:

Step 1. Select a facilitator for the meetings. This will be someone who is *not* a stakeholder, and therefore can participate objectively.

Step 2. Create a technical advisory committee consisting of stakeholders and experts representing various MCOSD programs or divisions, the individual preserve, and the stakeholders. Participants will be selected because of their intimate knowledge of MCOSD preserves, planning process, individual preserve(s), and/or familiarity with relevant technical subject matter (e.g., fire management, landscape architecture, hydrology, wildlife biology, botany, or other studies). Member selection will be based largely on the participants' "real-world" experiences that will enable them to prioritize the project actions effectively. The advisory committee can be made up of county staff only, or a combination of staff and outside stakeholders.

Step 3. Synthesize existing resource data into a visual format. Relevant natural resource, fire, and invasive plant data will be synthesized and compiled into a visual format that can be readily manipulated. A GIS database is an excellent format for this planning exercise, but printed aerial photographs or vegetation maps with clear overlays can also be used. A series of map layers representing similar resources or subject matter can be created as clear acetate overlays for a common base map. The participants will use the various resource layers to identify where there are overlapping areas of concern (e.g., invasive plants on a cultural resource site, bird nests near hazard trees to be removed) or areas of high resource values and restoration opportunities (e.g., areas with wetland resources, important wildlife areas, major trails).

Step 4. Identify project ranking criteria. During a brainstorming session, the participants will develop a final list of project ranking criteria. Possible project ranking criteria are presented below (see table 5.2); however, the committee may modify them or weight them based on relative importance. Possible types of ranking criteria include

- projects that reduce overall maintenance costs
- projects that reduce fuel load or improve forest health
- projects that increase fire and visitor safety (e.g., reduce fire risk, improve trail conditions)
- projects that restore native habitats and increase wildlife and wetland habitat values
- projects that can easily be sequenced with other planned activities
- projects that create wildlife corridors and protect or restore wildlife habitat values
- projects that control target invasive plants and provide sustainable restoration opportunities
- projects that offer opportunities for increased community involvement
- projects that improve the visitor experience (e.g., creating viewsheds, interpretive opportunities)
- projects that maintain the rugged and wild character of the preserves

Step 5. Conduct initial planning session to discuss selection criteria and possible projects. The committee will conduct a free-form discussion of what projects might meet the suggested criteria. The visual aids (maps) should be available for reference throughout the discussion so that all resource issues can be accurately considered. The goal of the initial session will be to reach full or partial consensus on both the selection criteria and on the types of projects that should be considered. The intent of the first meeting is not to reach complete agreement on all issues and projects, but rather to identify those issues and projects that will or will not be acceptable to all participants. This will allow the group to focus on those issues and projects that will require more consideration and discussion to reach consensus.

Step 6. Conduct second planning session to discuss project priorities. At the second planning session, the participants should discuss the project priorities based on the application of the project selection criteria. The project boundaries, objectives, and timing of each of the various proposed projects should be considered, as well as new projects and modified projects. As a result of the second planning session, the participants should come to agreement on most of the major issues and reach agreement on most, but not all, of the priorities.

Step 7. Assess capacity, capabilities, and planning timeframe and adjust projects accordingly. The projects selected as a result of the second planning session will be screened to ascertain that they can be accomplished within the specified timeframe and that MCOSD and other stakeholder groups have sufficient staff, oversight, and other capacities to successfully implement the projects using staff, contractors, volunteers, or a combination. A smaller group of MCOSD management staff or experts with extensive experience implementing projects should be involved in this assessment. As a result of input from these staff and experts, the list of projects under consideration will be reduced to those that are considered reasonable to implement within the planning timeframe.

Step 8. Gather any remaining technical data necessary to finalize decisions. As the proposed project list is further refined, technical questions will surface that require additional data collection and assessment efforts. Additional information gathering should be conducted to help develop a greater understanding about the feasibility and appropriateness of the proposed projects.

Step 9. Prepare list of annual project priorities. Based on the initial list of projects, the capabilities and timeframe assessment, and the additional technical data, a list of project priorities for the year will be developed and circulated to the participants for review and comment. The group should be encouraged to view the projects in the field and then submit any final comments, suggestions, changes, or approvals.

Step 10. Finalize List of Projects. After receiving final input from participants, a final list of projects to be conducted in the next calendar year will be developed. These will be the projects that are considered by the group to be strategically important, technically sound, feasible to undertake, and possible to coordinate within the planned project timeframe.

The prioritization process described above will result in a list of projects that have been ranked (in this case, numerically scored) in order of importance. This process is typically conducted once, and updated every one to three years. Monitoring data is used to determine success, and adaptive management results usually feed into selecting or modifying selection criteria. The data sheet below (table 5.2) provides a sample numerical ranking system.

Table 5.2 Project Ranking System

Project Ranking Criteria	Ranking (0,1,2,3, N/A)	TOTAL
Sensitive Biological Resources		
a. Protects or enhances special-status and/or locally rare species.		
b. Protects or enhances sensitive vegetation types, unique microclimates, or geologic features (e.g., serpentine outcrops).		
c. Protects or enhances wetlands or riparian areas.		
Sum		
Threats To Natural Resources		
a. Controls and/or removes targeted invasive plants.		
b. Controls erosion and/or restores natural hydrology/drainage.		
c. Reduces spread of plant pathogens.		
d. Reduces risk of vegetation type conversion.		
e. Improves forest health.		
Sum		
Fire Risk Reduction, Fire Hazard Management		
a. Increases public safety and/or reduces risk of fire damage to buildings and structures.		
b. Reduces fuel loads and related risk of wildfires on MCOSD preserves.		
c. Maintains existing fuel management areas in a manner that reduces invasive plants and establishes a 5-year maintenance treatment cycle.		
d. Reduces overall maintenance costs.		
Sum		
Public Engagement and Support		
a. Improves public recreational and/or interpretive opportunities.		
b. Provides for increased volunteer and/or stewardship opportunities.		
c. Has significant public interest and support.		
d. Increases public understanding and support for MCOSD preserves.		
Sum		
Potential for Funding		
a. Funding available (in part) through other programs and/or projects.		
b. Current funding potential.		
c. Potential for future funding advantage (grants, partnerships etc.).		
Sum		
Potential for Implementation Success, Project Feasibility		
a. Project can be accomplished within projected timeline, including permitting and CEQA (project readiness).		
b. High level of outcome for resources expended.		
c. Integrates with existing programs.		
Sum		

Table 5.2 Project Ranking System

Project Ranking Criteria	Ranking (0,1,2,3, N/A)	TOTAL
Consistency with Internal Programs and Staff Capacity		
a. Consistent with existing MCOSD mission statement, values, and/or program goals and objectives		
b. Within available MCOSD staff capacity		
c. Reduces overall maintenance costs		
d. Compatible with internal organizational priorities		
Sum		
Total ranking for proposed project		
Note: Projects will be ranked within each category using the following criteria: **3 This project meets all the applicable criteria for this category.** **2 This project meets most of the applicable criteria for this category.** **1 This project meets a few of the applicable criteria for this category.** **0 This project does not meet any of the criteria for this category.** **N/A This project does not have any relevance to this criteria category (e.g., a polygon that includes invasive plant removal only, would receive an n/a for the trails criteria).**		

Community Engagement and Volunteerism

This section provides an overview of the role volunteers can, and will, play in implementation of vegetation management actions now and in the future.

Background

Community participation in the stewardship of natural areas has been growing exponentially during the past 20 years. Volunteers contribute millions of hours of donated labor to conservation efforts each year. According to a recent survey, an estimated two million Californians participated in volunteer workdays sponsored by community-based stewardship groups such as the “Adopt a Creek” or “Friends of Local Parks” groups that have become ubiquitous throughout California.

Volunteerism is an integral component of MCOSD programs, engaging thousands of participants annually. MCOSD first established a volunteer program in 1979 by creating the Volunteer Mounted Patrol. MCOSD expanded the volunteer program in 1993, when it hired a half-time volunteer program coordinator. By the mid-1990s, the program grew to include the Environmental Stewardship and Native Plant Nursery programs. Within the past decade, MCOSD added the Trail Watch and the Conservation Easement Monitoring programs, and the volunteer coordinator has become full time. Natural resource, administrative, and seasonal staff also support volunteer program efforts.

This section outlines additional volunteer opportunities that can be undertaken by MCOSD, possible community engagement and partnership opportunities to further augment the current program, volunteer work plan coordination and reporting recommendations, and resources to support prioritizing and evaluating volunteer activities specific to vegetation management. Going forward, there will be increased opportunities for volunteers to participate in stewardship activities.

Currently, many of the volunteer project sites fall within the legacy and sustainable natural systems zones. Therefore, existing projects are likely to remain high priorities. Additionally, the adoption of new vegetation management and monitoring activities, such as an early detection and rapid response program, and a more robust special-status species monitoring program, will provide new volunteer opportunities.

Summary of Current Volunteer Program Activities and Accomplishments

Currently, volunteers support habitat restoration, native plant propagation, community education, and trail and conservation easement monitoring. Volunteers are also the backbone of many special events. Participants range from senior citizens to local youth, and represent a diversity of interests and backgrounds.

MCOSD's volunteer program currently focuses most of its vegetation management activities at the Ring Mountain, Old St. Hilary's, Santa Venetia and Bothin Marsh, Rush Creek, and Terra Linda/Sleepy Hollow Preserves. The volunteer program coordinator selected these locations because they host sensitive natural resources and present a need for resource protection and management.

MCOSD has held more than 50 volunteer workdays annually since 2007. Volunteers complement and support the work of full-time and seasonal staff, accomplish important tasks, and support programs that would either be limited or cease to exist without volunteer participation. Volunteers have been, and will continue to be, integral to achieving vegetation management goals on MCOSD preserves. Over the years, the volunteer program has recruited many community members who have made significant, tangible contributions to resource protection and restoration; the program has provided student enrichment; and it is poised to achieve even more.

Volunteer Program Vision Statement, Goals, and Strategies

The volunteer program has the following vision statement:

> *The volunteer program engages the community in the responsible stewardship of parks, open space, and landscape facilities, and provides opportunities for unique, meaningful experiences in projects and programs that help fulfill the mission and goals of MCOSD.*

As noted in the strategic plan, the volunteer program is responsible for recruiting, training, and retaining volunteers, including both individuals and organizations, to perform activities mostly related to habitat restoration and trail maintenance. These programs include Environmental Stewardship, Easement Eagles (conservation easement monitoring), Volunteer Mounted Patrol, Native Plant Nursery Programs, and numerous large-group and special events.

The *Marin County Strategic Plan* identifies the following goals for volunteerism:

- Foster discovery, learning, and stewardship.
- Engage the community by providing volunteer and educational experiences for people to discover, learn about, protect, and restore their parks and open space.

Linked to these goals are specific strategies to grow the current volunteer program:

- Conduct outreach to Marin County's diverse populations in an effort to increase access to MCOSD preserves.
- Develop an outdoor education program to complement other local programs.

Building from the goals and strategies outlined in the strategic plan, the goals for the vegetation management program (listed in chapter 1) include the following goal related to volunteerism:

- Provide the public with opportunities to engage in stewardship of MCOSD lands through participation in volunteer-based vegetation management activities.

Ongoing community engagement, public involvement, volunteerism, and education are paramount to both achieving these goals and successfully achieving vegetation management goals. Therefore, staff will continue to work with stakeholders, schools, and other partners to enrich existing programs, increase coordination between departments, and develop new program opportunities that will engage visitors and integrate volunteers in hands-on activities.

Developing an Annual Volunteer Work Plan

All local land managers interviewed agreed that the most effective volunteer programs are those that successfully address both management priorities and community interests. Programs built from this foundation often find it easier to leverage and allocate limited agency funding, build and sustain community involvement, and demonstrate tangible shared results (for example, a volunteer effort that targets the protection of one of MCOSD's most sensitive resources, and the reduction of fire fuels along a boundary shared by MCOSD and a homeowner association).

Understanding, integrating, and then prioritizing management and community needs can often be a difficult task, especially when compounded by funding constraints, limited staffing, and other MCOSD priorities. Concurrently, the Volunteer Program responds to the interests of local stakeholders and partners when identifying projects to undertake.

The success of transitioning and expanding the volunteer program will rely upon its use of the project prioritization process for vegetation management actions described earlier in this chapter. Once annual project priorities are developed and approved, the volunteer coordinator will then work collaboratively with natural resource and operations and maintenance staff to determine which annual tasks will be appropriate for volunteer participation.

Establishing an interdepartmental priority-setting structure that involves the volunteer program will also help the MCOSD to achieve two of the outcomes identified within the strategic plan (MCOSD 2008): improving internal communication among staff and creating structured opportunities for diverse audiences to engage in long-term substantive involvement in supporting the MCOSD's resource preservation work.

Volunteer Project Assessment Criteria

Currently, the following criteria are used to informally assess the feasibility and appropriateness of assigning tasks to volunteers:

- The project or activity is part of past volunteer efforts.
- The activity protects and/or enhances special-status species.
- The activity reduces the risk of fire
- The activity is achievable by volunteers.
- The activity is accessible and can safely be accomplished by volunteers.
- The activity has easily-demonstrated values.
- There is community interest in performing the activities.
- The work is best performed by volunteers.
- The activities can be performed using tools that are appropriate for volunteers.

Given the anticipated future program growth, MCOSD will consider the following additional criteria to guide future project selection:

- The project or activity is an MCOSD priority.
- If the activity is undertaken, plans and resources are in place to ensure that the desired

outcome is achieved and maintained.

- The program has the capacity to train and oversee the volunteers.
- The volunteers can clearly visualize the effect they have had through their volunteer contributions.

An annual volunteer work plan of priority projects will serve as a tool for volunteer recruitment and placement, for communicating shared expectations and goals with local community stakeholders, and for budgeting and fundraising. As the number of vegetation management projects undertaken by MCOSD increases over time, it will be essential to add capacity to the volunteer program.

Information and Data Management

Currently, the volunteer program uses an Access database to track information about volunteers (e.g., contact information, number of hours), as well as project information (e.g., preserve, location, project type, date). The need for up-to-date vegetation maps is a high priority for supporting volunteer activities, as well as maps that depict the locations of special-status species and invasive weeds. As a result, data for the volunteer program will be linked to the GIS and spatial data will be recorded during every activity.

Evaluation and Reporting

The coordinator is responsible for analyzing and evaluating volunteer records, including the number of volunteers and the number of hours spent on the myriad of tasks performed. Reporting occurs on a semi-annual basis. The volunteer “experience” is informally assessed at the conclusion of individual work days by asking volunteers to share what they have learned or something about their experience.

A strong evaluation measure of the success of a volunteer program is retention –do volunteers continue to participate, do they increase their level of participation, and have the number of partnerships been increased? MCOSD’s volunteer program has been successful in terms of sustaining long-term volunteers. Additionally, the program has increased the number of long-term partnerships with nonprofit organizations. MCOSD will continue to grow and diversify these long-term relationships as an integral component of implementing the *Vegetation and Biodiversity Management Plan*.

Several other evaluation measures will be developed or adapted from other land managers to capture more qualitative information about the quality of the volunteer experience, the perceived value of the program, and volunteer interests for existing activities and new activities. It is also critical to assess which activities are best suited for volunteer participation, and which are better suited for staff or contractors. These assessment measures may also support the acquisition of future grant funding. Outcome-based evaluation measures are also good indicators of the breadth and impact of a volunteer program. Additionally, reporting could also reflect the number of special events held, community workdays completed, youth served, etc.

Staff and Volunteer Training

Volunteer-based stewardship programs are numerous in the Bay Area. They include almost a hundred Friends-of-Creeks groups; dozens of programs facilitated by land management, government, and non-profit organizations; and numerous volunteer-based conservation organizations. Each program provides the volunteer with a different experience and opportunity to perform service. The experience is largely shaped by the setting, the understanding of the value of the work, the type of work, and the coordinator's leadership. As MCOSD continues to grow the volunteer program, it will provide more comprehensive training programs for staff and other volunteers who lead volunteer programs, especially as more rangers, seasonals, and other staff are needed to facilitate program delivery. It is recommended that other MCOSD staff also receive volunteer management training. This training could take the form of short interactive modules, possibly conducted in conjunction with a project partner or through another land manager's training program. Training topics could include the following:

- how to run workdays and interpret the vegetation management work and outcomes
- how to manage diverse audiences
- how to manage groups of varying ages

Many training resources are available to support staff and volunteer development. For example, the *Weed Workers' Handbook* (The Watershed Project and California Invasive Plant Council 2004) provides a detailed outline of commonly asked questions about vegetation management, steps for running a work day, and tools and strategies for managing weeds with volunteer support.

Equally important is creating continued educational opportunities for participating volunteers and partners. Several focus groups and studies (Farrell 2003) have shown that while many volunteers initiate their volunteer service based on responding to a need or their desire to protect and restore the environment, the majority sustain their participation when they have a social or community experience and continually receive educational experiences. Education can take the form of information shared during program introductions and wrap-ups, as well as more structured activities. Hands-on engagement for people of all ages offers rich opportunities to develop insights and understanding into local and global ecological issues. Resource education activities not only foster eco-literacy, but also contextualize the volunteer work and, in turn, help promote volunteer motivation and retention.

As described above, several land managers and organizations provide training for volunteers interested in resource and vegetation management; most specifically weed removal and monitoring. MCOSD already provides in-depth field training to some participants, such as the Mounted Patrol, as well as naturalist programs and walks as a part of some volunteer workdays. Going forward, formal and informal educational experiences could be expanded. This will be especially important for new program opportunities, such as integrating volunteers into the early detection of weeds, or having volunteers locate and map new rare plant occurrences.

Additionally, training courses associated with management and stewardship of natural areas could be developed to build staff and volunteer capacity. These courses could include

- native plant and weed identification
- weed control techniques
- leading volunteer activities in natural areas
- monitoring methods
- native plant seed collection and revegetation
- natural history of the Marin County region
- interpretive training
- public speaking

Opportunities for Increasing Community Engagement and Partnerships

MCOSD will build the capacity of its volunteer program to further support the goals and actions outlined in this plan. That commitment, coupled with increasing vegetation management requirements, underscores the need to build the program's capacity and infrastructure. This will likely require expanding MCOSD's community engagement efforts to new audiences by strategically considering regional and local trends. This section outlines a number of relevant trends that can be further explored, new and existing audiences that could support program goals, and program infrastructure considerations.

Trends

Increasing familiarity with current trends can provide insight into which audiences to target; how to better brand and market programs; and understanding what programs can best support public interest and outreach strategies. Access to trends analyses and findings is typically available through volunteer centers, program partners, institutions, and foundations in local geographic areas. Below are a number of findings to consider when growing the Volunteer Program.

National Attention on Volunteerism

Over the past year, there has been increased national attention on volunteerism generated by the first-ever Service Nation Presidential Candidates Forum, a new bipartisan legislative proposal to expand support for volunteering and service, and the emergence of cabinet-level positions on volunteering in two states. It is anticipated that increased funding will be available for programs such as AmeriCorps and other agencies and organizations that have a national/regional focus on service and civic engagement.

The volunteer program received administrative and program delivery support until recently from AmeriCorps participants. These national initiatives may create new opportunities to renew that partnership through local Conservation Corps, and provide much needed support for augmenting the MCOSD's volunteer management needs and growing an early detection and rapid response and other monitoring programs.

Attention on Collaborative School/Park Partnerships

There is currently increased national attention, focus, and potential funding linked to collaborative school/park partnerships, including America's Great Outdoors Initiative and others (http://www.doi.gov/americasgreatoutdoors), Let's Move (http://www.letsmove.gov/), Outdoor Nation (http://www.outdoornation.org/). The Volunteer Program has a number of school-based partnerships and is currently growing a docent program to further support these partnerships. Further opportunities and funding may be become available to support these efforts—specifically in increasing participation from under-represented youth. Under these initiatives, partnerships could be strategically developed with school districts, organizations supporting youth development, and other partners. While funding is promising, it is important to note that overseeing youth-based volunteer programs requires considerable staff resources.

Recognition of Health Benefits of Volunteering

According to a 2005 Marin County health needs assessment, 34 percent of young people ages 2 to 17 years are overweight and 30 percent of young adults aged 18 to 24 years are overweight. Links between childhood obesity and limited exposure to healthy outdoor experiences and foods are becoming more recognized. There is also a growing recognition of the health benefits associated with volunteering, especially in areas where volunteers actively participate outdoors in MCOSD projects. Studies supporting this include national survey studies, sociology studies, women's health articles, and more. These studies primarily cover three types of benefits: physical health benefits, mental health benefits, and community/social health benefits. Some studies, such as the one published in *Harvard Heart Letter* (July 2004), even include the number of calories that a participant can burn when weeding or planting trees. On a local level, the Institute at the Golden Gate National Recreation Area recently hosted a forum on "park prescriptions" which brought together open space managers, doctors, and researchers to discuss the health benefits of getting people outdoors, including volunteering. Caution is offered, however, about how coordinators use the health benefits of volunteering as a tool for recruiting potential volunteers. Wilson and Musick (1999) noted that, “There can be little doubt that these benefits are usually unintended consequences of behavior that is motivated not by extrinsic but intrinsic rewards. Indeed, there are justifiable fears that attaching rewards to altruism will undermine motivation and distort values. It is not likely, then, that this information on benefits can be used productively as a recruitment tool or means of mobilizing volunteer effort … Self-discovery is not the effect of volunteering; it is volunteering itself.”

Increase in Older Volunteers

The number of Baby-Boomers, or Americans over 65, will increase 50 percent by 2020. The strategic plan also notes that Marin County’s population aged 65 and over will increase dramatically, from 13.8 percent in 2000 to 23.5 percent by 2010, and this population is expected to increase further in the future. Baby-Boomers are reported to be healthier and more educated than past retirement-aged citizens, and are predicted to live longer than their parents (Eisner, Grimm, Maynard & Washburn, 2009). This demographic represents a possible recruitment opportunity for the volunteer program, specifically the recruitment of volunteers with valuable and specialized skills and flexible schedules. Older volunteers could serve as a vital resource, once trained to become volunteer leaders, monitors, docents and/or to provide data management and administrative support to the program.

Increased Participation by Corporate and Religious Groups

Promising strategies to recruit new volunteers include partnering with businesses and religious organizations that want to participate in structured volunteer service programs (Eisner, Grimm, Maynard & Washburn, 2009). These types of organizations and corporations are likely to increase their encouragement of employee volunteerism in the next decade, especially given a recent study that noted that 68 percent of people between the ages of 18 and 26 are reported to prefer to work for a company that provides volunteer opportunities through the workplace (Deloitte & Touche, 2007).

Potential for Increased Contributions from Marin County Residents

Anecdotal evidence suggests that many Marin County residents lean toward a culture of monetary contributions to, rather than participation in, land management and stewardship. As an example, the Golden Gate National Parks Conservancy Stewardship program reports that a larger portion of the drop-in volunteers who participate in southern Marin County volunteer work events are from San Francisco or the East Bay, rather than from Marin County. Feedback from a number of Parks Conservancy staff and volunteers suggests that many Marin County residents have more money than time, and would rather support these types of volunteer efforts financially because they are already involved in many other community activities (e.g., parent-teacher associations, sports teams). In response, the MCOSD will consider developing a clearly articulated statement of funding needs for the volunteer program identifying discrete projects and activities. This could be used to generate philanthropic support and donations from the community. Additionally, the volunteer program could also expand its outreach to East and South Bay organizations who are seeking volunteer experiences in more rural environments.

Audiences

Exploring and understanding trends like those presented above can help program managers understand community interests and demographics so that they can focus volunteer program recruitment on activities that are appealing or important to specific audiences. This section describes the current and potential future audience for the volunteer program. Programming and outreach strategies will flow from an understanding of the target audiences and their optimal communication pathways.

The Volunteer Program currently works with volunteers of all ages. The greatest participation is currently with youth under 18 years of age and adults over 40 years of age. There has been a shift in the past five years toward more youth participation due to increasing partnerships and participation with local schools. Participating schools are located throughout Marin County, and include elementary, middle, and high schools.

Volunteer groups vary in size, and range from a few individuals to more than 100 participants, with an average attendance of approximately 20 volunteers per event. Program partners also include nonprofit organizations, such as The Bay Institute's Students and Teachers Restoring a Watershed program and Conservation Corps North Bay, and other advocacy groups, such as the Marin County Bicycle Coalition. Strategically, MCOSD is seeking to expand its partnerships with colleges, local homeowner associations, and citizen groups, as well as increase participation from under-represented groups and young families.

Implementation of the *Vegetation and Biodiversity Management Plan* will likely increase the breadth of experiences available to volunteers as well as the types of services volunteers can provide to MCOSD. Attracting new volunteers and providing current volunteers with a greater selection of activities will be critical to successful implementation. For example, the *Vegetation and Biodiversity Management Plan* proposes the expansion of MCOSD's vegetation monitoring program to include an early detection and rapid response program for invasive plants; a more robust special-status species monitoring program; and a rapid assessment program to annually assess the condition of individual preserves. As noted in chapter 3, a number of agencies have successfully integrated volunteers in these types of efforts; in some instances, volunteers perform the majority of work and data entry for land management organizations.

MCOSD could use volunteers to implement the early detection and rapid response program. Targeted participants could be Environmental Stewardship volunteers, neighbors and regular trail users who have an interest in mapping and removing newly emerging weeds, retirees, homeowner associations, and local community members who reside directly adjacent to a specific preserve. Similarly, California Native Plant Society members who helped map the

MCOSD's special-status species could serve as mentors and partners with the MCOSD to train future volunteers or partners, such as garden clubs and local college instructors, for monitoring special-status plants.

Listed below are audiences that could be cultivated or targeted to help achieve vegetation management goals. These audiences were identified through a variety of sources, including the volunteer program coordinator, other land managers, and conversations with participants at public meetings. Further cultivation of these audiences will present certain challenges as well as benefits, and those are listed below, as well. While these are not the only audiences who are likely to both participate in and benefit from volunteer-based activities, these groups will likely increase and diversify the range of participants in the volunteer program, particularly by including youth and young families.

Overall, establishing long-term partners can be more sustainable and less time-consuming from a management perspective than management of drop-in volunteers, because they involve maintaining a strong relationship with one central partner, rather than many individual volunteers, who then helps organize the people within the organization. Many organizations and agencies with limited staffing are shifting to this approach, as partnerships provide a strong foundation of support for tasks and activities that span multiple years.

The following organizations and institutions are identified as new potential partners based on one or more of the following:

- those with shared or adjacent land ownership/management
- those with similar resource/land management and education goals
- those with shared community and outreach interests

Educational Partners

Educational partners seek ongoing educational and research opportunities for their students. In return, they can provide a volunteer work force that can help perform necessary vegetation management, or can provide short- and long-term interns to assist MCOSD staff with various aspects of record keeping, monitoring, and mapping.

MCOSD preserves provide an amazing outdoor classroom experience, rich with potential hands-on learning that is not possible in a conventional classroom. In addition, most educational institutions support a culture of civic engagement. Many schools either require community service or have a growing interest in service learning. Nontraditional schools or programs, especially ones developed for students who are not succeeding in the traditional classroom, and after school programs often have more time for service learning than mainstream schools, enabling participants to spend longer periods of time volunteering. For example, in the Tamalpais Union High School District, Tamescal and San Andreas High Schools offer an alternative experience for local high school students and are often seeking opportunities to engage students in real, science-based learning.

Potential partners include:

- K-12 schools abutting preserve boundaries
- colleges and institutions such as
  - » Dominican University
  - » Indian Valley College
  - » College of Marin

Participation with these educational partners, especially biology, environmental science, and geography programs, can provide students with extra credit and real-life applications of ecology, and provide MCOSD with an opportunity to engage diverse audiences of young people who traditionally do not use the preserves.

It is recommended that MCOSD strategically select partners based upon the level of student expertise required to accomplish the priority tasks (i.e., can middle school students accomplish work or does it require college students?). In addition, the geographic location, level of commitment expressed, and the amount of staffing and resources required to sustain the partnership will be considered when selecting potential partners. It is important to note that educational groups typically require a higher staff-to-participant ratio (typically between 1:6 and 1:10) than typical volunteer workdays because this type of program delivery requires a mix of structured learning and direct service. Additionally, advanced preparation is usually required to structure the day around the desired educational topics. A typical educational workday would be structured to have 50 percent of the time spent on either exploring or learning, and the remaining 50 percent on direct service, such as vegetation management work.

Like all audiences, there are challenges in sustaining volunteer participation with educational partners. For example, establishing personal relationships with specific instructors provides a strong foundation for growing the partnership. However, once that teacher leaves, the partnership is vulnerable until another like-minded instructor is identified. Transportation can also be a challenge, particularly for schools and youth. While the MCOSD strategic plan prioritizes making preserves more accessible to communities that do not traditionally visit, individuals from these communities are much less likely to have a car. Therefore, it will be important to consider allocating project funds to provide transportation money for educational groups who do not have transportation.

Summer or work-study internships also provide excellent mechanisms to integrate diverse youth into MCOSD volunteer programs. Typically, these positions are held by college students or high school seniors who are interested in gaining career development experience or who are exploring the environmental field. Interns can undertake a specific project, develop and deliver interpretive materials to the public, and/or provide support or leadership for workdays and events. Interns typically require an increased level of supervision and mentoring, which would need to be provided by MCOSD staff or program partners. Focused outreach to life sciences professors and teachers would likely draw in a pool of potential interns for the volunteer program. Additionally, local nonprofits may be seeking placement of trained youth interns at no cost to an agency. For example, the Golden Gate National Parks Conservancy's LINC (Linking Individuals to their Natural Community) program places second-year interns in organizations with similar missions to increase student learning and experiences while contributing service to the environment.

Homeowner Associations and Community Groups

Homeowners who share boundaries with MCOSD preserves are likely to already be invested in the overall condition and use of the preserves that they use. An example of this is the Broom Busters, who for more than a decade have built community involvement around improving the ecological health of Old St. Hillary's preserve. It is recommended that the MCOSD provide presentations, attend community events, or prepare newsletter articles for use by homeowner associations that are located near MCOSD preserves. A similar approach could be undertaken with local garden clubs, single interest or recreational groups, and faith-based organizations. It is important to consider what each organization gives and gains from the relationship. It is also important to determine the level of agency investment required to sustain and build the partnerships.

Regardless of the type of partner, its proximity to the preserve is critical. Theoretically, there will be a greater sense of connection to the site—or at least the connection can be made easily through providing meaningful experiences and education.

Businesses and Corporate Groups

A number of proposed actions within this *Vegetation and Biodiversity Management Plan*, specifically large-scale invasive plant control projects, require both dedicated long-term volunteers and periodic influxes of large work groups to conduct initial and follow-up control efforts of invasive species leading to eradication or sustained control. Local business and corporate groups can be a consistent source of support for these types of projects. These groups can provide funding, services (e.g., printing fliers, preparing signs), materials (e.g., fencing, lumber), and volunteers. These groups may benefit from the partnership by receiving tax deductions, community recognition, on-site marketing, and team-building opportunities.

Corporations such as REI, Levis Straus, the Gap, Oracle, Chevron, and many others often organize staff volunteer days to support open space protection and restoration projects. Many of these corporations also offer grant programs to support projects and volunteer efforts. Participation varies, but average representation can range from 20-150 participants. Public agencies such as Pacific Gas and Electric and the Environmental Protection Agency also organize volunteer workdays as vehicles to build staff awareness, increase staff appreciation and support funded projects.

While facilitating these types of workdays typically takes a number of staff to support program delivery, outreach and volunteer recruitment is often streamlined to one or two staff within the business or corporation.

In addition to businesses and corporations, there are a number of other nonprofits and organizations such as One Brick, Community Impact, Volunteer Match, and HandsOn Bay Area that link and network volunteer groups to agency priorities by organizing events which specifically target young people by touting them as “for singles,” “more extreme,” or “intense field work.”

Program Infrastructure

Expansion of the volunteer program is necessary to help meet MCOSD goals. It is recommended that either full-time or seasonal staff, partner-based interns (e.g., AmeriCorps, LINC), or other resources be allocated to support the implementation of this *Vegetation and Biodiversity Management Plan*. The number of staff and/or interns necessary will be determined annually based upon work plan projections and community engagement goals. The volunteer program coordinator will provide overall program leadership, develop and sustain program partners, formulate work plans, track and evaluate program outcomes and content, coordinate between departments, report findings, prepare funding proposals, and train staff and volunteer leaders. Without this added support, it would not be feasible to cultivate and implement new monitoring and detection programs or expand volunteer involvement in other activities identified in this *Vegetation and Biodiversity Management Plan.*

6: RAPID ASSESSMENT AND PROJECT MONITORING PROTOCOLS

Background

Monitoring is the collection and analysis of repeated observations or measurements to evaluate changes in condition and progress toward meeting a management objective (Elzinga et al. 1998). This chapter outlines two separate types of monitoring, each serving a distinct purpose.

The first type of monitoring is *annual rapid assessment monitoring*. This type of monitoring will help in routine assessment of the condition of MCOSD lands, and rapid detection of new threats to conservation targets. Rapid assessment monitoring will assess the condition of conservation targets so that dramatic changes or steady trends are detected and can be acted upon in a timely manner, before threats have expanded and caused harm. Rapid assessment monitoring protocols are designed to be simple and quick, and can be performed by volunteers or staff.

The second type of monitoring is *project-specific monitoring*. This type of monitoring will help to evaluate the outcome of various types of management actions. Project-specific monitoring is designed to assess how conditions have changed as a result of vegetation management actions, and to help evaluate whether project objectives have been met.

Annual Rapid Assessment Monitoring

As stated above the early detection of threats, while they are still small, allows for action to be taken to prevent harm to conservation targets. Likewise, early detection of changes to conservation targets provides the opportunity to conduct more detailed study and, if necessary, to act to protect resources before they are severely damaged or degraded. Detecting problems early also saves money and resources. For this reason, the monitoring program includes a substantial allocation for annual rapid assessment monitoring. This section provides an overview of rapid assessment methods and suggested action thresholds (i.e., thresholds for determining when vegetation management action is needed).

Annual Trail-Based Rapid Assessment

Purpose

The annual trail-based rapid assessment is designed to efficiently accomplish three things:

- Detect new threats or significant changes in existing threats.
- Categorize the detected threats according to urgency.
- Collect sufficient information so that staff can return to the area as needed to conduct more detailed assessments.

The objective of this monitoring is to identify 100% of the threats categorized as urgent, that are visible from MCOSD roads and trails, early enough to be considered in annual project planning and the annual project assessment and ranking process. Annual trail-based rapid assessment is designed to allow monitoring personnel to quickly conduct low-detail assessments over a large area, and it consequently reflect a necessary trade-off between detail and coverage. Monitoring data forms are designed to allow monitoring personnel to move quickly along the survey routes with few interruptions, collect data rapidly, and report and enter data quickly.

Monitoring personnel are directed to collect data only for significant changes in condition. The primary information to be collected is the geographic location of the observation, the type of feature observed, a photo illustrating the observed condition, and a qualitative assessment of the observed condition. Additional information may also be collected for specific features. For example, trail/road length and width is collected for vegetation observations, species identification is recorded for tree assessments and invasive plant observations, and approximate area (square feet) is collected for erosion observations.

Features to Be Monitored

The main categories of features to be assessed include

- vegetation maintenance status
  - » trail or roadside vegetation in need of management (e.g., mowing, pruning, thinning)
  - » trail or roadside vegetation recently managed but that is not shown on maps
- forest health and tree management needs
  - » dead or dying trees (e.g., possible California oak mortality syndrome , insect infestations)
  - » trees blocking road or trail access in need of removal
- soil erosion that could result in sediment transport into wetlands or invasive plant colonization
  - » landslides

  - erosion from culverts or roads resulting in significant sediment or bare soil
  - erosion into creeks or streams
  - road grading creating bare ground subject to plant invasion
- trespass or other incursions
  - green waste dumping
  - unauthorized trail construction
  - removal of MCOSD vegetation by neighbors
  - spread of garden plants across property boundaries
  - defensible space management needed on neighboring property
- status of priority invasive plants
  - new occurrences of high priority invasive plants that are not shown on maps
  - significant increase in extent of existing infestations
  - presence of conditions likely to exacerbate existing infestations

Personnel

The annual trail-based rapid assessments can be conducted by a variety of personnel, including staff and trained volunteers. The monitoring protocols and data forms have been designed so that any of these personnel can complete the annual trail-based rapid assessments.

Training is required to ensure that all monitoring personnel understand the protocols for field data collection and to ensure that interpretation of conditions is standardized among personnel. It is recommended that short training sessions be conducted at least once each year prior to the start of the rapid assessment to train new personnel and to refresh previously trained personnel. Ideally, each training session will include all the personnel expected to conduct trail-based rapid assessments that year; joint training also helps to ensure that all personnel interpret features in a standardized and consistent way.

MCOSD natural resource staff will develop the trail assessment schedule and generate annual maps for use by monitoring personnel. They will also enter field assessment data into the GIS system and make the data available for use by other staff.

Planning, Data Management, and Evaluation for Action

The annual trail-based rapid assessment program is designed so that a portion of each preserve is assessed at least once a year, and each preserve is fully evaluated at least once every three years. A rolling assessment schedule is recommended to ensure that the most sensitive areas are protected. The portion of roads and trails that occur within Legacy Zones will be assessed every year, in order to provide timely care to these important areas. Roads and trails that occur in the highly disturbed zone or natural landscape zone will be assessed at least once every two years, to ensure that important threats are detected with sufficient time to act appropriately. (Roads and trails that occur in other heavily used areas will be assessed at least once every three years, although the fact that these areas are heavily used means that they will receive informal assessment on a more frequent schedule.) Using this system, an average of at least 1/3 of each preserve will be assessed systemwide each year.

MCOSD's GIS data management systems will be modified to support the development of maps for use by monitoring personnel; tracking of the systemwide assessment schedule; and evaluation of whether threats have exceeded action thresholds. At least every 6 months, assessment data from data forms and GPS camera photos will be evaluated by MCOSD natural resource staff with regard to action thresholds. All conditions described as urgent will be reviewed individually and categorized as either 'no follow-up needed,' 'additional assessment needed,' or 'action needed.' Features requiring additional assessment will be grouped and assigned to natural resource staff for additional assessment. Features requiring action will be assigned to relevant staff for follow-up action.

The results of evaluations will be communicated to operations and maintenance staff. Small-scale actions will be integrated into routine staff activities; for larger-scale actions and projects, MCOSD natural resource staff will prepare individual project plans and an annual summary of rapid assessment projects for consideration by the technical advisory committee (see the discussions of project planning and the project prioritization process in chapter 5).

Volunteers and other staff will receive notice acknowledging receipt of the data they collected and updating them on whether their detections have led to action. MCOSD's volunteer program staff will be included in communications with volunteer monitoring personnel. Each year, a short illustrated report will be compiled that summarizes the miles of road assessed, the number of features detected within each type category, and the proportion of threat detections that received follow-up assessment or action.

Systemwide Monitoring of Invasive Plants for Early Detection and Rapid Response

Purpose

Systemwide early detection of invasive plants is designed to efficiently accomplish two things:

- Detect new occurrences of known species of priority invasive plants.
- Collect information on new invasive species (i.e., species not previously known from MCOSD preserves) that natural resource managers can use to prioritize a rapid response.

The objective of this type of monitoring is to identify new invasive plants, and to evaluate new occurrences/populations of high priority invasive plants, while they are small enough to be completely eradicated. Early treatment of new occurrences/populations greatly reduces the effort and cost of treatment when compared to treatment of existing well-established occurrences/populations.

The recommended protocol for systemwide invasive plant early detection monitoring parallels that developed by the National Park Service (NPS) for early detection of invasive plants in the San Francisco Bay Area network of parks (Williams et al. 2008). This protocol has undergone rigorous peer-review to ensure that the information is scientifically credible and technically accurate. It is the basis for invasive plant early detection programs on lands adjacent to MCOSD, including lands managed by ACR, GGNRA, and MMWD, and is the standard protocol recommended by the Bay Area Early Detection Network. While the protocol elements provided here differ in detail from those in the NPS protocol, the NPS protocol and systems remain excellent sources for additional guidance in structuring an effective systemwide early detection monitoring program.

Basic elements of the early detection protocol include:

- Develop a list of target species.
- Identify and prioritize management units for monitoring.
- Conduct regular field assessment surveys to identify and document new invasive plant occurrences.

The monitoring system will use innovative new technological tools to streamline and improve field data collection and the management of that data. The system was selected based on its ability to concisely collect complete data sets using available personnel; its compatibility with different data collection tools; and the ease with which MCOSD staff can collect and report data both systematically (i.e., as part of the annual field assessment) and opportunistically (i.e., when invasive plants are encountered during day-to-day operations).

Features to Be Monitored

While invasive plants are the only features to be assessed under this protocol, there are two main categories included in the assessment:

- new occurrences of high-priority invasive plants that already occur elsewhere on MCOSD lands
- infestations of harmful invasive plants not previously known from MCOSD lands

Monitoring personnel will collect the same information for each of these categories, but there are distinctions in survey methodology and prioritization for action as discussed below.

Information collected for each occurrence includes

- plant species name (scientific name)
- observer name
- date and time of observation
- location (latitude and longitude)
- photograph of infestation
- gross area (size of the area which contains the target species)
- infested area (total amount of space occupied by the target species)

Personnel

Invasive plant early detection monitoring protocols are suitable for use by a variety of personnel, including MCOSD natural resource staff, rangers, maintenance staff, and trained volunteers. Since the best early detection monitoring is done by those with botanical expertise, natural resource staff will be assigned to conduct directed assessments of high-priority management units, and they will be expected to be an important source of new species reports. They will also collect data on an opportunistic basis, as important infestations are discovered during the course of other fieldwork. Rangers and maintenance staff will also make early detection reports, primarily as small satellite populations of known infestations are discovered during routine on-site work. Because of the limited botanical knowledge of these staff, their initial reports of locations of suspected new occurrences of high-priority invasive plants will be followed with field surveys by MCOSD natural resource staff to verify the initial sightings.

Volunteers are also expected to be active in making detections, with the most valuable detections likely being made by volunteers with some botanical experience. The majority of volunteers, who have limited botanical expertise, are expected to report primarily high-profile species that are already known to occur on MCOSD lands. The protocol that will be followed for this monitoring includes guidance on assessing the quality of data reported by persons with no botanical expertise. Adjacent agencies are already training early detection volunteers to be “Weed Watchers,” and the MCOSD may initiate a Weed Watchers franchise and adopt the Weed Watchers training protocols (available through the Bay Area Early Detection Network). Refer to chapter 5 for information on incorporating volunteers into a Weed Watchers group.

Training will be required to ensure that all monitoring personnel understand the protocols for field data collection and are able to identify target invasive plants (Rew and Pokorney 2006). Training will be minimal for monitoring personnel with botanical expertise; nonbotanists will require additional training in plant identification (including various life stages), and as stated above, the data they collect will be reviewed by natural resource staff for quality control purposes. Training sessions will be conducted at least once each year prior to monitoring, to train new personnel and to refresh previously trained personnel. Ideally, each training session will include a mix of all the personnel expected to conduct trail-based rapid assessments; joint trainings should help to ensure that all personnel interpret features in a standardized and consistent way.

MCOSD natural resource staff will generate maps for use by monitoring personnel and periodically download data from the online occurrence database and add these data to MCOSD GIS databases.

Planning, Data Management, and Evaluation for Action

The invasive plant early detection monitoring program includes both passive and active survey techniques. Passive surveys (also called opportunistic sampling) include detections made during the course of other activities, and can be made by staff conducting routine work or by volunteers visiting preserves for recreation or other purposes. Passive surveys can be extremely valuable for identifying important infestations of harmful invasive plants. Active surveys are those in which monitoring personnel are assigned survey routes that have been determined to be high priorities for early detection. Active surveys use the same tools as passive surveys, but they additionally require planning and coordination.

A list of target species is required for both passive and active surveys. Target species lists are likely to change over time and will be regularly updated by natural resource staff (as described in chapter 4). The most current MCOSD list of nonnative plants is provided in appendix C, table C.1. This list should be updated to include both the original MCOSD target species and additional invasive plants from watch lists developed by the Bay Area Early Detection Network and the Marin-Sonoma Weed Management Area.

MCOSD natural resource staff will develop a list of invasive plant management units to be surveyed, prioritize survey areas, create a schedule for conducting surveys, and coordinate monitoring personnel to ensure that priority units are surveyed. The priorities for invasive species management described in chapter 4 (table 4.5) are a good starting point for prioritizing invasive plant surveys. The invasive plant monitoring protocol allocates active survey efforts primarily to the legacy and highly disturbed zones. Survey efforts are allocated secondarily to the sustainable natural system and natural landscape zones. The legacy zone is prioritized for survey because this zone supports unique and irreplaceable remnants of natural diversity, including protected species that could be lost or displaced by invasive species. The highly disturbed zone is prioritized because it is located near the wildland-urban interface and therefore encompasses innumerable point sources for the introduction of new invasive species into the preserves through green waste dumping and backyard garden escapees.

Data management responsibilities will be minimized by the use of the *Observer* smart phone application; through which invasive plant detection reports will be transmitted directly to the Bay Area Early Detection Network/Calflora database. Remaining data management needs will include downloading and archiving the backup track files from GPS receivers, using online web applications to add additional information to reports, and periodically downloading updated data sets from the state database for integration in MCOSD's invasive plant database. The *Observer* system records occurrences as points, which is appropriate for monitoring small, early detection infestations; following detection and recording of the location of the infestation, larger infestations may need to be re-mapped to generate polygon map data.

Action thresholds will be evaluated in two distinct ways. First, occurrence reports in the state database will be regularly evaluated by the Bay Area Early Detection Network to identify regionally important early detections; these regionally important infestations will be prioritized for elimination, and Bay Area Network staff will work with MCOSD, the Weed Management Area, and other partners to ensure that they are addressed with appropriate action. Second, MCOSD staff will conduct an independent evaluation of early detection monitoring data to identify infestations that are important with respect to management of MCOSD preserves. Infestations prioritized for treatment will be added to the invasive plant treatment schedule, and the need for follow-up action will be communicated to appropriate field staff, or an action plan will be initiated for project-scale actions and submitted to the technical advisory committee as part of a report summarizing all proposed projects (see chapter 5).

Volunteers and other staff will receive notice acknowledging receipt of the data they collected and updating them on whether their detections have led to action. Each year, a short illustrated report will be compiled that summarizes the number of high-priority infestations detected, number of new species detected, the proportion of threat detections receiving follow-up assessment or action, and the outcome of actions.

Focused Conservation Target Monitoring

Focused conservation target monitoring is intended to help staff detect changes in population size, condition, or composition of conservation targets (e.g., special-status species, sensitive vegetation types) so that staff can determine if active vegetation management is warranted to protect and preserve these resources.

Purpose

The purpose of focused conservation target monitoring is to continually assess the condition of high-value conservation targets as defined in chapter 4 and to identify any threats or changes in the condition of these important biological resources. Focused conservation target monitoring has two objectives. First, it is intended to detect new threats, or expansion of existing threats, that could result in harm to conservation targets. Second, it is intended to detect either sudden (e.g., damage due to landslides) or long-term incremental changes (e.g., degradation of a population over time due to displacement by invasive plants) that may trigger a need for active vegetation management.

Focused conservation target monitoring requires regular visits to known populations of special-status species and sensitive vegetation on a rotating schedule, with frequency of visitation determined based on species rarity and sensitivity and biological and ecological characteristics. Because each of the conservation targets is different, monitoring will be tailored to collect different data from each occurrence.

Features to Be Monitored

Features to be monitored during focused conservation monitoring include those site conditions that represent potential threats to conservation targets. These features are also relatively easy to monitor and include

- soil disturbance, soil erosion
- changes in roads or trails
- incursions such as green waste dumping, trespass, formation of nondesignated trails
- damage to plants or other direct impacts caused by use or trespass

In addition, monitoring personnel will collect data that can be used to assess changes in the condition of the conservation target. This data is intended to be quickly and easily collected by a range of personnel. Conservation target data will vary according to the conservation target, based on the distinct biology of the species and on site circumstances. Key data to be collected include the following:

- geographic extent of the feature (i.e., the area occupied by the population or vegetation type)
- number of individuals of a target special-status species (or number of flowers or other proxy)
- for long-lived species, the health or condition of individuals
- for sensitive vegetation types, plant species compositional changes, including loss of characteristic dominant species or increase in invasive species
- for sensitive vegetation types, architectural changes, including proportion of open ground, shrub or grass cover, tree cover, and other changes in structure

Personnel

Protocols for focused conservation target monitoring are designed to be quick, simple and to generate reliable results when applied by different monitoring personnel. It is anticipated that a majority of the annual monitoring will be conducted by volunteers, but the same protocols can be applied by MCOSD natural resource staff, rangers, and maintenance staff. All personnel will receive training in using the data forms, navigating to monitoring sites, visiting sites without harming conservation targets, and counting or sampling as appropriate for specific conservation targets.

Protocols are designed both to detect sudden changes and to evaluate long-term incremental change; therefore, consistency in data collection among years is very important. Since different personnel may have slightly different approaches, varying personnel among years can create variation in data collections. Inconsistencies may also occur in analyzing the resulting data. For this reason, it is recommended that specific populations or sites be monitored, and the data assessed, by the same person each year. To the degree possible, personnel should “adopt” specific populations or sites and revisit these each year. MCOSD natural resource staff will generate maps for use by monitoring personnel and assign specific populations or sites to monitoring personnel. Natural resource staff will also transcribe data forms and generate simple graphs and statistics to visualize change in status of conservation targets. Natural resource staff may conduct monitoring of some populations or sites, and they should periodically visit populations or sites to repeat monitoring done by volunteers, to verify the quality of volunteer-collected data.

Volunteers are expected to implement much of the monitoring described in this section. It is expected that a small number of dedicated individuals (e.g., CNPS members, local botanists) will conduct the majority of the monitoring, and these individuals will be cultivated and supported so that they remain engaged and return every year. Less-skilled volunteers can also participate in much of the conservation target monitoring, such as monitoring of less sensitive populations or sites, or monitoring for easily identified threats.

Rangers and maintenance staff are not expected to conduct extensive monitoring of conservation targets, because of their limited botanical knowledge. However, they will be made aware of the location of important populations and sites, so that they may avoid adversely affecting them, and they will be encouraged to report any important changes that are noticed during the course of other duties.

Finally, MCOSD will consider establishing an annual “Rare Plant-a-thon” program, such as that conducted by Point Reyes National Seashore. This program brings volunteers and experts together on a single day and sends teams out to visit specific sites. By promoting the program in local media and generating publicity, a Rare Plant-a-thon increases the number of participants, successfully recruits experts as well as novices and pairs them in teams, and increases countywide recognition of MCOSD’s important role in stewarding Marin County’s natural legacy. A large number of sites can be assessed in a single day, and participants can be recruited who can then conduct additional assessments at other times.

Planning, Data Management, and Evaluation for Action

MCOSD will attempt to monitor all federally and state-listed plants annually in conformance with monitoring guidelines provided for several listed species (e.g., *Hesperolinon congestum, Streptanthus niger*) in the *Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area* (Elam et al. 1998). However, annual monitoring for other high-value resources is not feasible, given the size and geographic scale of the preserves and the limited staffing and budgetary resources of MCOSD. Populations of species with CNPS ranks of 1B or 2 will be revisited and surveyed every other year. Populations of species with CNPS ranks of 3 or 4 and locally rare species will be revisited and surveyed every two to four years. Sensitive vegetation types with rarity rankings of G1, G2, S1, or S2 will be revisited and surveyed every other year. Other sensitive vegetation types will be visited as resources allow, and their aerial extent will be reevaluated on a 5- to 10-year interval in association with regular repeated vegetation mapping. Surveys will be timed to occur at a time of year when the target species are evident, identifiable, and suitable for assessment.

Data management for the focused survey of conservation targets involves transcribing survey data forms into an appropriate database and generating simple standardized figures and tables to visually evaluate conditions and trends. Data that will be maintained in this manner include the number of plants present each year, number of flowers, number of dead plants, area of population, and other quantitative metrics. Qualitative metrics, such as those used to evaluate threats, will inform MCOSD natural resource staff of the presence of important changes that require additional investigation. These qualitative metrics will be reviewed by MCOSD natural resource staff as completed data forms are submitted by volunteers, but in many cases they may not need to be entered into the long-term database.

Action thresholds will be evaluated in two distinct ways. First, MCOSD staff will review completed data forms as they are submitted. All populations or sites with threat conditions marked “urgent” will be immediately visited by staff for additional assessment; targets with threats classified as “major” will be scheduled for a visit and assessment within two months. Photos taken by monitoring personnel using the GPS camera can be used to assist in evaluating the urgency of threat. Second, graphs of quantitative data, such as population size, will be visually assessed to quickly determine if there is dramatic change. These data will also be analyzed to determine whether action thresholds have been exceeded (e.g., “25% decline in 1 year” or “5 years of consistently declining population size”).

As described for the previous protocols, exceeding action thresholds will require additional study. Little is known about the population dynamics of most special-status species, and population sizes can vary naturally from year to year. Consequently, detailed work may be required to determine whether a sudden decline or long-term trend reflects a change in status that necessitates action, or alternatively is the result of natural variation in the conservation target. Collecting annual monitoring data will establish a valuable baseline with which to improve our understanding of these conservation targets, and each additional year of data will improve our ability to assess whether a certain level of change is natural or cause for alarm. These data will improve stewardship on MCOSD lands, and if shared with other conservation professionals can improve stewardship of special-status plants and sensitive vegetation types elsewhere.

If a decline to conservation targets is detected and if additional investigation indicates that additional action is required to maintain or restore the viability of conservation targets, MCOSD staff will conduct additional planning to ensure these species are not impacted. In some cases, such as removal of small invasive plant infestations, these can simply be prioritized for treatment and added to the invasive plant treatment schedule. In other cases, an implementation plan may need to be initiated for project-scale actions (see chapter 5). In some cases, staff may be required to obtain and comply with regulatory permits.

Volunteers and other staff will receive a notice acknowledging receipt of the data they collected and updating them on whether their surveys have led to action.

Project-Specific Monitoring Protocols

Project-specific monitoring protocols are intended to evaluate the outcome of vegetation management actions and to determine whether the actions taken have achieved the desired project objectives. The protocols for project-specific monitoring are designed to collect only the information necessary to answer specific questions about vegetation management projects, and to help make key management decisions. These monitoring protocols try to minimize the effort, time, and resources spent collecting, managing, and analyzing data, while still collecting enough data to support decisions about vegetation management. To accomplish this balance, it is critical that the question or objective addressed by the monitoring be clearly defined in advance of data collection. This will ensure that the data collected will be useful and also will help define data management systems that support efficient and effective analysis and evaluation. Once the question or objective is carefully defined, then the required information can be identified and a data collection system designed to efficiently collect only the required information.

Adaptive management is a tool that allows natural resource managers to make good decisions based on real-time information. Benefits of using adaptive management include the ability to evaluate whether planned and implemented management actions were successful in meeting specific project goals, and the management discretion to modify projects to ensure that desired results are achieved and maintained over time.

Establishing project objectives is a fundamental requirement of project-specific monitoring. Project objectives should specify intended outcome in terms that are specific, measurable, and achievable on a designated timeline, and monitoring should serve to collect information that evaluates whether or not the stated objectives have been met. These results can then be used to modify future actions or, in the event that performance criteria are not met, to implement remedial actions.

This section provides project-specific monitoring protocols for four types of common vegetation management projects (described in detail below).

Monitoring the Outcome of Invasive Plant Management Projects

This type of monitoring is intended for use in determining what effects invasive plant management had on conservation targets so that staff can adaptively manage ongoing vegetation management to maximize results.

Purpose

The protocols for monitoring invasive plant management projects are designed to accomplish two objectives. First, monitoring will help to determine whether invasive plant treatments are successful in eradicating, controlling, or containing target invasive plants. Second, monitoring will yield additional data such as labor costs, equipment costs, and cost per acre. This information can be used by MCOSD natural resource staff to improve the cost-effectiveness of invasive plant management projects. Quantifying cost-effectiveness is important for communicating with the public and decision makers, for selecting the most appropriate treatment techniques, and for improving future invasive plant management.

Features to Be Monitored

The monitoring protocols are designed to collect only information to meet the two objectives described above. The main categories of features to be assessed include

- reporting information
  - » date of record
  - » observer name
  - » patch id code
  - » photograph of infestation
- location
  - » preserve name
  - » specific location
  - » GPS location (latitude and longitude)
  - » mapped polygons of the infestation
- treatment information
  - » date of treatment application
  - » plant phenological stage at time of treatment (e.g., seedling, adult, reproductive, and post-reproduction)
  - » treatment applied, including details about methodologies and tools used
  - » labor type
  - » person hours of labor used and cost per hour of labor
  - » amount removed (number of individuals, trash bags or truck loads of biomass)
  - » area treated (square feet and % of the total infested area)
- target plant population characteristics
  - » plant species name (scientific name of target species)
  - » gross area (size of the area in square feet or acres which contains the target species)

  - » infested area (total amount of space occupied by the target species in square feet or acres)
  - » percent cover by the target species
  - » distribution of plants within the patch
  - » life stages present and relative dominance
  - » number of plants in the patch (determined by census, estimate, or sampling)

Personnel

Monitoring of invasive plant removal projects includes a variety of distinct data collection actions over a range of time, and different data collection actions will be performed by different personnel. At a minimum, the three essential data collection actions are

- characterization of the project site prior to treatment
- collection of data regarding treatments that were applied
- collection of post-treatment data

Initial characterization of the invasive plant removal site will generally be done by MCOSD natural resource staff using the MCOSD's GIS database information. In addition, basic information on treatment polygon size, invasive plant patch sizes, plant density, and other basic site characterization (e.g., vegetation types present, site access, staging areas) will be recorded by MCOSD staff as part of the project planning phase.

Information on invasive plant treatments, labor hours, and project costs will be estimated by MCOSD natural resource staff during project planning and recorded again by the staff, volunteer, or contractor, performing the work as part of daily or weekly work logs and timesheets, and as part of the IPM reporting process.

Monitoring of project outcomes may be performed by a range of personnel, depending on the specific performance criteria assigned to the individual project. Monitoring that requires detailed and complicated data collection, such as recording a reduction in invasive plant vegetative cover, will be performed by MCOSD natural resource staff. Monitoring the outcome of projects with simple performance criteria, such as projects that seek to completely eliminate an infestation of an easily-recognized invasive plant, may be performed by a wider variety of personnel, including MCOSD natural resource staff, operations and maintenance staff, rangers, or volunteers.

Planning, Data Management, and Evaluation for Action

Prior to implementing treatment at any site, staff will develop a clear statement of the problem at that location and clearly articulate invasive plant management goals and objectives for the individual project.

As described in greater detail in chapter 4, typical invasive plant management projects include one of the following types of projects:

- eradication
- sustained control
- containment

In addition to the above types of treatments, MCOSD may also conduct an invasive plant removal project as mitigation for other projects that occur in Marin County. In many cases, projects other than vegetation management result in impacts on special-status species and sensitive vegetation types. Many of these projects require compensatory mitigation to offset project impacts. In many cases, treating invasive plants to increase the amount and functioning of special-status plant populations or native vegetation types can be used to offset project impacts.

Monitoring the Outcome of Revegetation and Restoration Projects

This section provides sample project-specific protocols for monitoring the outcome of revegetation and restoration projects. These projects include vegetation management activities intended to assist the recovery of an ecosystem that has been degraded, damaged, or destroyed.

Purpose

Monitoring of revegetation and restoration projects serves at least three purposes. First, monitoring is conducted to evaluate the success of the project; success will help meet a program objective and may also fulfill a requirement of a permit or project approval by a regulatory agency. Second, monitoring allows staff to identify mid-course corrections that can help ensure that the project meets stated performance criteria. For example, detecting high mortality in the first season after planting makes it possible to replant or investigate and address the cause of the plant die-off. Third, monitoring generates data that allow for the improvement of similar projects in the future (adaptive management).

Features Monitored

The monitoring protocols are designed to collect the information necessary to evaluate the project outcome and to determine whether the project objectives have been met, without requiring staff to collect more information than is required to make this determination. One exception is that the protocols include collecting photos and other nonquantitative data that are valuable for communicating with funders, decision makers, and the public.

Typical features that are monitored during revegetation and restoration projects include

- species-based features
  - » number of individuals surviving
  - » number of individuals per unit area
  - » average height of a species
  - » percent cover by a target species
  - » natural recruitment of target species
- vegetation-based features
  - » percent cover by all plants
  - » percent cover by native plants
  - » percent cover by invasive plants
  - » ratio of native to nonnative plants
  - » presence or absence of high priority invasive plants
  - » vegetation cover or architectural characteristics
  - » recruitment of native plants
  - » species richness or diversity
  - » percent cover by leaf litter, bare soil, or other features
- general site features
  - » richness or abundance of native wildlife species
  - » diversity of native wildlife

  - » utilization of site by native wildlife
  - » appearance of site (e.g., presence of vandalism, trash)
  - » site geomorphology, hydrologic function, or other physical characteristics
- quantitative monitoring techniques
  - » census to determine number of individuals (e.g., presence/absence data, mortality counts for plantings)
  - » sampling and extrapolation to determine number of individuals (e.g., vegetation data collected along transects or using quadrats, then extrapolated to represent site conditions)
  - » estimation to determine number of individuals (e.g., density data, rough population counts in 10s, 100s or 1,000s)
  - » measurement of plant characteristics (e.g., height, canopy cover)
  - » quadrat- or transect-based estimation of vegetative cover
  - » surveys to record all species present (species richness) at the site during the survey (used to assess frequency of target plants and also to detect unwanted plants such as invasive species)
- qualitative monitoring techniques
  - » visual site evaluations
  - » photomonitoring

Personnel

Because the quality of revegetation and restoration data is paramount, only trained staff will collect data. For most revegetation and restoration projects, monitoring will be completed primarily by MCOSD natural resource staff or by contractors and consultants hired to assist in project planning and implementation. Volunteers and other MCOSD staff may participate in monitoring projects for which performance criteria are easily evaluated (e.g., census of easily identified species).

Planning, Data Management, and Evaluation for Action

Planning for revegetation and restoration projects will follow many of the same principles described above for designing monitoring of invasive plant management projects. In particular, each project will include project-specific goals and objectives, with performance criteria specific to that individual project. In some cases, performance criteria will be specified by regulatory and permitting agencies. In other cases, criteria may be developed by project staff. In all cases, objectives and performance criteria will conform to standard guidelines for structuring good objectives (Elzinga et al. 1998).

Objectives and performance criteria will be specific and numeric, whenever possible and include clear and precise descriptions of the relevant geographic area, the timeframe for completion, and an acceptable range of variation or levels of uncertainty. For example, an appropriate project objective is: “At least 20 flowering plants of Streptanthus niger will be established within the mapped restoration site by August 2013,” or “average percent cover by native trees in the mapped project site will reach 75% +/- 10% by August 2013.”

Project-specific monitoring will be integrated into project design from the earliest stages of project development. Early monitoring may include nearby offsite reference sites or the baseline (pre-project) conditions of the project site (recommended). The parameters should be simple and easy to interpret, such as comparing species composition, canopy cover, or density of selected target plants between the monitoring site and the reference site. Monitoring may be quantitative (e.g., plant counts, estimates of vegetation cover) or qualitative (e.g., photomonitoring, narrative assessment). Regardless, the data to be collected will be explicitly identified during project planning and scheduling, since they may be difficult or impossible to collect after implementation has begun. Similarly, for some project-specific monitoring programs, permanent monitoring fixtures (such as plot locations, permanent photopoints, or transects) may need to be established prior to the start of implementation activities.

Data collection during project implementation may be critical to subsequent monitoring efforts. For example, projects that include active planting should keep records of the number of plants that were installed at the site because this information will be essential to calculating survival rates. Similarly, it may be necessary to document native plants already present at the site so that these plants can be evaluated separately when determining survival rates and post-implementation natural recruitment rates.

While projects will include specific quantitative objectives, qualitative information can be also valuable. Qualitative information will not only help evaluate outcomes, but also will be especially valuable for communicating with stakeholders, funders, and the public. To this end, photomonitoring and narrative photography will be used to visually assess projects for problems such as vandalism, herbivory by rodents or deer, presence of trash, or invasive species. Visual inspection will give valuable feedback on the success of planted stock, problems or successes with pests, quality of material, water stress, mortality or morbidity, or other factors that may affect success. While many of these factors may be suitable for quantitative monitoring, qualitative assessment of restoration sites is an inexpensive and powerful tool for evaluating project outcome.

Management of monitoring data will be dictated by each project's distinctive monitoring framework and the type, frequency, and quantity of data collected. In general, project monitoring will be designed to minimize the data collected, the time spent collecting data, and the number of monitoring visits required. In many cases, monitoring data may be managed using spreadsheets or other simple systems. In a few cases, especially when project objectives have a geographically explicit component or require statistical analysis to evaluate outcome, more sophisticated databases or GIS may be required for data management.

Monitoring the Outcome of New Fuel Management Projects

In many ways, the monitoring of new fuel management projects mirrors the steps outlined above for monitoring the outcome of revegetation and restoration projects. A successful fire fuel management project, much like a successful restoration project has the following attributes:

- Is ecologically sustainable over time.
- Restores natural and historic ecosystem processes wherever possible.
- Enhances overall wildlife and habitat values of the individual preserve and the MCOSD system as a whole, wherever possible.

In addition to these attributes, a successful fuel management project also accomplishes the following:

- Results in the reduction of flashy fuels, fuel ladders, and overall vegetation biomass.
- Reduces maintenance costs over time.
- Reduces overall fire hazard

7: BEST MANAGEMENT PRACTICES

This chapter provides information on the Best Management Practices (BMPs) for implementing vegetation management actions so that work is conducted in a manner that avoids, or fully minimizes effects on sensitive biological resources (i.e., special-status plant and wildlife species, sensitive vegetation, wetlands, and other habitats), to the extent feasible. Implementation of these BMPs will reduce effects related to soil disturbance, erosion, and ongoing maintenance activities, and to reduce the potential for the spread of invasive plants from infested areas to non-infested areas.

Each individual BMP description is written to stand on its own. As a result, there is some unavoidable overlap and repetition between the individual BMPs.

General Best Management Practices

The best management practices in table 7.1 apply to all vegetation management actions, and if implemented will help avoid and/or minimize impacts to sensitive biological resources, including special-status species and sensitive vegetation types.

Table 7.1 General Best Management Practices

General Best Management Practices	
BMP-GENERAL-1 **Limit Work Area Footprints, Minimize Work Footprints in Sensitive Resource Areas (Sensitive Vegetation Types, Special-status plant and wildlife populations)**	Limit the size of construction-related vegetation management projects to the minimum size needed to meet project objectives. BMPs include: • ***Minimize project footprint.*** Minimize the size of the work area, including treatment area, access roads, and staging areas. Wherever possible, use existing upland roads, trails, and other disturbed areas for project activities in order to reduce unnecessary disturbance, minimize soil and water erosion, and reduce overall project costs. • ***Reduce or relocate footprint during planning and design phase.*** Reduce the work area footprint in sensitive resource areas or move the work area to common natural communities and upland areas. Implement further refinements during site preparation and construction to further reduce impacts. • ***Minimize soil disturbance.*** Minimize soil disturbance to the greatest extent possible to reduce the potential for introducing or spreading invasive plants, to protect topsoil resources, and to reduce available habitat for the establishment of new invasive plants. • ***Mark project footprint near sensitive natural resources.*** Mark ingress/egress routes, staging areas, and sensitive resources to prevent inadvertent impacts to sensitive resources. • ***Restrict soil disturbance and import of nonnative soil or fill material.*** To reduce the potential for damage of native plants and/or introduction of invasive plants, the contractor will be required to minimize the footprint of soil disturbance to the minimum amount necessary to complete the contracted work. In particular, access roads, staging areas, and areas of temporary disturbance will be minimized in size. The contractor and its staff and subconsultants agree not to drive off-road or drive or park on native vegetation unless approved in advance by MCOSD natural resource staff. The contractor agrees that if soil excavation is required, every attempt will be made to have a balanced cut and fill project that reuses all native soils onsite. No nonnative soil or fill material will be brought onsite, or used during the contractor's activities unless approved by MCOSD natural resource staff.

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General Best Management Practices	
BMP-GENERAL-2 **Modify Vegetation Management Methods in and near Wetlands, Riparian Vegetation Types. Limit Necessary Work to Low Flow or Low Tide Periods.**	Restrict construction-related vegetation management near wetlands in a manner that reduces the potential for sediment or pollutants to enter wetlands. Implement the following BMPs, as needed: • ***Establish a buffer of 100 feet from wetland and tidally influenced areas*** (i.e., from the ordinary high water mark of flowing or standing water in creeks, streams, or ponds). Avoid construction work within this buffer area. • ***If construction work in wetlands and riparian areas cannot be fully avoided, consult with the appropriate state and federal agencies to obtain permits.*** • ***Within the buffer, restrict routine vegetation management activities in creeks, streams, other waterways, and tidally influenced areas.*** Limit vegetation management work to least-harmful methods; restrict herbicides to those that are EPA-approved for use near water. Prohibit activities that disturb soil or could cause soil erosion or changes in water quality. • ***Within the buffer, limit work that may cause erosion to the low flow or low tide periods.*** Low flow months for local creeks are typically August to October. For tidal areas, work will not occur within 2 hours of high tide events at construction sites when high tide is greater than 6.5 feet measured at the Golden Gate Bridge, using corrections for areas near individual MCOSD preserves. Tide charts are available online form the National Oceanic and Atmospheric Agency / National Weather Service (http://www.wrh.noaa.gov/mtr/sunset.php). • ***Within the buffer, minimize erosion and sedimentation; maintain erosion and sediment control devices during ground disturbing activities and until all disturbed soils have been stabilized.*** Measures include weed-free straw, hydromulch, geofabrics, wattles, sediment traps, check dams, drainage swales, and sand bag dikes. Materials must be certified weed-free to prevent the introduction of wheat, barley, and other nonnative plant seeds. Erosion control materials must be constructed of natural fibers (e.g., coconut fiber mats, burlap and rice straw wattles, etc.) and may not be constructed with plastic monofilaments or other materials that could entrap snakes or amphibians. • ***Prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) to protect water quality for vegetation work in or near wetlands, ponds, seeps, creeks, tidal areas, or stream crossings.***

Table 7.1 General Best Management Practices

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BMP-GENERAL-3 **Minimize Potential for Erosion**	Conduct vegetation management in a manner that controls and minimizes the potential for soil erosion and contribution of sedimentation to wetlands. Implement the following BMPs, as needed: • ***To minimize erosion and sedimentation, maintain erosion and sediment control devices during ground disturbing activities and until all disturbed soils have been stabilized.*** Measures include rice straw, hydromulch, geofabrics, wattles, sediment traps, check dams, drainage swales, and sand bag dikes. Materials must be certified weed-free to prevent the introduction of wheat, barley, and other nonnative plant seeds. Erosion control materials must be constructed of natural fibers (e.g., coconut fiber mats, burlap and rice straw wattles, etc.) and may not be constructed with plastic monofilaments or other materials that could entrap snakes or amphibians. • ***Unless no feasible alternative is available, avoid using heavy equipment in areas with soils that are undisturbed, saturated, or subject to extensive compaction.*** Where staging of heavy equipment, vehicles, or stockpiles is unavoidable, limit and mark the allowable disturbance footprint with flagging or fencing. Following the end of work, scarify surface soils to retard runoff and promote rapid revegetation. • ***Immediately rehabilitate areas where project actions have disturbed soil.*** Require areas disturbed by equipment or vehicles to be rehabilitated as quickly as possible to prevent erosion, discourage the colonization of invasive plants, and address soil compaction. Techniques include decompacting and aerating soils, recontouring soils to natural topography, stabilizing soils via erosion control materials, revegetating areas with native plants, and removing and monitoring invasive plants. • ***In areas with highly erosive soils or steep slopes, leave roots of target invasive trees and shrubs in place. Stumps may be cut or ground-to-ground level.***
BMP-GENERAL- 4 **Control Food-Related Trash**	Food-related trash can attract wildlife to vegetation management sites. • ***Store food-related trash in closed containers and remove from the project site daily.***
BMP-GENERAL- 5 **Modify Construction Methods Relating to Soil Disturbance, Restrict use of Offsite Soil, Aggregate, or Other Construction Materials**	Conduct construction-related vegetation management in a manner that restricts the use of offsite materials that could introduce or spread invasive plants. Implement the following BMPs, as needed: • ***Minimize soil disturbance.*** Minimize soil disturbance to the greatest extent possible to reduce the potential for introducing or spreading invasive plants, to protect topsoil resources, and to reduce available habitat for the establishment of new invasive plants.

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	• ***Do not allow the introduction of incompatible fill.*** Use only clean, native soils and aggregate materials from projects within the preserve, or use fill that is purchased from a certified weed-free source, before allowing the importation of materials from outside the preserves. Fill materials should be approved by natural resource staff to ensure compatibility with future restoration/rehabilitation goals. • ***Segregate and treat soils and vegetation contaminated with invasive plant seeds and propagules.*** Treat, as appropriate, to prevent the spread of invasive plants. Treatment may include disposal onsite within already infested areas, chipping or pile burning and mulching to eliminate viable seeds, or disposal at an approved cogeneration plant or green waste facility. • ***Salvage, store, and reuse topsoil.*** Where activities disturb soil temporarily, require salvage of the top 6 to 12 inches of topsoil (to retain seeds, soil mycorrhizae, and fungi) from all excavation and disturbance areas. Require reapplication of the salvaged topsoil as a topdressing or topcoat over backfill, unless known to contain invasive plant seeds or propagules. • ***Establish dedicated areas for cleaning vehicles (BMP-INVASIVE-5) to clean vehicles, inside and out, of soil or invasive plant seeds or plant parts before entering MCOSD preserves, whenever moving equipment between areas within the preserves, and before leaving preserves.*** Within the wash areas, the tires and body of vehicles and equipment will be brushed off and/or hosed down. • ***Inspect construction equipment for soil or invasive seeds or plant parts.*** Require contractors to make equipment available for inspection before entering MCOSD preserves, when moving between sites within the preserves, and before leaving preserves. • ***Develop a native seed mix for erosion control.*** Develop the seed mixture on a project-by-project basis based on the observed mixture of native and naturalized plants in and near the impact area. Where possible, ensure that seeds are collected locally (i.e., within the same watershed or preserve as the impact), or obtained from a reputable native plant nursery specializing in seed that is collected from local sources. • ***Maintain erosion and sediment control devices during ground disturbing activities and until all disturbed soils have been stabilized to help minimize erosion and sedimentation.*** Measures include rice straw, hydromulch, geofabrics, wattles, sediment traps, check dams, drainage swales, and sand bag dikes. Materials must be certified as weed-free to prevent the introduction of wheat, barley, and other nonnative plant seeds. Erosion control materials must be constructed of natural fibers (e.g., coconut fiber mats, burlap and rice straw wattles, etc.) and not of plastic monofilaments or other materials that could entrap snakes or amphibians.

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	• ***Immediately rehabilitate areas where project actions have disturbed soil. Require areas disturbed by equipment or vehicles be rehabilitated as quickly as possible to prevent erosion, discourage the colonization of invasive plants, and address soil compaction.*** Techniques include decompacting and aerating soils, recontouring soils to natural topography, stabilizing soils via erosion control materials, revegetating areas with native plants, and removing and monitoring invasive plants.
BMP-GENERAL-6 **Prevent or Reduce Potential for Pollution**	Ensure that actions are untaken during ongoing vegetation management activities to prevent or reduce the potential for pollutants entering the MCOSD preserve system from vegetation management activities. Implement the following BMPs, as needed: • ***Properly use, store, and dispose of chemicals, fuels, and other toxic materials.*** • ***Prohibit, or restrict equipment refueling, fluid leakage, equipment maintenance, and road surfacing activities near wetlands.*** Require placement of fuel storage and refueling sites in safe areas well away from wetlands. Safe areas include paved or cleared roadbeds, within contained areas such as lined truck beds, or other appropriate fuel containment sites. Inspect equipment and vehicles for hydraulic and oil leaks regularly. Do not allow leaking vehicles on MCOSD preserves, and require the use of drip pans below equipment stored onsite. Require that vehicles and construction equipment are in good working condition, and that all necessary onsite servicing of equipment be conducted away from the wetlands. • ***Require all contractors to possess, and all vehicles to carry, emergency spill containment materials. Absorbent materials should be on hand at all times to absorb any minor leaks and spills.***
BMP-GENERAL-7 **Include Standard Procedures in Construction Contracts**	When using contractors to perform vegetation management, the MCOSD will include some or all of the following standard procedures into construction contracts: • ***Time of work.*** The contractor will work with MCOSD natural resource staff to determine the optimal timing of contracted work. Many timing restrictions relate to protecting special-status species. Other types of timing restrictions include timing to control invasive plants; timing to avoid migration, gestation, or flowering periods for special-status species; or timing work in wetlands to the dry season. • ***Work in and near wetlands.*** Establish a buffer of 100 feet from wetland and tidally influenced areas (i.e., from the ordinary high water mark of flowing or standing water in creeks, streams, or ponds). Avoid construction work within this buffer area. » Within the buffer, restrict routine vegetation management activities in creeks, streams, other waterways, and tidally influenced areas. Limit vegetation management work to least-harmful methods; restrict

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	herbicides to those that are EPA-approved for use near water. Prohibit activities that disturb soil or could cause soil erosion or changes in water quality. » Within the buffer, limit work that may cause erosion to low flow periods**.** Low flow months for local creeks are typically August to October. For tidal areas, work will not occur within 2 hours of high tide events at construction sites when high tide is greater than 6.5 feet measured at the Golden Gate Bridge, using corrections for areas near individual MCOSD preserves. Tide charts are available online form the National Oceanic and Atmospheric Agency / National Weather Service (http://www.wrh.noaa.gov/mtr/sunset.php). » If construction work cannot be fully avoided in wetlands and riparian areas, consult with the appropriate state and federal agencies to obtain permits. » Require the contractor to prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) to protect water quality for vegetation work in or near wetlands, ponds, seeps, creeks, tidal areas, or stream crossings. • ***Work in and near invasive plant infestations.*** The contractor will work with MCOSD natural resource staff to identify any priority invasive plants that occur near the project work area, including the project footprint, access roads, staging areas, and similar work areas. The contractor agrees to comply with requirements to reduce the spread or transport of priority invasive plants related to construction activities. Requirements may include some or all of the following: » Conduct a training program for all field personnel involved with the proposed vegetation management project prior to initiating project. The program will consist of a brief presentation by person's knowledgeable in the special-status species, sensitive resource, or invasive plants known from the project area. The program will include the following: a photograph and description of each special-status species, sensitive resource, or invasive plant known from the project area; a description of its ecology and habitat needs; an explanation of the measures being taken to avoid or reduce adverse impacts; and the workers' responsibility under the applicable environmental regulation. The worker training may be conducted in an informal manner (e.g., as part of a routine tailgate safety meeting). » Restrict work to periods when invasive plants are not in fruit or flower. » Establish dedicated area for cleaning vehicles, inside and out, of soil or invasive plant seeds or plant parts before entering MCOSD preserves, whenever moving equipment between areas within the preserves, and before leaving preserves. Within the wash areas, the tires and body of equipment will be brushed off or hosed down.

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	» Inspect construction equipment for soil or invasive seeds or plant parts. Require contractors to make equipment available for inspection before entering MCOSD preserves, when moving between sites within the preserves, and before leaving preserves. » Dispose of green waste in a manner that does not spread invasive plants (i.e. onsite disposal in an already infested area; offsite disposal to a cogeneration plant or an approved green waste composting facility). • ***Protect environmentally sensitive areas.*** MCOSD natural resource staff shall identify any Environmentally Sensitive Areas in or near construction work areas prior to the start of work. Environmentally Sensitive Areas may include: special-status plant or wildlife species or their habitats (e.g., woodrat nests, habitat for special-status plant and wildlife species, individuals or populations of listed special-status plant or wildlife species or locally rare species); wetlands including creeks streams and related riparian area; and sensitive vegetation types as described in this report. MCOSD staff and contractors will fully avoid and protect such areas during habitat restoration work, or will help obtain and comply with necessary permits and regulatory requirements. • ***Use locally collected plant materials for revegetation projects.*** Plant materials will be collected onsite at MCOSD preserves or within the same watershed as the revegetation project. The contractor will work with the MCOSD to identify native plant nurseries that can collect and propagate seed and other plant materials from the local area. No use of commercial grassland mixtures for erosion control unless approved in advance by the MCOSD. The contractor will allow the MCOSD to inspect and approve all plant materials and seed prior to use onsite. • ***Work in and near special-status species habitat.*** For vegetation work in or near special-status species habitat, the contractor is required to comply with requirements of MCOSD project permits to protect special-status species and their associated habitats before and during construction, and to cooperate with the MCOSD in implementing any state and federal permits and agreements for the project. The special-status species population plus a buffer should be designated as an "Environmentally Sensitive Area" using lath and flagging, pin flags, or temporary fencing (depending on resource sensitivity to work). The contractor will be required to avoid all designated Environmentally Sensitive Areas during construction. For any special-status species or their habitats that cannot be fully avoided, the contractor will work with the MCOSD to obtain and comply with federal and state Endangered Species Acts, the federal Migratory Bird Treaty Act, and the state Fish and Game Code permits and agreements. • ***Restrict soil disturbance, import of nonnative soil or fill material.*** To reduce the potential for damage of native plants and/or introduction of invasive plants, the contractor will be required to minimize the footprint of soil disturbance to the minimum amount necessary to complete the contracted work. In

Table 7.1 General Best Management Practices

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	particular, minimize the footprint of access roads, staging areas, and areas of temporary disturbance. The contractor and its staff and subconsultants agree not to drive off-road or drive or park on native vegetation unless approved in advance by MCOSD natural resource staff. The contractor agrees that if soil excavation is required, every attempt will be made to have a balanced cut and fill project that reuses all native soils onsite. Unless pre-approved by MCOSD natural resource staff, there will be no use of nonnative soil or fill material during the contractor's activities. • ***Erosion control.*** To minimize erosion and sedimentation, maintain erosion and sediment control devices during ground disturbing activities and until all disturbed soils have been stabilized. Measures include rice straw, hydromulch, geofabrics, wattles, sediment traps, check dams, drainage swales, and sand bag dikes. Materials will be certified weed-free to prevent the introduction of wheat, barley, and other nonnative plant seeds. Erosion control materials will be constructed of natural fibers (e.g., coconut fiber mats, burlap and rice straw wattles, etc.) and may not be constructed with plastic monofilaments or other materials that could entrap snakes or amphibians. Other procedures: • ***All entry gates to the project site not used for construction access will be locked at all times and gates used for construction access will be locked during non-construction hours.*** • ***All vehicles will carry a suitable fire extinguisher.*** • ***Immediately rehabilitate areas where project actions have disturbed soil.*** Require areas disturbed by equipment or vehicles to be rehabilitated as quickly as possible to prevent erosion, discourage the colonization of invasive plants, and address soil compaction. Techniques include decompacting and aerating soils, recontouring soils to natural topography, stabilizing soils via erosion control materials, revegetating areas with native plants, and removing and monitoring invasive plants. • ***Unless no feasible alternative is available, avoid using heavy equipment in areas with soils that are undisturbed, saturated, or subject to extensive compaction.*** Where staging of heavy equipment, vehicles, or stockpiles is unavoidable, limit and mark the allowable disturbance footprint with flagging or fencing. Following the end of work, scarify surface soils to retard runoff and promote rapid revegetation. • ***Cover stockpiled material at the end of each day and during storm events with undamaged 12-mil polyethylene or an equivalent impermeable barrier to prevent windblown dispersion, weed and seed contact, and contact with precipitation.*** When more than one sheet is required to cover the material, overlap sheets a minimum of 1.5 feet in a manner that prevents water from

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	flowing onto the material. Secure the cover in a manner that keeps it in place at all times. • ***Restrict placement of refueling areas, chemical treatment staging areas, and other areas where petroleum and herbicide products are stored or handled to designated areas.*** MCOSD will routinely inspect such areas to ensure chemicals are properly stored, do not spill, or become displaced into wildland areas. MCOSD staff and contractors shall ensure that should hazardous spills occur, they will be completely cleaned up and disposed up properly, in compliance with state, federal and IPM procedures, and EPA and labeling guidelines. • ***There will be no vegetation removal operations when there is a red flag day warning in effect for Marin County.***
BMP-GENERAL-8 **Control Noise**	To reduce daytime noise and potential disturbance to wildlife species, the MCOSD will require contractors to muffle or control noise from equipment through implementation of the following measures: • ***Equipment and vehicles should utilize the best available noise control techniques (e.g., improved mufflers, equipment redesign, and use of intake silencers, ducts, engine enclosures and acoustically attenuating shields or shrouds, and installation of sound blanket around the project site.***
BMP-General-9 **Conduct Worker Training**	• ***Conduct a worker-training program for all field personnel involved with the proposed vegetation management project prior to initiating project.*** The program will consist of a brief presentation by persons knowledgeable in the special-status species, sensitive resource, or invasive plants known from the project area. The worker training may be conducted in an informal manner (e.g., as part of a routine tailgate safety meeting).The program will include the following: » a photograph and description of each special-status species » sensitive resource, or invasive plant known from the project area » a description of its ecology and habitat needs » an explanation of the measures being taken to avoid or reduce adverse impacts » the workers’ responsibility under the applicable environmental regulation

Best Management Practices Related to All Sensitive Natural Resources

The following best management practices apply to work conducted near known or suspected locations of high-value natural resources, including special-status wildlife and plants and sensitive vegetation types. Implementation of these best management practices will reduce the potential for effects on these high-value resources during vegetation management activities. Table 7.2 lists best management practices related to all sensitive natural resources. Table 7.3 lists best management practices related to special-status wildlife species. Table 7.4 lists best management practices related to special-status plants.

Table 7.2 Best Management Practices Related to All Sensitive Natural Resources

Best Management Practices Related to All Sensitive Natural Resources	
BMP-SENSITIVE NATURAL RESOURCES-1 **Modify Vegetation Management Practices near Sensitive Natural Resources**	For construction-related vegetation management activities requiring extensive ground disturbance in and near known sensitive biological resources, MCOSD will assess the project or proposed action prior to the start of work to suggest modifications to standard procedures considered necessary to help ensure avoidance of impacts to special-status species and other sensitive biological resources. Actions that may be taken include one or more of the following: • ***Mark project footprint near sensitive natural resources.*** Mark ingress/egress routes, staging areas, and sensitive resources to prevent inadvertent impacts to sensitive resources. • ***Inspect ingress/egress routes, escort vehicles, and equipment onto the site if necessary to help prevent impacts on ground nesting and ground dwelling species.*** Work should be conducted during bird non-breeding season (published DFW non-breeding season dates are August 15-March 1, but should be adjusted to local conditions), as described in more detail in BMP-SPECIAL-STATUS WILDLIFE SPECIES-1. • ***Maintain a 15 MPH speed limit in sensitive habitat areas.*** This will reduce the potential for mortality, dust impacts on vegetation and wildlife. For larger projects, water the roads for dust control near sensitive resources.

Table 7.3 Best Management Practices Related to Special-Status Wildlife Species

Best Management Practices Related to Special-Status Wildlife Species	
BMP-SPECIAL-STATUS WILDLIFE SPECIES-1 **Implement Seasonal Restrictions During Bird Nesting Season; Avoid Active Nests or Obtain and Comply with a 2081 Agreement with DFW**	• ***Identify potential habitat for nesting birds and survey to determine if active nests are present before initiating vegetation management actions.*** Surveys will include the proposed vegetation management footprint and a 1/4 mile buffer area (for raptors) or a 150 foot buffer area (for other birds). Surveys will be conducted within 14 days of the start of active ground disturbing activities. • ***If any active nests of protected bird species are found, prohibit brushing, mowing and tree removal vegetation management activities at the nest site and within a buffer area until the young birds have fledged and left the site, and/or the nest has been abandoned.*** The buffer area will be 150-250 feet, or as determined through consultation with the Department of Fish and Wildlife, pursuant to Section 2081 of the state Fish and Wildlife Code and the federal Migratory Bird Treaty Act. In general, a line-of site buffer of at least 150 feet between the nest site and vegetation management activities is recommended. For raptors, buffer distances may be increased to 250 feet or more, depending on the visual distance from the nest to the vegetation management work area, and the sensitivity of the raptor species to vegetation management activities. In addition, a 5MPH speed limit will be enforced in and near bird nesting habitats and other sensitive habitat areas. • ***If impacts to nesting birds cannot be avoided, contact the USFWS and the DFW to obtain the necessary permits before initiating vegetation management activities.***
BMP- SPECIAL-STATUS WILDLIFE SPECIES-2 **Avoid and Protect Northern Spotted Owl**	Northern Spotted Owls have potential to occur on MCOSD preserves. The MCOSD will undertake the following actions when construction-related vegetation management is planned to occur within or adjacent to potential Northern Spotted Owl habitat: • ***Identify potential habitat for Northern Spotted Owls and survey to determine if it is occupied or if active nests are present before initiating vegetation management actions.*** Surveys will include the proposed vegetation management footprint and 150 foot buffer area. Surveys will be conducted within 14 days of the start of active ground disturbing activities. • ***To the greatest extent possible, avoid occupied habitat completely during key northern spotted owl breeding and nesting season (March-September).*** • ***Establish a buffer of at least 100 feet around occupied habitats.*** Within the buffer area, select least harmful vegetation management activities. Within the buffer area, retain old growth forest trees and forest canopy, and minimize removal of other vegetation to the fullest extent possible. • ***Mark occupied habitat with flagging or temporary fencing.*** • ***Ensure that mechanical fuel reduction activities in suitable Northern Spotted Owl habitat do not substantially alter the percent cover of canopy over-story***

Table 7.3 Best Management Practices Related to Special-Status Wildlife Species

Best Management Practices Related to Special-Status Wildlife Species	
	and ensure that multilayered structure is preserved. If shaded fuelbreak features are constructed in suitable northern spotted owl habitat, then the resulting multilayered canopy will only be reduced to a height of 6 to 8 feet, or along roadways as needed for emergency vehicle clearance. • ***Avoid cutting native trees greater than 10 inches diameter at breast height within Northern Spotted Owl habitat within occupied habitat areas.*** • ***Conduct a worker-training program for all field personnel involved with the proposed vegetation management project prior to initiating project.*** The program will consist of a brief presentation by persons knowledgeable about the Northern Spotted Owl. The program will include the following: a photograph and description of the Northern Spotted Owl, a description of its ecology and habitat needs, an explanation of the measures being taken to avoid or reduce adverse impacts, and the workers' responsibility under applicable environmental regulations. The worker training may be conducted in an informal manner (e.g., as part of a routine tailgate safety meeting). • ***If impacts cannot be avoided, contact the USFWS and/or the DFW to obtain the necessary permits before initiating vegetation management activities.*** • ***Notify the USFWS and/or the DFW within 24 hours of finding any injured special-status species or any unanticipated damage to their habitats associated with the proposed action.*** Notification must include the date, time, and precise location of the specimen/incident, and any other pertinent information. Dead animals should be sealed in a zip lock bag containing a piece of paper indicating the location, date and time when it was found, and the name of the person who found it; and the bag should be frozen in a freezer in a secure location. The MCOSD will contact the USFWS within 7 days to transfer any dead or injured specimens.
BMP- SPECIAL-STATUS WILDLIFE SPECIES-3 **Avoid and Protect Double Crested Cormorant Nests, Heron, and Egret Rookery Sites**	There are several known or suspected double-crested cormorant, great blue heron, snowy egret and black-crowned night heron rookery and or nesting sites on MCOSD preserves. The following procedures are similar to those described in BMP-Special-Status Species-1 for nesting birds, but are more specific to these particular bird species therefore supersede procedures described in BMP-Special-Status Species-1. The MCOSD will undertake the following actions when construction-related vegetation management is planned to occur within or adjacent to potential nest or rookery sites: • ***Identify potential habitat for double-crested cormorant, heron, and egret nest and rookery sites and survey to determine if they are occupied, or if nests are present before initiating vegetation management actions.*** Surveys will include the proposed vegetation management footprint and 150-foot buffer area. Surveys will be conducted within 14 days of the start of active ground disturbing activities.

Table 7.3 Best Management Practices Related to Special-Status Wildlife Species

Best Management Practices Related to Special-Status Wildlife Species	
	• ***To the greatest extent possible, avoid nests and rookery sites completely during key breeding and nesting periods.*** Activities in or near known sites will be limited during the known nesting seasons for each species, or until young have fully fledged. • ***Establish a buffer of at least 100 feet around rookery and nest sites.*** Within the buffer area, select least harmful vegetation management activities. Restrict activities within the buffer to those that will not disturb roosting or nesting behavior (e.g., noise and visual disturbances). • ***Mark occupied habitat with flagging or temporary fencing.*** • ***Prohibit the removal of known roost or nest trees. Restrict the removal of other mature riparian trees within buffer zone.*** • ***Conduct a worker-training program for all field personnel involved with the proposed vegetation management project prior to initiating project.*** The program will consist of a brief presentation by persons knowledgeable about the special-status species. The program will include the following: a photograph and description of the special-status species, a description of its ecology and habitat needs, an explanation of the measures being taken to avoid or reduce adverse impacts, and the workers' responsibility under applicable environmental regulations. The worker training may be conducted in an informal manner (e.g., as part of a routine tailgate safety meeting). • ***Notify the DFW within 24 hours of finding any injured special-status species or any unanticipated damage to their habitats associated with the proposed action.*** Notification must include the date, time, and precise location of the specimen/incident, and any other pertinent information. Dead animals should be sealed in a zip lock bag containing a piece of paper indicating the location, date and time when it was found, and the name of the person who found it; and the bag should be frozen in a freezer in a secure location. The MCOSD will contact the USFWS within 7 days to transfer any dead or injured specimens. • ***If impacts cannot be avoided during the nesting season (March 1-August 31), contact the DFW to obtain the necessary permits before initiating vegetation management activities.*** • ***Prohibit, or restrict equipment refueling, fluid leakage, equipment maintenance, and road surfacing activities near wetlands.*** Require placement of fuel storage and refueling sites in safe areas well away from wetlands. Safe areas include paved or cleared roadbeds, within contained areas such as lined truck beds, or other appropriate fuel containment sites. Inspect equipment and vehicles for hydraulic and oil leaks regularly. Do not allow leaking vehicles on MCOSD preserves, and require the use of drip pans below equipment stored onsite. Require that vehicles and construction equipment are in good working condition, and that any and all necessary onsite servicing of equipment be conducted away from the wetlands.

Table 7.3 Best Management Practices Related to Special-Status Wildlife Species

Best Management Practices Related to Special-Status Wildlife Species	
	• ***Require all contractors to possess, and all vehicles to carry, emergency spill containment materials. Absorbent materials should be on hand at all times to absorb any minor leaks and spills.***
BMP- SPECIAL-STATUS WILDLIFE SPECIES-4 **Avoid and Protect California Clapper Rail, California Black Rail, and Salt Marsh Harvest Mouse**	MCOSD preserves encompass some tidal areas that are known to support, or have the potential to support salt-marsh harvest mouse, California clapper rail, and California black rail. In areas where vegetation management is planned to occur within or adjacent to salt marsh or brackish marsh habitats, MCOSD will first consult with the U.S. Fish and Wildlife Service (USFWS) and the Department of Fish and Wildlife (DFW) to determine locations where salt-marsh harvest mouse, California clapper rail, and California black rail could potentially be affected by proposed vegetation management. The MCOSD would obtain and comply with necessary permits for working in suitable habitat for these species, including, but not limited to the following types of protective actions to prevent harm to the species: • ***Identify potential habitat for California Clapper Rail, California black Rail, and Salt Marsh Harvest Mouse and survey to determine if it is occupied before initiating vegetation management actions.*** Surveys will include the proposed vegetation management footprint and 150-foot buffer area. Surveys will be conducted within 14 days of the start of active ground disturbing activities. • ***To the greatest extent possible, avoid occupied habitat completely during key breeding and nesting periods.*** Activities in or near known California Clapper or Black Rail sites will be avoided during the nesting season (March 1-July 31). • ***Establish a buffer of at least 100 feet around occupied habitat.*** Within the buffer area, select least harmful vegetation management activities. Restrict activities within the buffer to those that will not disturb roosting or nesting behavior (e.g., noise and visual disturbances). • ***Mark occupied habitat with flagging or temporary fencing.***

Table 7.4 Best Management Practices Related to Special-Status Plants

Best Management Practices Related to Special-Status Plants	
BMP- SPECIAL-STATUS PLANTS-1 **Avoid and Protect Special-Status Plants near Vegetation Management Projects.**	**The MCOSD will undertake the following actions when construction-related vegetation management is planned to occur within or adjacent to special-status plant populations:** • ***Identify potential special-status plant habitat and survey to determine if it is occupied before initiating vegetation management actions.*** Surveys will include the proposed vegetation management footprint and 100-foot buffer area. Surveys will be conducted within 14 days of the start of active ground disturbing activities. • ***To the greatest extent possible, avoid occupied special-status plant populations completely.*** • ***If full avoidance is not possible, restrict work to the period when special-status plants have flowered or set seed.*** • ***Establish a buffer of at least 100 feet around special-status plant populations.*** Within the buffer area, select least harmful vegetation management activities. • ***Mark special-status plant populations with flagging or temporary fencing.*** • ***Prevent unnecessary vehicular and human intrusion and use into special-status plants habitat from adjacent construction, demolition, intensive special events, and recreation activities.*** Where necessary, reroute or sign and fence trails to accommodate the public rerouting through the special-status plant population. • ***Prohibit, or restrict equipment refueling, fluid leakage, equipment maintenance, and road surfacing activities near special-status plant populations.*** Require placement of fuel storage and refueling sites in safe areas well away from special-status plant populations. Safe areas include paved or cleared roadbeds, within contained areas such as lined truck beds, or other appropriate fuel containment sites. Inspect equipment and vehicles for hydraulic and oil leaks regularly. Do not allow leaking vehicles on MCOSD preserves, and require the use of drip pans below equipment stored onsite. Require that vehicles and construction equipment are in good working condition, and that all necessary onsite servicing of equipment be conducted away from special-status plant populations. • ***To minimize downslope erosion and sedimentation near special-status plants, maintain erosion and sediment control devices during ground disturbing activities and until all disturbed soils have been stabilized.*** Measures include rice straw, hydromulch, geofabrics, wattles, sediment traps, check dams, drainage swales, and sand bag dikes. Materials must be certified weed-free to prevent the introduction of wheat, barley, and other nonnative plant seeds.

Table 7.4 Best Management Practices Related to Special-Status Plants

Best Management Practices Related to Special-Status Plants	
	Erosion control materials must be constructed of natural fibers (e.g., coconut fiber mats, burlap and rice straw wattles, etc.) and may not be constructed with plastic monofilaments or other materials that could entrap snakes or amphibians. • ***Conduct a worker-training program for all field personnel involved with the proposed vegetation management project prior to initiating project.*** The program will consist of a brief presentation by person's knowledgeable about the special-status species. The program will include the following: a photograph and description of the special-status species, a description of its ecology and habitat needs, an explanation of the measures being taken to avoid or reduce adverse impacts, and the workers' responsibility under applicable environmental regulations. The worker training may be conducted in an informal manner (e.g., as part of a routine tailgate safety meeting). • ***If impacts cannot be avoided, contact the USFWS and/or the DFW to obtain the necessary permits before initiating vegetation management activities.*** Permit conditions will likely require presence of a biological monitor, installation of exclusion fencing, surveys to relocate or avoid the species, and/or possibly timed or staged vegetation management activities that avoid the species or reduce potential for take or harm. • ***If this species is detected during work activities, stop work immediately at that location and contact the USFWS and/or DFW within two working days.*** Work will not resume at that location until authorization is obtained from the USFWS and/or DFW unless prior approval has been granted by these agencies. • ***Notify the USFWS and/or the DFW within 24 hours of finding any damaged special-status species or any unanticipated damage to their plant habitats associated with the proposed action.*** Notification must include the date, time, and precise location of the specimen/incident, and any other pertinent information. Dead animals should be sealed in a zip lock bag containing a piece of paper indicating the location, date and time when it was found, and the name of the person who found it; and the bag should be frozen in a freezer in a secure location. The MCOSD will contact the USFWS within 2 days to transfer any dead or injured specimens.
BMP- SPECIAL-STATUS PLANTS-2 **Ensure Proposed Actions are Consistent with Ongoing Programs**	Some MCOSD preserves have ongoing special-status plant management and monitoring programs (e.g., Ring Mountain and Old St Hilary's), In these locations the MCOSD should ensure that all new proposed vegetation management projects are consistent with the ongoing management of these sites. The MCOSD will: • ***Review existing management plans and analyze proposed actions for consistency against adopted procedures.***

Table 7.4 Best Management Practices Related to Special-Status Plants

Best Management Practices Related to Special-Status Plants	
	• ***Ensure that new vegetation management projects do not interfere with ongoing management and maintenance projects.***
BMP- SPECIAL-STATUS PLANTS-3 **Use Native Soils Where Earthwork Occurs near Special-Status Plant Populations**	Many special-status plants are closely associated with specific soil types or geologic conditions (e.g., serpentine or ultramafic soils). To protect these species, the MCOSD will: • ***Not allow the introduction of incompatible fill near special-status plant populations.*** Use only clean, native soils and aggregate materials from projects within the preserve, or use fill that is purchased from a certified weed-free source, before allowing the importation of materials from outside the preserves. Fill materials should be approved by natural resource staff to ensure compatibility with future restoration/rehabilitation goals. • ***Salvage, store, and reuse topsoil. Where activities disturb soil temporarily, require salvage of the top 6 to 12 inches of topsoil (to retain seeds, soil mycorrhizae, and fungi) from all excavation and disturbance areas.*** Require reapplication of the salvaged topsoil as a topdressing or topcoat over backfill, unless it is known to contain invasive plant seeds or propagules.
BMP- SPECIAL-STATUS PLANTS-4 **Limit Erosion Potential near Special-Status Plants**	The MCOSD will seek to prevent erosion near special-status plants. Where practical and appropriate, measures will: • ***Unless no feasible alternative is available, avoid using heavy equipment in areas with soils that are undisturbed, saturated, or subject to extensive compaction.*** Where staging of heavy equipment, vehicles, or stockpiles is unavoidable, limit and mark the allowable disturbance footprint with flagging or fencing. Following the end of work, scarify surface soils to retard runoff and promote rapid revegetation. • ***Maintain a 15 MPH speed limit in sensitive habitat areas.*** This will reduce the potential for dust impacts on vegetation. For larger projects, water the roads for dust control near sensitive resources. • ***Immediately rehabilitate areas where project actions have disturbed soil. Require areas disturbed by equipment or vehicles to be rehabilitated as quickly as possible to prevent erosion, discourage the colonization of invasive plants, and address soil compaction.*** Techniques include decompacting and aerating soils, recontouring soils to natural topography, stabilizing soils via erosion control materials, revegetating areas with native plants, and removing and monitoring invasive plants. • ***To minimize erosion and sedimentation, maintain erosion and sediment control devices to protect special-status plant populations during ground disturbing activities and until all disturbed soils have been stabilized. Measures include rice straw, hydromulch, geofabrics, wattles, sediment traps, check dams, drainage swales, and sand bag dikes.*** Materials must be certified weed-free to prevent the introduction of wheat, barley, and other nonnative plant

Table 7.4 Best Management Practices Related to Special-Status Plants

<table>
<tr><th colspan="2">Best Management Practices Related to Special-Status Plants</th></tr>
<tr><td></td><td>seeds. Erosion control materials must be constructed of natural fibers (e.g., coconut fiber mats, burlap and rice straw wattles, etc.) and may not be constructed with plastic monofilaments or other materials that could entrap snakes or amphibians.</td></tr>
<tr><td>BMP- SPECIAL-STATUS PLANTS-5
Use Locally Collected and Weed-Free Plant Materials for Restoration in and near Special-Status Plant Populations</td><td>The MCOSD will:
• To the extent feasible, use plant seeds, cuttings, and other propagules that are collected from the same area as the project site (usually the same watershed or preserve). Allow collection of no more than 5% of any native plant population to prevent over collecting of wild plant material sources.
• Prevent the introduction of invasive and other nonnative plant material in to special-status plant habitats. Preventative measures will include:
» To minimize erosion and sedimentation, maintain erosion and sediment control devices during ground disturbing activities and until all disturbed soils have been stabilized. Measures include rice straw, hydromulch, geofabrics, wattles, sediment traps, check dams, drainage swales, and sand bag dikes. Materials must be certified weed-free to prevent the introduction of wheat, barley, and other nonnative plant seeds. Erosion control materials must be constructed of natural fibers (e.g., coconut fiber mats, burlap and rice straw wattles, etc.) and not of plastic monofilaments or other materials that could entrap snakes or amphibians.
» Do not allow the introduction of incompatible fill. Use only clean, native soils and aggregate materials from projects within the preserve, or use fill that is purchased from a certified weed-free source, before allowing the importation of materials from outside the preserves. Fill materials should be approved by natural resource staff to ensure compatibility with future restoration/rehabilitation goals.
» Segregate and treat soils and vegetation contaminated with invasive plant seeds and propagules. Treat, as appropriate, to prevent the spread of invasive plants. Treatment may include disposal onsite within already infested areas, chipping or pile burning and mulching to eliminate viable seeds, or disposal at an approved cogeneration plant or green waste facility.
» Establish vehicle-cleaning areas (BMP-INVASIVE PLANT-5) to clean vehicles, inside and out, of soil or invasive plant seeds or plant parts before entering MCOSD preserves, whenever moving equipment between areas within the preserves, and before leaving preserves. Within the wash areas, the tires and body of equipment will be brushed off or hosed down.
» Inspect construction equipment for soil or invasive seeds or plant parts. Require contractors to make equipment available for inspection before entering MCOSD preserves, when moving between sites within the preserves, and before leaving preserves.</td></tr>
</table>

Best Management Practices Related to Control of Invasive Plants

The following best management practices apply to work conducted near known or suspected invasive plant infestations. Implementation of these best management practices will reduce the potential for spreading invasive plants and the related adverse effects on sensitive resources during vegetation management activities.

Table 7.5 Best Management Practices Related to Control of Invasive Plants

Best Management Practices Related to Control of Invasive Plants	
BMP-INVASIVE PLANT-1 **Comply with IPM Ordinance**	All herbicide use will be administered under Marin County's IPM Ordinance, and work will only be conducted under the supervision of a certified Pest Control Applicator. All herbicide use for vegetation management actions will be posted and reported consistent with the IPM Ordinance.
BMP-INVASIVE PLANT-2 **Limit Herbicide Use near Sensitive Natural Resources**	• ***Limit herbicide use within 100 feet of sensitive natural resources.*** Where possible, ensure use of least harmful method to conduct vegetation management (e.g. hand control, mechanical control, cultural controls).
BMP-INVASIVE PLANT-3 **Survey and Control Invasive Plants in Project Footprint, Including Access Roads and Staging Areas**	• ***Before ground-disturbing activities begin, inventory and prioritize invasive plant infestations for treatment within the project footprint and along access routes.*** As feasible, control priority invasive plant infestations at least a year prior to the planned disturbance to minimize invasive plant seeds in the soil. • ***Where feasible, survey the road shoulders of access routes for invasive plants and remove priority invasive plants that could be disturbed by passing vehicles.*** • ***Avoid establishing staging areas in areas dominated by invasive plants.*** If populations of priority invasive plants occur within or near staging areas, flag their perimeters so that vehicle and foot traffic can avoid them. • ***Establish vehicle-cleaning areas (BMP-INVASIVE PLANT-5) to clean vehicles, inside and out, of soil or invasive plant seeds or plant parts before entering MCOSD preserves, whenever moving equipment between areas within the preserves, and before leaving preserves.*** Within the wash areas, the tires and body of equipment will be brushed off or hosed down. • ***Inspect construction equipment for soil or invasive seeds or plant parts.*** Require contractors to make equipment available for inspection before entering MCOSD preserves, when moving between sites within the preserves, and before leaving preserves.

Table 7.5 Best Management Practices Related to Control of Invasive Plants

Best Management Practices Related to Control of Invasive Plants	
BMP-INVASIVE PLANT-4 **Limit Soil Disturbance**	Soil disturbance during vegetation management projects, including road and trail maintenance, mechanical treatments, and prescribed bums, will be minimized to the greatest extent possible to reduce the potential for introduction or spread of invasive plants, to protect topsoil resources and to reduce available habitat for new invasive plants. • ***Remove only enough vegetation to accomplish the management objectives.***
BMP-INVASIVE PLANT-5 **Clean Invasive Plant Materials and Propagules from Heavy Equipment, Maintenance Tools, and Fire Management Vehicles**	The MCOSD will implement the following procedures when working in or near infested areas: • ***Establish vehicle-cleaning areas (BMP-INVASIVE-5) to clean vehicles, inside and out, of soil or invasive plant seeds or plant parts before entering MCOSD preserves, whenever moving equipment between areas within the preserves, and before leaving preserves.*** Within the wash areas, the tires and body of equipment will be brushed off or hosed down. • ***Inspect construction equipment for soil or invasive seeds or plant parts.*** Require contractors to make equipment available for inspection before entering MCOSD preserves, when moving between sites within the preserves, and before leaving preserves.
BMP-INVASIVE PLANT-6 **Reduce Potential for Establishment of Invasive Plants on Disturbed Soil Surfaces**	Measures will be taken to minimize the establishment of invasive species in disturbed soil areas. The MCOSD will consider implementing one or more of the following actions: • ***To minimize erosion and sedimentation, maintain erosion and sediment control devices during ground disturbing activities and until all disturbed soils have been stabilized. Measures include rice straw, hydromulch, geofabrics, wattles, sediment traps, check dams, drainage swales, and sand bag dikes. Materials must be certified weed-free to prevent the introduction of wheat, barley, and other nonnative plant seeds.*** Erosion control materials must be constructed of natural fibers (e.g., coconut fiber mats, burlap and rice straw wattles, etc.) and may not be constructed with plastic monofilaments or other materials that could entrap snakes or amphibians. • ***Do not allow the introduction of incompatible fill.*** Use only clean, native soils and aggregate materials from projects within the preserve, or use fill that is purchased from a certified weed-free source, before allowing the importation of materials from outside the preserves. Fill materials should be approved by natural resource staff to ensure compatibility with future restoration/rehabilitation goals. • ***Segregate and treat soils and vegetation contaminated with invasive plant seeds and propagules.*** Treat, as appropriate, to prevent the spread of invasive plants. Treatment may include disposal onsite within already infested areas,

Table 7.5 Best Management Practices Related to Control of Invasive Plants

Best Management Practices Related to Control of Invasive Plants	
	chipping or pile burning and mulching to eliminate viable seeds, or disposal at an approved cogeneration plant or green waste facility.
BMP-INVASIVE PLANT-7 **Monitor and Control Invasive Plants in Management Work Areas**	• ***Monitor areas subject to vegetation management, including fuel management treatments periodically for a minimum of 3 years following project completion for the presence of invasive plants.*** If invasive plants become established or spread as a result of project activities, treat and remove invasive plants.
BMP-INVASIVE PLANT-8 **Restrict Use of Invasive Plants for Horticultural Use**	MCOSD natural resource staff will work with Marin County Planning staff to develop a list of approved plant material for horticultural use. This list will exclude any known or potentially invasive plants and will be periodically revised.
BMP-INVASIVE PLANT-9 **Protect Stream Banks and Water Quality During Invasive Plant Removal**	The MCOSD will install approved erosion control measures and non-filament based geotextiles when working near wetlands, streams, creeks, ponds, and riparian areas, and following the removal of invasive plants from stream banks to prevent sediment movement into watercourses and to protect bank stability. MCOSD will obtain and comply with necessary wetland permits and IPM procedures related to work in and near wetlands. Where appropriate, the MCOSD will also seek guidance from a fisheries biologist regarding the amount of material permissible to remove when controlling large patches of invasive plants from stream corridors, so as to prevent changes in water temperature and quality.

Best Management Practices Related to Fire Fuel Management and Risk Reduction

The best management practices presented in table 7.6 apply to vegetation management actions related to fire fuel management and risk reduction. These include actions to reduce fuel loads, create and maintain fuelbreaks, and create and maintain defensible space zones, as well as general actions to reduce the risk of a wildfire on MCOSD land. Implementation of these best management practices will reduce the potential for impacts on sensitive natural resources, erosion, and spread of invasive plants during fuel and vegetation management actions to reduce fire risk.

Table 7.6 Best Management Practices Related to Fire Fuel Management and Risk Reduction

Best Management Practices Related to Fire Fuel Management and Risk Reduction	
BMP- FUEL MANAGEMENT-1 **Process Green Waste To Reduce Risk of Ignition**	• ***Brush to be left onsite will be chipped or cut into sections that will stack flat to reduce the potential for ignition.*** MCOSD will limit the size of brush piles to 4 cubic yards or less, and space them to minimize impacts to soils from high impact fires.
BMP- FUEL MANAGEMENT-2 **Use of Herbicides During Fuel Management**	• ***All herbicide use will be administered under Marin County's IPM Ordinance, and work will only be conducted under the supervision of a certified Pest Control Applicator.*** All herbicide use for fire management actions will be reported monthly to the IPM coordinator.
BMP- FUEL MANAGEMENT-3 **Treat Existing Brush Piles during Fuel Management**	• ***Since burn piles can provide wildlife habitat, the piles should be spread out (to help ensure wildlife are not present) as much as possible before burning.*** If moving the piles is not feasible, the fire management project manager will ensure that piles are lit from one side only (with firefighters on the ignition side), so any wildlife in the pile can relocate.
BMP- FUEL MANAGEMENT-4 **Develop plans for Managing Fuels Within Special-Status Plant Populations**	• ***To address fire actions occurring within special-status plants populations, site and/or species-specific rehabilitation plans will be developed to minimize or avoid impacts to the greatest extent possible.***
BMP- FUEL MANAGEMENT-5 **Develop Restoration Plans in Conjunction with Fuel Management**	• ***When vegetation management actions disturb the habitat of special-status plants, revegetation and weeding plans will be developed in conjunction with project planning.***

Table 7.6 Best Management Practices Related to Fire Fuel Management and Risk Reduction

Best Management Practices Related to Fire Fuel Management and Risk Reduction	
BMP- FUEL MANAGEMENT-6 **Protect Nesting Birds During Fuel Management**	• ***Prescribed burns, mechanical treatments, and mowing of shrubs and grasses taller than 8 inches will not be conducted during the bird-nesting season (March 1-August 15), unless a qualified biologist conducts a pre-project survey for nesting birds and determines that birds are not nesting within the project area.*** To the greatest extent possible, these activities will be planned and conducted outside bird-nesting season. In intensively managed landscapes where mowing is justified for fuel reduction, vegetation will be maintained at a height of less than 8 inches throughout the nesting season to discourage the nesting of ground-dwelling bird species.
BMP- FUEL MANAGEMENT-7 **Monitor and Remove Invasive Plants**	• ***Monitor areas subject to vegetation management, including fuel management treatments periodically for a minimum of 3 years following project completion for the presence of invasive plants.*** If invasive plants become established or spread because of project activities, treat and remove invasive plants.
BMP- FUEL MANAGEMENT-8 **Reduce Potential for Spread of Invasive Plants During Fuel Management**	All fuel management projects will incorporate techniques that control existing populations of invasive plants at the project site and incorporate practices to reduce the spread of invasive plants to non-infested areas. Practices to reduce the spread of invasive plants include: • ***Restrict the movement or deposition of fill, rock, or other materials containing invasive plant seed or viable plant cuttings to areas relatively free of invasive plants.*** • ***Where feasible, survey the road shoulders of access routes for invasive plants and remove priority invasive plants that could be disturbed by passing vehicles.*** • ***Establish vehicle-cleaning areas (BMP-INVASIVE-5) to clean vehicles, inside and out, of soil or invasive plant seeds or plant parts before entering MCOSD preserves, whenever moving equipment between areas within the preserves, and before leaving preserves.*** Within the wash areas, the tires and body of equipment will be brushed off or hosed down. • ***Inspect construction equipment for soil or invasive seeds or plant parts.*** Require contractors to make equipment available for inspection before entering MCOSD preserves, when moving between sites within the preserves, and before leaving preserves.
BMP- FUEL MANAGEMENT-9 **Conform with Federal and State Regulations Governing Sudden Oak Death, Implement**	• ***Ensure that all vegetation management actions conform to federal and state regulations governing interstate and intrastate restrictions adopted to prevent the artificial spread of Sudden Oak Death (Phytophthora ramorum).*** MCOSD natural resource staff will ensure that current guidelines and regulations are circulated to staff involved in vegetation management actions. Current regulations do not permit the movement of specific plant species and associated material outside of the regulated quarantine area

Table 7.6 Best Management Practices Related to Fire Fuel Management and Risk Reduction

Best Management Practices Related to Fire Fuel Management and Risk Reduction	
Procedures to Contain the Spread of SOD	that includes Marin, San Francisco, and San Mateo Counties. • ***As feasible, fell SOD-infected trees and leave plant matter in place. Do not conduct additional treatment activities within 200 feet of infected trees.*** Locate staging, parking, and work areas away from infected trees. Inspect all equipment, vehicles, and individuals upon leaving project areas for soil, leaves, twigs, and branches. If found, clean onsite avoid the spread of SOD.
BMP- FUEL MANAGEMENT-10 **Follow Procedures for Take of Listed Species during Emergency Fire Management Actions**	• ***When emergency actions must be taken to prevent imminent loss of human life or property and these actions would result in a taking of listed species or adverse modification of critical habitat not covered under an existing biological opinion, respond to the situation in an expedient manner to protect human health and safety.*** After the incident is under control, initiate emergency consultation procedures with the appropriate agency(ies).
BMP- FUEL MANAGEMENT-11 **Seek to Adhere to No Net Loss of Listed Species from Fire Management Activities**	All fire management actions will seek to achieve No Net Loss of Endangered Species wherever possible. The project review process will be used to document the no net loss finding through the conformance assessment conducted for each FMP action proposed for listed species habitat.
BMP- FUEL MANAGEMENT-12 **Limit Work in Wetlands During Emergency Fire Management Actions**	• ***Avoid fire suppression damage by allowing fire back into, around, or through wetlands and meadows.*** To the greatest extent possible, do not construct fire lines or breaks in wetlands. Where wetlands are used as a natural boundary to help contain a fire, construct the control line outside the wetland area. If a control line is needed within the wetland, use trample, rather than dug, lines.
BMP- FUEL MANAGEMENT-13 **Work with County Fire and Private Property Owners if Encroachment onto MCOSD Preserves is Necessary to Meet Defensible Space Zone Requirements**	MCOSD will work with County Fire and adjacent private property owners to meet Defensible Space Zone requirements around habitable structures. MCOSD will support efforts to: • ***Support Achievement of Low Fuel Zone (0-30 feet from all habitable structures).*** MCOSD will provide guidance to landowners on proper clearance techniques, using a standard MCOSD permitting process, if encroachment onto MCOSD lands is necessary to meet Defensible Space Zone requirements. If a wooden deck is part of the back of the home, this 30-foot distance starts from the edge of the deck outward. MCOSD will provide guidance to property owners on proper clearance techniques, including: • ***Brush and invasive plants must be cut to the ground, raked up, and removed***

Table 7.6 Best Management Practices Related to Fire Fuel Management and Risk Reduction

Best Management Practices Related to Fire Fuel Management and Risk Reduction	
	from the property. Single specimens of trees and shrubbery used as ground cover can remain, provided that they do not form a means of rapidly transmitting fire from the native growth to any structure. • ***Trim trees horizontally to at least 10 feet away from the home and decks.*** If a homeowner wishes to keep a tree within this 10-foot distance, they must trim any nearby trees a minimum of 10 feet away from this tree within this first 30-foot space. • ***Large trees should be limbed up to a minimum of 8 feet above the ground and smaller trees limbed up proportionately.*** • ***Support Achievement of Reduced Fuel Zone (30-100 feet from all structures).*** MCOSD will provide guidance to landowners on proper clearance techniques, using a standard MCOSD permitting process, if encroachment onto MCOSD lands is necessary to meet Defensible Space Zone requirements. MCOSD will provide guidance to property owners on proper clearance techniques, including: • ***In this additional 70-foot space, the vegetation should be cut so that it is not more than 18 inches above the ground. The cut vegetation can be left in place as long as it is mulched down.*** • ***Trees within this 70-foot space should also be limbed up a minimum of 8 feet above the ground for large trees and proportionately for smaller trees.*** • ***Remove any dead vegetation, (branches, dead trees etc.).*** • ***Remove or reduce understory vegetation.*** Flammable vegetation and combustible growth should be cut and removed from below the canopies of the trees in this space. • ***Determine if fuel ladders are present, and if so, remove.*** The ladder fuel problem can be corrected by providing a separation between the vegetation layers. Within the defensible space area, a vertical separation of three times the height of the lower fuel layer is recommended. (For example, if a shrub growing adjacent to a large tree is three feet tall, the recommended separation distance would be 9 feet (3 foot shrub height x 3 = 9 feet). This could be accomplished by removing the lower tree branches, reducing the height of the shrub, or both. A maximum height of 18 inches for all shrubs within 30 feet is recommended. • ***Break up "continuous" vegetation.*** Sometimes wildland plants can occur as an uninterrupted layer of vegetation (as opposed to being patchy or widely spaced individual plants). The more continuous and dense the vegetation, the greater the wildfire threat. If this situation is present within the recommended defensible space area, it can be "broken-up" by creating patches or spaces between small groups of plants.

Table 7.6 Best Management Practices Related to Fire Fuel Management and Risk Reduction

Best Management Practices Related to Fire Fuel Management and Risk Reduction	
	• ***Individual specimens or small groups of wildland shrubs and trees can be retained so long as they are kept healthy, free of dead wood, and pruned to reduce the amount of fuel and height, and ladder fuels are removed.*** • ***For some areas, substantial removal of wildland vegetation may not be allowed.*** In these instances, wildland vegetation should conform to the recommended separation distances, be kept free of dead plant material, pruned to remove ladder fuels and reduce fuel load, and arranged so it cannot readily convey a fire from the wildlands to the house.

Best Management Practices Related to Ongoing Maintenance

The best management practices presented in table 7.7 apply to vegetation management actions undertaken as ongoing maintenance activities, such as road brushing, mowing of flashy fuels, maintenance of fuel reduction areas, and similar activities. Implementation of these practices will reduce the potential for impacts on sensitive natural resources, erosion, and the spread of invasive plants during ongoing maintenance activities.

Because ongoing maintenance work may occur at any location throughout the preserve system, best management practices for this work are by default very broad, and generally repeat best management practices described above. To be effective, MCOSD staff will have to review resource maps to determine if maintenance activities have the potential to affect sensitive natural resources, and then adopt best management practices as necessary.

Table 7.7. Best Management Practices Related to Ongoing Maintenance

Best Management Practices Related to Ongoing Maintenance	
BMP- MAINTENANCE-1	Implement General BMPs (BMP-GENERAL-1 through BMP-GENERAL-9).
BMP- MAINTENANCE-2	Implement sensitive natural resource restrictions when working in known special-status species habitats (implement BMP-SPECIAL-STATUS WILDLIFE SPECIES and BMP-SPECIAL-STATUS PLANTS-1).
BMP- MAINTENANCE-3	Implement Bird Nesting Restrictions for vegetation removal projects (BMP-SPECIAL-STATUS WILDLIFE SPECIES-1)
BMP- MAINTENANCE-4	Implement BMP-INVASIVE PLANT-1 through BMP-INVASIVE PLANT-9 for all maintenance activities in and near invasive plant infestations.
BMP- MAINTENANCE-5	Implement BMP-FUEL MANAGEMENT-1 through BMP-FUEL MANAGEMENT-5 for all fuel maintenance projects. Implement BMP-FUEL MANAGEMENT-9 and BMP-FUEL MANAGEMENT-13 as applicable.

APPENDIXES

A: Current Management Plans and Practices

Starting in the 1980s, MCOSD expanded efforts to manage vegetation resources on its preserves. Over a dozen preserve-specific resource management plans were developed (see table A.1), and became early blueprints for protecting sensitive plant and wildlife species, as well as for controlling nonnative plants. General land management plans specific to one or more preserves were also prepared. Many of these documents contained vegetation management actions. In an effort to utilize that information, the documents were reviewed and synthesized, and relevant vegetation management recommendations were brought forward into the vegetation and biodiversity management plan.

Table A.1 Preserve-Specific Management Plans and Reports

Land Management and Resource Management Plans	
Kent Island Restoration Plan at Bolinas Lagoon (2009)	*The Kent Island Restoration Plan at Bolinas Lagoon* guides restoration of tidal wetlands at Kent Island. The plan Includes 13 recommendations from the Bolinas Lagoon Ecosystem Restoration Project (see below).
San Geronimo Valley Salmon Enhancement Plan (2009)	The plan provides enhancement recommendations for salmonid habitats and associated riparian corridors in San Geronimo Valley to achieve the following goals: (1) preserve and improve habitat conditions for salmonids, (2) promote ecosystem resiliency through rehabilitating natural processes, (3) correct and avoid activities that degrade habitat, and (4) sustain character and quality of life in San Geronimo Valley.
Fuelbreak Vegetation Assessment– Marin County Open Space District (2008)	The *Fuelbreak Vegetation Assessment* assesses native vegetation diversity and maps invasive plants in existing and proposed fuelbreak areas in 15 MCOSD preserves. It recommends perpetual maintenance of all current fuel management areas and fire roads to help curb the spread of invasive plants throughout the preserves, and the maintenance of specific areas for fire risk reduction, using alternative strategies (e.g. controlled burns) to meet fuel reduction goals. The assessment also recommends the potential realignment of some fuelbreaks from the interiors of the preserves to the perimeters of the preserves, and/or to already disturbed areas, to help maintain large intact areas of undisturbed native habitats. Maintenance guidelines are included for fuel management actions implemented within the interiors of the preserves, along with recommendations and planning-level cost estimates intended to assist MCOSD with prioritizing invasive species control efforts.
Draft Bolinas Lagoon Ecosystem Restoration Project Recommendations for Restoration and Management (2008)	This document contains very little on vegetation management. It focuses on restoration of natural sediment transport and natural processes and ecological function, protection of water quality, and the amelioration of human-induced negative effects. It contains 13 recommendations, which are also included in the Kent Island restoration plan (see above).
Ring Mountain Preserve Sensitive Resources Monitoring and Enhancement Strategy (2008)	The document provides baseline information about sensitive species locations on Ring Mountain and an assessment of impacts and remedial measures for managing sensitive vegetation, but it does not include comprehensive vegetation management recommendations for the preserve. It includes a list of targeted invasive plants and a list of priority invasive plant management projects in and near special-status species occurrences.
Grazing Recommendations for Mount Burdell Open Space Preserve (2008)	In addition to providing grazing recommendations, this document identifies vegetation management goals and objectives for the Mount Burdell preserve, summarizes existing site and grassland conditions, identifies and maps sensitive resources, identifies threats and impacts to resources (specifically, targeted invasive plants), and describes the current grazing regime and infrastructure.
Cascade Canyon and White Hill Open Space Preserves Draft Land Management Plan (2005)	The draft *Land Management Plan* for the Cascade Canyon and White Hill preserves establishes goals and operating policies; describes site conditions, including resource summaries and maps; describes fuel reduction strategies and fuelbreak placement; and recommends management actions for the two preserves. Goals include (1) preserving and enhancing the native plant and animal communities, geologic, hydrologic, and historic resources and scenic values of the preserves; (2) maintaining and enhancing opportunities for public recreation, education, and aesthetic enjoyment of preserves; (3) reducing the threat of wildfire to the surrounding community; and (4) minimizing and reducing the impacts of preserve use on the surrounding community. The plan attempts to reconcile the effects of varying management actions on the preserves' biodiversity by making recommendations about how to control invasive plant establishment in fuelbreaks, the timing and sequencing of maintenance activities, the priorities for monitoring, and the best management practices for trails and fire roads.
Santa Venetia Marsh Enhancement Plan - Existing Condition Study and Enhancement Recommendations (2002)	The *Santa Venetia Marsh Enhancement Plan* assesses existing conditions, identifies invasive plant control actions, and identifies three categories of enhancement measures to improve habitat values and benefits: (1) Upland Buffer Zone enhancement planting, (2) buffer and marsh plain protection measures, and (3) channel modification.
Interim Management Guidelines for the Horse Hill Area Alto Bowl/ Horse Hill Open Space Preserve (1998)	Developed as an interim document to guide decision making until a more comprehensive management plan is prepared, this guideline focuses on achieving a balance of protecting resources while meeting equestrian needs. Recommendations for vegetation management include the fencing and monitoring of sensitive resources and the control of targeted invasive plants (e.g., broom, pampas grass, yellow and purple star thistles).
Bolinas Lagoon Management Plan Update (1996)	This plan has been superseded by the 2008 *Draft Bolinas Lagoon Ecosystem Restoration Project Recommendations for Restoration and Management* (see above).
Mount Tamalpais Area Vegetation Management Plan (1995)	The *Mt. Tamalpais Area Vegetation Plan* contracted by MMWD and MCOSD covers more than 19,000 acres of MMWD lands and an adjacent 1,150 acres of MCOSD preserve lands. The chief goals of the plan are fire-hazard reduction and maintaining the watershed's biological diversity.

Table A.1 Preserve-Specific Management Plans and Reports

Land Management and Resource Management Plans	
Land Management Plan for Santa Venetia Marsh & Santa Margarita Island Open Space Preserves (1992)	The land management plan for these preserves recommends zoning to support prioritization of uses and management to protect resources. It includes policy statements about improving accessibility, communications with adjacent landowners, and dog management. It gives a high priority to actions to protect endangered species, presents best management practices for trail construction and viewshed management and targets invasive plants and control mechanisms. It briefly addresses fire management, with a focus on suppression, fuelbreak maintenance, and designated access routes.
Terra Linda/Sleepy Hollow & San Rafael Ridge Open Space Preserve - Land Management Plan (1991)	The land management plan for these preserves establishes goals and makes recommendations for maintaining ecological diversity, minimizing fire hazard, and providing public access and visitor use opportunities. Management recommendations are prioritized, and detailed descriptions and cost estimates are included. The plan identifies invasive plants.
Land Management Plan for San Pedro Ridge Open Space Preserve (1990)	Developed as a tool to guide MCOSD daily maintenance and management activities, this plan evaluates existing conditions and influencing factors, provides recommendations for improving resource conditions, and cites management issues to be addressed. It Identifies invasive plants and includes recommendations for control. It recommends that fire management be expanded as a resource management tool, instead of used as a tool for just managing fire hazard. It suggests that sensitive resource areas be designated to protect unique natural and cultural resources. The plan appendixes include survey data and maps.
Mount Burdell Open Space Preserve Native Tree Revegetation Plan (1990)	This plan outlines a revegetation strategy for 28 specific sites within the preserve. It describes site conditions, provides criteria for site selection and prioritization,, recommends revegetation techniques and timing, and estimates implementation costs. Native trees are the primary species for revegetation.
Land Management Plan for Indian Tree and Verissimo Hills Open Space Preserves (1989)	This land management plan outlines specific management recommendations for each preserve. Recommended actions include site-specific vegetation management (revegetation, invasive species control, biomass management, etc.), fire suppression, and trail placement and maintenance activities. The plan includes recommendations for zoning sites for high use and resource protection, completing districtwide fire management policies, creating multidisciplinary teams to ensure fire management actions are integrated, and restoring nondesignated trails.
Land Management Plan for Roy's Redwoods and Maurice Thorner Memorial Open Space Preserves (1989)	This document is similar to the Indian Tree and Verissimo Hills plan. It outlines specific management recommendations for each preserve. Recommended actions include site-specific vegetation management (revegetation, invasive species control, biomass management, etc.), fire suppression, and trail placement and maintenance activities. The plan Includes recommendations for developing a fire management policy that is consistent with restoration objectives.
Monitoring Plans, Status and Conditions Reports	
Range Resource Survey of Horse Hill, Mill Valley, Marin County 2009 Grazing Season (2009)	This document assesses the impacts of grazing on the grassland vegetation and recommends actions to address the issues. It includes observations and recommendations about controlling French broom (*Genista monspessulana*).
Terra Linda/Sleepy Hollow Preserve Goatgrass Management Project (2005-2009).	This document recommends actions to remove barbed goatgrass (*Aegilops triuncialis*) using an IPM approach to preserve native biological diversity and promote wildlife habitat.
Mt. Burdell Preserve Yellow Starthistle Management Project (2005-2009)	This documents recommends actions to control yellow starthistle (*Centaurea solstitialis*) using an IPM approach to restore an estimated 125 acres of land infested by this invasive plant.
Ring Mountain Preserve Sweet Fennel Management Project (2009)	This document recommends actions to remove sweet fennel using an IPM approach to preserve native biological diversity and promote wildlife habitat.

Table A.2 Supporting Documentation and Management Documents Presented by Preserve

	Document Number and Name	Author	Date	Preserve																																		
				ALL	Alto Bowl	Bald Hill	Baltimore Canyon	Blithedale Summit	Bolinas Lagoon	Bothin Marsh	Camino Alto	Cascade Canyon	Deer Island	French Ranch	Gary Giacomini	Horse Hill	Ignacio Valley	Indian Tree	Indian Valley	King Mountain	Little Mountain	Loma Alta	Loma Verde	Lucas valley	Maurice Thorner Memorial	Mt Burdell	Old St Hilary's	Pacheco Valle	Ring Mountain	Roy's Redwoods	Rush Creek	San Pedro Ridge	Santa Venita Marsh	Santa Margarita Island	Terra Linda/Sleepy Hollow	Tiburon Ridge	Verrissimo Hills	White Hill
1	Interim Management Guidelines for The Horse Hill Area Alto Bowl/ Horse Hill Open Space Preserve	Marin County Open Space District	Dec-98		X											X																						
2	Range Resource Survey of Horse Hill, Mill Valley, Marin County 2009 Grazing Season	David Amme, Resource Restoration and Management	Jun-09		X											X																						
3	Ring Mountain Preserve Sensitive Resources Monitoring and Enhancement Strategy	LSA Associates, Inc.	Jan-08																										X									
4	Draft Bolinas Lagoon Ecosystem Restoration Project Recommendations for Restoration and Management	A Working Group of the Sanctuary Advisory Council - Gulf of the Farallons National Marine Sanctuary with assistance from MCOSD and the United States Army Corps of Engineers	May-08						X																													
5	Bolinas Lagoon Management Plan Update	Wetlands Research Associates, Philip Williams Associates, Avocet Research Associates	Mar-96						X																													
6	Mount Tamalpais Area Vegetation Management Plan	Leonard Charles and Associates	Feb-95	X[1]	X		X	X[2]			X[3]									X																		
7	Vegetation and Fire Management Baseline Studies: The Marin Municipal Water District and the Marin County Open Space District (Northridge lands), Marin County, California - Summary Report	Leonard Charles and Associates	Apr-91		X		X	X[4]			X									X																		
8	Mount Tamalpais Area Vegetation Management Plan Technical Appendix A Unit (Polygon) Prescriptions	Leonard Charles and Associates	Jun-93		X		X	X[5]			X									X																		
9	Vegetation and Fire Management Baseline Studies: The Marin Municipal Water District and the Marin County Open Space District (Northridge lands), Marin County, California - Technical Appendixes	Leonard Charles and Associates	Jun-91		X		X	X[6]			X									X																		
10	Land Management Plan for San Pedro Ridge Open Space Preserve	Wittenkeller & Associates	Sep-90																													X	X[7]	X[8]				

[1] All parcels in Northridge Open Space Preserve
[2] Blithedale Ridge
[3] Blithedale Ridge
[4] Blithedale Ridge
[5] Blithedale Ridge
[6] Blithedale Ridge

Table A.2 Supporting Documentation and Management Documents Presented by Preserve

	Document Number and Name	Author	Date	Preserve																																		
				ALL	Alto Bowl	Bald Hill	Baltimore Canyon	Blithedale Summit	Bolinas Lagoon	Bothin Marsh	Camino Alto	Cascade Canyon	Deer Island	French Ranch	Gary Giacomini	Horse Hill	Ignacio Valley	Indian Tree	Indian Valley	King Mountain	Little Mountain	Loma Alta	Loma Verde	Lucas valley	Maurice Thorner Memorial	Mt Burdell	Old St Hilary's	Pacheco Valle	Ring Mountain	Roy's Redwoods	Rush Creek	San Pedro Ridge	Santa Venita Marsh	Santa Margarita Island	Terra Linda/Sleepy Hollow	Tiburon Ridge	Verrissimo Hills	White Hill
11	Appendices for San Pedro Ridge Open Space preserve	Wittenkeller & Associates	Sep-90																																			
12	Santa Venetia Marsh Enhancement Plan - Existing Condition Study and Enhancement Recommendations	Wetlands Research Associates, Inc.	Dec-02																														X					
13	Appendices Land Management Plan for Santa Venetia Marsh & Santa Margarita Island Open Space Preserves	Wittenkeller & Associates	May-92																														X	X				
14	Terra Linda/Sleepy Hollow Open Space Preserve - Land Management Plan	Leonard Charles and Associates	Aug-91																																X			
15	Terra Linda/Sleepy Hollow Open Space Preserve - Appendix to the Land Management Plan	Leonard Charles and Associates	Sep-91																																X			
16	Mount Burdell Open Space Preserve Native Tree Revegetation Plan	Harold C. Appleton RPF	Dec-90																							X												
17	Grazing Recommendations for Mount Burdell Open Space Preserve	Lisa Bush, California Certified Rangeland Manager #18	Dec-08																							X												
18	Land Management Plan for Indian Tree and Verissimo Hills Open Space Preserves	Brian Wittenkeller & Associates	Jan-09															X																			X	
19a &b	Land Management Plan for Roy's Redwoods and Maurice Thorner Memorial Open Space Preserves	Brian Wittenkeller & Associates	Jan-89																						X					X								
20	Cascade Canyon and White Hill Open Space Preserves Land Management Plan	Leonard Charles and Associates	Jul-05									X																										X
21	Cascade Canyon and White Hill Open Space Preserves Draft Land Management Plan - Final Environmental Impact Report	Leonard Charles and Associates	Jul-05									X																										X
22	Bothin Marsh Enhancement Plan - Existing Condition Study Enhancement Recommendations	Wetlands Research Associates, Inc.	Jun-04							X																												
23	Community Wildfire Protection Plan	Marin County Fire Department in Collaboration with FIRE Safe Marin	Jul-05	X[9]																																		
24	Marin County Fire Department in collaboration with FIRE Safe Marin "Community Wildfire Protection Plan"	Marin County Fire Department	Sep-10																																			

[7] Some
[8] Some
[9] Throughout Marin

Table A.3 Supporting Documents and Management Documents Presented by Topic Area

	Document Number and Name	Author	Date	Topic: ALL	Plant /Vegetation Communities	Wildlife	Sensitive Species	Sensitive Habitats	Invasive Plants	Natural Succession	Forest Health	Grazing and Grazing Mgmt.	Invasive / Problem Wildlife & Mgmt.	Erosion & Erosion Mgmt.	Fire/Fuel Load Mgmt.	Weed Control/Invasive Plant Detection and Control	Coordination with other Agencies	Veg Mgmt. Recommendations	Best Management Practices And Policies	Maintenance Program	Monitoring Program	Volunteer Involvement Opportunities	Research	Public Concerns And/Or Comments	Visitor Use	Land Use History	Costs
1	Interim Management Guidelines for The Horse Hill Area Alto Bowl/ Horse Hill Open Space Preserve	Marin County Open Space District	Dec-98		6-8	12-13	*	*	6-8	*	*	1-19	*	9-11	8-9	7-8	*	2, 7-8,	*	*	*	*	*	1-19	1-19	*	*
2	Range Resource Survey of Horse Hill, Mill Valley, Marin County 2009 Grazing Season	David Amme, Resource Restoration and Management	Jun-09		1-4	*	*	*	1-7	*	*	1-7	*	*	*	7	7	6-7	*	6-7	*	*	*	*	*	*	7
3	Ring Mountain Preserve Sensitive Resources Monitoring and Enhancement Strategy	LSA Associates, Inc.	Jan-08		8-11, Appendix A	*	12-19, Figures	*	34-39, Figures	40-41 (coyote brush & bracken fern)	*	23, 27	23, 27, 32 (herbivores & argentine ants)	*	*	34-39, 34, 34a-b, Table E	*	34-39 , 40-41, Appendix B & C	Appendix C	Appendix B & C	20-32 Appendix B & D	Appendix C	27, 29, 30, 31	*	33-34	*	*
4	Draft Bolinas Lagoon Ecosystem Restoration Project Recommendations for Restoration and Management	A Working Group of the Sanctuary Advisory Council - Gulf of the Farallones National Marine Sanctuary with assistance from MCOSD and the United States Army Corps of Engineers	May-08		*	*	*	*	35-36 Table 4 (pg. 77)	*	34	*	36 (inverts and crab)	*	*	29-30, 33-34, 35-36, Tables 1, 2, 3	35-36	33-34, 35-36	33-34 52-58 (permitting agencies), Table 2	Tables 1, 2, 3	Table 3	*	*	42-43	*	14-15	*
5	Bolinas Lagoon Management Plan Update	Wetlands Research Associates, Philip Williams Associates, Avocet Research Associates	Mar-96		39 -43	24-52	Appendix D (summary 130) Table 3 (birds 26-28) Table 4 (fishes 29-31), Table 5 (inverts 32-36)	*	Appendix E (132-133)	*	*	*	*	73-75	*	78	*	78	Appendix B (regulations), Appendix H (MCOSD code)	78	78-79	62-64, 78	56	*	69-73, 65-66	*	56-58

Table A.3 Supporting Documents and Management Documents Presented by Topic Area

	Document Number and Name	Author	Date	Topic: ALL	Plant /Vegetation Communities	Wildlife	Sensitive Species	Sensitive Habitats	Invasive Plants	Natural Succession	Forest Health	Grazing and Grazing Mgmt.	Invasive / Problem Wildlife & Mgmt.	Erosion & Erosion Mgmt.	Fire/Fuel Load Mgmt.	Weed Control/Invasive Plant Detection and Control	Coordination with other Agencies	Veg Mgmt. Recommendations	Best Management Practices And Policies	Maintenance Program	Monitoring Program	Volunteer Involvement Opportunities	Research	Public Concerns And/Or Comments	Visitor Use	Land Use History	Costs
6	Mount Tamalpais Area Vegetation Management Plan	Leonard Charles and Associates	Feb-95	all parcels in "Northridge Open Space Preserve"	9-12, 166-168, 190-199	*	11, 190-199	166-168	149-186	166-190 Oak Woodland - D. Fir, Grasslands - Shrub or forest, loss of chaparral, oak understory development 199-200	see "natural succession"	122-123	*	94, 206, 168, 249	2-8, 70-148, entire document	9-12, 149-186	18, 214-225, 230-231, 251-299	2-8,9-12, 70-200	91-123 (prescription guidelines), Exhibit A	91-123,, 234-235	18, 157-158, 245-250	161-162,164, 296-297	Table 8 135, 156-157	59-65	13-14	26-31	14-17, 91-135, 160, 164, Table 8, 186-187, 190, 199, 213, 224-225, 229-231, 236-244, 248, 297-299
7	Vegetation and Fire Management Baseline Studies: The Marin Municipal Water District and the Marin County Open Space District (Northridge lands), Marin County, California - Summary Report	Leonard Charles and Associates	Apr-91		8-9, 11-25	8, 26-27	11-12, 20-25, 26, 28-29	14	*	16-25	*	*	*	*	9-10, 20-25, 28-47	*	*	*	*	*	*	5-6	*	3, 5	*	*	*
8	Mount Tamalpais Area Vegetation Management Plan Technical Appendix A Unit (Polygon) Prescriptions	Leonard Charles and Associates	Jun-93		*	*	*	*	*	*	*	*	*	*	entire document	*	*	entire document	*	*	*	*	*	*	*	*	*
9	Vegetation and Fire Management Baseline Studies: The Marin Municipal Water District and the Marin County Open Space District (Northridge lands), Marin County, California - Technical Appendixes	Leonard Charles and Associates	Jun-91		Appendix 1, 2, 3,	Appendix 4	Appendix 1, 2, 4	*	Appendix 3	Appendix 1, 3	see "natural succession"	Appendix 3	Appendix 4	Appendix 3	Appendix 1, 3, 5, 6, 7, 8, 9	*	*	*	*	*	*	*	*	Appendix 10	*	*	*

Table A.3 Supporting Documents and Management Documents Presented by Topic Area

	Document Number and Name	Author	Date	Topic: ALL	Plant /Vegetation Communities	Wildlife	Sensitive Species	Sensitive Habitats	Invasive Plants	Natural Succession	Forest Health	Grazing and Grazing Mgmt.	Invasive / Problem Wildlife & Mgmt.	Erosion & Erosion Mgmt.	Fire/Fuel Load Mgmt.	Weed Control/Invasive Plant Detection and Control	Coordination with other Agencies	Veg Mgmt. Recommendations	Best Management Practices And Policies	Maintenance Program	Monitoring Program	Volunteer Involvement Opportunities	Research	Public Concerns And/Or Comments	Visitor Use	Land Use History	Costs
10	Land Management Plan for San Pedro Ridge Open Space Preserve	Wittenkeller & Associates	Sep-90		18-19	23-24	18,23	30	19, 21	*	*	20	24-25 dogs, nearby feral cats	13-15, 19, 21	20, 24, 28, 31, 38-41, 52, 54	21-22	33-36 (adjacent lands)	21	27-32 (district wide policies and guidance)	*	*	*	*	*	16, 20, 42-46	8-9	*
11	Appendices for San Pedro Ridge Open Space preserve	Wittenkeller & Associates	Sep-90		Appendix I	Appendix J	Appendix I, J	*	Appendix I	*	*	*	*	Appendix H	Appendix E	*	*	*	*	*	*	*	*	Appendix D	Appendix D	Appendix B	*
12	Santa Venetia Marsh Enhancement Plan - Existing Condition Study and Enhancement Recommendations	Wetlands Research Associates, Inc.	Dec-02		6, 10-15	15-16	6,7,15-16, 17	*	15, 17,	*	*	*	*	*	17, 19	18-19	*	17-20	*	*	*	*	19-20 (hydrologic study)	*	*	*	*
13	Appendices Land Management Plan for Santa Venetia Marsh & Santa Margarita Island Open Space Preserves	Wittenkeller & Associates	May-92		Appen-dixB, H	Appendix B, I	Appendix H, Appen-dix I	Appendix H	Appendix H, 5-7	*	*	*	*	*	*	Appendix H, 5-7	*	*	Appendix A	*	*	*	*	Appendix D	*	Appendix B	*
14	Terra Linda/Sleepy Hollow Open Space Preserve - Land Management Plan	Leonard Charles and Associates	Aug-91		29-47, map in envelope - Vegeta-tion Maps, Manage-ment Maps (Exotics)	48-52	38, 46	13, 37, 49	13, 33, 35-37	43-44, 48, 50, 67	*	13, 16 17 , 34-35, 38-43, 45-46, 48, 50-52, 84-99, 134	13, 49-50-52	23, 130-138, map in envelope (Erosion)	13, 14, 15, 50-52 53-83, 171-172	13, 35-46, 59-71, 76-83	144-147	13-18, 44-47,59-74, 76-83, 94-99	*	13-18, 44-47, 50-52, 76-83, 94-99, 134-138	13, 46, 97-98	*	*	Addendum 171-end of document	100-123,149	6-9	19-22, 80-83, 98-99, 110-111, 123, 138, 154-156, 163-165

Table A.3 Supporting Documents and Management Documents Presented by Topic Area

				Topic																							
	Document Number and Name	Author	Date	ALL	Plant /Vegetation Communities	Wildlife	Sensitive Species	Sensitive Habitats	Invasive Plants	Natural Succession	Forest Health	Grazing and Grazing Mgmt.	Invasive / Problem Wildlife & Mgmt.	Erosion & Erosion Mgmt.	Fire/Fuel Load Mgmt.	Weed Control/Invasive Plant Detection and Control	Coordination with other Agencies	Veg Mgmt. Recommendations	Best Management Practices And Policies	Maintenance Program	Monitoring Program	Volunteer Involvement Opportunities	Research	Public Concerns And/Or Comments	Visitor Use	Land Use History	Costs
15	Terra Linda/Sleepy Hollow Open Space Preserve - Appendix to the Land Management Plan	Leonard Charles and Associates	Sep-91		*	Appendix E	*	*	Appendix D	*	*	*	*	Appendix J	Appendix G	Appendix D	Appendix C	*	Appendix B	*	*	*	*	*	*	*	*
16	Mount Burdell Open Space Preserve Native Tree Revegetation Plan	Harold C. Appleton RPF	Dec-90		1-2	*	*	*	*	*	*	12	*	*	*	12	*	10-16 (all revegetation)	*	10-16 (all revegetation)	*	1, 15-16,	*	*	*	1-2	1, 19, Table 1,
17	Grazing Recommendations for Mount Burdell Open Space Preserve	Lisa Bush, California Certified Rangeland Manager #18	Dec-08		1,2, Appendix	*	1,2, 6-9, 13-14, 20	*	9,10-13, Appendix	*	*	1-20	*	*	2	10-13, 15	17	1,2, 13-20	*	1,2, 13-20	17-19	*	*	*	*	1	*
18	Land Management Plan for Indian Tree and Verissimo Hills Open Space Preserves	Brian Wittenkeller & Associates	Jan-09		16-18, 55-56, 66 Appendix L	19-21, 57-58	*	39, 73	17, 55	58	*	17, 20, 56, 58, 78	20, (feral cats, pigs, dogs), 58	*	17, 20, 21-22, 46, 55-56, 58, 59-60, 802	43-44	*	43-44 Appendix L 77-78	36-37, 70-71	17, 56	38, 72	34, 68	*	*	17, 33-34, 41-42, 56, 75-76	11-13	*
19a &b	Land Management Plan for Roy's Redwoods and Maurice Thorner Memorial Open Space Preserves	Brian Wittenkeller & Associates	Jan-89		15-22, 59-60	25-26, Appendix K, 41-42, 61-63,	*	42, 49, 74	22, 59	*	15-18	16, 22, 60, 80	26 (feral pigs and cats), 63 (feral animals and dogs)	*	18, 22, 26, 27-29, 49-50, 60, 62, 64-66, 81,	46, 79	*	42, 45-47, 78-79	39-40, 72-73,	60	41, 74	37	*	*	11-12, 17, 20, 36-37, 43-44, 60, 62, 75-77	10-12	*
20	Cascade Canyon and White Hill Open Space Preserves Land Management Plan	Leonard Charles and Associates	Jul-05		6-20	21-28,	7, 22	7, 22-25	8-10	10, 19 (D. fir)	19, 20,	*	25 (dogs) 26-28, Table 4	20, 24, 28-32, Table 4	35-44, Table 4	16-20	90	5, 16-20, 43-44, Table 4	*	90, Table 4 (action summary and prioritization)	19, 20, 43, 88-89	90	*		58-75	3-5	96-101
21	Cascade Canyon and White Hill Open Space Preserves Draft Land Management Plan - Final Environmental Impact Report	Leonard Charles and Associates	Jul-05		8-16, 52, 117-131	16-21, 52, 132-151, Appendix F	16-21, 119-122, 138-139	16-21	9, 122-124	9, 124 (D. fir)	11	*	16-21, Table 2	Table 2, 21, 97-110, Appendix D	21-26, Table 2, 53, 152-167,	8-16, 126-131	8-16, 21-26, Table 2, 126-131	8-16, 21-26, Table 2, 126-131	72 Table 4 (mitigations)	*	36-38	*	*	3, 56-58, Appendix B	55, 175-188, Appendix C	*	*
22	Bothin Marsh Enhancement Plan - Existing Condition Study Enhancement Recommendations	Wetlands Research Associates, Inc.	Jun-04		1-2, 6, 20-26, 29-32	9, 26-29	2, 23, 27, 30	*	25-26	19-20, 29-32 marsh processes and limiting factors	*	*	34 pets, feral animals	17-19, 32, Appendix B	*	33-34	*	33-34	*	*	*	*	*	*	*	*	*

Table A.3 Supporting Documents and Management Documents Presented by Topic Area

	Document Number and Name	Author	Date	Topic																							
				ALL	Plant /Vegetation Communities	Wildlife	Sensitive Species	Sensitive Habitats	Invasive Plants	Natural Succession	Forest Health	Grazing and Grazing Mgmt.	Invasive / Problem Wildlife & Mgmt.	Erosion & Erosion Mgmt.	Fire/Fuel Load Mgmt.	Weed Control/Invasive Plant Detection and Control	Coordination with other Agencies	Veg Mgmt. Recommendations	Best Management Practices And Policies	Maintenance Program	Monitoring Program	Volunteer Involvement Opportunities	Research	Public Concerns And/Or Comments	Visitor Use	Land Use History	Costs
23	Community Wildfire Protection Plan	Marin County Fire Department in collaboration with FIRE Safe Marin	Jul-05	unclear, throughout Marin	*	*	*	*	*	*	*	*	*	*	entire plan	*	*	entire plan	22-24 Urban Wildland Interface Code	*	*	*	*	*	*	*	14-15
24	Marin County Fire Department in collaboration with FIRE Safe Marin "Community Wildfire Protection Plan"	Marin County Fire Department	Sep-10		*	22	*	*	*	*	*	*	*	24	entire plan	*	*	30	*	*	*	*	*	*	25	*	*

B: Native Vegetation on Preserves

Table B.1 summarizes the available information about native vegetation types occurring somewhere within the MCOSD preserves. Table B.2 identifies which particular vegetation types occur in each of the MCOSD preserves. Table B.3 lists all of the special-status species and other species of special concern that could exist on the MCOSD preserves. This table covers both plants and animals, recognizing that vegetation management must address the habitat requirements of all species.Table B.4 identifies which particular special-status and other species of special concern occur in each of the MCOSD preserves.

Table B.1 Vegetation Types on Preserves

Map #	Vegetation Type	Sensitivity		Associated Special Status Species
		Global/State Ranking and Name Cross-reference	Upland Habitat Goals	
1101	Lower Elevation Mixed Broadleaf Mapping Unit and Coast Live Oak, Madrone or Black Oak or Oregon Oak dominant and Coast Live Oak, Black Oak or Oregon Oak and Coast Live	S3: *Quercus garryana var. garryana* Alliance	Rank 1: Black Oak Forest/ Woodland, Rank 2: Coast Live Oak Forest/Woodland, Rank 2:Oregon Oak Woodland	Amorpha californica var. napensis, Aster radulinus, Lessingia hololeuca, Linanthus acicularis, Navarettia heterodoxa, Pentachaeta bellidiflora, Streptanthus glandulosus var. pulchellus, Trifolium albopurpureum var. dichotomum
1102	Tanoak and California Bay and Canyon Oak Mixed Forest	S3: *Lithocarpus densiflorus* Alliance	Rank 1: Tanoak Forest, Rank 2/3: California Bay Forest	
1103	California Bay and Alder and Big Leaf Maple and Willow spp. Riparian Forest	S3: *Acer macrophyllum* Proposed Alliance	Rank 1: Central Coast Riparian Forests, Rank 2/3: California Bay Forest	Navarettia heterodoxa, Piperia unalascensis
1104	Madrone and California Bay and Tanoak	S3: *Lithocarpus densiflorus* Alliance	Rank 1: Tanoak Forest, Rank 2/3: California Bay Forest	Amorpha californica var. napensis, Arctostaphylos hookeri ssp. montana, Arctostaphylos virgata, Fremontodendron californicum, Lessingia hololeuca, Pentachaeta bellidiflora
1110	California Bay Alliance		Rank 2/3: California Bay Forest	Arctostaphylos hookeri ssp. montana, Ceanothus velutinus, Cirsium hydrophilum var. vaseyi, Lessingia hololeuca, Pentachaeta bellidiflora, Streptanthus glandulosus
1111	California Bay (pure)		Rank 2/3: California Bay Forest	Calochortus tiburonensis, Calochortus umbellatus, Hesperolinon congestum, Linanthus acicularis, Navarretia leucocephala ssp. bakeri, Stylomeccon heterophylla
1112	California Bay and Buckeye	G3S3: *Aesculus californica* Alliance	Rank 2/3: California Bay Forest	
1113	California Bay and Interior Live Oak		Rank 2/3: California Bay Forest	Amorpha californica var. napensis, Arctostaphylos hookeri ssp. montana, Boschniakia hookeri, Ceanothus velutinus, Linanthus acicularis
1114	California Bay and Canyon Oak		Rank 2/3: California Bay Forest	
1115	California Bay and Coast Live Oak		Rank 2/3: California Bay Forest, Rank 2: Coast Live Oak Forest/Woodland	Amorpha californica var. napensis, Amsinckia lunaris, Arctostaphylos hookeri ssp. montana, Boschniakia hookeri, Calochortus umbellatus, Ceanothus velutinus, Erigeron bioletti, Erigeron foliosus var. franciscensis, Lessingia hololeuca, Lessingia micradenia, Linanthus acicularis, Navarettia heterodoxa, Navarretia leucocephala ssp. bakeri, Piperia elegans, Piperia unalascensis, Ranunculus orthorhyncus var. bloomeri, Streptanthus glandulosus, Streptanthus glandulosus var. pulchellus, Trifolium albopurpureum var. dichotomum
1116	California Bay and Tanoak	S3: *Lithocarpus densiflorus* Alliance	Rank 1: Tanoak Forest, Rank 2/3: California Bay Forest	Arctostaphylos hookeri ssp. montana, Arctostaphylos virgata

Table B.1 Vegetation Types on Preserves

Map #	Vegetation Type	Sensitivity		Associated Special Status Species
		Global/State Ranking and Name Cross-reference	Upland Habitat Goals	
1140	Tanoak Alliance	S3: *Lithocarpus densiflorus* Alliance	Rank 1: Tanoak Forest	
1160	Madrone Alliance			Aster radulinus, Calochortus umbellatus, Linanthus acicularis, Trifolium albopurpureum var. dichotomum
1170	Canyon Oak Alliance			
1180	Giant Chinquapin Alliance	G3S3: *Chrysolepis chrysophylla* Alliance		Amorpha californica var. napensis
1210	Redwood Alliance	G3S3: *Sequoia sempervirens* Alliance	Rank 2: Redwood Forest	
1211	Redwood / Tanoak	G3S3: *Sequoia sempervirens* Alliance		Amorpha californica var. napensis,
1212	Redwood and Douglas-fir and (Mixed Hardwoods	G3S3: *Sequoia sempervirens* Alliance		Arctostaphylos hookeri ssp. montana, Arctostaphylos virgata, Cirsium hydrophilum var. vaseyi, Lessingia micradenia, Streptanthus glandulosus,
1213	Redwood / Chinquapin	G2 (MMWD)	Rank 2: Redwood Forest	
1214	Redwood / California Bay	G3S3: *Sequoia sempervirens* Alliance	Rank 2: Redwood Forest, Rank 2/3: California Bay Forest	Amorpha californica var. napensis, Boschniakia hookeri, Ceanothus velutinus var. hookeri, Lessingia hololeuca, Linanthus acicularis
1215	Redwood (pure)	G3S3: *Sequoia sempervirens* Alliance	Rank 2: Redwood Forest	Amorpha californica var. napensis
1216	Redwood - Upland Mixed Hardwoods	G3S3: *Sequoia sempervirens* Alliance	Rank 2: Redwood Forest	Arctostaphylos virgata, Boschniakia hookeri
1217	Redwood and Riparian (Maple, California bay, Tanoak, and/or White alder in the secondary canopy)	G3S3: *Sequoia sempervirens* Alliance	Rank 1: Central Coast Riparian Forests, Rank 2: Redwood Forest	Amorpha californica var. napensis, Boschniakia hookeri, Ceanothus velutinus
1218	Redwood and Madrone	G3S3: *Sequoia sempervirens* Alliance	Rank 2: Redwood Forest	
1220	Douglas-fir Alliance			
1221	Douglas-fir - Mixed Hardwoods in upland drier settings (Coast Live Oak, Madrone)			Cirsium hydrophilum var. vaseyi, Lessingia micradenia, Linanthus acicularis, Navarettia heterodoxa

Table B.1 Vegetation Types on Preserves

Map #	Vegetation Type	Sensitivity		Associated Special Status Species
		Global/State Ranking and Name Cross-reference	Upland Habitat Goals	
1222	Douglas-fir Mixed Hardwoods in upland forest settings (California Bay, Canyon Oak, Tanoak and Madrone)	S3: *Pseudotsuga menziesii - Lithocarpus densiflorus* Alliance	Rank 1: Tanoak Forest	Arctostaphylos hookeri ssp. montana, Arctostaphylos virgata, Navarettia heterodoxa, Navarretia rosulata
1223	Douglas-fir and California Bay Mapping Unit (may include Coast Live Oak as an associate)			Arabis blepharophylla, Ceanothus velutinus, Lessingia hololeuca, Lessingia micradenia, Streptanthus glandulosus, Trifolium albopurpureum var. dichotomum, Zigadenus micranthus var. fontanus
1224	Douglas-fir and Tanoak	S3: Pseudotsuga menziesii - Lithocarpus densiflorus Alliance	Rank 1: Tanoak Forest	Arctostaphylos virgata, Navarettia heterodoxa
1226	Douglas-fir (pure)			Arctostaphylos hookeri ssp. Montana
1227	Douglas-fir and California Bay / Interior Live Oak		Rank 2/3: California Bay Forest	Arctostaphylos hookeri ssp. Montana
1231	Bishop Pine / Eastwood Manzanita	G2 (MMWD)		
1240	Sargent Cypress Alliance	G3S3: *Cupressus sargentii* Alliance		
1241	Sargent Cypress / Mt. Tamalpais Manzanita	G1 (MMWD)		Arctostaphylos hookeri ssp. montana, Fremontodendron californicum, Linanthus acicularis, Navarretia rosulata
1242	Sargent Cypress (pure)	G3S3: *Cupressus sargentii* Alliance		Navarretia rosulata
1310	Mixed Willow Mapping Unit (Arroyo Willow, Red Willow, and Yellow Willow Alliances		Rank 1: Central Coast Riparian Forests	Calochortus umbellatus
1410	Black Oak Alliance		Rank 1: Black Oak Forest/ Woodland	
2110	Coast Live Oak Alliance		Rank 2: Coast Live Oak Forest/Woodland	Aspidotis californica, Calochortus umbellatus, Erigeron bioletti, Erigeron foliosus var. franciscensis, Eriogonum luteolum var. caninum, Hesperolinon congestum, Lessingia micradenia, Linanthus acicularis, Navarettia heterodoxa, Streptanthus niger
2111	Coast Live Oak / (Grass-Poison Oak)		Rank 2: Coast Live Oak Forest/Woodland	Arctostaphylos hookeri ssp. montana, Erigeron bioletti, Linanthus acicularis, Navarettia heterodoxa

Table B.1 Vegetation Types on Preserves

Map #	Vegetation Type	Sensitivity		Associated Special Status Species
		Global/State Ranking and Name Cross-reference	Upland Habitat Goals	
2112	Coast Live Oak and Riparian		Rank 2: Coast Live Oak Forest/Woodland	
2113	Coast Live Oak and Douglas-fir (a small component of conifer cover [< or = 5%])		Rank 2: Coast Live Oak Forest/Woodland	Arctostaphylos hookeri ssp. Montana
2210	Oregon Oak Alliance (Includes Oregon Oak mixed with lower to equal Coast Live Oak or California bay cover	S3: *Quercus garryana var. garryana* Alliance	Rank 2: Coast Live Oak Forest/Woodland, Rank 2/3: California Bay Forest	Calochortus umbellatus, Streptanthus glandulosus var. pulchellus
2220	California Buckeye Alliance (Includes California Buckeye mixed with lower Coast Live Oak	G3S3: *Aesculus californica* Alliance	Rank 2: Coast Live Oak Forest/Woodland	Asclepias fasicularis
2230	Valley Oak Alliance	G3S3: *Quercus lobata* Alliance		
2231	Valley Oak Riparian Mapping Unit (California Bay and/or Big Leaf Maple- Alder are a co-dominant in a riparian setting)	G3S3: *Quercus lobata* Alliance	Rank 1: Central Coast Riparian Forests	
2232	Valley Oak and Coast Live Oak Mapping Unit	G3S3: *Quercus lobata* Alliance	Rank 2: Coast Live Oak Forest/Woodland	Asclepias fasicularis, Erigeron bioletti, Hesperolinon congestum, Linanthus acicularis, Monolopia major
2233	Valley Oak/ Grass	G3S3: *Quercus lobata* Alliance		Lessingia hololeuca, Linanthus acicularis, Streptanthus glandulosus var. pulchellus
2240	Blue Oak Alliance			
2241	Blue Oak and White Oak (Valley or Oregon Oak hybrids Mapping Unit			
3101	Mesic Trending Chaparral (includes Birchleaf Mtn Mahogany, Chamise, Ceanothus spp., Toyon)			
3110	Chamise Alliance		Rank 2: Chamise Chaparral	
3112	Chamise - Serpentine Chaparral (Relatively pure chamise on ultramafic soils)		Rank 1: Serpentine Scrub, Rank 2: Chamise Chaparral	Arctostaphylos hookeri ssp. montana, Lessingia micradenia, Linanthus acicularis, Navarettia heterodoxa, Streptanthus glandulosus var. pulchellus
3114	Chamise (Stands with a co-dominance of chamise with other shrub species such as Sticky Monkey-flower or Wedgeleaf Ceanothus		Rank 2: Chamise Chaparral	Arctostaphylos hookeri ssp. montana, Boschniakia hookeri, Linanthus acicularis, Pentachaeta bellidiflora

Table B.1 Vegetation Types on Preserves

Map #	Vegetation Type	Sensitivity		Associated Special Status Species
		Global/State Ranking and Name Cross-reference	Upland Habitat Goals	
3115	Chamise (pure)		Rank 2: Chamise Chaparral	Arctostaphylos hookeri ssp. Montana
3120	Mt. Tamalpais Manzanita Alliance (Includes possibly 3 associations with Eastwood Manzanita, Chamise, or Jepson's Ceanothus as associates.	G2S2: *Arctostaphylos hookeri* ssp. *montana* Alliance		Arctostaphylos hookeri ssp. montana, Cirsium hydrophilum var. vaseyi, Navarretia rosulata, Streptanthus glandulosus, Zigadenus micranthus var. fontanus
3121	Mt. Tamalpais Manzanita - Chamise - (Garraya - Leather Oak and Jepson ceanothus and Serpentine Chaparral	G2S2: *Arctostaphylos hookeri* ssp. *montana* Alliance		Arctostaphylos hookeri ssp. montana, Cirsium hydrophilum var. vaseyi, Lessingia micradenia, Navarretia rosulata, Sidalcea hickmannii spp. Viridis, Streptanthus glandulosus, Streptanthus glandulosus var. pulchellus
3122	Mt. Tamalpais Manzanita - with Sparse Douglas-fir emergent (5 - 25%)	G2S2: *Arctostaphylos hookeri* ssp. *montana* Alliance		Amsinckia lunaris, Cirsium hydrophilum var. vaseyi, Erigeron foliosus var. franciscensis
3130	Sensitive Manzanita Alliance (Small stands that may include Eastwood Manzanita or Huckleberry)			
3150	Eastwood Manzanita Alliance (may have up to 10-15% Douglas-fir emergent)			Amorpha californica var. napensis, Streptanthus glandulosus var. pulchellus
3155	Common Manzanita			
3160	Interior Live Oak Alliance			Arctostaphylos hookeri ssp. Montana
3161	Interior Live Oak-Eastwood Manzanita (Coast live oak and big berry manzanita are co-dominants)			Amorpha californica var. napensis, Arctostaphylos hookeri ssp. montana, Fremontodendron californicum, Linanthus acicularis
3180	Leather Oak and Chamise and Mt. Tamalpais Manzanita Serpentine Chaparral	G2S2: *Arctostaphylos hookeri* ssp. *montana* Alliance	Rank 1: Serpentine Scrub, Rank 2: Chamise Chaparral	
3190	Chamise and Eastwood Manzanita	G2 (MMWD)	Rank 2: Chamise Chaparral	Amorpha californica var. napensis, Arctostaphylos hookeri ssp. montana, Boschniakia hookeri, Ceanothus velutinus var. hookeri
3220	Coyote Brush Alliance			Lessingia hololeuca
3221	Coyote Brush and California Sagebrush and Sticky Monkey Flower			Lessingia micradenia
3222	Coyote Brush / Annual or Perennial Grasslands (open stands)			Calamogrostis ophitidis, Calochortus umbellatus, Erigeron foliosus var. franciscensis, Hesperolinon congestum, Lessingia hololeuca, Lessingia micradenia, Streptanthus glandulosus var. pulchellus

Table B.1 Vegetation Types on Preserves

Map #	Vegetation Type	Sensitivity		Associated Special Status Species
		Global/State Ranking and Name Cross-reference	Upland Habitat Goals	
3223	Coyote Brush and Mixed Shrub / Grass (May include Poison Oak or California Blackberry with mixture of grass spp.)			Calochortus umbellatus, Eriogonum luteolum var. caninum, Hesperolinon congestum, Lessingia hololeuca, Navarettia heterodoxa, Streptanthus glandulosus var. secundus, Streptanthus niger, Zigadenus micranthus var. fontanus
3310	California Sagebrush Alliance			Trifolium albopurpureum var. dichotomum
3311	California Sagebrush and Sticky Monkey Flower			Trifolium albopurpureum var. dichotomum
3400	Temperate Broadleaf Cold Season Deciduous Shrubland			
3410	Poison Oak Alliance (small stands found in Coyote Brush patches)			
3430	Upland Deciduous Shrubs (includes dogwood, hazelnut, etc.)			
4101	Undifferentiated Marsh (cattail, bulrush, other scirpus spp.)		Rank 1: Coastal Salt Marsh/Coastal Brackish Marsh	
4110	Cattail Alliance			
4200	Seasonally or Temporarily Flooded Graminoids		Rank 1: Wet Meadows	
4210	Sedge and Rush and Wet Graminoids Meadow (Including Juncus, Carex, and Meadow barley)		Rank 1: Wet Meadows	Fritillaria liliacea, Hesperolinon congestum, Navarretia leucocephala ssp. Bakeri
4211	Temporarily flooded or saturated Meadow Edge		Rank 1: Wet Meadows	Calochortus umbellatus, Hesperolinon congestum, Navarretia leucocephala ssp. Bakeri
4300	Tall Temperate Annual Graminoids			
4310	California Annual Grasslands Alliance (Native Component Variable)			Lilium pardalinum
4311	Grasslands on well-developed soils (generally dense bio-mass)			Amsinckia lunaris, Arctostaphylos hookeri ssp. montana, Asclepias fasicularis, Aspidotis californica, Calamogrostis ophitidis, Calochortus tiburonensis, Calochortus umbellatus, Castilleja affinis ssp. neglecta, Erigeron bioletti, Erigeron foliosus var. franciscensis, Eriogonum luteolum var. caninum, Fritillaria liliacea, Hesperolinon congestum, Lessingia hololeuca, Lessingia micradenia, Linanthus acicularis, Navarretia cotulifolia, Navarretia leucocephala ssp. bakeri, Parnassia californica, Streptanthus glandulosus var. pulchellus, Streptanthus glandulosus var. secundus, Trifolium albopurpureum var. dichotomum, Zigadenus micranthus var. fontanus

Table B.1 Vegetation Types on Preserves

Map #	Vegetation Type	Sensitivity		Associated Special Status Species
		Global/State Ranking and Name Cross-reference	Upland Habitat Goals	
4312	Grasslands on poorly developed soils (generally sparse bio-mass)		Rank 1: Native Grassland	Calochortus umbellatus, Navarettia heterodoxa
4313	Grasslands with a fern or sub-shrub component (either Thermopsis or fern)			
4400	Tall Temperate Perennial Herbaceous			
4500	Native Temperate Perennial Grasslands		Rank 1: Native Grassland	Arctostaphylos hookeri ssp. Montana
4520	Purple Needlegrass (Small patches with annual grasses and sometimes other native grasses such as California Melic)	S3: *Nasella pulchra* Alliance	Rank 1: Native Grassland	
4600	Serpentine Grassland		Rank 1: Serpentine Grassland	
4610	Upland Serpentine Grassland (may include perennial and annual species at varying cover seasonally and annually, such as Purple Needlegrass, Torrey's Melic, Dwarf Plantain, Small Fescue, Sticky Western Rosinweed)	G2 (MMWD)	Rank 1: Serpentine Grassland	Arctostaphylos hookeri ssp. montana, Calamogrostis ophitidis, Calochortus tiburonensis, Calochortus umbellatus, Calochortus uniflorus, Castilleja affinis ssp. neglecta, Cirsium hydrophilum var. vaseyi, Eriogonum luteolum var. caninum, Fritillaria liliacea, Hesperolinon congestum, Lessingia hololeuca, Lessingia micradenia, Lilium pardalinum, Navarretia rosulata, Parnassia californica, Streptanthus glandulosus, Streptanthus niger, Zigadenus micranthus var. fontanus
4611	Rocky Serpentine grasses (primarily on Ring Mtn.)		Rank 1: Serpentine Grassland	Arctostaphylos hookeri ssp. montana, Calamogrostis ophitidis, Calochortus tiburonensis, Calochortus umbellatus, Castilleja affinis ssp. neglecta, Eriogonum luteolum var. caninum, Fritillaria liliacea, Hesperolinon congestum, Lessingia hololeuca, Lessingia micradenia, Navarretia cotulifolia, Streptanthus glandulosus var. pulchellus, Streptanthus niger, Zigadenus micranthus var. fontanus
4620	Wetland Serpentine Grassland (May include perennial and annual species at varying cover seasonally and annually, such as Meadow barley, Rosinweed, Goldfields, etc.)		Rank 1: Serpentine Grassland	Calochortus umbellatus, Hesperolinon congestum
4701	Estuarine Marsh Habitats (Pickleweed, Saltgrass, Alkali Heath, Jaumea)		Rank 1: Coastal Salt Marsh/Coastal Brackish Marsh	
9210	Rangeland and Pastureland			

Table B.1 Vegetation Types on Preserves

Map #	Vegetation Type	Sensitivity		Associated Special Status Species
		Global/State Ranking and Name Cross-reference	Upland Habitat Goals	
9400	Sparsely Vegetated or Unvegetated Areas		Rank 2: Barren/Rock	Hesperolinon congestum
9401	Serpentine Balds (Including rare species such as Tamalpais Jewelflower	G2 (MMWD)		Streptanthus glandulosus var. pulchellus
9420	Cliffs and Rock Outcrops		Rank 2: Barren/Rock	Calochortus umbellatus
9800	Water			
9820	Small Ephemeral Ponds			
3210	French Broom Alliance (May include low cover of Coyote Brush			Pentachaeta bellidiflora
4410	Harding Grass Alliance			
4420	Teasal Alliance (Dipsacus sativa)			
4440	Pampas Grass			
9100	Urban Developed and Built Up			Pentachaeta bellidiflora
9250	Eucalyptus			Pentachaeta bellidiflora
9260	Other Introduced Ornamentals including Mayten, Acacia, etc.			
9302	Quarry			
1201	Planted Stands of Pine (Monterey Pine and Bishop Pine and Monterey Cypress and other spp.)			

Table B.2 Vegetation Types Presented by Preserve

Map #	Vegetation Type	Number of Preserves with an Occurrence	Amt. on MCOSD Preserves (Acres)	Acreage of Known Occurrences																																	
				Alto Bowl	Bald Hill	Baltimore Canyon	Blithedale Summit	Bolinas Lagoon	Bothin Marsh	Camino Alto	Cascade Canyon	Deer Island	French Ranch	Gary Giacomini	Horse Hill	Ignacio Valley	Indian Tree	Indian Valley	King Mountain	Little Mountain	Loma Alta	Loma Verde	Lucas valley	Maurice Thorner Memorial Open Space	Mt Burdell	Old St Hilary's	Pacheco Valle	Ring Mtn	Roy's Redwoods	Rush Creek	San Pedro Ridge	Santa Venita Marsh	Santa Margarita Island	Terra Linda/Sleepy Hollow	Tiburon Ridge	Verrissimo Hills	White Hill
1101	Lower Elevation Mixed Broadleaf Mapping Unit and Coast Live Oak, Madrone or Black Oak or Oregon Oak dominant and Coast Live Oak, Black Oak or Oregon Oak and Coast Live	21.0	1737.7	3.0	8.9	0.3	95.3			17.2	165.3	11.7		0.8		632.3	71.7	279.8	62.4	93.5	8.5	13.3	19.6				78.7	3.9		21.1	94.5			43.3			12.6
1102	Tanoak and California Bay and Canyon Oak Mixed Forest	1.0	1.0			1.0																															
1103	California Bay and Alder and Big Leaf Maple and Willow spp. Riparian Forest	6.0	92.9								17.7			0.7		25.6		29.2																19.0			0.8
1104	Madrone and California Bay and Tanoak	17.0	827.3	3.2	10.3	15.1	97.4			10.6	65.2		4.3	5.7		192.8		1.2	86.1		8.3		33.6				35.1		35.8		166.9			44.2			11.4
1110	California Bay Alliance	15.0	245.1		0.6	6.5	12.4			10.2	13.6		5.1	68.9		3.4	2.7		1.9		0.9	2.5	3.6		8.0									105.0			
1111	California Bay (pure)	24.0	461.5			0.6	2.9			29.0	5.0	3.0		33.6	3.0	9.3	15.8	78.5	8.3	31.6	33.6	2.5	61.2		10.9		3.8	4.8	16.9	5.7	8.3			63.1		6.0	24.3
1112	California Bay and Buckeye	1.0	3.8													3.8																					
1113	California Bay and Interior Live Oak	5.0	116.0			15.0	61.5				1.3			36.4																							1.8
1114	California Bay and Canyon Oak	2.0	0.7			0.7								0.0																							
1115	California Bay and Coast Live Oak	29.0	2872.0	18.7	22.3	45.8	19.6			26.2	111.8	36.3	36.8	11.6	16.2	234.5	145.5	194.8	9.5	44.2	163.2	125.4	471.2	9.3	344.5	128.3	156.8	34.1	20.5	166.0	25.0			155.7	3.9	28.3	66.1
1116	California Bay and Tanoak	1.0	28.5											28.5																							
1140	Tanoak Alliance	1.0	0.7											0.7																							
1160	Madrone Alliance	11.0	199.0			0.1					21.3	1.4		6.5		96.4	18.6	16.1	4.7								19.9				4.4						9.5
1170	Canyon Oak Alliance	2.0	2.9								2.7			0.2																							
1180	Giant Chinquapin Alliance	3.0	10.0			0.5	8.6							0.8																							
1210	Redwood Alliance	2.0	50.2				49.4			0.8																											
1211	Redwood / Tanoak	2.0	87.3				61.4							25.8																							
1212	Redwood and Douglas-fir and Mixed Hardwoods	6.0	696.7							1.4			33.3	636.1			17.5												2.9								5.6
1213	Redwood / Chinquapin	1.0	1.2			1.2																															
1214	Redwood / California Bay	11.0	287.0		4.8	38.8	71.4			29.3	1.1			7.8			31.3		11.0										31.9		47.2						12.5
1215	Redwood (pure)	7.0	17.8		0.1	7.3	3.5			0.9				2.5			3.3		0.2																		
1216	Redwood - Upland Mixed Hardwoods	3.0	156.4			48.7	98.1							9.5																							

Table B.3. Special-Status and Other Species of Special Concern that Could Exist on Preserves

		Special-Status Species			
Scientific Name	**Common Name**	**Federal**	**State**	**Other[a]**	**Habitat Association**
		Plants			
Amorpha californica var. *napensis*	Indigo bush	-	-	CNPS 1B	Forest/chaparral/woodland
Amsinckia lunaris	Bent-flowered fiddleneck	-	-	CNPS 1B	Coastal bluff scrub/woodland/ grassland
Arctostaphylos hookeri ssp. *montana*	Mt. Tamalpais manzanita	Special concern	-	CNPS 1B	Chaparral/grassland
Arctostaphylos virgata	Marin manzanita	-	-	CNPS 1B	Coniferous forest/chaparral
Astragalus pycnostachyus var. *pycnostachyus*	Marsh milk vetch	-	-	CNPS 1B	Dunes/marshes/swamps
Kopsiopisis hookeri	Coast ground cone	-	-	CNPS 1B	Coniferous forests
California macrophylla	Round leaved phyllary	-	-	CNPS 1B	Valley grassland, foothill woodland
Calochortus tiburonensis	Tiburon Mariposa lily	Threatened	Threatened	CNPS 1B	Serpentine grassland
Castilleja affinis ssp. *neglecta*	Tiburon Indian paintbrush	Threatened	Threatened	CNPS 1B	Serpentine grassland
Ceanothus masonii	Mason's ceanothus	-	-	CNPS 1B	Chaparral/serpentine
Cirsium hydrophilum var. *vaseyi*	Mt. Tamalpais thistle	-	-	CNPS 1B	Forest/chaparral
Cordylanthus maritimus ssp. *palustris*	Point Reyes bird's beak	-	-	CNPS 1B	Coastal salt marsh, wetland-riparian salt-marsh
Cordylanthus mollis ssp. *mollis*	Soft bird's beak	Endangered	Rare	CNPS 1B	Coastal salt marsh
Dirca occidentalis	Western leatherwood	-	-	CNPS 1B	Forest/chaparral/woodland
Entostodon kochii	Koch's cord moss	-	-	CNPS 1B	Unknown
Eriogonum luteolum var. *caninum*	Tiburon buckwheat	-	-	CNPS 1B	Coastal prairie, chaparral, valley grassland ser-pentine soils
Fissidens pauperculus	Minute pocket-moss	-	-	CNPS 1B	Forest floor along coast.
Fritillaria liliacea	fragrant fritillary	Special concern	-	CNPS 1B	Coastal scrub/prairie/grassland
Gilia capitata ssp. *tomentosa*	Wooly-headed gilia	-	-	CNPS 1B	Coastal bluff scrub/outcrops
Gilia millefoliata	Dark-eyed gilia	-	-	CNPS 1B	Coastal dunes
Grindelia hirsutula var. *maritima*	San Francisco gumplant	-	-	CNPS 1B	Coastal bluff scrub/coastal scrub/ grassland
Hemizonia congesta ssp. *congesta*	Seaside tarplant	-	-	CNPS 1B	Northern coastal scrub, valley grassland, serpen-tine
Hesperolinon congestum	Marin western flax	Threatened	Threatened	CNPS 1B	Chaparral/grassland
Layia carnosa	Beach layia	Endangered	Endangered	CNPS 1B	Coastal dunes
Leptosiphon acicularis	Bristly linanthus	-	-	CNPS 4	Coastal bluff scrub, coastal prairie
Lessingia micradenia var. *micradenia*	Mt. Tamalpais lessingia	Special concern	-	CNPS 1B	Chaparral/grassland in serpentine

Table B.3. Special-Status and Other Species of Special Concern that Could Exist on Preserves

		Special-Status Species			
Scientific Name	**Common Name**	**Federal**	**State**	**Other[a]**	**Habitat Association**
Navarretia leucocephala ssp. *bakeri*	Baker's navarretia	-	-	CNPS 1B	Woodland/seeps/pools/grassland/ forest
Navarretia rosulata	Marin County navarettia	-	-	CNPS 1B	Coniferous forest/chaparral
Plagiobothrys glaber	Hairless popcorn flower	-	-	CNPS 1A	Meadows/seeps/marshes/swamps
Pleuropogon hooverianus	North Coast semaphore grass	-	Threatened	CNPS 1B	Forest/steeps
Sidalcea hickmanii ssp. *viridis*	Marin checkerbloom	-	-	CNPS 1B	Chaparral
Streptanthus batrachopus	Tamalpais jewel-flower	-	-	CNPS 1B	Coniferous forest/chaparral.
Streptanthus glandulosus ssp. *pulchellus*	Mt. Tamalpais jewelflower	-	-	CNPS 1B	Chaparral/grassland
Streptanthus niger	Tiburon jewelflower	Endangered	Endangered	CNPS 1B	Valley grassland
Thermopsis macrophylla	Common false lupine	-	-	CNPS 1B	Mixed evergreen forest, foothill woodland
Thermopsis macrophylla var. *macrophylla*	Robust false lupine	-	-	CNPS 1B	Mixed evergreen forest, foothill woodland
Amphibians					
Clemmys marmorata marmorata (= Actinemys marmorate)	Northwestern pond turtle	-	Special concern	-	Streams/ponds/lakes
Rana aurora draytonii	California red-legged frog	Threatened	Special concern	-	Forests/woodlands/grasslands and streamsides
Rana boylii	Foothill yellow-legged frog	-	Special concern	-	Streams with rocky substrate
Birds					
Accipiter cooperii	Cooper's hawk		Special concern		Forests/woodlands/grasslands
Accipiter striatus	Sharp-shinned hawk		Special concern		Forests/woodlands/grasslands
Agelaius tricolor	Tricolored blackbird nesting colony	-	Special concern	-	Freshwater marsh and surrounding fields
Ammodramus savannarum	Grasshopper sparrow			Locally rare (PRBO)	Open grasslands/scrub
Ardea alba	Great egret rookery	-	-	Protected rookery	Colonial nester in large trees
Ardea herodias	Great blue heron rookery	-	-	Protected rookery	Colonial nester in trees, cliffsides, marshes
Asio flammeus	Short-eared owl	-	Special concern	-	Open grasslands/scrub
Athene cunicularia	Burrowing owl burrow sites	-	Special concern	-	Open grasslands/scrub

Table B.3. Special-Status and Other Species of Special Concern that Could Exist on Preserves

		Special-Status Species			
Scientific Name	**Common Name**	**Federal**	**State**	**Other**[a]	**Habitat Association**
Circus cyaneus	Northern harrier nesting	-	Special concern	-	Nesting in marsh and low shrubs
Contopus cooperi	Olive-sided flycatcher			Locally rare (PRBO)	Mid- to high-elevation montane and coniferous forests, often associated with Forest openings and edges
Dendroica petechia brewsteri	Yellow warbler nesting	-	Special concern	-	Nesting in willows and riparian cover
Egretta thula	Snowy egret rookery	-	-	Protected rookery	Colonial nester in trees, cliffsides, near marsh-land
Elanus leucurus	White-tailed kite (nesting)	-	-	Fully protected	Nesting in grassland/marshland with trees
Geothlypis trichas sinuosa	Salt marsh common yellowthroat	-	Special concern	-	Salt and brackish-water marsh
Laterallus jamaicensis coturniculus	California black rail	-	Threatened	Fully protected	Coastal salt marsh
Melospiza melodia samuelis	San Pablo song sparrow	-	Special concern	-	Salt-water marsh
Nycticorax nycticorax	Black-crowned night heron rookery	-	-	Protected rookery	Colonial nester in trees/shrubs near marshland
Pandion haliaetus	Osprey nesting	-	Special concern	-	Nesting in trees associated with water bodies
Phalacrocorax auritus	Double crested cormorant (nesting)	-	-	Protected Nesting	Coastal/bay shorelines and open water
Rallus longirostris obsoletus	California clapper rail	Endangered	Endangered	-	Salt and brackish marsh
Strix occidentalis caurina	Northern spotted owl	Threatened	-	-	Forest and woodland
Fish					
Eucyclogobius newberryi	Tidewater goby	Endangered	Special concern	-	Brackish water, marsh/bays
Oncorhynchus kisutch	Coho salmon	Endangered	Threatened / endangered	-	Spawns in freshwater streams
Oncorhynchus tshawytscha	Chinook salmon	Threatened	Threatened	-	Spawns in freshwater streams
Oncorhynchus mykiss irideus	Steelhead trout	Threatened	Special concern	-	Spawns in freshwater streams
Pogonichtys macrolepidotus	Sacramento splittail	-	-	-	Brackish water, marsh/bays

Table B.3. Special-Status and Other Species of Special Concern that Could Exist on Preserves

		Special-Status Species			
Scientific Name	**Common Name**	**Federal**	**State**	**Other[a]**	**Habitat Association**
Invertebrates					
Caecidotea tomalensis	Tomales isopod	-	-	-	Freshwater marsh/ponds
Calicina diminua	Marin blind harvestman	-	-	-	No information
Callophrys mossii marinensis	Marin elfin butterfly	-	-	-	Serpentine
Danaus plexippus	Monarch butterfly (nesting colonies)	-	-	Locally rare	Overwinters in blue gum eucalyptus
Haliotis cracherodii	Black abalone	Candidate	-	-	Rocky intertidal zone and ocean waters
Haliotis sorenseni	White abalone	Endangered	-	-	Rocky intertidal zone and ocean waters
Icaricia icarioides missionensis	Mission blue butterfly	Endangered	-	-	Shrubs/grasslands with lupine host
Lavinia symmetricus ssp. *symmetricus*	Tomales roach	-	Special Concern	-	Tributaries of Tomales Bay
Microcina tiburona	Tiburon micro-blind harvestman	-	-	-	Serpentine outcrops near spring/seeps
Speyeria zerene myrtleae	Myrtle's silverspot	Endangered	-	-	Scrub/grassland with larval host
Syncaris pacifica	California freshwater shrimp	Endangered	Endangered	-	Freshwater streams with undercut banks
Talanites ubicki	Ubick's gnaphosid spider	-	-	-	Serpentine
Trachusa gummifera	Leaf cutter bee	-	-	-	
Tryonia imitator	Mimic tryonia	-	-	-	Freshwater
Vespericola marinensis	Marin hesperian	-	-	-	Terrestrial wet, very moist sites
Mammals					
Antrozous pallidus	Pallid bat	-	Special concern	-	Roosts in protected locations
Corynorhinus townsendii townsendii	Townsend's western big-eared bat	-	Special concern	-	Roosts in protected locations
Eumetopias jubatus	Stellar sea lion	Threatened	-	-	Open ocean, beaches
Enhydra lutris nereis	Southern sea otter	Threatened	-	Fully protected	Near shore marsh habitat
Lasirus cinereus	Hoary bat	-	-	-	Roosts in protected locations
Myotis evotis	Long-eared myotis bat	-	-	-	Roosts in protected locations
Myotis thysanodes	Fringed myotis bat	-	-	-	Roots in protected locations
Myotis volans	Long-legged myotis bat	-	-	-	Roots in protected locations
Myotis yumanensis	Yuma myotis bat	-	-	-	Roots in protected locations
Reithrodontomys raviventris	Salt marsh harvest mouse	Endangered	Endangered	Fully protected	Coastal salt marsh

Table B.3. Special-Status and Other Species of Special Concern that Could Exist on Preserves

		Special-Status Species			
Scientific Name	**Common Name**	**Federal**	**State**	**Other**[a]	**Habitat Association**
Scapanus latimanus insularis	Angel Island mole	-	Special concern	-	Coastal scrub/prairie on Angel Island
Taxidea taxus	American badger			Special concern	Open areas, grasslands/scrublands
Zapus trinotatus orarius	Point Reyes jumping mouse	-	Special concern	-	Coastal scrub/grassland from Point Reyes
Other Locally Rare Species of Interest					
Allium lacunosum	Pitted onion	-	-	Locally rare	Serpentine endemic
Asclepias fasicularis	Narrow leaf milkweed	-	-	Locally rare	Cismontane grasslands, Valley and foothill grass-land chaparral
Calamagrostis ophitidis	Serpentine reed grass	-	-	Limited distribution	Chaparral, valley grassland serpentine endemic
Calandrinia breweri	Brewer's redmaids	-	-	Limited distribution	Chaparral, northern coastal scrub, coastal sage scrub
Calochortus umbellatus	Oakland star-tulip	-	-	Limited distribution	Chaparral, Valley Grassland, Yellow Pine Forest, Mixed Evergreen Forest Serpentine endemic
Ceanothus velutinus	Tobacco brush	-	-	Locally rare	Yellow pine forest, red fir forest, lodgepole for-est, subalpine forest, chaparral
Ceanothus velutinus var. *hookeri*	Hooker's tobacco brush	-	-	Locally rare	Yellow pine forest, red fir forest, lodgepole for-est, subalpine forest, chaparral
Elymus californicus	California bottle brush grass	-	-	Limited distribution	North coastal coniferous forest, closed-cone pine forest, redwood forest, douglas-fir forest, mixed evergreen forest, foothill woodland
Erigeron biolettii	Streamside daisy	-	-	More info needed	Dry slopes, rocks, ledges along rivers
Erigeron foliosus var. *franciscensis*	San Francisco leafy fleabane	-	-	Locally rare	Foothill woodland, chaparral, pinyon-juniper woodland, yellow pine forest, southern oak woodland, northern oak woodland, foothill woodland, douglas-fir forest, coastal sage scrub, coastal strand, joshua tree woodland
Fremontodendron californicum	California fremontia			Locally rare	Chaparral, yellow pine forest, pinyon-juniper woodland
Lessingia hololeuca	Wooly headed lessingia	-	-	More info needed	Valley grassland, yellow pine forest, northern coastal scrub, serpentine endemic
Lilium pardalinum	Leopard lily	-	-	Limited distribution	North coastal coniferous forest, mixed evergreen forest, yellow pine forest, wetland-riparian along streambanks

Table B.3. Special-Status and Other Species of Special Concern that Could Exist on Preserves

		Special-Status Species			
Scientific Name	**Common Name**	**Federal**	**State**	**Other[a]**	**Habitat Association**
Linanthus acicularis= Leptosiphon acicularis	Bristly leptosiphon	-	-	Limited distribution	Coastal prairie, chaparral, foothill woodland
Mielichhoferia elongata	Elongate copper moss	-	-	CNPS 2	None
Monardella purpurea	Coyote mint			Locally rare	Mixed evergreen forest, yellow pine forest
Monolopia major	Cupped monolopia	-	-	Locally rare	Valley grassland
Navarretia cotulifolia	Featherleaf navarretia			Limited distribution	Chaparral, foothill woodland, valley grassland, wetland-riparian in wetlands
Navarretia heterodoxa	Calistoga navarettia	-	-	Locally rare	Chaparral, mixed evergreen forest
Parnassia palustris	California grass of Parnassus	-	-	Locally rare	Foothill woodland, yellow pine forest, red fir forest, lodgepole forest, subalpine forest, mixed evergreen forest, wetland-riparian, serpentine soils
Polygonum marinense	Marin knotweed	-	-	More info needed	Marshes/swamps
Ranunculus lobbii	Lobb's buttercup	-	-	Limited distribution	Valley grassland, foothill woodland, redwood forest, freshwater wetlands, wetland-riparian in vernal pools
Rhododendron macrophyllum	Coast rhodendron	-	-	Locally rare	Redwood forest, mixed evergreen forest, douglas-fir forest, yellow pine forest
Streptanthus glandulosus	Bristly jewelflower	-	-	Locally rare	Northern oak woodland, foothill woodland, chaparral, coastal prairie
Streptanthus glandulosus ssp. *secundus*	One sided jewelflower	-	-	Locally rare	Northern oak woodland, foothill woodland, chaparral, coastal prairie
Trifolium albopurpureum var. *dichotomum*	Branched Indian clover	-	-	Locally rare	Coastal prairie, mixed evergreen forest
Triteleia peduncularis	Long-rayed brodiaea	-	-	Locally rare	Closed-cone pine forest, mixed evergreen forest, foothill woodland, wetland-riparian serpentine endemic
Toxicoscordion fontanum	Marsh zigadenus	-	-	Limited distribution	Chaparral, mixed evergreen forest

[a]Other categories include the following:
[a]CNPS (California Native Plant Society) Ratings:
1A = Seriously endangered in California
1B = Rare, threatened, or endangered in California and elsewhere
2 = Rare or endangered in California, more common elsewhere
4 = Plants of limited distribution
Fully protected = Rare or facing possible extinction and receiving additional protections under federal or state law
Locally rare = Considered by local experts to be unique or unusual on MCOSD preserves and in Marin County
PRBO = Point Reyes Bird Observatory Conservation Science, Bird Species of Special Concern

Table B.4 Special-Status Species Known to Exist on Preserves

Scientific Name	Common Name	Number of preserves with species	Alto Bowl	Bald Hill	Baltimore Canyon	Blithedale Summit	Bolinas Lagoon	Bothin Marsh	Camino Alto	Cascade Canyon	Deer Island	French Ranch	Gary Giacomini	French Ranch	Ignacio Valley	Indian Tree	Indian Valley	King Mountain	Little Mountain	Loma Alta	Loma Verde	Lucas valley	Maurice Thorner Memorial Open Space	Mt Burdell	Old St Hilary's	Pacheco Valle	Ring Mtn	Roy's Redwoods	Rush Creek	San Pedro Ridge	Santa Venita Marsh	Santa Margarita Island	Terra Linda/Sleepy Hollow	Tiburon Ridge	Verissimo Hills	White Hill
Allium lacunosum	pitted onion	1																								■									
Amorpha californica var. napensis	indigo bush	2			■					■																									
Amsinckia lunaris	bent-flowered fiddleneck	1																		■															
Arctostaphylos hookeri ssp. montana	Mt. Tamalpais manzanita	2										■	■	■																					
Arctostaphylos virgata	Marin manzanita	1											■																						
Asclepias fasicularis	narrow leaf milkweed	1																						■											
Aspidotis californica	California lace fern	1										■		■																					
Astragalus pycnostachyus var. pycnostachyus	marsh milk vetch	1					■																												
Boschniakia hookeri	coast ground cone	1			■																														
Calamagrostis ophitidis	serpentine reed grass	3										■	■	■												■									
Calandrinia breweri	Brewer's redmaids	1			■																														
Calochortus umbellatus	Oakland star-tulip	3											■							■						■									
Castilleja affinis ssp. neglecta	Tiburon indian paintbrush	2																							■		■								
Castilleja ambigua ssp. humboldtiensis	Humboldt Bay owl's clover	1					■																												
Ceanothus velutinus var. hookeri	Hooker's tobacco brush	1			■																														
Ceanothus velutinus	tobacco brush	1											■																						
Cirsium hydrophilum var. vaseyi	Mt. Tamalpais thistle	1											■																						
Cordylanthus maritimus ssp. palustris	Point Reyes bird's beak	2					■	■																											
Elymus californicus	California bottle brush grass	1											■																						
Erigeron biolettii	streamside daisy	1																						■											
Erigeron foliosus var. franciscensis	San Francisco leafy fleabane	1																							■										
Eriogonum luteolum var. caninum	Tiburon buckwheat	5			■							■		■										■	■		■								
Fremontodendron californicum	California fremontia	1											■																						
Fritillaria liliacea	fragrant fritillary	2																						■											
Hemizonia congesta ssp. congesta	hayfield tarweed	10										■	■	■		■	■			■				■	■		■						■		
Hesperolinon congestum	Marin western flax	5											■							■				■	■		■								
Lessingia hololeuca	wooly headed lessingia	4																						■				■					■		
Lessingia micradenia var. micradenia	Mt. Tamalpais lessingia	2										■	■	■																					
Lilium pardalinum	leopard lily	1																							■										
Linanthus acicularis	bristly leptosiphon	7										■	■	■		■	■					■		■				■							
Monolopia major	cupped monolopia	1																						■											
Navarretia cotulifolia	featherleaf navarretia	1																						■											
Navarretia heterodoxa	Calistoga navarettia	1								■																									
Navarretia leucocephala ssp. bakeri	Baker's navarretia	1																						■											
Navarretia rosulata	Marin County navarettia	1											■																						

Table B.4 Special-Status Species Known to Exist on Preserves

Scientific Name	Common Name	Number of preserves with species	Alto Bowl	Bald Hill	Baltimore Canyon	Blithedale Summit	Bolinas Lagoon	Bothin Marsh	Camino Alto	Cascade Canyon	Deer Island	French Ranch	Gary Giacomini	French Ranch	Ignacio Valley	Indian Tree	Indian Valley	King Mountain	Little Mountain	Loma Alta	Loma Verde	Lucas valley	Maurice Thorner Memorial Open Space	Mt Burdell	Old St Hilary's	Pacheco Valle	Ring Mtn	Roy's Redwoods	Rush Creek	San Pedro Ridge	Santa Venita Marsh	Santa Margarita Island	Terra Linda/Sleepy Hollow	Tiburon Ridge	Verrissimo Hills	White Hill
Parnassia californica	California grass of Parnassus	1																							■											
Pentachaeta bellidiflora	whiteray pygmydaisy	1																■																		
Ranunculus lobbii	Lobb's buttercup	2																						■									■			
Rhododendron macrophyllum	coast rhodendron	1				■																														
Stebbinsoseris decipiens	Santa Cruz microseris	1											■																							
Streptanthus glandulosus ssp. pulchellus	Mt. Tamalpais jewelflower	2								■			■																							■
Streptanthus glandulosus ssp. secundus	one sided jewelflower	1																															■			
Streptanthus glandulosus	bristly jewelflower	1											■																							
Streptanthus niger	Tiburon jewelflower	1																							■											
Thermopsis macrophylla var. macrophylla	robust false lupine	5											■				■			■							■									
Thermopsis macrophylla	common false lupine	1																									■									
Trifolium albopurpureum var. dichotomum	branched Indian clover	1																																		■
Trifolium amoenum	showy Indian clover	1																									■									
Trifolium buckwestiorum	Santa Cruz clover	1																									■									
Triteleia peduncularis	long-rayed brodiaea	1																									■									
Zigadenus micranthus var. fontanus	marsh zigadenus	4										■	■	■											■		■									

C: Nonnative Vegetation on Preserves

Table C.1 lists the nonnative plants known to exist in each of the MCOSD preserves. Table C.2 lists the priority invasive plants known to exist in each of the MCOSD preserves.

Table C.1 Nonnative Plants Known to Exist on Preserves

Scientific Name	Common Name	No. of Preserves	Alto Bowl	Bald Hill	Baltimore Canyon	Blithedale Summit	Bolinas Lagoon	Bothin Marsh	Camino Alto	Cascade Canyon	Deer Island	French Ranch	Gary Giacomini	Horse Hill	Ignacio Valley	Indian Tree	Indian Valley	King Mountain	Little Mountain	Loma Alta	Loma Verde	Lucas valley	Maurice Thorner	Mt Burdell	Old St Hilary's	Pacheco Valle	Ring Mountain	Roy's Redwoods	Rush Creek	San Pedro Ridge	Santa Margarita Island	Santa Venita Marsh	Terra Linda/Sleepy Hollow	Tiburon Ridge	Verissimo Hills	White Hill
Acacia decurrens	black wattle	5	■		■								■				■															■				
Acacia longifolia	Sydney golden wattle	1																							■											
Acacia melanoxylon	black acacia, blackwood acacia	9			■	■		■	■									■	■						■						■	■				
Aegilops triuncialis	barb goatgrass	4																			■			■								■	■			
Agapanthus sp.	lily-of-the-Nile	1							■																											
Ageratina adenophora	croftonweed, eupatorium	4			■	■	■																		■											
Agrostis avenacea	Pacific bentgrass	3									■													■					■							
Ailanthus altissima	tree-of-heaven	1																											■							
Aira caryophyllea	silver hairgrass	11	■		■						■	■			■	■	■		■				■			■						■				
Aira elegantissima	elegent hairgrass	3															■		■				■													
Allium triquetrum	three-cornered leek	5	■		■							■	■						■																	
Ammophila arenaria	European beachgrass	1					■																													
Anagallis arvensis	scarlet pimpernill	14	■		■						■	■	■		■	■	■	■	■				■	■		■						■				
Anthemis cotula	dog fennel	3									■												■			■										
Anthriscus caucalis	bur chervil	3	■												■																	■				
Arctotheca calendula	capeweed	4	■													■																■				■
Arum italicum	cuckoo pint	2																	■							■										
Arundo donax	giant reed	3					■					■																					■			
Avena barbata	slender wild oat	12	■		■						■	■	■		■	■	■	■	■							■						■				
Avena fatua	wild oat	7	■		■											■		■	■							■						■				
Barbarea verna	early yellow rocket, land cress	2	■																													■				
Bellardia trixago	bellardia	7											■				■	■	■							■	■						■			
Bellis perennis	English daisy	1														■																				
Brachypodium distachyon	false brome	7									■					■	■	■	■							■						■				
Brassica nigra	black mustard	3														■							■									■				
Brassica rapa	birdsrape mustard, field mustard	4														■							■			■						■				
Briza maxima	big quackingrass, rattlesnakegrass	11	■		■						■				■	■	■	■	■				■			■						■				
Briza minor	little quaking grass	13	■		■						■	■	■		■	■	■	■	■				■			■						■				
Bromus diandrus	ripgut brome	11	■		■						■	■			■	■	■	■	■							■						■				
Bromus hordeaceus	soft brome	11	■		■						■	■			■	■	■	■	■							■						■				
Bromus madritensis ssp. *rubens*	red brome	4			■											■	■						■													
Bromus racemosus	bald brome	1	■																																	
Capsella bursa-pastoris	shepherd's purse	5											■			■			■				■									■				
Carduus pycnocephalus	Italian thistle	20	■		■	■				■	■	■	■		■	■	■	■	■			■	■	■		■	■		■			■			■	

Table C.1 Nonnative Plants Known to Exist on Preserves

Scientific Name	Common Name	No. of Preserves	Alto Bowl	Bald Hill	Baltimore Canyon	Blithedale Summit	Bolinas Lagoon	Bothin Marsh	Camino Alto	Cascade Canyon	Deer Island	French Ranch	Gary Giacomini	Horse Hill	Ignacio Valley	Indian Tree	Indian Valley	King Mountain	Little Mountain	Loma Alta	Loma Verde	Lucas valley	Maurice Thorner	Mt Burdell	Old St Hilary's	Pacheco Valle	Ring Mountain	Roy's Redwoods	Rush Creek	San Pedro Ridge	Santa Margarita Island	Santa Venita Marsh	Terra Linda/Sleepy Hollow	Tiburon Ridge	Verissimo Hills	White Hill
Carduus tenuiflorus	slenderflower thistle	1																■																		
Carex pendula	drooping sedge	1																											■							
Carpobrotus edulis	hottentot-fig, iceplant	5					■	■																		■	■					■				
Carthamus lanatus	woolly distaff thistle	5														■		■	■			■											■			
Centaurea calcitrapa	purple starthistle	12							■							■		■	■	■		■	■	■		■	■					■	■			
Centaurea melitensis	Malta starthistle, tocalote	14	■			■					■	■				■	■	■	■				■	■		■	■		■			■				
Centaurea solstitialis	yellow starthistle	23			■						■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■			■	■		■	■
Centaurium tenuiflorum	slender centaury	4									■												■			■						■				
Cerastium fontanum ssp. vulgare	mouse eared chickweed	1														■																				
Cerastium glomeratum	common chickweed	13	■		■							■	■		■	■	■	■	■				■			■						■			■	
Cerastium viscosum	sticky chickweed	1	■																																	
Chamomilla suaveolens	chammomile	10	■		■							■	■			■	■		■				■			■									■	
Cirsium arvense	Canada thistle	1																								■										
Cirsium vulgare	bull thistle	22	■		■	■	■				■	■	■	■		■	■	■	■				■	■	■	■	■	■	■			■		■	■	
Conium maculatum	poison-hemlock	6									■								■				■			■		■				■				
Convolvulus arvensis	field bindweed	9									■	■	■			■	■	■	■							■						■				
Conyza bonariensis	hairy horseweed	1														■																				
Conyza floribunda	asthmaweed	2															■						■													
Coronopus didymus	swinecress	4														■			■				■									■				
Cortaderia jubata	jubata grass	17	■		■	■	■	■	■			■					■		■	■					■	■	■		■	■		■	■			
Cortaderia selloana	Pampas grass	1																								■										
Cotoneaster sp.	cotoneaster	6					■			■							■	■									■						■			
Cotula australis	Australian waterbuttons	5			■											■			■				■									■				
Cotula coronopifolia	brassbuttons	5															■		■				■			■						■				
Crataegus monogyna	hawthorn	1																														■				
Crocosmia crocosmiiflora	montbretia	1					■																													
Crypsis schoenoides	swamp prickleweed	2																■														■				
Cynodon dactylon	Bermuda grass	4														■		■								■						■				
Cynosurus echinatus	hedgehog dogtailgrass	13	■		■						■	■	■		■	■	■	■	■				■			■						■				
Cyperus involucratus	umbrella grass	1			■																															
Cytisus scoparius	Scotch broom	17	■		■	■			■	■		■	■	■			■	■	■	■			■			■		■	■					■		
Dactylis glomerata	orchard grass	1									■																									
Delairea odorata	Cape-ivy, German-ivy	6	■			■	■		■							■																	■			
Dipsacus sativus	fuller's teasel	11	■									■	■	■			■	■					■			■	■	■						■		
Dittrichia graveolens	stinkwort, stink weed	2			■																								■							
Echium candicans	pride-of-Madeira	5			■	■	■																		■								■			

Table C.1 Nonnative Plants Known to Exist on Preserves

Scientific Name	Common Name	No. of Preserves	Alto Bowl	Bald Hill	Baltimore Canyon	Blithedale Summit	Bolinas Lagoon	Bothin Marsh	Camino Alto	Cascade Canyon	Deer Island	French Ranch	Gary Giacomini	Horse Hill	Ignacio Valley	Indian Tree	Indian Valley	King Mountain	Little Mountain	Loma Alta	Loma Verde	Lucas valley	Maurice Thorner	Mt Burdell	Old St Hilary's	Pacheco Valle	Ring Mountain	Roy's Redwoods	Rush Creek	San Pedro Ridge	Santa Margarita Island	Santa Venita Marsh	Terra Linda/Sleepy Hollow	Tiburon Ridge	Verissimo Hills	White Hill
Ehrharta erecta	erect veldtgrass	3		■												■	■																		
Epipactis helleborine	broad-leaved helleborine	1		■																															
Erechtites glomerata	cutleaf burnweed	2		■																					■										
Erechtites minima	Australian fireweed+b106	5	■		■							■			■		■																			
Erechtites prenanthoides	coastal burnweed	1	■																																	
Erigeron karvinskianus	Mexican daisy	2	■		■																															
Erodium botrys	broadleaf filaree	13	■		■						■	■	■		■	■	■	■	■				■			■						■				
Erodium brachycarpum	short-fruited filaree	6	■		■						■												■			■						■				
Erodium cicutarium	redstem filaree	13		■						■	■	■		■	■	■	■	■				■	■		■						■				
Erodium moschatum	whitestem filaree	10	■		■								■		■	■	■		■				■			■						■				
Erodium obtusiplicatum	short fruit stork's bill	1	■																																	
Eucalyptus globulus	Tasmanian blue gum	8											■				■	■	■							■	■		■			■				
Euphorbia esula	leafy spurge	3				■												■			■															
Euphorbia lathyris	caper spurge	1		■																															
Euphorbia maculata	spotted spurge	1														■																				
Euphorbia oblongata	oblong spurge	4				■					■						■																■			
Euphorbia peplus	petty spurge	4															■	■	■						■											
Festuca arundinacea	tall fescue	5									■					■		■								■						■				
Ficus carica	edible fig	1																					■													
Filago gallica	narrow leaf cudweed	12	■		■						■	■				■	■	■	■				■			■						■			■	
Foeniculum vulgare	fennel	26	■		■	■	■	■	■		■	■	■				■	■	■	■		■	■	■	■	■	■		■		■	■	■	■	■	■
Galium murale	tiny bedstraw	1									■																										
Galium spurium	false cleavers	1	■																																	
Gastridium ventricosum	nitgrass, shining nitgrass	4									■						■	■								■										
Genista monspessulana	French broom	29	■		■	■	■	■	■	■	■	■	■	■		■	■	■	■	■		■	■		■	■	■		■	■	■	■	■	■	■	■
Geranium dissectum	cutleaf geranium	13	■		■						■	■	■		■	■	■	■	■				■			■						■				
Geranium molle	dovefoot geranium	11	■		■							■	■			■	■	■	■				■			■						■				
Gnaphalium luteo-album	weedy cudweed	8		■											■		■	■				■			■						■			■	
Hainardia cylindrica	common barbgrass	1																■																		
Hedera helix	English ivy	15	■		■	■	■	■	■	■		■	■				■	■	■							■					■	■				
Hirschfeldia incana	shortpod mustard, summer mustard	8									■		■			■	■		■				■			■						■				
Holcus lanatus	common velvet grass	7	■				■				■	■						■								■	■									
Hordeum hystrix	Mediterranean hairy barley	1																	■																	
Hordeum marinum ssp. *gussoneanum*	Mediterranean barley	10	■		■						■	■			■	■	■	■	■							■										
Hordeum vulgare	barley (cultivar)	1													■																					

Table C.1 Nonnative Plants Known to Exist on Preserves

Scientific Name	Common Name	No. of Preserves	Alto Bowl	Bald Hill	Baltimore Canyon	Blithedale Summit	Bolinas Lagoon	Bothin Marsh	Camino Alto	Cascade Canyon	Deer Island	French Ranch	Gary Giacomini	Horse Hill	Ignacio Valley	Indian Tree	Indian Valley	King Mountain	Little Mountain	Loma Alta	Loma Verde	Lucas valley	Maurice Thorner	Mt Burdell	Old St Hilary's	Pacheco Valle	Ring Mountain	Roy's Redwoods	Rush Creek	San Pedro Ridge	Santa Margarita Island	Santa Venita Marsh	Terra Linda/Sleepy Hollow	Tiburon Ridge	Verissimo Hills	White Hill
Hypochaeris glabra	smooth cat's ear	14	■		■						■	■	■		■	■	■	■	■				■			■						■			■	
Hypochaeris radicata	rough cat's ear, hairy dandelion	14	■		■						■	■	■		■	■	■	■	■				■			■						■			■	
Ilex aquifolium	English holly	2											■				■																			
Kniphofia uvaria	red hot poker, torch lily	1			■																															
Lactuca saligna	willow leaf lettuce	5									■								■				■			■						■				
Lactuca serriola	prickly wild lettuce	5									■					■		■					■									■				
Lamium amplexicaule	henbit	1											■																							
Lapsana communis	common nipplewort	1										■																								
Lathyrus latifolius	sweet pea (cultivar)	3									■								■							■										
Lathyrus tingitanus	tangier pea	2									■															■										
Leontodon taraxacoides	lesser hawkbit	1													■																					
Lepidium latifolium	perennial pepperweed, tall whitetop	4					■	■			■																					■				
Leucanthemum vulgare	ox-eye daisy	1																															■			
Ligustrum texanum	waxleaf privet	1				■																														
Linaria vulgaris	yellow toadflax, butter and eggs	1																								■										
Linum bienne	pale flax	6	■		■						■		■						■							■										
Lolium multiflorum	Italian ryegrass	12	■		■						■		■		■	■	■	■	■				■			■						■				
Lolium perenne	perennial ryegrass	3									■					■																■				
Lotus corniculatus	bird's-foot trefoil	3											■			■			■																	
Lotus glaber	naked bird's-foot trefoil	1																								■										
Lotus tenuis	narrow-leaf bird's-foot trefoil	2																								■						■				
Lunaria annua	annual honesty	1										■																								
Lythrum hyssopifolia	hyssop loosestrife	1																														■				
Malva nicaeensis	bull mallow	3											■			■																■				
Marrubium vulgare	white horehound	1																														■				
Matricaria discoidea	disk mayweed	1													■																					
Matricaria matricarioides	pineapple weed	1	■																																	
Maytenus boaria	mayten	1																									■									
Medicago arabica	spotted burclover	6											■		■	■			■				■									■				
Medicago lupulina	black medick	2													■				■																	
Medicago polymorpha	California burclover	15	■		■						■	■	■		■	■	■	■	■				■			■						■			■	
Melilotus alba	while sweet clover	2														■																■				
Melilotus indicus	sweet clover	5									■					■	■									■						■				
Mentha pulegium	pennyroyal	8											■			■	■		■					■		■						■	■			

Table C.1 Nonnative Plants Known to Exist on Preserves

Scientific Name	Common Name	No. of Preserves	Alto Bowl	Bald Hill	Baltimore Canyon	Blithedale Summit	Bolinas Lagoon	Bothin Marsh	Camino Alto	Cascade Canyon	Deer Island	French Ranch	Gary Giacomini	Horse Hill	Ignacio Valley	Indian Tree	Indian Valley	King Mountain	Little Mountain	Loma Alta	Loma Verde	Lucas valley	Maurice Thorner	Mt Burdell	Old St Hilary's	Pacheco Valle	Ring Mountain	Roy's Redwoods	Rush Creek	San Pedro Ridge	Santa Margarita Island	Santa Venita Marsh	Terra Linda/Sleepy Hollow	Tiburon Ridge	Verissimo Hills	White Hill
Myosotis latifolia	common forget-me-not	8	■		■	■			■			■	■				■	■																		
Narcissus papyraceus	paper white	1							■																											
Narcissus pseudonarcissus	daffodil	1																							■											
Nerium oleander	oleander	1																														■				
Olea europaea	olive	1			■																															
Oxalis albicans ssp. *pilosa*	radishroot wood sorrel	2			■												■																			
Oxalis corniculata	creeping woodsorrel	2														■																■				
Oxalis laxa	dwarf woodsorrel	1														■																				
Oxalis pes-caprae	bermuda buttercup	6			■								■				■						■									■				■
Paspalum dilatatum	dallis grass	1																														■				
Phalaris aquatica	hardinggrass	22	■		■	■		■			■		■			■	■	■	■	■		■	■	■	■	■	■	■	■		■	■	■			
Phalaris paradoxa	hood canarygrass	1																■																		
Phoenix canariensis	Canary Island date palm	2																													■	■				
Phoradendron densum	dense mistletoe	1										■																								
Phyllostachys spp.	bamboo	1			■																															
Picris echioides	bristly ox tongue	11											■			■	■	■	■				■	■	■	■						■			■	
Pinus pinea	italian stone pine	1																															■			
Pinus sp.	pine	5			■		■				■								■						■											
Pittosporum crassifolium	pittosporum, dwarf cheesewood	1													■																					
Pittosporum tenuifolium	kohuhu, silversheen pittosporum	1													■																					
Pittosporum undulatum	victorian box	1													■																					
Plantago coronopus	cutleaf plantain	1																	■																	
Plantago lanceolata	English plantain	14	■		■						■	■	■		■	■	■	■	■				■	■		■						■				
Plantago major	common plantain	3			■							■					■																			
Poa annua	annual bluegrass	11	■		■							■	■		■	■	■	■	■				■									■				
Poa bulbosa	bulbous bluegrass	1																														■				
Poa pratensis	Kentucky bluegrass	1																								■										
Polycarpon tetraphyllum	fourleaf allseed	6			■							■				■			■							■						■				
Polygonum arenastrum	knotweed	3											■			■		■																		
Polypogon monspeliensis	rabbits foot grass	4	■								■					■										■										
Portulaca oleracea	common purslane	1														■																				
Prunella vulgaris var. *vulgaris*	self-heal	1			■																															
Prunus cerasifera	cherry plum	1																■																		
Prunus domestica	cherry tree	1																															■			
Pyracantha angustifolia	firethorn	2																	■								■									

Table C.1 Nonnative Plants Known to Exist on Preserves

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Ranunculus muricatus	prickly buttercup	11	■		■							■	■		■	■	■	■	■				■									■				
Raphanus raphanistrum	wild radish	3									■												■			■										
Raphanus sativus	radish (cultivar)	5			■								■						■							■						■				
Reseda luteola	dyer's mignonette	1																														■				
Romulea rosea	rosy sand crocus	3																				■		■								■				
Rubus discolor	Himalayan blackberry	16	■		■	■	■			■	■	■	■		■	■	■							■		■	■					■	■			
Rumex acetosella	red sorrel, sheep sorrel	11	■		■						■	■	■		■	■		■	■							■						■				
Rumex crispus	curly dock	9									■	■	■		■		■	■	■							■						■				
Rumex pulcher	European minionete	7									■	■				■	■	■								■						■				
Salsola soda	oppositeleaf russian thistle	1						■																												
Sanguisorba minor ssp. muricata	garden burnet	1																■																		
Scandix pecten-veneris	shepherd's needle	7										■			■			■	■				■									■			■	
Scleranthus annuus ssp. annuus	German knotweed	1									■																									
Senecio glomeratus= Erichtites glomerata	fireweed grounsel	1																								■										
Senecio vulgaris	common grounsel	10	■		■							■				■	■		■				■			■						■			■	
Sherardia arvensis	sherardia	9			■							■	■		■	■	■		■				■			■										
Silene gallica	common catchfly	14	■		■						■	■	■		■	■	■	■	■					■		■						■			■	
Silybum marianum	milkthistle	16			■		■				■	■	■		■	■	■	■	■				■	■		■			■			■			■	
Sisymbrium officinale	hedge mustard	6	■													■	■	■					■									■				
Solanum americanum	black nightshade	2																						■				■								
Soliva sessilis	field burweed	13	■		■						■	■	■		■	■	■		■				■			■						■			■	
Sonchus asper	spiny sowthistle	13	■		■						■	■	■		■	■	■	■	■				■									■			■	
Sonchus oleraceus	common sowthistle	12	■		■						■	■			■	■	■		■				■			■						■			■	
Sorghum sudanense	Sudan grass	1																						■												
Sparaxis tricolor	harlequin flower	1																								■										
Spartina alterniflora	cord grass	1					■																													
Spartium junceum	Spanish broom	5								■									■	■					■	■										
Spergula arvensis	corn spurry, common sand spurry	1																														■				
Spergula arvensis ssp. arvensis	corn spurry, common sand spurry	3														■	■									■										
Spergularia rubra	red sand spurry	14	■		■						■	■	■		■	■	■	■	■				■			■						■			■	
Spergularia villosa	hairy sandspurry	1																														■				
Stellaria media	common chickweed	11	■		■							■	■			■	■		■				■			■						■			■	

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Scientific Name	Common Name	No. of Preserves	Alto Bowl	Bald Hill	Baltimore Canyon	Blithedale Summit	Bolinas Lagoon	Bothin Marsh	Camino Alto	Cascade Canyon	Deer Island	French Ranch	Gary Giacomini	Horse Hill	Ignacio Valley	Indian Tree	Indian Valley	King Mountain	Little Mountain	Loma Alta	Loma Verde	Lucas valley	Maurice Thorner	Mt Burdell	Old St Hilary's	Pacheco Valle	Ring Mountain	Roy's Redwoods	Rush Creek	San Pedro Ridge	Santa Margarita Island	Santa Venita Marsh	Terra Linda/Sleepy Hollow	Tiburon Ridge	Verrissimo Hills	White Hill
Taeniatherum caput-medusae	Medusahead grass	2																						■									■			
Taraxacum laevigatum	rock dandelion	1	■																																	
Taraxacum officinale	common dandelion	8	■		■							■				■	■		■				■									■				
Torilis arvensis	hedge parsley	5									■				■	■							■			■										
Torilis heterophylla	spreading hedge parsley	4	■															■	■													■				
Torilis nodosa	knotted hedge parsely	9	■		■						■				■	■	■		■				■									■				
Tradescantia fluminensis	green wandering jew	1			■																															
Tragopogon porrifolius	purple salsify	9			■						■					■			■				■			■		■	■			■				
Tribulus terrestris	puncture vine	2																														■	■			
Trifolium angustifolium	narrowleaf crimson clover	1													■																					
Trifolium campestre	field clover	2																	■													■				
Trifolium cernuum	nodding clover	1																	■																	
Trifolium dubium	low hop clover	12			■						■	■	■		■	■	■	■	■							■						■			■	
Trifolium fragiferum	strawberry clover	1																								■										
Trifolium glomeratum	clustered clover	7			■						■		■		■	■	■		■																	
Trifolium hirtum	rose clover	8									■					■	■	■	■				■			■						■				
Trifolium incarnatum	crimson clover	1									■																									
Trifolium pratense	red clover	2	■		■																															
Trifolium repens	white clover	5			■						■				■	■																■				
Trifolium subterraneum	subterraneum clover	11			■						■		■		■	■	■	■	■				■			■						■				
Tropaeolum majus	garden nasturtium	1					■																													
Veronica persica	persian speedwell, birds-eye speedwell	2											■										■													
Vicia benghalensis	purple vetch	6														■		■	■				■			■						■				
Vicia sativa	garden vetch	12									■	■	■		■	■	■	■	■				■			■						■			■	
Vicia villosa	hairy vetch	8			■										■	■		■	■				■			■						■				
Vinca major	big periwinkle	11	■				■		■	■							■		■				■			■	■					■	■			
Vulpia bromoides	squirreltail fescue	8	■									■			■	■	■		■							■						■				
Vulpia myuros	rattail fescue	7			■								■		■		■		■				■									■				
Xanthium spinosum	spiny cocklebur	1																						■												
Zantedeschia aethiopica	calla lily	2					■																										■			

Notes: Plant list was compiled from MCOSD plant survey notes, field notes from local botanists (W. Follette, D. Smith unpublished data), and from the Calflora database(<www.calflora.org> downloaded December 5, 2009). Nonnative designation was based on The Jepson Manual: *Higher Plants of California* (Hickman 1993) determination of species origin. For each plant species, presence in a specific preserve is based on available data, and is indicated by square black dot. Not all nonnative species become invasive (defined as plants that cause economic or environmental harm, displace native species). Refer to table C.2 for a list of priority invasive plant species know to occur on the MCOSD preserves.

Table C.2 Known Priority Invasive Plant Species on Preserves

Scientific Name	Common Name	Number of Preserves	Alto Bowl	Bald Hill	Baltimore Canyon	Blithedale Summit	Bolinas Lagoon	Bothin Marsh	Camino Alto	Cascade Canyon	Deer Island	French Ranch	Gary Giacomini	Horse Hill	Ignacio Valley	Indian Tree	Indian Valley	King Mountain	Little Mountain	Loma Alta	Loma Verde	Lucas valley	Maurice Thorner	Mt Burdell	Mt Tamalpais	Old St Hillary's	Pacheco Valley	Ring Mtn	Roy's Redwoods	Rush Creek	San Pedro Ridge	San Rafael Ridge	Santa Margarita Island	Santa Venita Marsh	Terra Linda/Sleepy Hollow	Tiburon Ridge	Verrissimo Hills	White Hill
Acacia decurrens	*black wattle*	5	■		■								■				■																	■				
Acacia longifolia	*Sydney golden wattle*	1																								■												
Acacia melanoxylon	*black acacia, blackwood acacia*	9			■	■		■	■									■	■							■							■	■				
Aegilops triuncialis	*barb goatgrass*	4																			■			■										■	■			
Ageratina adenophora	*croftonweed, eupatorium*	4			■	■	■																			■												
Carpobrotus edulis	*hottentot-fig, iceplant*	5					■	■																			■	■						■				
Carthamus lanatus	*woolly distaff thistle*	5														■		■	■			■													■			
Centaurea calcitrapa	*purple starthistle*	12							■							■		■	■	■		■	■	■			■	■						■	■			
Centaurea solstitialis	*yellow starthistle*	23			■						■	■	■	■	■	■	■	■	■	■	■	■	■	■			■	■	■	■				■	■		■	■
Cortaderia jubata	*jubata grass*	17	■		■	■	■	■	■			■					■		■	■						■	■	■		■	■			■	■			
Cortaderia selloana	*Pampas grass*	1																									■											
Cotoneaster sp.	*cotoneaster*	6					■			■							■	■										■							■			
Cytisus scoparius	*Scotch broom*	17	■		■	■			■	■		■	■	■			■	■	■	■			■				■		■	■						■		
Delairea odorata	*Cape-ivy, German-ivy*	6	■			■	■		■							■																			■			
Dittrichia graveolens	*stinkwort, stink weed*	2			■																									■								
Dittrichia graveolens	*stinkwort, stink weed*	2			■																									■								
Echium candicans	*pride-of-Madeira*	5			■	■	■																			■									■			
Ehrharta erecta	*erect veldtgrass*	3			■												■	■																				
Eucalyptus globulus	*Tasmanian blue gum*	8											■				■	■	■								■	■		■				■				
Foeniculum vulgare	*fennel*	26	■		■	■	■	■	■		■	■	■				■	■	■	■		■	■	■		■	■	■		■			■	■	■	■	■	■
Genista monspessulana	*French broom*	29	■		■	■	■	■	■	■	■	■	■	■		■	■	■	■	■		■	■			■	■	■		■	■		■	■	■	■	■	■
Lepidium latifolium	*perennial pepperweed, tall whitetop*	4					■	■			■																							■				
Phalaris aquatica	*hardinggrass*	22	■		■	■		■			■		■			■	■	■	■	■		■	■	■		■	■	■	■	■			■	■	■			
Rubus discolor (R. armeniacus)	*Himalayan blackberry*	16	■		■	■	■			■	■	■	■		■	■	■							■			■	■						■	■			
Spartina alterniflora	*cord grass*	1					■																															
Spartium junceum	*Spanish broom*	5								■									■	■						■	■											
Tribulus terrestris	*puncture vine*	2																																■	■			

Notes: Plant list was compiled from MCOSD plant survey notes, field notes from local botanists (W. Follette, D. Smith unpublished data), and from the Calflora database(www.calflora.org downloaded December 5, 2009). Non-native designation was based on The Jepson Manual: Higher Plants of California (Hickman 1993) determination of species origin. For each plant species, presence in a specific preserve is based on available data, and is indicated by square black dot. Not all non-native species become invasive (defined as plants that cause economic or environmental harm, displace native species). Refer to Table 4.3.3a for a list of Invasive plant species with highest priority for management on MCOSD preserves.

D: Development of Vegetation Management Zones

Process Used To Develop Zones

MCOSD staff followed a six-step process to develop the four vegetation management zones:

Step 1: Identify High-Value Resources and Associated Threats

High-value resources were defined to be a limited suite of species, vegetation or habitat types, and ecological systems selected to represent and encompass the biodiversity found within the MCOSD preserves. Threats to these resources were considered actions or factors that would directly or indirectly degrade the resources and that must be mitigated or managed where feasible to avoid or lessen that effect.

Step 2: Assess and Augment Existing Vegetation Data

Existing vegetation data sets were identified, assessed, and augmented as possible and practicable. Data sets included monitoring reports, GIS data, maps, and other available information. Data that was not already in a digital format, and that could be incorporated into the existing MCOSD GIS database, was scanned or digitized. (This step is described in greater detail below.)

Step 3: Describe and Identify the Purpose of Each Zone

Zones were described in terms of their resource values, threats (primarily invasive species), and proximity to developed areas. The purpose for each zone was determined to be a particular vegetation management focus appropriate to these factors.

Step 4: Develop Criteria for Zones

Criteria were developed that could be applied consistently across all 34 preserves to create the boundaries of each vegetation management zone. The criteria were developed after review of the high-value resources and were subsequently reviewed and modified by local experts.

Step 5: Apply Criteria, Create and Refine Zone Maps

The criteria were used to create the zoning maps. The maps were refined based on the review of local experts.

Step 6: Acknowledge Limitations of Zoning

The development of vegetation zoning is an imprecise science. The zoning maps represent the best available science and expert judgment, but also may include inaccuracies and reflect data limitations (i.e., incomplete maps, nonspecific location information about species occurrence, or other potential inaccuracies). These vegetation zones, therefore, are intended to be dynamic in nature, and will be revised as better information becomes available.

Descriptions of Data Sets Used To Map Vegetation Management Zones

The following is a list of GIS data sources, associated reports and the description of the data sources used in the zone development process.

SPECIAL-STATUS PLANTS

The data layer displaying special-status plants distribution was assembled by combining data from two different data sources. The first source was the MCOSD legacy data from the allrare.shp GIS shapefile. These locations were identified by MCOSD staff based on field work conducted in 2006. The other source of special-status plant locations was the shapefiles MCOSD_rare_plants_areas.shp and MCOSD_rare_plants_points.shp. These shapefiles identify the locations of rare plant populations that were noted on paper maps by MCOSD staff in 2009 and hand digitized by May and Associates, with population polygons placed in one shapefile and point occurrences in another. LSA mapping of Ring Mountain in 2007 was included.

To create a single data layer for use in zoning, all of the data sources described above were joined by MCOSD staff. Duplicate occurrences were compared visually, and duplicates were removed from the merged zoning layer. Occurrences were labeled according to level of rarity, using status as listed in tables B.3 in appendix B, “Special-Status and Other Species of Special Concern that Could Exist on Preserves,” and B.4. “Special-Status Species Known to Exist on Preserves,” and assigned different colors on the zoning map to indicate level of rarity.

LOCALLY RARE PLANTS

Locally rare plants were compiled from paper maps provided by the California Native Plant Society and from a panel of local plant botanists and ecologists at a 2010 workshop held at Hamilton Field. The plant locations on the paper maps were digitized, and the data were then combined into a shapefile, MCOSD_Locally_Rare.shp, and used as a reference file during the zoning process.

INVASIVE NONNATIVE PLANT INFESTATIONS

The data layer displaying distribution of invasive plants was assembled by combining data from two different data sources. The first source was MCOSD legacy data from the weedlayers.gdb geodatabase. This database is maintained to prioritize and track management of invasive plant infestations on MCOSD lands. Invasive species population polygons in this database were field mapped using different techniques over a number of years. For some species (such as Aegilops triuncialis), polygons represent carefully delineated occurrences of a species made over several sequential years, and have a very high degree of spatial and temporal resolution. In other cases and for particular species (such as *Carduus pycnocephalus* at Mount Burdell), polygons represent preliminary assessment of the broad distribution of species and are more appropriate for indicating presence of a widely distributed species at a preserve. For use in zone mapping, polygons from these broader assessments were excluded from the data set, and only a select group of species with high ecological importance and very well-defined polygons were displayed. Only occurrences with more than 25% cover are indicated on zoning maps.

The second invasive plant data set used in zoning was the shapefile exotics_5_7.shp. These data were collected in 2008 as part of an assessment of existing and proposed fuelbreak areas in MCOSD preserves. Infestations were hand mapped on aerial photographs and field verified and field mapped by hiking and driving the preserve fuelbreaks and fire roads. While not all of MCOSD lands were surveyed, the scope of this effort and the consistent quality of data collection makes these data very reliable. While six invasive plants were mapped, zoning maps include only occurrences of broom (*Cytisus scoparius* and *Genista monspessulana*). Only occurrences with high (>66%) and medium (36-65%) cover are indicated on zoning maps.

VEGETATION TYPES

In 2008 the MCOSD vegetation communities were mapped according to protocols set forth by the California Native Plant Society (CNPS) and the Manual of California Vegetation. Prior to mapping, a list of MCOSD vegetation types was developed based upon prior mapping efforts of the Marin Municipal Water District (MMWD) and in consultation with MCOSD and CNPS staff. This list of MCOSD vegetation types, table B.1 “Vegetation Types on Preserves,” along with vegetation type “signatures” developed from field visits, was used for preliminary delineation of polygons from aerial photos by Aerial Information Systems (AIS). At the same time, a CNPS-trained field crew gathered 400 releves (lists of the plants in a delimited plot of vegetation, with information on species cover and on abiotic features in the plot) and rapid assessments to inform and aid the delineations. Data gathered from the field effort was used by in final delineations of the vegetation polygons, which covered more than 21,000 acres and identified more than 100 vegetation communities across MCOSD lands.

The spatial extent of the data covers all MCOSD preserves with terrestrial or upland vegetation types; wetlands at the Bolinas Lagoon Preserve and Bothin Marsh were not mapped. The vegetation maps extend beyond preserve boundaries as far as the natural extent of each polygon would allow, with a minimum of 300 feet of distance. Certain private lands with potential for acquisition by MCOSD were also mapped, as well as most of the Miller Creek watershed. The minimum mapping unit was ½ hectare.

The vegetation communities dataset has been used as a base layer for subsequent projects, such as the Shelterbelt Builders weed mapping effort, the upcoming Point Reyes Bird Observatory bird species modeling effort, and a series of derived layers that were utilized in this *Vegetation and Biodiversity Management Plan*.

GLOBAL, STATE, SAN FRANCISCO BAY UPLANDS, AND LOCAL RARITY RANKINGS TO VEGETATION TYPES

Identifying the location and distribution of rare and sensitive vegetation types was simplified by the high quality vegetation mapping work conducted by Aerial Information Systems. In July 2008, AIS completed detailed vegetation mapping of most of the MCOSD preserves, using signature identification of September 2004 aerial photography to classify vegetation polygons to alliances and associations as possible. The vegetation classification used by AIS was based on classification used in MMWD vegetation mapping.

The preferred vegetation classification was that used by the Manual of California Vegetation (MCV). However, a variety of other vegetation classifications had been used in the available vegetation maps and lists of rare and sensitive vegetation types. For example, the Upland Habitat Goals Project had used a modified version of the CALVEG, a vegetation classification system and map developed by the U.S. Forest Service. The identification of rare and sensitive vegetation stands therefore required a manual cross-walk among the different classification systems, which included the following determinations:

The AIS mapping data was examined to identify all vegetation polygons containing wetland features; all such wetland vegetation polygons were identified as sensitive vegetation types.

AIS data was compared with lists of globally rare vegetation types as managed in the NatureServe Central Databases, and with vegetation types described as rare within California Department of Fish and Wildlife (CDFW) “List of California Vegetation Alliances.” Where an MCOSD vegetation stand contained a dominant or subdominant species that was the basis of a rare alliance in NatureServe or the CDFW list, the rarity ranking for that alliance was transferred to the MCOSD alliance or association. For example, within NatureServe the *quercus lobata* alliance is ranked G3S3, and so MCOSD polygons containing valley oak and coast live oak mapping units were ranked G3S3.

Rarity rankings for vegetation types determined by the Upland Habitat Goals Project to be rare in either the Marin coast ranges or coastal grassland units were transferred to appropriate MCOSD vegetation types. For example, Upland Habitat Goals determined that serpentine scrub was a rank 1 vegetation type in the Marin coast ranges, and so MCOSD sites containing chamise/serpentine chaparral were assigned an Upland Habitat Goals rarity rank 1.

Rare and underrepresented vegetation types were identified based on their distribution and abundance within the MCOSD preserve system. A vegetation type was considered locally rare if it occurred on only three or fewer of the 34 MCOSD preserves. A vegetation type was also considered locally rare if its total area comprised less than 10 acres of the approximately 15,000 acres owned and managed by MCOSD.

WETLANDS

This dataset was compiled by integrating palustrine and estuarine features of the National Wetlands Inventory with buffered riverine stream features derived from Marin County streams. The streams layer, maintained by the Marin County Department of Public Works, was buffered to a total width of 230 feet, which includes 30 feet of average channel width and 100 feet from the top of each bank. This width is consistent with buffer widths recommended by the 2008 *Marin Countywide Plan*.

LANDBIRD SPECIES HABITAT MODELING

This dataset was derived from model developed by the Point Reyes Bird Observatory (PRBO 2010). Two modeling outputs were integrated into the development of the vegetation zones: overall native avian species diversity, and areas supporting at-risk bird species (bird species of special concern and/or declining).

PRBO modeled the overall diversity of native avian species from the total number of native species that were detected across all bird surveys and years (see figure D.1). Species diversity measures the number of species detected weighted by the number of individuals of each species. A high diversity score indicates a more equal representation of the species, and may represent high ecological diversity. Species that were not well sampled by the point count method (e.g., nonterritorial, colonial species) were excluded. Species diversity data indicates areas and habitats that are occupied by many avian species; areas supporting high species diversity likely indicate high structural vegetation diversity or the presence of habitat ecotones.

PRBO's findings seem to coincide with others that have demonstrated the importance of general vegetation structure, rather than specific plant species composition, at the landscape scale (Rotenberry and Wiens 1980). Furthermore, in some cases, the importance of landscape metrics, such as patch size and patch cohesion, in the modeling outputs suggests that habitat configuration and pattern are important as well. This was reflected in the vegetation zone modeling attributes—specifically, in areas supporting high biological diversity and low habitat fragmentation. At the MCOSD level, the hardwood vegetation type, which includes California bay laurel, coast live oak, and tanoak (*Lithocarpus densiflorus*) vegetation types, appeared to be most important across a range of avian species and metrics. This is supported by other studies that have demonstrated the importance of oaks and other hardwood tree species in providing nesting and foraging habitat for avian species (Verner 1980). Hardwoods often represent ecotones between or within other habitat types. Ecotones are known to be species-rich (Smith et al. 1997), and this result highlights the importance of habitat mosaics within the district.

Figure D.1 Predicted Native Avian Species Diversity on Preserves

Landbird species that showed some evidence of a decline (at-risk species) on MCOSD

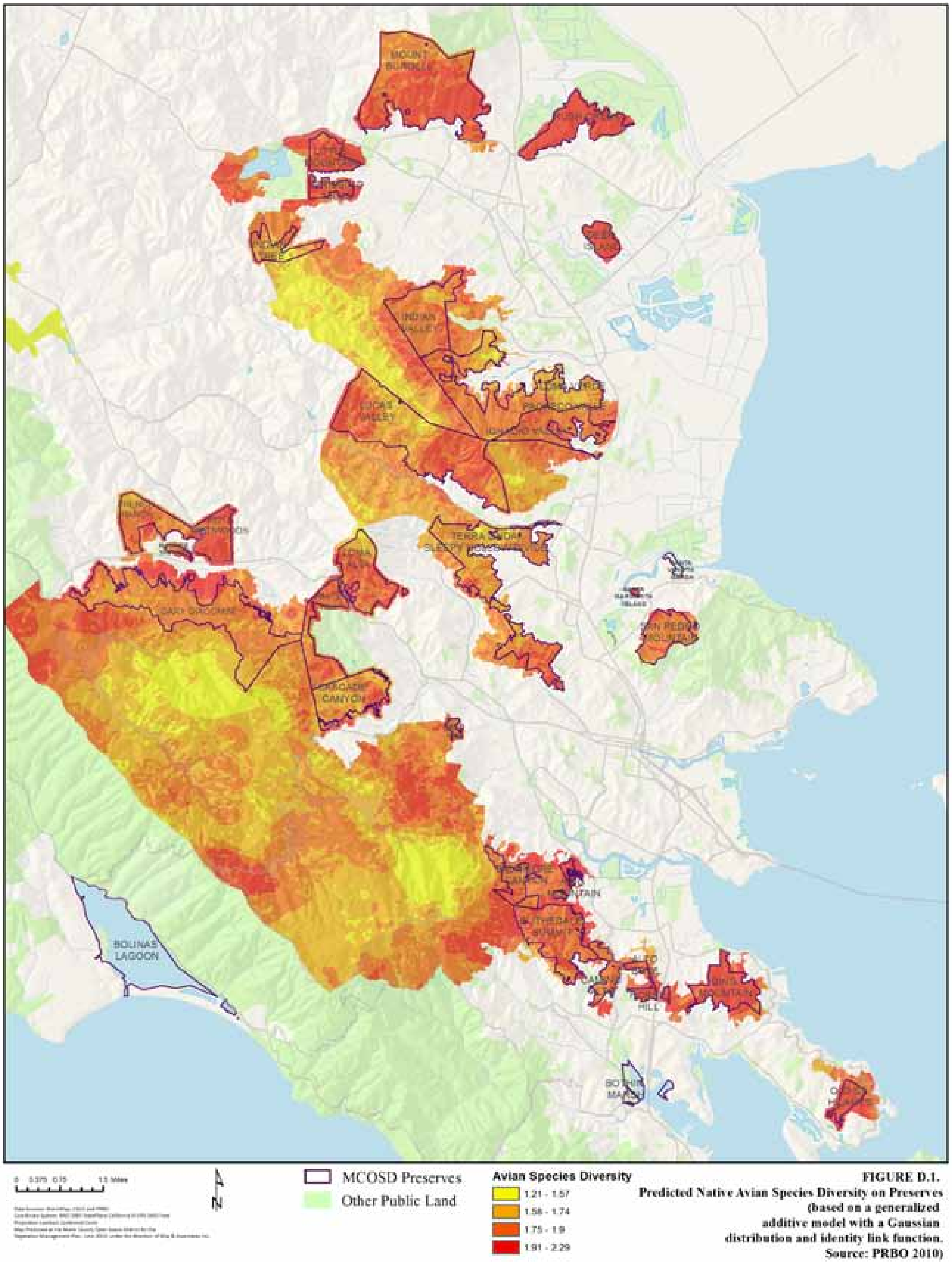

FIGURE D.1.
Predicted Native Avian Species Diversity on Preserves (based on a generalized additive model with a Gaussian distribution and identity link function. Source: PRBO 2010)

lands occurred in all habitat types—riparian, coastal scrub, grassland, and hardwoods. To develop the at-risk species model, PRBO developed several individual species models (including models for disturbance-sensitive and ground-nesting species) and then combined them. Figure D.2 presents the model output. Vegetation types supporting the greatest probability of at-risk species decline were evaluated as a part of the vegetation zone development.

100-FOOT RESIDENTIAL BOUNDARIES

This dataset was initially derived from the Marin County building footprints layer, which is a representation of all of the built structures in the county. The layer was built using traditional photogrammetric techniques by VARGIS in 2005 and delivered with the aerial photos that were flown in September 2004. The 100-foot residential boundaries were derived by selecting all of the building footprints that were within 300 feet of district preserve boundaries. Then, structures that were identified as residential were extracted from this layer, and a 100-foot buffer was applied to these residential building footprints. The final step in the process was to clip the buffered layer so that only that area which overlaid district preserves was retained, and the rest of the layer was discarded. The resulting layer shows the impact that a 100-foot defensible space clearing from residential structures might have on MCOSD property.

MCOSD VEGETATION MANAGEMENT

A data layer showing the spatial extent of MCOSD vegetation management, including current, historic, and planned efforts, was compiled through surveys and mapping sessions with MCOSD staff who are currently or have historically been in charge of vegetation management efforts. Data include the spatial extent of vegetation mapping efforts, the cost of the work, and who performed the work. This dataset also incorporates two other primary sources of data: maps provided by Marin County Fire that show the location of existing and desired fuelbreaks on MCOSD land, and a 2005 dataset tracking vegetation management of MCOSD lands.

The spatial representation of this layer is to scale. The resulting data have been used to show that the amount of managed area has increased from 250 to 528 acres. These data have been classified by type of management, using the definitions of fuel modification zones described by the Marin Municipal Water District (MMWD 2008b).

POWER LINES

The primary source of data was paper maps provided by Pacific Gas and Electric (PG&E) showing the distribution of power lines on MCOSD preserves. Power line distribution was digitized using these paper maps along with 2004 and 2009 aerial imagery. Because of discrepancies between the PG&E stated locations and what is visible on the aerial imagery, this is considered to be a partial dataset. The larger transmission lines were easy to see and map; however, locations of smaller distribution lines were not always apparent and could not be digitized. It is estimated that 75% of the power lines that cross MCOSD preserves have been captured in this dataset.

Figure D.2 Declining Landbird Species on Preserves

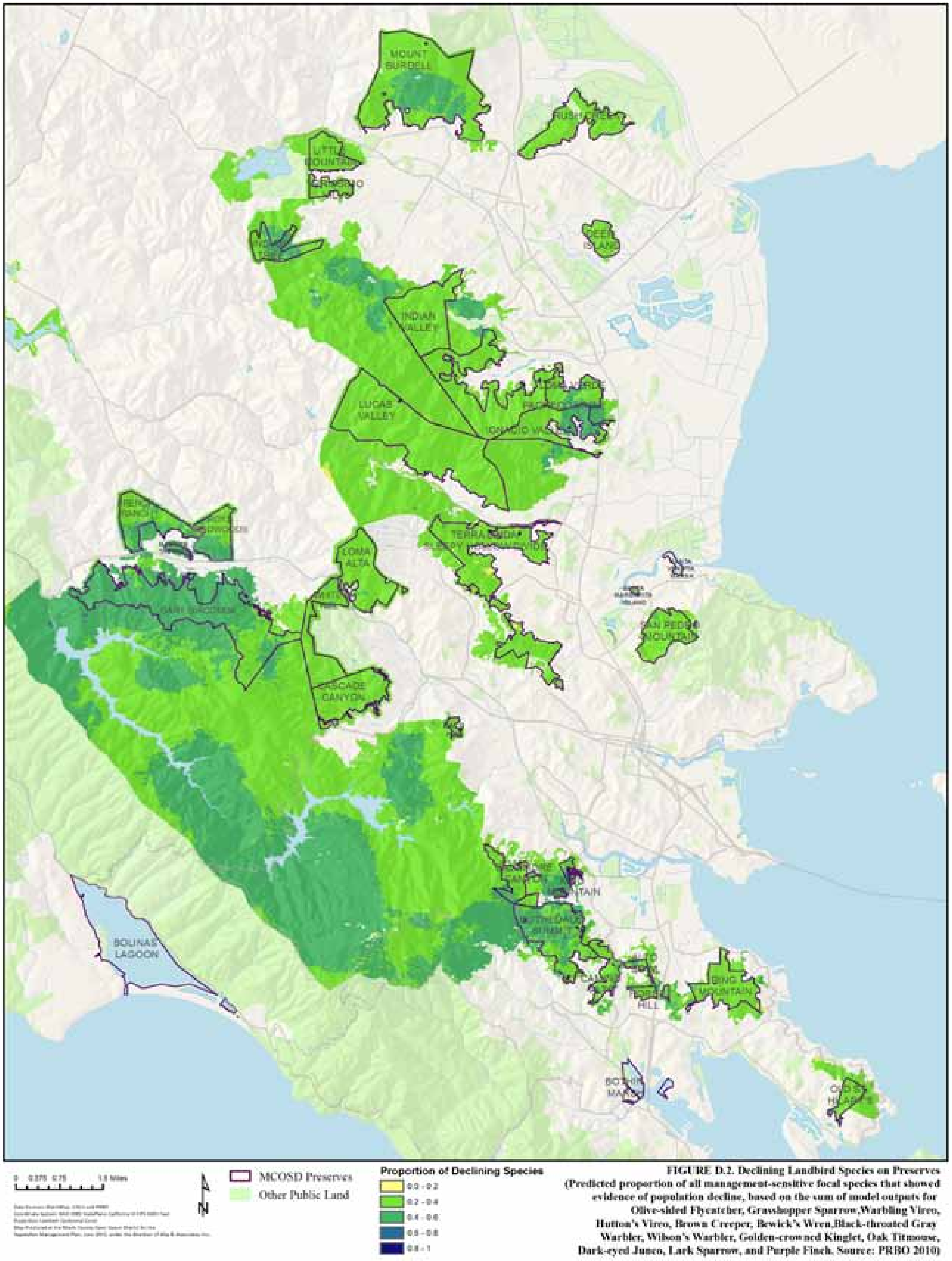

FIGURE D.2. Declining Landbird Species on Preserves (Predicted proportion of all management-sensitive focal species that showed evidence of population decline, based on the sum of model outputs for Olive-sided Flycatcher, Grasshopper Sparrow, Warbling Vireo, Hutton's Vireo, Brown Creeper, Bewick's Wren, Black-throated Gray Warbler, Wilson's Warbler, Golden-crowned Kinglet, Oak Titmouse, Dark-eyed Junco, Lark Sparrow, and Purple Finch. Source: PRBO 2010)

GLOSSARY

Action threshold A predetermined measureable change in conditions, such as an increase in the size or density of an invasive plant infestation, which triggers a vegetation management action.

Adaptive management The practice of revisiting management decisions and revising them in light of new information.

Annual plants Plants that complete their life cycle (germination through death) in one year or growing season.

Biennial plants Plants that complete their life cycle (germination through death) in two years or growing season (generally flowering only in the second).

Biodiversity, biological diversity The variety of life found on Earth; the variety of genes, species, populations, and the ecosystems that support them (Pimm et. al. 2008).

Biological control Control of an undesirable population through the use of a biological organism (e.g., parasite, predator, pathogen).

Chemical control Control of an undesirable population by use of herbicides or pesticides. Chemical control methods use chemical compounds to inhibit or prevent the growth of plants.

Community Two or more populations of interacting organisms in a given area.

Containment A management action designed to prevent the spread of an invasive species from a given area, without attempting to reduce the existing population.

Control Decrease plant density and abundance to an acceptable or defined level; a general term of invasive plant management.

Cultural control Control of an undesirable population through modification of human behavior (e.g., requiring equipment to be cleaned before and after entering an infested area).

Ecosystem A naturally occurring unit defined by both its living and non-living components; a system within which the exchange of nutrients and energy takes place.

Defensible space zone A type of fuel modification zone established between a developed area and the surrounding undeveloped area for the purpose of reducing the potential for wildfires to spread between the two areas.

Fire hazard The ease of ignition and resistance to control of a fuel source.

Fire risk The probability of ignition.

Fuel modification zone An area where vegetation is managed to reduce fire risk or fire hazard. (See also individual types of fuel modification zones: defensible space zone, ignition prevention zone, fuelbreak, ingress/egress zone.)

Fuelbreak A type of fuel modification zone designed to diminish the hazard of fire spreading across the break. Primary fuelbreaks are typically 100-200 feet wide; these breaks are designed to control lower intensity fires or to control the edges of higher-intensity fires to provide for firefighter safety. Secondary fuelbreaks are 60-100 feet wide and are primarily located next to roads.

Ignition prevention zone A type of fuel modification zone designed and managed to minimize and, if feasible, reduce the chance of a fire igniting.

Ingress/Egress zone A type of fuel modification zone designed and managed to ensure that patrol, maintenance, fire, and other emergency vehicles have unobstructed access along fire road.

Integrated pest management A systematic approach to the control of pests (e.g., undesirable vegetation, insects, rodents, other pest species) that are considered problematic in a specific area or to a specific resource.

Invasive species A species whose introduction causes, or is likely to cause, economic or environmental harm or harm to human health. Invasive species reduce biodiversity by displacing native organisms, bring about changes in species composition, community structure, or ecosystem function. Not all nonnative plants are invasive. Only a small minority of the thousands of species introduced to California has escaped cultivation, and a minority of those has established problematic populations in natural areas.

Locally rare species Species that are considered by resource agencies or local experts as sensitive, declining, locally rare, locally endemic, or as having limited or restricted distribution.

Manual control Control of an undesirable population through manual or mechanized manipulation (e.g., cutting, pulling).

Native species Species growing within their natural historic range and natural zone of dispersal potential. They are species or subspecies that are within the range that they could occupy without direct or indirect introduction and/or care by humans.

Priority invasive plants Plants that are regulated under state and/or federal law or policy, are listed by various agencies and organizations who regulate or research plant invasiveness, and were determined by staff and local experts to pose the greatest threat to special-status species, sensitive plant communities, fire management, and public enjoyment of MCOSD open space lands.

Pyrophitic plants Plants that have adapted to tolerate fire and to require fire for regeneration.

Releve A list of the plants in a delimited plot of vegetation, with information on species cover and on substrate and other abiotic features in the plot.

Resilience An ecosystem's ability to regain structural and functional attributes that have suffered harm from stress or disturbance.

Special-status species Species listed as endangered, threatened, rare, or of special concern by the federal government or the State of California.

Sustained control Management of an invasive plant population to prevent its reproduction, while incrementally reducing its distribution over time (as funding and staffing allow) until it is eventually eradicated.

Wildlands Lands that are in a natural uncultivated state, especially when they form habitat for wildlife.

Wildland–urban interface The area where developed lands adjoin undeveloped wildlands

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Useful Information

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http://biodiversity.ca.gov/

California Native Grassland Association
http://www.cnga.org/

California Society for Ecological Restoration
http://www.sercal.org/

California State Parks
http://www.parks.ca.gov/ and http://resources.ca.gov/lester.html

East Bay Regional Parks, Stewardship, and Land Management
http://www.ebparks.org/stewardship

National Park Service - Restoration Projects around the Bay Area
http://www.nps.gov/goga/naturescience/restoration-projects.htm>

Marin Municipal Water District, Resource Management Information
http://www.marinwater.org/controller?action=menuclick&id=247

Mid Peninsula Regional Open Space District
http://www.openspace.org/

Point Reyes National Seashore
http://www.nps.gov/pore/

Wetland Regional Monitoring Program
http://www.wrmp.org/

Special-Status Species

Websites

California Department of Fish and Wildlife
http://www.dfg.ca.gov/hcpb/species/species.shtml

U.S. Fish and Wildlife Service
http://ecos.fws.gov/ecos/index.do

California Native Plant Society
http://www.cnps.org/

CNPS- Marin Chapter
http://www.marin.edu/cnps/

Audubon Society of California
http://www.audubon-ca.org/california_birding.htm

Marin Audubon Society
http://www.marinaudubon.org/

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http://tncweeds.ucdavis.edu/handbook.html

California Invasive Plant Council (Cal-IPC)
http://www.cal-ipc.org/

Californians for Alternatives to Toxics
http://www.alternatives2toxics.org/

Bay Area Early Detection Network (BAEDN)
http://baedn.org/
(888) 427-4447
e-mail: coordinator@baedn.org

Global Invasive Species Database
http://www.invasivespecies.net/database/species/ecology.asp?si=563&fr=1&sts=sss

The Global Invasive Species Team
http://tncweeds.ucdavis.edu/esadocs.html

Marin County Agriculture Commissioner's website
http://www.co.marin.ca.us/depts/AG/Main's /index.cfm

Marin/Sonoma Weed Management Area's website
http://www.marinsonomaweedmanagement.org/

Invasive Spartina Project
http://www.spartina.org/

U.C. Cooperative Extension Weed Research and Information Center
http://wric.ucdavis.edu/information/information.html

California Department of Food and Agriculture's *Noxious Times* newsletters
http://www.cdfa.ca.gov/PHPPS/ipc/noxioustimes/noxtimes_archives.html

Weed Prevention and Management Guidelines for Public Lands, U.S. Department of the Interior, Bureau of Land Management
http://www.cdfa.ca.gov/PHPPS/ipc/noxioustimes/noxtimes_archives.htmU.S

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1682 Novato Blvd., Suite 150-A
Novato, CA 94947-7021
(415) 499-6700 p
(415) 499-7543 f

Species Identification Guides

Books

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http://www.calflora.org/species/index.html

Jepson Manual Online (plants)
http://ucjeps.berkeley.edu/interchange.html

National Park Service (common plants and animals in local national parks)
http://www.nps.gov/goga/parklabs/library/wildlifeguide/>

Plant Diseases and Pests

Websites

California Oak Mortality Task Force
www.suddenoakdeath.org

California Department of Food and Agriculture
http://www.cdfa.ca.gov/phpps/pe/sod_survey/

California Forest Pest Council c/o Wilbur-Ellis Company
http://www.caforestpestcouncil.org

Pitch Canker Task Force
http://frap.cdf.ca.gov/pitch_canker/

Species Initiative, Gallery of Pests
http://tncweeds.ucdavis.edu/products/gallery/phyra1.html

UC IPM Pitch Canker Management Guidelines
http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74107.html

UC Cooperative Extension Tree Root Rot Fungus Detection and Control
http://danr.ucop.edu/ihrmp/oak16.htm

Forestry and Fire Protection

Websites

California Department of Forestry
http://frap.cdf.ca.gov/

California Oak Foundation
www.californiaoaks.org

East Bay Municipal Utilities
To order document entitled "Firescape: Landscaping to Reduce Fire Hazard"
http://www.ebmud.com/conserving_&_recycling/conservationpublications/default.htm

FireSafe Marin- Defensible Space Information
http://www.firesafemarin.org/defensible.htm

Homeowner's Brochures
http://www.xmrfire.org/mrn/Prevention%20Documents/Marin%20landscape%20brochureREV2.pdf and http://www.kwpoa.com/_documents/Marinsafepractices.pdf

UC Berkeley Forestry Department
http://forestry.berkeley.edu/lectures/wmmain3.html

UC Berkeley Fire Management Plan
http://oep.berkeley.edu/programs/fire_mitigation/

US Forest Service
http://www.fs.fed.us/psw/

U.S. Forest Service, Fire Effects Information System
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Livestock Grazing in Wildlands

Websites

California Rangeland Trust
http://www.rangelandtrust.org/

RangeNet
http://www.westernwatersheds.org/rangenet/rangenet.html

Range Biome
http://www.rangebiome.org/

Society for Range Management
http://www.rangelands.org/srm.shtml

California Cattlemen's Association
http://www.calcattlemen.org/

California Native Grassland Association
http://www.cnga.org/index.php

Use of Goats for Management of Unwanted Vegetation
http://www.cals.ncsu.edu/an_sci/extension/animal/meatgoat/MGVeget.htm

Prescription Grazing for Vegetation Management
http://www.cnr.uidaho.edu/rx-grazing/prescriptions.htm

Knowledgeable Individuals

Living Systems Land Management, LLC
295 Fell Street, Suite A
San Francisco, California 94102
(415) 845-6747
http://www.livingsystemslandmanagement.com/?gclid=CJqP9IGX0KQCFQIGbAodPhndEA

Integrated Pest Management

Websites

U.C. Davis Integrated Pest Management
http://www.ipm.ucdavis.edu/

U.S. Environmental Protection Agency
http://www.epa.gov/pesticides/ipm/

National Integrated Pest Management Center
http://www.ippc.orst.edu/DIR/

UC Cooperative Extension Marin County
http://cemarin.ucdavis.edu

Native Plants and Planting Materials

Websites

California Native Plant Link Exchange
http://www.cnplx.info/

Local Native Plant Nurseries

Rooted Stock

Central Coast Wilds
114 Liberty Street, Santa Cruz, CA 95060
(831) 459-0655
http://www.centralcoastwilds.com

Cornflower Farms
P.O. Box 896, Elk Grove, CA 95759
(916) 689-1015
http://www.cornflowerfarms.com

Native Here Nursery
101 Golf Course Dr., Tilden Park,
Berkeley, CA 94708
(510) 549-0211
http://www.ebcnps.org/nativehere.html

North Coast Native Nursery
P.O. Box 744, Petaluma, CA 94953
(707) 769-1213
www.northcoastnativenursery.com

Seed

Hedgerow Farms
21740 County Road 88, Winters, CA 95694
(530) 662-6847
www.hedgerowfarms.com

Larner Seeds
P.O. Box 407, Bolinas, CA 94924
www.larnerseeds.com

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19500 Skyline Blvd., Woodside, CA 94062
(650) 851-1668
www.yerbabuenanursery.com

Vegetation Biomass Disposal and Processing

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1999 *Organic Materials Management Strategies 1999.* U.S. EPA Publication No. EPA530-R-99-016. Washington