Midpeninsula Regional
Open Space District

R-21-85
Meeting 21-19
June 23, 2021

AGENDA ITEM 3

AGENDA ITEM

Authorization to enter into an Agreement with Panthera to conduct a Five-Year Wildlife and Livestock Protection Study and create a Wildlife/Livestock Conflict Management Plan

GENERAL MANAGER'S RECOMMENDATIONS

Authorize the General Manager to enter into an Agreement with Panthera for a not-to-exceed contract price of $335,000 to conduct five years of research on the effectiveness of non-lethal wildlife and livestock protection methods and their effect on wildlife behavior (e.g. deterring predation), wildlife health, grazing productivity, and livestock health and to utilize the results to develop an informed Wildlife and Livestock Conflict Management Plan.

SUMMARY

The recently amended Conservation Grazing Management Policy (Attachment 1) includes an implementation measure focused on researching safe livestock and wildlife protection measures. To meet this policy goal, the Midpeninsula Regional Open Space District (District) solicited proposals from regional wildlife/livestock conflict management experts to determine a research-based approach for understanding and mitigating potential wildlife/livestock conflicts on District conservation grazing lands. The General Manager recommends entering into an agreement with Panthera, who will collaborate with University of California Division of Agriculture and Natural Resources (UC ANR), the Santa Cruz Puma Project (SCCP), and other research scientists, to develop and implement a five-year study of the factors influencing wildlife and livestock conflict. Contributors from Panthera, UC ANR and SCCP have signed a letter of support indicating their commitment to the proposed project (Attachment 2). Panthera would subsequently develop a Wildlife and Livestock Conflict Management Plan (CMP) that includes recommendations for reducing potential wildlife/livestock conflicts within each District conservation grazing lease area, all for a not-to-exceed total amount of $335,000. There are sufficient funds in the Fiscal Year 2021-22 (FY22) adopted budget to cover the cost of the recommendation for year 1 of the study. Funds to complete the work in future years will be proposed as part of the annual Budget and Action Plan process.

DISCUSSION

The District began its conservation grazing program in 2007 using livestock grazing to maintain and enhance the diversity of native plant and animal communities within grassland habitats, manage fuel loads for fire protection, sustain the local agricultural community, and preserve the region's rural agricultural heritage. For numerous years, conservation grazing tenants have reported livestock losses due to predation by mountain lions and coyotes. In 2018, the District contracted with a Wildlife Conflict Specialist to develop a scientific literature review

(Attachment 3) of existing methods for addressing livestock/wildlife conflicts. This work led to a recent update to the Conservation Grazing Management Policy (R-21-22) that provides clear guidance for District staff in reducing conflicts while protecting local wildlife, including mountain lions and coyotes. The updated policy specifies the District's role and strategy in managing these conflicts while providing a clear understanding by conservation grazing tenants of District provisions for addressing these issues and assuring the general public that the District remains committed to protecting local wildlife, including native predators.

Recent Board-approved policy updates include the following:

> Research of safe livestock and wildlife protection measures: supporting research on the safe means for reducing wildlife and livestock conflicts that remain protective of both livestock and local wildlife.

In accordance with policy direction, the District seeks to implement a 5-year study on the efficacy of wildlife and livestock protection measures and develop a CMP that details strategies for reducing wildlife and livestock conflicts within District conservation grazing areas.

Research Approach/Scope of Work

Panthera will develop appropriate scientific research on wildlife and livestock protection methods, which may include: enhanced fencing and barriers, passive and active deterrents, use of livestock protection animals, removal of attractants (such as livestock carcasses), landscape feature alterations (such as removing vegetative cover around water troughs and other areas where livestock congregate), changes in cattle operations, increased human presence, and hazing. The proposed research effort would involve a 5-year wildlife and livestock protection research study with the following objectives:

- Identify predation hotspots throughout the District's jurisdiction west of Skyline Boulevard. An additional optional task includes expanding this analysis to cover the entirety of the District's jurisdiction.

- Assess the efficacy of non-lethal wildlife and livestock protection measures.

- Identify, and if possible, track individual predators that may be habituating to feeding on livestock.

- Evaluate grazing productivity through a statistical analysis of weight gain, cattle energy expenditure, and/or losses in conservation grazing areas with documented predation, areas without documented predation, and areas utilizing other types of wildlife and livestock protection measures.

- Evaluate the effects of wildlife and livestock protection measures on wildlife behavior and habitat use (both predator species and non-target wildlife species).

- Collect data on livestock losses and work with the California Department of Fish and Wildlife (CDFW) and District to respond in the event of suspected livestock predation.

- Evaluate conservation grazing tenant satisfaction with, and willingness to use wildlife and livestock protection measures.

- Evaluate the effectiveness of a pilot livestock monitoring volunteer program (contingent on volunteer program timeline).

- Build upon and add to existing regional research on the topic of predation.

- Collaborate with other researchers and ongoing research projects focused on predation.

- Qualify for publication in one or more peer-reviewed accredited scientific journals.

- Develop an informed wildlife and livestock CMP for use on District lands.

Wildlife and Livestock Conflict Management Plan

Using information gathered through the wildlife and livestock protection research study, the CMP will guide District efforts to reduce potential conflicts between wildlife and livestock within conservation grazing areas. More specifically the CMP will:

- Incorporate findings from research conducted on District lands, the Literature Review document (Attachment 1), and any additional relevant scientific literature or research.

- Include site-specific recommendations for reducing conflicts between wildlife and livestock within District conservation grazing areas. Incorporate findings from the evaluations of conservation grazing tenant satisfaction with wildlife and livestock protection measures, effects on wildlife behavior and habitat use, and effects on grazing productivity.

- Analyze the economic viability of wildlife and livestock protection measures.

- Include a predation risk map covering the District's jurisdiction west of Skyline Boulevard, with an optional task of expanding the map to cover the entire jurisdiction. Map layers and associated data will be made available for incorporation into the District's GIS data.

Consultant Selection

In April of 2021, District staff released a Request for Proposals and Qualifications to regional and state-wide wildlife/livestock conflict experts to solicit research proposals that would enhance the scientific understanding of wildlife/livestock conflict management. The solicitation was directly sent to 10 local researchers, academic professionals and organizations, in addition to being posted on the District's website and Periscope Source website.

Panthera arose as the sole proposer. Panthera is a 503c non-profit organization dedicated to the conservation of big cats, including mountain lions. District staff have confirmed that Panthera possesses local expertise, are in good standing with CDFW, hold a Scientific Collection Permit (SCP) to conduct research work in the study area, and they propose to perform the work at a fair

and reasonable price. Panthera effectively demonstrated an ability to utilize the best available research to protect large carnivores and the surrounding human communities. They take a collaborative approach and work with local governments, communities, and other NGOs to increase the benefits of their conservation efforts. Panthera's proposal includes in-kind contributions of $245,700 over five years that will cover salaries and benefits for the Primary Investigator and research technician, as well as office space and a GIS map subscription.

The recommended contract with Panthera for $335,000 would fund the following expenses over five years to complete the research work and develop the CMP:

- Field equipment
- Deterrent devices
- Deterrent device maintenance
- Environmental DNA analysis; and
- Gas and vehicle mileage.

Dr. Veronica Yovovich would be the Primary Investigator for Panthera. Dr. Carolyn Whitesell would be the co-Primary Investigator from UC ANR. Additional support would be provided by Dr. Chris Wilmers of SCCP, Dr. Stewart Breck of Colorado State University, Dr. Zach McFarlane of California Polytechnic State University, and Sheila Barry, Natural Resources Advisor for the Bay Area UC Cooperative Extension. The researchers that make up this team have authored or co-authored over 58 peer-reviewed scientific papers on wildlife and livestock conflict management with 28 of these publications directly informing management actions.

FISCAL IMPACT

There are sufficient funds in the FY22 adopted budget to cover the cost of the recommendation for year 1 of the study. Funds to complete the work in future years will be proposed as part of the annual Budget and Action Plan process. In-kind contributions will be provided by Panthera for a total of $245,700 over the five-year period of the contract.

The recommended action is not funded by Measure AA.

BOARD COMMITTEE REVIEW

Plans to complete the work under the recommended contract were first introduced to the Board at the February 10, 2021 Special Board Meeting regarding the Conservation Grazing Management Policy amendment (R-21-22) (meeting minutes).

PUBLIC NOTICE

Public notice was provided as required by the Brown Act. Public notice was sent to the Natural Resource Management, Conservation Grazing, and Coastal Area interested parties lists by postal or electronic mail.

CEQA COMPLIANCE

This project consists of biological research to be conducted on District lands by qualified biological professionals under a study design that will require approval by CDFW. This project

is categorically exempt from CEQA as it consists of basic data collection, research, experimental management, and resource evaluation which do not result in a serious or major disturbance to an environmental resource. The research project and associate activities are strictly for information gathering purposes, or as part of a study leading to an action that a public agency has not yet approved, adopted, or funded (CEQA Guidelines section 15306). Any proposed future action of the District, including implementation of a site-specific CMP, will be subject to environmental review to be completed prior to full implementation.

NEXT STEPS

Upon approval by the Board of Directors, the General Manager will execute an agreement with Panthera to conduct a wildlife and livestock protection study for five years, provide annual updates and research findings, create a predation risk map, conduct and evaluate a pilot volunteer livestock monitoring program, publish research findings, and develop a site-specific CMP for reducing wildlife/livestock conflicts in conservation grazing areas.

In 2018, staff began work on the Agricultural Policy however this development process was paused to allow staff to focus efforts on the Conservation Grazing Policy development, including the work described in this report. Staff is re-initiating the Agricultural Policy development work in the upcoming fiscal year and work is anticipated to be completed in 2022. An Informational Report is in preparation and will be included at a future meeting.

Attachment

1. Resource Management Policy Chapter XI: Conservation Grazing Management
2. Letter of Support from Panthera, UC ANR, and SCCP
3. Wildlife and Livestock Protection Policy Literature Review

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Attachment 1

RESOURCE MANAGEMENT POLICIES

MIDPENINSULA REGIONAL OPEN SPACE DISTRICT

February 2021

RESOURCE MANAGEMENT POLICIES

MIDPENINSULA REGIONAL OPEN SPACE DISTRICT

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PREFACE

ABOUT THIS DOCUMENT

Document Purpose

This Resource Management Policies (RMPs) document defines the policies and practices used by the Midpeninsula Regional Open Space District (District) to protect and manage **resources** on District lands. The word resources as used in this document includes plants, animals, water, **soil,** terrain, geologic formations, **historic,** scenic, and cultural features. Recreational resources are described in other documents.[1]

The purpose of the RMPs is to:

- Set the framework for the District's resource management program;
- Provide general guidance for issue-specific and site-specific planning;
- Provide staff and Board a tool for informed, consistent, and effective resource management decision making;
- Inform the public of the purpose and intent of the District's resource management program;
- Provide a basis for evaluating the District's progress in reaching its resource management objectives.

This document does not provide detailed plans for management of individual preserves or resources. Other more specific master plans, site plans, and resource management plans will supplement these policies to further refine and resolve the implementation strategies on a site-specific basis.

The suitability and scope of implementation of a specific RMP can only be effectively determined on a site-specific or issue-specific basis given the

[1] These documents include Use and Management Plans for individual preserves, Trail Use Guidelines and Mitigation Measures, Land Use Regulations and the Visitor's Guide to the Open Space Preserves.

circumstances and conditions to be addresses. The suitability or effectiveness of a RMP may depend on a number of factors. These may include evaluation of potential environmental impacts associated with the RMP, physical or other constraints, availability of funding, and feasibility of implementation. Therefore, the determination of whether and to what extent a RMP is implemented in whole or in part will be made on a site-or issue-specific basis. In some circumstances, deviations from an RMP will represent a more effective resource management approach given applicable factors.

In addition, carrying out and implementing RMPs will be achieved over time, and is subject to funding availability and competing District needs and overall feasibility. Competition for District funds requires balancing the expense of resource management with the cost of continued land acquisition, project planning, and the cost of access and facilities improvements.

Document Organization

The RMPs are organized into chapters by subject and resource category. The chapter format generally consists of a background section and a section containing goals, policies, and implementation measures. The background section provides rationale for the goal and policies that follow. The goal is phrased as a broad, general statement describing the desired state or condition to be achieved. The policies state what steps the District will take in order to attain that goal. Policies are numbered according to chapter with the first letter of each of the fist two words of the Chapter title followed by a number (e.g. **VM-1** is **V**egetation **M**anagement Policy **1**).

Each policy includes one or more recommended implementation measures, highlighted by bullets (♦). Implementation measures specify action items the District will strive to carry out to apply the policies to the landscape where feasible. Implementation measures are referenced internally according to bullets. For instance, VM-1: Measure 2 refers to the second bulleted measure under VM-1. Informational sidebars identify current knowledge and practices regarding resource conservation. Key words are noted in **bold** and definitions for each can be found in the Glossary.

The District will apply the RMPs to every day District functions and operations from the planning of new trails and facilities to the evaluation of new

prospective land acquisitions, to routine Preserve maintenance. It will draw upon varied expertise to balance resource needs and public interests. The annual action plan will describe existing and proposed resource management plans and projects, and progress towards resource management goals.

Document Review and Amendment

The RMPs comprise a "living" document that will grow and change regularly, based on new experience and information. It will be reviewed and updated every five to ten years and chapters amended as needed to respond to ever-changing resource conditions (e.g. insect or disease outbreaks, large cataclysmic events, climate change etc.). The staff or Board may decide to amend the document for a significant single purpose at any time.

I. DISTRICT RESOURCE MANAGEMENT PROGRAM

MIDPENINSULA REGIONAL OPEN SPACE DISTRICT

Midpeninsula Regional Open Space District (District) is a public agency that owns and manages 26 **open space** preserves totaling over 59,000 acres of land (as of 2011). Created by a voter initiative in 1972, the District's mission statement is "To acquire and preserve a regional greenbelt of open space land in perpetuity; protect and **restore** the **natural** environment; and provide opportunities for ecologically sensitive public enjoyment and education."

District boundaries enclose an area of 227,900 acres in northern Santa Clara and southern San Mateo counties, and a small portion of Santa Cruz County. The District's Sphere of Influence, or the area within which the District is likely to expand, includes an additional 12,333 acres. Extending from Montara in the north to the Lexington Hills in the south, the District directly serves more than 25 communities having a combined population of over 700,000. Preserves vary in size from 59 acres (Stevens Creek Nature Study Area) to over 17,000 acres (Sierra Azul). Elevations range from sea level in the baylands preserves to 3,486 feet atop Mount Umunhum in the Sierra Azul Range.

The District manages land primarily to preserve a regional greenbelt of open space land. There are few improvements, other than parking areas, some rest rooms, and informational signs. Over 220 miles of public trails invite activities such as hiking, biking, jogging, horseback riding, dog walking, and picnicking limited only as required. The preserves are open to the public every day, free of charge. Because the preserves are "close to home," they serve as popular weekday and weekend recreational destinations.

District lands protect a variety of **habitats** rich in both numbers and variety of plants and animals. The District preserves tidal salt marshes in the east, home to the endangered clapper rail and salt marsh harvest mouse and

used by thousands of migratory birds. The heart of the District straddles the eastern and western flanks of the Santa Cruz Mountains. These lands are covered in a diverse mix of oak **woodland,** grassland, **chaparral**, coastal scrub, and both evergreen and **coniferous forests** that form an impressive scenic backdrop for the densely populated San Francisco Bay Area and Central California Coast. Creeks and streams that run through District lands provide refuge area for endangered coho salmon and threatened steelhead trout. The natural setting of District preserves provides a peaceful refuge for visitors seeking low intensity recreational opportunities away from the pressures of urban life.

PURPOSES OF OPEN SPACE

Open space consists of land and water areas that remain in a natural state and are minimally developed. Open space may include compatible agriculture uses. Open space preserves provide protection in the form of permanent sanctuaries for **native** wildlife and vegetation. These irreplaceable resources are rapidly disappearing as human presence and activity encroach into natural areas. Reasons to preserve open space that are discussed in the District's Master Plan include protecting scenic beauty, public health and safety, natural, cultural and agriculture resources; shaping urban growth; and providing low-intensity outdoor recreation opportunities and environmental education.

NEED FOR RESOURCE MANAGEMENT POLICIES

Resource management at the District includes management of both natural cultural and agricultural resources. Natural resource management generally consists of protecting, restoring, enhancing, and monitoring native vegetation and wildlife, and monitoring and protecting the quality of geo-

logical and hydrological conditions. Cultural resource management consists of identifying and evaluating and protecting archeological sites and **cultural landscapes**.

The District faces many issues, challenges, and choices in management of District land and sensitive resources. Land acquisition is politically, socially, and opportunistically driven, sometimes independent of resource needs. Defining, identifying and communicating resource needs and management objectives provides for more informed decision making, guides property acquisition, and results in better protection of land and sensitive natural and **cultural resources.**

The complex and constantly changing **ecosystems** of District preserves are comprised of a wide variety of interrelated components resources that sometimes have competing needs for preservation. Managers must be able to recognize, distinguish, and decide among competing priorities. Compounding these inherent challenges is the change in open space management needs over time: the amount of land managed by the District continues to grow; employees and board members who function as caretakers change; funding sources come and go; and the public's interests, values, and use patterns differ over both time and place; and visitation continues to increase which can place increased pressure upon natural systems. A well-defined set of policies is essential for the District to maintain consistent and effective resource management despite these changes.

The Basic Policy adopted March 10, 1999 directs the District to:

> *"follow management policies that ensure proper care of the land, that provide public access appropriate to the nature of the land, and that are consistent with ecological values and public safety."*

Although the Basic Policy implies a direction for managing the land, it does not offer specific guidance as to what constitutes "proper care." These RMPs are intended to provide that guidance.

MISSION STATEMENT FOR RESOURCE MANAGEMENT

The resource management mission statement defines the purpose toward which the District directs its resource management efforts. The District's resource management program is one of stewardship not only intended to protect resources and to sustain them in perpetuity. The District calls its lands “preserves” rather than “parks,” emphasizing the goal of resource preservation. The following overall mission statement reflects the District's commitment to resource management:

Resource Management Mission Statement

The District will protect and restore the diversity and integrity of its resources and ecological processes for their value to the environment and to people, and will provide for the use of the preserves consistent with resource protection.

Overall Resource Management Strategies

The following general strategies summarize how the District will achieve its resource management mission.

Strategy 1 — Favor protection of resources when use significantly interferes with resource protection and preservation.

Strategy 2 — Provide an effective interdisciplinary program to protect and **enhance** natural and cultural resources. This program should include planning, **interpretation,** research, protection, maintenance, and monitoring practices.

Strategy 3 — Prevent or minimize human-caused and accelerated impacts, including erosion, invasion by **non-native** species, disruption of the natural flow of water, degradation of **water quality**, trampling of vegetation, and displacement of wildlife.

Strategy 4 — Protect and restore known rare, endangered, **special status** species and sensitive **habitats**, as well as seriously

degraded or deteriorating areas. Give priority to sensitive habitats and consider the relative scarcity of the specific resources involved.

Strategy 5 Manage open space as a composite resource, rather than as separate and isolated parts. Maintain ecological processes as well as individual species and features. Consider the regional context and cumulative impacts of resource management decisions. Favor long-term goals over short-term benefits.

Strategy 6 Support low intensity recreational and agricultural use of District lands consistent with resource protection. Consider present and potential use.

Strategy 7 Balance efforts to protect and restore resources with efforts to acquire and provide public access to lands.

Strategy 8 Monitor changing conditions and the effectiveness of resource management practices.

Strategy 9 Increase public knowledge, understanding, and appreciation of the natural and cultural resources of the preserves, and support for their conservation.

PLANNING AND IMPLEMENTATION

The RMPs are to be used to guide the overall planning, budgeting, and decision making processes for individual Preserves and for District-wide programs. Implementation of the policies will be through the Use and Management Plan and Master Plan for each Preserve. The District's Land Acquisition Policies shall reference the RMPs to help guide future land acquisitions. Successful implementation of the Policies will result in informed, consistent, and effective resource management.

II. VEGETATION MANAGEMENT

BACKGROUND

District Plant Communities

The District is located along the western edge of the North American continent on a geologically active peninsula between the Pacific Ocean and San Francisco Bay, which limits migration of plants and animals. This unique location is dominated by the Santa Cruz Mountains which are influenced by a Mediterranean climate comprised of mild wet winters and long hot and dry summers cooled by cyclical coastal fog. Because of this climate regime, the landscape is subject to periodic fire. The San Andreas Fault, one of the world's longest and most active faults, cuts through the eastern side of the Santa Cruz Mountains. Continuing movement along the fault and differing composition of the underlying rocks created many **soil** types and terrain features including steep, narrow canyons, rolling hills, and flat bay lands. The eastern edge of the District is heavily influenced by the urban areas of San Francisco, San Jose and other peninsula cites which result in **natural** lands that are often used as a large “urban backyard” rather than a pristine wilderness. These and other factors have shaped diverse and dynamic **native** plant communities that are precisely adapted to these complex and varied conditions.

A **plant community** is a group of plants growing in an interrelated manner on a particular site. Each community has characteristic dominant and associated species, spacing, and **habitat.**

Native plant communities in District preserves include the following general vegetation types:

- Salt marsh and brackish marsh
- Freshwater marsh
- Redwood **forest**
- Douglas fir forest
- Coastal scrub
- **Chaparral**
- Mixed evergreen forest
- **Riparian** forest

- Native grassland
- Oak **woodland**

The condition of vegetation affects other **resources** in the preserves. A mixture of natural plant communities gives scenic character to a landscape, and provides the diversity and stability needed to support native wildlife, clean water and reduce erosion. Loss or fragmentation of plant communities reduces their ability to provide the full range of ecological benefits, including maintenance of species diversity, soil and watershed protection, wildlife, and recreational and aesthetic values. It is the main reason why animal species have become endangered or threatened.

Alterations to Vegetation

Continuing effects of past and present land use practices, including **fire suppression**, grazing, logging, **non-native** plant invasion, feral animals, and uses which trample vegetation, threaten the District's native plant communities. Such activities have caused drastic and rapid changes in vegetation. In some areas the alteration is permanent.

Protection of Sensitive Species

A number of plants listed by either federal or State agencies or the California Native Plant Society as rare, threatened, endangered, and of limited distribution have been identified within or near District preserves. Site-specific information is needed for both existing and new properties to protect sensitive species.

Ecological Restoration

Ecological restoration is the process of returning land that has been degraded and disturbed into ecologically functioning habitat**.** The District often employs the principles of ecological restoration when performing **vegetation management.** Vegetation management is the maintenance, establishment, or **restoration** of target vegetation that meets a preserve's management objectives. The term **revegetation** is used to describe the process of replacing existing vegetation or bare ground on a site with ap-

Ecological restoration is an intentional activity initiated by the District that accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability. Frequently, ecosystems requiring restoration have been degraded, damaged, transformed, or destroyed by direct and indirect human actions.

propriate plant species. Selecting effective vegetation management strategies requires understanding natural ecological processes at a specific site. It also may involve coordinating with neighbors, as part of the District's "good neighbor" policy. The District applies ecological restoration when it replaces landscaping with native vegetation, stabilizes slopes or restores degraded sites with natural drainage patterns.

Management measures may include actions such as eliminating or restricting activities that destroy vegetation, restoring grasslands and meadows that were formerly maintained by natural processes, conducting prescribed burns, managing **conservation grazing**, and either planting or removing vegetation.

Fire Suppression

Periodic fires were a part of natural ecological processes on lands which now make up the District preserves. As a result, many species evolved with fire adaptations and need periodic fire for renewal. Fire opens forests to new generations of younger trees, purges grassland of invasive shrubs, and stimulates seed germination and shoot growth in chaparral. Without fire, fire-adapted communities are eventually replaced by forest, and plant and animal species are lost. **Fuel** in unburned areas can build up to such a high level that when a wildfire occurs, it can have devastating effects.

Local Native Americans allowed natural fires to burn and also deliberately set fires to clear underbrush and create meadow areas attractive to deer and other animals. Open meadows improved visibility for hunting and encouraged the growth of acorn oaks and other edible plants. Subsequent implementation of fire suppression policies eliminated these benefits, reversing their positive environmental effects.

Impacts of **fire suppression** continue to reduce **biodiversity** in the preserves. Grasslands and oak woodlands are decreasing in area due to invading brush and forest species. **Stands** of coastal scrub and chaparral have aged and are not being renewed. Dense tangles of brush and young trees have largely replaced the park-like understory beneath redwood and Douglas fir forests and mature oak woodlands described by early European explorers.

High Use Areas

High use areas such as those around parking lots, visitor centers, restrooms, and specially surfaced or whole access trails, require more intensive vegetation management than natural areas that make up the bulk of District land.

VEGETATION MANAGEMENT GOALS, POLICIES, AND IMPLEMENTATION MEASURES

Goal VM- Sustain and promote viable and diverse native plant communities characteristic of the region

Policy VM-1 Maintain the diversity of native plant communities. (See WR-7, ES-1, IS-2, and FM-6)

- Map and describe plant communities; analyze successional trends and formulate site-specific vegetation management goals as part of the Resource Management Plan for a preserve or geographic area.
- Identify appropriate areas for restoring lost or altered native plant communities and **restore** them to a natural condition. This is often best done by restoring natural processes and controlling invasive plants, rather than by planting.
- Manage native grassland sites to encourage reestablishment and perpetuation of California native grasses.
- Manage oak woodland to encourage reestablishment and perpetuation of California native oaks.
- Control invasive non-native plants. (See Section VI.)

Policy VM-2 Use native species occurring naturally on similar sites in ecological restoration projects.

- Use seed and cuttings collected from the same geographic area to revegetate or **enhance** degraded areas. One source of native seed is topsoil or mulch taken from adjacent intact habitat and applied thinly.

- Use fill, mulch, and seed mixtures that are as free as possible of non-native plants in ecological restoration projects. Know where such materials come from. (See GS-2 for possible exception.)
- Work with nurseries to grow native plants needed for ecological restoration projects.
- Avoid seeding with rye grass (unless sterile), "Zorro" fescue, Harding grass, or other non-native aggressive plants after fires to control erosion.
- Use plant material that is biologically and visually appropriate to the surrounding wild landscape and appropriate to the stage of plant community development at the site.
- Encourage District tenants to use native plants for landscaping to provide natural habitat.

Special status species are species that are state or federally listed as threatened, rare, endangered, species of special concern, candidate species, or those plant species listed by the California Native Plant Society's list 1B and 2.

Policy VM-3 Protect and enhance the habitats and **populations** of **special status** plant species.

- Identify the location and condition of special status plants and their habitats as part of the Resource Management Plan for a preserve or geographical area.
- Conduct surveys for special status plants during the appropriate season before significant site-specific development or any unusual anticipated increase in use. Modify the project or use to avoid impacting such plants.
- Protect areas with special status species from human activities and other negative impacts such as erosion. Examples of protective measures include trail rerouting, signs, and fencing. (See GS-2)

Policy VM-4 Manage forest diseases, when necessary, to protect native biological diversity and critical **ecosystem functions**.

- Develop a plan to detect, report, and monitor areas infested by high priority insects and diseases; utilize sanitation and **best management practices (BMPs)** to control the spread of infestations; train staff and educate the public; and support research to guide land management decisions.

- Prioritize research and management activities to slow the spread of Sudden Oak Death (SOD) and actively pursue partnerships with other public agencies to develop treatment alternatives.

Sudden Oak Death (SOD) is a prevalent disease of particular concern within District forested lands. SOD has killed over one million native oak and tanoak trees and infests many other forest species in one Oregon and 14 coastal California counties. Hundreds of dead tanoak trees and other symptoms of the SOD pathogen, Phytophthora ramorum, are commonly seen on the District's preserves. There currently is no cure for SOD, and as with other extensive forest diseases, a strategy may take decades to develop. The District has adopted a ten-year plan to slow the spread of SOD, collaboratively study impacts on wildland ecology and recreation, and develop a restoration strategy for heavily infested forests.

III. WILDLIFE MANAGEMENT

As pressures from the expanding human population increase, District preserves become more important as refuges for wildlife. The term **wildlife** as used here includes all animals, from the smallest invertebrates to the largest mammals. Without a sufficient amount of proper **habitat,** an animal cannot survive. As a result, most management of **native** wildlife involves management of habitat conditions and habitat impacts from visitor activities rather than hands-on management of the animals themselves. Protection of habitat is key to protection of wildlife.

BACKGROUND

Animal Habitat Characteristics

Habitat refers to the area where an organism occurs, its **natural** home or "neighborhood." An animal's habitat includes plant communities which provide the shelter, food, and water it needs to live and reproduce. Other aspects of the environment that affect an organism, such as geographic location, climate, and topography, are also part of its habitat.

Animals move from place to place and require a variety of land, both daily and seasonally. Some have precise habitat requirements; others are more flexible. Some species live their entire lives within one vegetation type. Others use several vegetation types in a single day or use different habitats at different stages of their lives. Some animals use one habitat for part of the year and migrate elsewhere for the rest. Ultimately it is important to preserve all these habitats to ensure continued wildlife diversity.

The habitats most important for wildlife are those which offer food, cover, topography, and other parameters essential to survival and reproduction. Examples include springs and seeps, nesting and breeding sites such as standing dead trees, movement and migration corridors, pathways to perennial streams, and foraging areas. Some of these habitats are considered **sensitive**, in that they are vulnerable to disturbance and do not recover easily once disturbed.

The Importance of Riparian, Pond, and Other Wetland Habitats

Certain habitats are intensively used by many kinds of wildlife. **Riparian** (streamside), pond, and other wetland habitat, with their wide variety of plants and readily available water, are perhaps the most important. These habitats provide a drinking source; dense, green foliage for cover and food; shade in which to rest and escape the heat; perennial or seasonal water bodies which are required for breeding by some amphibian and other wildlife species, and protected corridors through dry, open areas. Almost all species of wildlife depend on external sources of water and will often travel long distances to reach it. People are also attracted to water, especially ponds and riparian areas. Excessive human use can cause problems from trampling, **soil** compaction, destruction of vegetation, alteration of water quality and temperature, introduction of pathogens or foreign substances and species, and frequent disturbance of wildlife.

Predators Indicate Habitat Health

The presence of large predators is a strong indicator of a healthy habitat. Large predators are at the top of the food pyramid and depend on the availability of large numbers of smaller animals. The greenbelts of District and neighboring public lands in the Skyline and Sierra Azul areas are large and diverse enough to support such wide-ranging predators as black bear (although no resident black bears are present in the Santa Cruz Mountains presently), mountain lion, coyote, bobcat, fox, badgers, and numerous hawks and owls. The chance to see such animals is a big incentive for many people to visit the preserves.

Results of Habitat Fragmentation

In the last century, population growth, urban expansion, and construction of roads and highways have fragmented habitats and interrupted wildlife movement corridors. Fragmentation has four main consequences for wildlife:

a. Isolated habitat **patches** may not be large enough to support wildlife that requires a certain size of habitat. Fragmentation may also destroy particular plant species that some animals require for food or cover.

b. Wide-ranging animals such as the larger predators can be cut off from territories they need for feeding and breeding.

c. **Non-native** species become more common, displacing natives and thereby also reducing **biodiversity.**

d. Inbreeding increases when **populations** are cut off from neighboring **populations**. The resulting lack of diversity in the gene pool weakens the species through "inbreeding depression" and reduces the **population's** long-term chance of survival. A single environmental change or disease could then eliminate all members of the local **population**.

WILDLIFE MANAGEMENT GOALS, POLICIES, AND IMPLEMENTATION MEASURES

Goal WM-	**Maintain and promote healthy and diverse native wildlife populations**

Policy WM-1 Understand and maintain the diversity of native wildlife. (See WR-6 and WR-7)

- ♦ Identify wildlife usage, movement patterns, and habitat features with high value to wildlife.
- ♦ Consider and avoid or minimize impacts on wildlife when planning trails and other facilities.
- ♦ Develop a wildlife data base to record wildlife sightings and guide management decisions.
- ♦ Non-native wildlife release on District lands shall adhere to the policies identified in the Integrated Pest Management chapter (See IPM).

- The District shall strive to control or remove non native wildlife using management actions identified in the Integrated Pest Management chapter (See IPM).
- Native wildlife shall not be released onto District land if it is adapted to urban conditions or interaction with human.
- Native wildlife can be released onto District preserves if the animal has been rehabilitated by an animal rescue center specializing in wildlife, it is disease-free, suitable unoccupied habitat is available, and there is a high likelihood for the animal to adapt and survive in its new surroundings without adversely affecting existing resources at the site. The rehabilitated animal should be marked or banded, if feasible, to allow monitoring of its adaptation.

Examples of wildlife using human-made structures on District lands include the Red barn at La Honda Creek Open Space Preserve which is used by both the Townsend's big-eared bat (Plecotus townsendii) and Pallid bat (Antrozous pallidus).

Policy WM-2 Protect, maintain and **enhance** habitat features that have particular value to native wildlife. (See HC-2: Measure 5, WR-6 and WR-7)

- Inventory critical and sensitive wildlife habitats and develop management strategies for their protection.
- Leave brush piles, **snags**, and fallen trees in areas where they do not pose a fire hazard or visual blight, to provide cover and nesting sites for animals, and nursery conditions for forest seedlings.
- Evaluate the wildlife habitat value associated with human-made structures before altering or removing them and avoid or mitigate any impacts.
- Repair, modify, and maintain stock ponds as wildlife watering sources and habitat for aquatic and semi aquatic organisms (See WR-3).

Wildlife movement and safe passage is affected at a regional level by large-scale transportation needs and development including housing, roadways, and commercial development. The District works with Preserve neighbors, municipalities, counties, and regional planning organizations to improve new development projects through the use of wildlife friendly fencing, clustering new development away from sensitive areas, and providing refuge areas for wildlife.

Policy WM-3 Protect animal **populations** against the impact of human actions. (See HC-2: Measure 5)

- Discourage human intrusion into sensitive wildlife habitats by appropriate placement of facilities and trails.
- Identify and eliminate **barriers** (e.g. remove unnecessary fences, old barbed wire, and other barriers) and provide safe crossings (e.g. protect established wildlife crossings and use wildlife friendly fencing) to

enhance wildlife movement on a regional basis. (See HC-3, HC-4, and GM-2: Measure 1)

- Consult with responsible wildlife agencies to conserve special status species or to control problem wildlife when human life, property, or other significant natural resources are threatened.
- Reduce conflicts between wildlife and humans through notification and education, control of human access and, as a last resort, control of wildlife presence or movement.
- Prohibit hunting or trapping in District preserves except as a management tool or for scientific or educational purposes.
- Fishing is allowed only in areas declared by the District to be permitted fishing areas, where state laws regulate the taking of game fish.
- Review and update criteria for designating temporary (e.g., day-use) access areas for domestic animals into District preserves. Incorporate the criteria into District regulations.

Policy WM-4 Protect and enhance the habitats and **populations** of **special status** animal species.

- Conduct surveys of special status animals in affected areas before initiating significant development or any substantial increase in use. Give priority to protection of special status species.

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IV. INTEGRATED PEST MANAGEMENT

BACKGROUND

Integrated Pest Management

Pesticide is a broad term that includes any material (natural, organic, or synthetic) used to control or prevent pests including herbicides (weed or plant killers), insecticides (insect killers), and rodenticides (rodent killers) as a few examples.

Integrated pest management (IPM) is a process for efficiently managing **pests** while protecting human health and environmental quality. IPM is a long-term, science-based, decision-making system that uses a specific methodology to manage damage from **target pests**. IPM requires monitoring site conditions before, during, and after treatment to determine if objectives are being met and if methods need to be revised. IPM requires that non-chemical methods be considered in addition to chemical methods (i.e., **pesticides**, herbicides, insecticides). If chemical methods are necessary to meet a pest control objective, the potential for harm to the public and workers are carefully considered, as are effects on the environment and **non-target organisms**, and then the least toxic and most effective, efficient, and target-specific method is chosen.

The Problem with Invasive Species

Invasive species can alter ecosystem processes by changing biotic ecosystem characteristics (such as plant community composition, structure, and interactions; trophic relationships; and genetic integrity) and abiotic characteristics and processes (such as fire regimes, erosion, sedimentation, hydrological regimes, nutrient and mineral conditions, and light availability).

Invasive species are animal or plant species that invade and dominate sufficiently large areas causing a reduction in **biodiversity.** They proliferate in the absence of natural control and interfere with the natural processes that would otherwise occur on **wildlands**. Once established, invasive species can become difficult to manage and they can eliminate native species or otherwise alter the **ecosystem**. This chapter addresses the management of invasive species in order to protect the native species and natural processes of the preserves.

Invasive Plants

Invasive plants have greatly altered many of California's natural plant communities. Because they originated elsewhere, many invasive plants are not susceptible to **predation** or diseases of this region. They are extremely adaptable and can thrive in a wide range of conditions. They can grow quickly, reproduce early, produce many long-lasting seeds, and tolerate disturbance. They reduce native biodiversity by gradually crowding out or competing with native plants for water and sun, and by reducing or modifying wildlife **habitat**.

Invasive Animals

Ranking second to loss of habitat resulting from human intrusion, invasive animals pose another threat to native wildlife. Escaped domestic animals and other non-native wildlife species can thrive in the favorable climate of the San Francisco peninsula. Once established in a preserve, they compete for valuable **resources** and disturb the sensitive balance of natural **food webs.** Bullfrogs and wild pigs are examples of invasive introduced animals found in District preserves that physically displace or predate upon native plants and wildlife.

Programs to manage pests require long-term commitment. With many invasive plant and animal species, short-term lapses in management activity may negate years of expensive control programs.

Wild (feral) pigs are an example of an invasive wildlife species with obvious impact on District lands. They have been widespread in the central coast of California since about 1970, reproduce rapidly, dig up meadows and wetlands, and carry diseases that can affect people and livestock. They eat acorns, bulbs, and soil animals, and are difficult to control. Feral pigs were abundant in the South Skyline region in the 1990s. The District has been trapping feral pigs since 2000 and has substantially reduced their population and damage from their rooting.

INTEGRATED PEST MANAGEMENT GOALS, POLICIES, AND IMPLEMENTATION MEASURES

Goal IPM- Control pests by consistent implementation of IPM principles to protect and restore the natural environment and provide for human safety and enjoyment while visiting and working on District lands.

Policy IPM-1 Develop specific pest management strategies and priorities that address each of the five work categories.

- Manage pests in buildings to support existing uses, while also protecting human health and surrounding natural resources.
- Manage pests and potential human interactions in recreational facilities to minimize conflict, ensure visitor safety and enjoyment, and protect the surrounding natural resources.
- Manage pests in fuel management areas to reduce risk to human life and property, while also protecting natural resources.
- Manage pests in rangelands and on agricultural properties to support existing uses, while also protecting human health and surrounding natural resources.
- Manage invasive species in natural areas and set priorities for their control based on the potential risk to sensitive native species and loss of native biodiversity.

Best management practices for preventing the introduction of invasive species include cleaning equipment before leaving a weedy site, and using seed, plant, forage, fill, erosion-control and other materials that are free of weed seeds.

Policy IPM-2 Take appropriate actions to prevent the introduction of new pest species to District preserves, especially new invasive plants in natural areas, rangelands, and agricultural properties.

The California Invasive Plant Council maintains an Invasive Plant Inventory that rates the threat of non-native plant species by evaluating their ecological impacts, invasive potential and ecological distribution. Along with local knowledge, the District uses this list to evaluate the invasive risk of existing and new non-native plants found on District preserves.

Policy IPM-3 Manage pests using the procedures outlined in the following eight implementation measures.

- Develop and implement tolerance levels for pests within each of the Work Categories to determine when to undertake pest control.
- Identify the pest, determine its life cycle and disruptive potential, and identify relevant site conditions prior to implementing a pest control activity. Review pest control objectives for consistency with other site goals and establish tolerance levels that must be exceeded before pest control is undertaken.
- Choose site-specific strategies and times of treatment that provide the best combination of protecting preserve resources, human health, and non-target organisms and that are efficient and cost effective in controlling the target pest. Whenever feasible, direct the control method narrowly at vulnerable points in the target organism's life cycle to avoid broad impacts.
- Monitor results and modify control methods over time as site conditions and treatment techniques change and as needed to obtain an effective level of control.
- Use the least harmful method(s) to control identified pests. Where the use of pesticides is necessary, apply according to the label using all safety precautions and take all measures needed to protect the environment, the health and safety of visitors, employees, neighbors, and the surrounding natural areas including water and soil resources.
- Plan for repeat treatments as indicated by the pest's regenerative capabilities.
- Coordinate and cooperate with adjacent landowners, neighbors, and other responsible agencies to control pests and limit secondary effects.
- If eradication of a pest from a distinct location is not feasible, apply measures to achieve containment, sustained control, slow down a pest's rate of spread, or minimize pest damage.

Policy IPM-4 Monitor pest occurrences and results of control actions and use adaptive management to improve results.

Prior to the approval of the use of any new biological control agent, the US and California Departments of Agriculture conduct years of laboratory and field studies to assess the candidate's host specificity and its potential impact on target and nontarget species and environmental safety.

The District coordinates with the San Mateo County and Santa Clara County Weed Management Areas, the California Invasive Plant Council, the California Department of Fish and Game, the California Department of Food and Agriculture, County Agricultural Departments, and the Cooperative Extension Service to stay informed on invasive plants and animals, IPM techniques, and pesticide regulations.

Policy IPM-5 Develop and implement an IPM Guidance Manual to standardize pest management and IPM procedures across all District Lands.

V. WATER RESOURCES

BACKGROUND

Water is essential to life on earth and is also one of the most important forces shaping **habitats** and **biodiversity**. District **open space** lands contain a variety of water **resources** that include such diverse habitats as freshwater **wetlands** (including ponds and seasonal wetlands) and **watercourses**, salt water tidal wetlands within San Francisco Bay, and groundwater resources such as springs, seeps, and underground aquifers. These water resources have **natural**, scenic, recreational, scientific, and educational values. In general, this policy will discuss **waters** (sag ponds, artificial impoundments, lakes, and aquifers), watercourses (such as streams and creeks), and wetlands. These terms are discussed further below.

“Waters” is a term that is broadly used to describe all aquatic systems. This policy defines “waters” as areas of standing water, both seasonal and permanent, such as lakes and ponds, as well as underground aquifers. “Watercourse” is a generic term used to define any land feature that conveys concentrated water flow, regardless of whether the water flow is ephemeral, intermittent, or perennial. “Wetlands” are distinguished by the presence of water, either at the surface or within the root zone. Wetlands have unique **soil** conditions that differ from adjacent uplands and support vegetation adapted to wet conditions. Wetlands provide critical ecological functions and habitat for a variety of fish, wildlife, and plant species

Wetlands are lands that are transitional between terrestrial and aquatic systems. The water table is usually at or near the surface, or land is covered by shallow water. Some functions of wetlands include the following: provide habitat for fish and aquatic wildlife, offer foraging habitat or water for terrestrial wildlife and birds, absorb flood waters, reduce erosion, recharge aquifers, cleanse pollutants, provide aesthetic values, support unique plant associations, and provide habitat for many rare species of plants and wildlife. In California, wetlands of all types have been greatly reduced in area from their historic extent and are being rapidly lost or adversely impacted.

Watersheds Within the District

District Preserves are located within 22 major **watersheds** extending from the Pacific Ocean in San Mateo County to the baylands in San Mateo and Santa Clara Counties. Watersheds are land or “basins” within which all precipitation within a given watershed drains to a single body of water, often a creek or stream. Many of the District’s lands are located within the headwaters or uppermost sections of these watersheds.

Most preserve watersheds contain steep ridges and deep canyons typical of the Santa Cruz Mountains. Rainfall occurs mostly between November and April with seasonal rainfall totals varying greatly within the District. The greatest rainfall quantities occur along the west facing slopes near the summit of the mountain range where totals can reach 40 to 50 inches per year, however, averages around 20 to 30 inches per year are more typical. In the Santa Cruz Mountains, fog accounts for approximately 10-20 inches of this precipitation, much of which is delivered in the dry summer months. Many smaller creeks and streams are intermittent, reflecting this seasonal distribution of rainfall. Winter flows are higher, especially during and immediately following storms.

The Influence of Water Movement

Water flows in predictable patterns on the surface, through rocks beneath the soil, and in underground water tables. Plants and animals are adapted to specific movement patterns of water, sediment, and nutrients occurring in their area. A significant change in any of these factors may reduce or eliminate original species in favor of those better able to survive in the new conditions. Maintaining and restoring hydrologic patterns is important in maintaining healthy **ecosystems**.

The condition of soil and vegetation influences the rate at which water moves as well as its quality and quantity. Leaf litter acts as mulch that helps absorb and conserve rainwater. Maintaining a continuous cover of live and decomposing vegetation residue is the most successful long- term approach to controlling erosion and maintaining **water quality** and quantity.

Water Management Within The District

As rain falls on District Preserves, it is captured and transported through the ecosystem. These processes create high-quality water for the environment and people. District Preserves also support groundwater recharge that helps sustain summer and fall water availability and mitigate the impact of drought.

The District is also dependent on water to fulfill its mission. District field offices require water for employees, equipment maintenance, dust control, and fire suppression. The District manages residential properties that are often located in areas without municipal supplies, thus relying on locally, naturally occurring water sources. **Conservation grazing** operations that manage grass-lands for multiple benefits require water in remote areas. Irrigation sup-ports farming that provides local food.

The District manages ponds that support aquatic and terrestrial wildlife. In the semi-arid region of the Santa Cruz Mountains, restoration of stream and a**quatic ecosystems** is a priority for managing ecosystems.

The District relies on a variety of water sources. **Springs** are captured and developed to provide water to people and **livestock** with the goal of allow-ing wildlife access to the spring water. Wells capture deeper groundwater sources and require energy to pump the water to the surface. Streamflow can be captured by small impoundments or pumps and diverted to the place it is needed. These waters are often stored to provide water during the dry seasons in tanks or ponds

Groundwater is water that is held underground in soil or pores and crevices in bedrock

Surface water is found in streams, rivers, ponds, and lakes.

Springs are a type of groundwater that surfaces at a point on the land.

Consumptive use is the amount of water that is used by people, livestock, or crops that is unavailable to the environment after use.

Water Resource Issues

Wetlands and watercourses on the District's open space lands provide valuable and increasingly scarce habitat for a variety of **native** plant and animal species as well as many **special status** species. Where aquatic habitat is not directly present on District lands, runoff from District lands supports habitats downstream, a connection that should be recognized and preserved. Issues associated with the management of water resources and water quality include erosion and sedimentation, excessive diversion of water for consumptive use, severe erosion following **wildland** fires, agricultural runoff, **pesticides** and fertilizers, septic system

wastewater disposal, stormwater runoff, flooding, drought, climate change, associated sea level rise, and chemical **contamination** from neighboring areas or from former use of preserve lands.

WATER RESOURCES GOALS, POLICIES, AND IMPLEMENTATION MEASURES

Goal WR- Protect and restore natural water courses, wetlands and hydrologic processes

Policy WR-1 Protect surface and ground water from contamination.

Contamination is man-made waste that has polluted the environment making it unfit or unsafe. Examples on District lands include deteriorated septic systems, underground storage tanks, leaking transformers, and trash and debris.

- Inventory existing facilities and uses that affect watercourses, **riparian** areas, and wetlands, and prepare plans for protection or **restoration**, as appropriate.
- Research and pursue cleanup of likely sources of pollution, such as buried fuel tanks, improperly dumped or stored material, and faulty waste or drainage systems.
- Utilize self-contained sanitary facilities or place rest rooms where they cannot contaminate water sources.
- Control activities having a high potential for pollution.
- Properly decommission abandoned septic systems and avoid water quality impacts when constructing new septic systems. Manage active and abandoned wells to avoid groundwater contamination
- Regulate the type and intensity of human activity on District lands to protect water quality.
- Review and comment on offsite land use and water management projects and policies that affect District water resources. Recommend and support measures to maintain natural water quality, channel flow, and sedimentation rates on District lands.

Policy WR-2 Restore, maintain or **enhance** water quality on District lands.

- Manage vegetation to improve watershed productivity and water quality.
- Manage agricultural leases and easements to maximize the protection and **enhancement** of riparian areas and water quality.
- Monitor sediment delivery and transport on District preserves located within watersheds identified as impaired by sediment or supportive of special status animals requiring aquatic habitat.
- Coordinate with agencies and organizations to establish volunteer-based monitoring programs. Participate in regional watershed management activities.

Restoration and enhancement are terms that are sometimes used interchangeably when discussing habitat improvement projects. Restoration refers to the process of returning land that has been degraded and disturbed into functional habitat. Enhancement refers to the process of altering a habitat to provide specific ecosystem functions that may be missing; typically to provide habitat for endangered species.

Policy WR-3 Restore Hydrologic Processes.

- Incorporate **best management practices (BMPs)** and develop storm-water pollution prevention plans (SWPPP) when required at staging areas.
- Inventory and assess roads and trails on District lands to identify significant erosion and sediment sources. Prioritize maintenance and road/trail management based on most severe erosion and sediment delivery sites.
- Manage human activities to control erosion--for example, abandon and where feasible **restore** to a natural condition poorly designed or sited roads to a natural condition, close certain trails to bicycle and equestrian use during the wet season, re-route existing trails to minimize erosion and sediment delivery.
- Restore hydrologic processes altered by past land uses by ‘slowing water, spreading it, and sinking it’ through installing erosion control materials and structures, removing culverts and drainage diversions where appropriate, and using improved drainage structures that minimize alteration of hydrology.
- Minimize soil disturbance during all construction projects.
- Locate new trails to minimize potential water pollution and stream bank erosion and sediment delivery.

Many of the District’s properties contain legacy logging and ranching roads that were not designed or constructed for year-round use. These road systems can greatly alter the flow of water across the land, causing erosion and sediment problems due to concentrated runoff from winter rains.

- Construct trails, roads, staging areas, and buildings so that streams are not permanently diverted nor interrupted, and runoff is not concentrated. Minimize creation of impermeable surfaces.
- Identify and mitigate significant impacts of altered water flow on plants and animals, including aquatic organisms.

Policy WR-4 Manage Water Consumption to Balance Operational and Environmental Needs.

Two types of surface water use are recognized under California law: appropriative rights and riparian rights.

Appropriative rights require a permit from the State Water Resources Control Board, which grants the right to use water on parcels not adjacent to the watercourse or to store water.

Riparian rights are the rights of any owner of a parcel immediately adjacent to a watercourse to use water.

- Phase in installation of water meters or other measures to monitor annual consumptive water use.
- Develop and regularly update BMPs for efficient water use in offices, field operations, residences, **conservation grazing**, and farming.
- Evaluate and consider the environmental and operational benefits and tradeoffs of each water source for new projects.
- Evaluate and consider the construction and operational costs of each water source.
- Balance operational and consumptive use needs with the goal of maintaining healthy ecological functions.
- Provide technical assistance to lessees of District lands and owners of lands on which the District has an agricultural easement to secure water rights for the continuation or establishment of viable agriculture consistent with the protection of sensitive habitats (see Coastal Service Plan PA.2).

Policy WR-5 Determine and maintain District water rights and utilization.

- Identify existing uses of surface water on newly acquired open space lands, as part of the purchase process. Protect appropriative and riparian water rights for appropriate and beneficial existing or possible future uses.
- Secure water rights for the continuation or establishment of viable agriculture and **conservation grazing** on District land consistent with protection of sensitive habitats.

Policy WR-6 Preserve and enhance fisheries habitats. (See WM policies).

- Inventory and assess stream reaches accessible to **anadromous** fish to identify impediments to fish passage and opportunities for habitat enhancement.
- Remove artificial **barriers** to fish passage where removal will enhance spawning and rearing habitats.
- Enhance spawning and rearing habitats for native fisheries through restoration. Prioritize restoration and enhancement of areas providing habitat to sensitive species.
- Monitor sensitive fish species **populations** in District waters.
- Monitor water quality and condition of high priority aquatic habitats associated with District projects containing spawning, breeding, rearing habitat for special status fish, reptile, amphibian, or other aquatic species.
- Evaluate and consider the environmental benefits and construction/operational costs of off-stream storage facilities to minimize stream diversion and/or allow for the release of water into natural waterways during low flow seasons and implement accordingly.
- Avoid new direct stream diversion for consumptive uses where economically feasible alternative water sources exist, or the diversion captures the majority of flows, or the aquatic habitat would be substantially impaired. Explore alternate sources for existing in stream diversions.

Policy WR-7 Preserve and enhance ponds and other wetland habitats. (See VM-1 and WM policies).

- Maintain ponds or other water bodies as wildlife watering sources as appropriate (See WM-2).
- Inventory and assess ponds and wetlands to identify opportunities for habitat maintenance and enhancement.
- Monitor sensitive reptile, amphibian, and aquatic organism **populations** dependent on District wetlands.

Few of the ponds in the Santa Cruz Mountains are naturally occurring features. The majority of ponds were created as artificial impoundments that require ongoing management to maintain. Regardless of their origin, ponds provide wildlife access to a scarce resource (water) and greatly increase the diversity of species inhabiting the District's lands.

- Preserve ponds through maintenance of artificial impoundment structures where ponds provide habitat for sensitive and other wildlife species.

Policy WR-8 Develop seasonal and multi-year drought management strategies for District lands.

- Evaluate and develop where appropriate wells and springs to create resilient water supplies.
- Identify and curtail diversions that strain naturally limited water sources, especially those that significantly impact special status species.
- Evaluate and implement where appropriate additional water storage infrastructure to store water when it is naturally abundant for later use during dry seasons.
- Evaluate and alter as appropriate water-intensive land management practices during drought conditions to reduce overall District-wide water consumption.

VI. GEOLOGY AND SOILS

BACKGROUND

District lands include a diverse set of dynamic geological **resources characterized by steep slopes**, earthquake faults, landslides, unstable and erosive **soils**, and attractive but fragile rock formations. **Open space** is an appropriate designation for such areas.

Soil – A Valuable and Fragile Resource

Soil is the essential surface layer that predominates in the District Preserves. Soil provides the rooting medium for plants and supplies most of the nutrients they require, whether native or cultivated. As plant communities mature, plant roots, surface debris, and animal remains break down and are incorporated into the soil. Over time, this organic material builds up soil structure and fertility. If depleted or lost, soil takes a long time to regenerate- often longer than a single human generation. This surface layer of the land is readily accessible and easy to disturb and therefore requires the most protection by land managers.

Factors Contributing to Soil Loss

In some areas, District soil erosion has been accelerated by loss of plant cover, disruption of **natural** drainage patterns, landslide activity and/or some types of recreational uses. Some of these are naturally occurring causes, some are natural causes accelerated by human activity. By far the largest amount of soil erosion on District lands is human-caused. Poor placement of roads or trails, shortcutting of trails, poor design, construction or placement of drainage systems, excessive grazing pressure or past cultivation practices, and development of facilities can accelerate natural erosion. These activities can destroy protective plant and mulch cover, exposing soil to wind and water or diverting water from natural drainages. Recovery of soils from such disturbances is slow. Monitoring, preventing, and, where necessary, remedying human-caused erosion are all important parts of the District's **resource management** responsibilities.

GEOLOGY AND SOILS GOALS, POLICIES, AND IMPLEMENTATION MEASURES

Goal GS-	**Avoid or minimize soil loss and prevent or remediate contamination related to human land use, and protect unique or exceptional geologic features**

Policy GS-1 Locate and construct facilities to avoid high-risk areas subject to landslides, liquefaction, faulting, flooding and erosion.

- Minimize construction of major improvements (examples: buildings, roads, pipelines, and septic tanks) in landslide-prone areas, active fault zones, flood zones, and highly erodible areas.
- Design trails with respect to natural topography to maintain or **restore** natural drainage patterns as much as possible. Design roads, trails and facilities to minimize disturbance to vegetation and soil.
- Review available geohazard data for proposed facilities and infrastructure, where **geologic hazards** may be present.

Policy GS-2 Minimize unnatural soil erosion and sedimentation. (See VM-3: Measure 3)

- Monitor soil erosion and slope failure and identify areas where these processes are accelerated and causing resource damage. Utilize existing information (soil maps, geologic reports etc.) to avoid construction in problem areas and to identify areas with conditions that may impact existing infrastructure.
- Reduce human-caused erosion by identifying, limiting of eliminating the causative activity, properly locating or relocating facilities, installing drainage or erosion control measures, or revegetating the area. Construct roads and trails to maintain natural drainage patterns.
- Reconstruct or stabilize and abandon roads and trails that display or have the potential for ongoing erosion problems.
- Limit agricultural activities, facility development, and trail construction in riparian and other wetland areas to protect them from disturbance.

- Minimize soil disturbance associated with construction and maintenance operations.
- Seed to rehabilitate disturbed ground and lessen erosion. Time seeding projects to ensure adequate soil moisture for seed germination. Utilize mulch or other appropriate groundcover to reduce erosion where sediment can be delivered to a **watercourse** or wetland.
- Utilize **native** plants when possible for projects requiring **revegetation** for long-term erosion control. **Non-native** sterile grass seed may be used to quickly establish ground cover and reduce erosion. In areas of active **livestock conservation grazing**, incorporation of non-invasive pasture grasses may be utilized.
- Prevent, to the extent possible, the physical removal of naturally occurring soil.

Policy GS-3 Protect unique or exceptional geologic features from human damage.

- Identify locations and document the condition of unique or exceptional geologic features (example: tafoni sandstone formations, serpentine outcrops, sag ponds).
- Monitor such features to determine if action is needed to prevent or stop damage.
- Control access to features requiring protection by informing visitors, placing signs and **barriers**, and enforcing restrictions.
- Develop security protocols to limit availability and distribution of geographic information for geology and soil resources to protect sites from accidental destruction, looting, and vandalism.

Policy GS-4 Prevent or remediate contaminated soils

- Prevent the release of hazardous materials into the environment associated with District operations by implementing and following Best Management Practices (BMPs) for spill prevention.
- Investigate areas where soil contamination may have occurred due to previous land use including: disposal sites, mining areas, or leaks from storage tanks.

- Remediate areas where contaminants pose a threat to human and ecological health through implementation of recommended treatment options including biodegradation, safe removal of contaminated soils, capping of soils, or other methods as recommended by a remediation professional.
- Adhere to requirements outlined in soil management plans approved for the preserves.

VII. SCENIC AND AESTHETIC RESOURCES

BACKGROUND

The District recognizes the protection of scenic values as one of the primary benefits of **open space**. The scenic and aesthetic **resources** of District lands provide physical and psychological relief from the stresses and uniformity of urban life. They also contribute to our "sense of place" - our appreciation of the qualities that set this area apart from others and make it feel like home.

District preserves include a variety of **natural** settings and landscapes that form magnificent scenic backdrops to the urbanized peninsula. Local residents and visitors particularly appreciate the interplay of color, pattern, form, and light on the coastal mountains, where rugged topography, hot sun, wind, and fog combine to create dramatic and appealing contrasts in vegetation.

In some cases, preserving a significant scenic or **historic** landscape may involve managing it to actually *prevent* natural succession, for example, without intervention; a shallow pond may gradually fill in and become a meadow or open grassland. Active management through vegetation maintenance or pond deepening not only promotes the scenic and aesthetic value of a wetland setting, but may also be more beneficial to wildlife. However in most instances, restoring or mimicking natural processes can help maintain the appealing visual and biological diversity of **native** communities.

SCENIC AND AESTHETIC RESOURCES GOAL, POLICIES, AND IMPLEMENTATION MEASURES

Goal SA- Preserve lands with natural appearance, diversity, and minimal evidence of human impacts

Policy SA-1 Minimize evidence of human impacts within preserves.

- Clarify and document appropriate standards for designing and locating trails, parking areas, and buildings.
- Locate trails to minimize their visibility from a distance.
- Where feasible, locate telecommunication towers, power lines, water towers, firebreaks, and other infrastructure along margins of roads, next to existing structures or where vegetation and terrain help ease undesirable visual and environmental impacts. Install utility lines underground, if practical.
- Cluster new facilities near existing development, where possible.
- Design facilities such as structures, bridges, fencing, benches, and barriers to harmonize with natural landscape features, colors, and materials.
- Cluster, reduce, and place signs to lessen their visual impact.
- Rehabilitate areas degraded by human use by restricting access or type(s) of use, rerouting trails and roads, removing unsightly human-made features and **non-native** plants, restoring natural contours, and revegetating with native plants.

District development consists of facilities such as trails, restrooms, parking lots, fencing, offices, and residences. District facilities are designed to blend into the natural surroundings and are located within or adjacent to previously disturbed areas such as placing parking lots along existing roadways, or improving, remodeling, or placing new structures in previously developed areas.

Policy SA-2 Maintain significant landscapes or features that were formerly maintained by natural processes.

- Control encroaching vegetation where it adversely affects significant scenic, historic or **habitat** resources (See **Vegetation Management**, **Cultural Resources**, and **Integrated Pest** Management policies).

- Control vegetation to create or maintain important scenic viewpoints and vistas (See Vegetation Management and Integrated Pest Management policies).
- Require District tenants to maintain landscapes and improvements to acceptable visual standards that do not detract from a visitor's experience or adversely impact wildlife.

Policy SA-3 Minimize unnatural noise within preserves

- Prevent or reduce unnatural sounds that adversely impact preserves resources or a visitors' enjoyment of them.

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VIII. CULTURAL RESOURCE MANAGEMENT

Native American groups, such as the Ohlone, have lived on the San Francisco Peninsula for thousands of years. Bedrock mortars and other artifacts from their habitation and use of the landscape can be seen on District lands today.

BACKGROUND

Cultural Resources at the District

The San Francisco Peninsula has had a rich and diverse history, including settlement by **Native** American groups; the Spanish (1776-1821) and Mexican Republican (1821-1848) colonization of the region; the annexation of California by the United States in 1848; and subsequent industrial, agricultural, and residential development. There are remains from each of these periods on District lands, including Native American village sites and bedrock mortars, barns and other ranching features, orchards, wineries, **historic** homes, sawmills, mines, historic roads and trails, and outdoor recreational sites. As time passes, more recent periods of California's history become **historically significant**. As such, some 20th century sites such as World War II and Cold War military sites are now considered historically significant **resources** throughout California. Collectively, these sites, structures, features, and **artifacts** comprise the **cultural resources** of the District.

During the Spanish Colonial and Mexican Republican periods, the San Francisco peninsula was divided into large ranching tracts. District preserves, including Rancho San Antonio, the Rancho de Guadalupe area of Sierra Azul, and La Honda Creek (formerly Rancho San Gregorio), were part of these large land grants.

The District was founded to preserve a regional greenbelt of **open space** land on the San Francisco Peninsula from the rapid suburban development that accelerated in the post-World War II boom in the Bay Area. Although the District's mission is to protect the greenbelt for open space values, **natural** resource protection, and ecologically sensitive recreation, this mission compliments cultural resource preservation goals. The development pressures from which the District protects open space land also threaten its associated **historic** and **prehistoric** structures, cultural landscapes, and **archaeological sites**. The preservation of open space land in the peninsula's greenbelt provides the opportunity for the District to protect and interpret the rural history of the Santa Cruz Mountains and San Francisco Bay for the benefit of present visitors and future generations.

In the second half of the 19th century, District forests were used for timber harvesting, residences, and outdoor recreation. Grasslands were developed for ranching and agriculture, including vineyards and orchards. Historic roads, such as Old Page Mill Road, connected communities and industries in the growing region.

Cultural resources are irreplaceable resources that face substantial threats such as disturbance from construction and maintenance activities, theft, vandalism, and deterioration over time. When the District acquires land with historic structures, the structures often have suffered years of neglect and are at risk of collapse. In these cases, it can be very expensive to **rehabilitate** and maintain these structures, many of which have already lost significant **resource integrity**. It is sometimes necessary to remove dilapidated historic structures due to public safety concerns and the prohibitive expense of **historical rehabilitation.** The District has adopted "Policies Regarding Improvements on District Lands" to provide a public process used to assess and determine whether District structures and improvements are cultural resources, and how they can most appropriately be managed. The District has successfully completed a number of important historic preservation projects, often with assistance from granting agencies and/or public/private partnerships. Cultivating relationships with historic preservation groups, research organizations, and knowledgeable local residents, including Native American groups, will allow the District to pursue new opportunities to preserve cultural resources and protect remnants of the peninsula's heritage for present and future Bay Area residents. The District serves communities of diverse ethnic heritage, who seek a wide variety of experiences in District preserves. To the extent that these practices can be accommodated with minimal impact to the natural and cultural resources, they should be encouraged and accommodated wherever feasible.

Examples of completed historic preservation projects on District lands include the Woodhills Home at Fremont Older, Picchetti Winery, Grant Cabin at Deer Hollow Farm, and the Red Barn at La Honda Creek.

CEQA defines a historical resource as potentially significant if it is at least 50 years old and is determined to be eligible for listing on the California Register of Historic Resources. A unique archaeological site is defined as a site that is at least 100 years old and has the potential to provide useful information about the past. Therefore, as time passes,

Regulatory Context

There are a number of state and federal laws pertaining to cultural resources to which the District must adhere in its operations. The California Environmental Quality Act (CEQA) (Guideline 15064.5, Public Resources Code 21038.2) states that a substantial adverse change to the significance of a historical resource or a unique archaeological resource must be treated as a significant effect on the environment in a project's environmental review. Public Resources Code 5097.9-5097.994 mandates protocols for protecting Native American graves and human remains, and prohibits unauthorized excavation, destruction, or vandalism to Native American archaeological sites on public land.

Section 106 of the National Historic Preservation Act of 1966 requires consideration of impacts to historic resources on federal lands or projects requiring federal permits. Likewise, any project that requires review under the National Environmental Policy Act of 1969 must consider impacts to cultural resources. The Native American Graves Protection and Repatriation Act of 1990 (NAGPRA) mandates the protection of Native American burial sites on federal lands and the repatriation of human remains and funerary objects to descendent Native American groups. Under NAGPRA, institutions with collections of Native American remains and funerary items must create an inventory and notify lineal descendents as part of the repatriation process.

In compliance with the statutes listed above, the District has included protocols for unexpected discoveries of archaeological sites and human remains as mitigation measures in District projects. An example of a District project specifically identifying protocols for cultural resource protection is the Service Plan and accompanying Environmental Impact Report for expansion of the District's boundaries to include coastal San Mateo County completed in 2003. The Service Plan recognized the unique value of cultural resources in the San Mateo County coastal area and established Cultural Resource Policies to preserve cultural resources in the Coastal Annexation Area. The Policies and Implementation Measures established in this Cultural RMPs are consistent with the Cultural Resource Policies in the Service Plan.

The Cultural RMPs is intended to be consistent with and to supplement the District's "Policies Regarding Improvements on District Lands." The purpose of this policy is to formalize and enhance the District's cultural resource management practices for the long-term stewardship of the District's significant historical and archaeological sites.

Cultural resources are not restricted to historic structures. Many of the landscapes on District preserves are artifacts of historic and prehistoric human activity. These include agricultural landscapes, such as the orchards at Stevens Canyon Ranch; the remnants of logging in the District's redwood forests; ranching landscapes; and the formal estates of August Schilling in Thornewood and, Harry Tevis in Bear Creek Redwoods and Fremont and Cora Older at Fremont Older.

CULTURAL RESOURCE GOALS, POLICIES, AND IMPLEMENTATION MEASURES

Archaeological sites include prehistoric sites, such as Native American villages and other remnants, and historic sites dating from after European settlement. These can include Spanish Colonial /Mexican sites, and sites dating from after the annexation of California by the United States.

To protect vulnerable archaeological resources, the State Legislature has exempted sensitive archaeological site information from disclosure requirements in the California Public Records Act.

Goal CR- Identify, protect, preserve, and interpret cultural resources for the benefit of present and future generations.

Policy CR-1 Maintain an inventory of cultural resources on District preserves.

- Inventory and assess cultural resources throughout the District, including **prehistoric** and historic archaeological sites, structures, and **cultural landscape** features. The **Cultural Resource Inventory** should include a Geographic Information Systems database; however, access to this inventory must be restricted to District staff and qualified professionals, to the extent allowed by law to protect sites from looting and vandalism.
- Record cultural resources in the District's Cultural Resource Inventory when purchasing new property and perform research on previous uses of the property. Examples of research activities include performing a records search with the **Northwest Information Center** and consulting historic preservation organizations, previous residents, and descendents to gather local historical information.
- Complete archaeological site records for known unrecorded sites on District land and file reports with the Northwest Information Center.

Policy CR-2 Address cultural resources in the development of preserve use and management plans.

- Consult the Cultural Resource Inventory when planning projects that may have an impact on cultural resources in the project area.
- Conduct appropriate reconnaissance measures, such as research or archaeological survey, early in the planning process for trail construc-

tion, maintenance activities, or other projects that entail ground disturbance in an area of known archaeological sensitivity. Monitor construction activities when appropriate.

- Locate facilities, such as trails, staging areas, and new structures, to avoid loss or degradation of historically or archaeologically significant resources wherever possible. If not possible to avoid, minimize impacts, for example by: capping site, recording important features and/or artifacts, relocating structures, or **data recovery** excavation.
- Include stakeholder groups when developing plans for the management of historically or **archaeologically significant** resources. Consult with descendent communities such as Native American and other ethnic groups when developing plans for the management of historically or archaeologically significant resources related to their heritage.
- Assess the significance, integrity, and feasibility of preservation of historic structures when developing Preserve Use and Management Plans or Master Plans. If a structure is determined to be eligible for the California Register of Historic Resources, assess feasibility of preserving the resource.

Policy CR-3 Protect cultural resources from disturbance to the maximum extent feasible.

- Wherever possible and appropriate, preserve historical resources and archaeological sites **in situ**.
- Prohibit looting, vandalism, and unauthorized removal of cultural resources and associated artifacts from District preserves.
- Implement security measures such as protective fencing and patrolling to reduce vulnerability of the resources due to vandalism and looting.
- Develop security protocols to limit availability and distribution of geographic information for cultural resources to protect sites from looting and vandalism.
- Prohibit District sale, purchase, or commercial trade of individual archaeological artifacts.

Looting of archaeological sites for commercial gain poses a threat to sites around the world. Codes of archaeological ethics therefore discourage any activity that commodifies artifacts and encourages their commercial trade.

- Develop and follow guidelines for reporting, protecting and recording archaeological sites and features in the event of unexpected discovery.
- Provide District staff with basic training to identify and protect cultural resources.
- Assess existing operations within areas of known archaeological sensitivity to protect and preserve cultural resources.
- Require that all archaeological investigations or research activities that have the potential to physically significantly impact archaeological resources are carried out by qualified archaeologists, and that a technical report for each project is provided to the District following excavation.

There are a number of potential sources of grant funding for historic preservation projects. In the past, the District has received grants from the Santa Clara County Historical Heritage Commission and the California Heritage Fund. Listing resources on local, state, or national registers can increase opportunities for grant funding.

Policy CR-4 Preserve and maintain cultural resources wherever feasible.

- Actively pursue grant assistance from local, state, federal, and other programs to supplement District funds to implement historic preservation projects for historically and archaeologically significant resources.
- Seek partnerships with private or non-profit groups to aid in the **restoration**, management, and use of historic structures.
- Assess the condition, identify needed repairs, and prepare maintenance plans for significant high priority historic structures as funds allow.
- Assess the eligibility of cultural resources for nomination on local registers, the California Register of Historic Resources, and the National Register of Historic Places. Consider nomination to registers for which a resource is determined eligible.

Provenience, or the contextual information associated with an artifact or collection, is important for retaining its research potential and relevance for interested communities. A cataloging system is a crucial tool for preserving this information and keeping it linked to objects.

- Catalog artifacts associated with sites on District lands to prevent deterioration and to document the site and location where the artifacts were recovered. Consider curating artifacts in danger of deterioration. Maintain a cataloging system to preserve artifacts' contextual information and storage locations. Where appropriate, coordinate with other agencies and organizations to assist in long-term curation of District collections.
- Develop and follow guidelines and procedures governing loans of artifacts to other agencies and organizations.

Policy CR-5 Provide public access and educational programs to interpret historical and archaeological resources. (See PI-1)

- Provide controlled public access to historical and archaeological sites where appropriate, considering other public access resource constraints and resource protection.
- Allow appropriate uses of cultural resources by descendent communities.
- Seek input from descendent communities, such as Native American and other ethnic groups, when planning public access and educational programs that interpret cultural resources related to their heritage.
- When developing partnerships for the use and management of historic structures, plan for public access to the structures where appropriate while minimizing impact to the structures and respecting the needs of building occupants.
- Provide interpretive materials such as signage or brochures for self-guided hikes to inform visitors about the history of District lands and the San Francisco Bay Area. Develop locations to display artifacts for public benefit.
- Encourage, utilize, and support historical research by docents and volunteers.
- Provide training opportunities for docents to aid them in the development of docent-led tours of **historic** and archaeological sites and landscapes.
- Facilitate school field trips of historic and **archaeological sites** and cultivate other opportunities to work with educational groups to interpret cultural resources on District preserves.
- Support historical and archaeological research conducted by District-approved, qualified cultural resource professionals on District lands.

Public interpretation and access to non-sensitive information about cultural resources on District land is an important part of their preservation, conveying their importance to the general public. The District's cultural resources are a valuable public asset.

Policy CR-6 Preserve District institutional history.

- Preserve documents and artifacts important to the history of the District.

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IX. RESEARCH AND COLLECTION OF INFORMATION

BACKGROUND

Achieving the District's **resource management** objectives requires support in the form of basic academic research and applied field studies. This level of research is usually conducted by colleges and universities, by consultants as part of environmental analysis for project proposals, or by environmental and wildlife organizations such as the California Native Plant Society, the Nature Conservancy, or the Audubon Society. Although the District may conduct or sponsor research directly, it will continue to depend on and support outside research to expand its knowledge about the **natural** resources under its care, and to provide the basis for sound planning and management decisions.

RESEARCH AND INFORMATION GOALS, POLICIES, AND IMPLEMENTATION MEASURES

Goal RC-	**Use and document scientific knowledge of preserve resources and resource management techniques as a basis for management decisions**

Policy RC-1 Maintain resource information files for each preserve and resource subject.

- Systematically gather information and data from appropriate agencies, universities, non-profit organizations, studies, and reports. Integrate spatial data into the District's **GIS database**.
- Maintain an electronic filing system to facilitate access of spatial data and information by location and resource type.
- Facilitate the reporting of resource related observational data by field staff and the public and its access by District staff.

- Respond to public information requests and promote release of non sensitive resource information to better distribute and share District scientific knowledge.
- Recruit interns and volunteers to help organize and maintain resource information files, in cooperation with the District's volunteer program.

Policy RC-2 Coordinate and cooperate with institutions, agencies, organizations, and individuals conducting resource management or research.

- Maintain a list of District related potential resource research projects. Encourage research directed to specific sites, District-related issues, or resource management practices.
- Administer the District's Resource Management Grant Program to fund projects that contribute to resource management projects. Incorporate the District's list of potential projects into the Grant Program.
- Explore partnerships and foster relationships with educational institutions, scientists, and other land management professionals in order to share information and resources and to develop Memorandums of Understanding or Memorandums of Agreement between the District and other agencies.
- Sponsor or participate in events and activities such as symposiums, workshops, and conferences that support scientific research and sound resource management practices.
- Encourage and facilitate currency on resource management techniques, such as **restoration**, **integrated pest management**, and erosion control.
- Provide internship support for appropriate research.

Policy RC-3 Undertake original research necessary for planning or management decisions.

- Carefully research existing information and explore opportunities for cooperative studies to collect additional information.

- Retain qualified consultants or researchers to conduct studies or collect additional information in a standardized format that can be integrated with the District's GIS database.
- Encourage and facilitate training of District staff to obtain environmental permits (such as scientific collection or sensitive species handling permits) in order to participate in or conduct needed research and monitoring and to maintain relationships with agency staff.
- Share significant new information through resource agency contacts and local and regional databases, such as the California Natural Diversity Data Base and Natural Resources Database.

Policy RC-4 Allow collecting, trapping, or other field research activities only in conjunction with legitimate research consistent with the District's management goals.

- Continue to administer the District's Special Use Permit Program for collection, trapping, archaeological research, or field studies on District lands.
- Require the researcher to share the information resulting from the studies with the District and other appropriate parties. If appropriate, integrate data into electronic filing system or GIS database.

Policy RC-5 Develop performance measures when designing District projects and collect monitoring data to evaluate project success.

- Research and utilize existing performance measures from comparable prior projects and partner agencies.
- Collect and evaluate monitoring data to measure project success and for use in adaptive management.
- Engage in benchmarking opportunities with public, partners, and research institutions through collaborations and the sharing of project data.

X. PUBLIC INTERPRETATION AND ENVIRONMENTAL EDUCATION

BACKGROUND

Communication and **outreach** are key to developing broad public support for acquiring and protecting **open space**. Increasing public knowledge and appreciation of the preserves**' natural** and **cultural resources** will improve support for their conservation. The District needs to inform the public about District treasures, so it will care about protecting them.

The **resource management** program will play a vital role in this effort by providing a greatly improved information base for the public. Studying the current condition of preserve resources and discovering how best to maintain and **restore** them will reveal information that stimulates public interest, makes the preserves more enjoyable places to visit, and inspires respect and a sense of stewardship.

The District's Public Affairs department is charged with communicating this information to the public. For example, staff works closely with local schools, districts, agencies, and other special groups to provide **environmental education** and interpretive programming to students, organizations, and the general public. The Public Affairs department also gets the word out through publications, presentations, and working with the media. The volunteer and docent programs greatly increase public outreach opportunities. The volunteer program provides a means for the public to learn firsthand about stewardship, by participating in District projects. The docent program trains docents to conduct activities on the preserves and interpret District resources. Docents also staff the Daniels Nature Center and lead environmental science-based field trips for students.

Environmental education is typically a curriculum-based approach targeted toward students to attain an ultimate goal (such as environmental stewardship). The District’s environmental science-based programming was established in 1996 and serves elementary school students in a field trip experience at the District’s Daniel’s Nature Center and surrounding Skyline Ridge Preserve. During the program students engage in hands on discovery and learning.

Interpretation is a communication method that reveals meanings, connections, and relationships by firsthand experience, and by illustrative media, such as web pages or signs. The District's interpretive program includes communication and outreach by District staff and docents, as well as through brochures, publications, signage, signboards, exhibits, and other means. Interpretive programs are often the most effective means of stimulating understanding and appreciation of open space, providing information, promoting stewardship of resources, and helping ensure visitor safety.

INTERPRETATION AND EDUCATION GOALS, POLICIES, AND IMPLEMENTATION MEASURES

An Interpretive Service Plan (ISP) serves to identify and prioritize the valuable natural and cultural resource "stories" and connections that can be brought forward through enhanced or new interpretive programs or facilities at each location being evaluated.

Goal PI-	**Increase public knowledge, understanding, and appreciation of the natural and cultural resources of the preserves, and support for their conservation.**

Policy PI-1 Provide interpretive **programming,** facilities, and materials. (See CR-5, GM-6 and GM-7)

- Develop appropriate and timely projects and plans to support natural and cultural resource interpretive opportunities that are guided by recommendations and priorities in the District's **Interpretive Systems Plan (ISP),**
- Provide interpretive materials via a wide range of media (web and print based).
- Continue to operate an interpretive program at the David Daniels Nature Center at Skyline Ridge Open Space Preserve with docents and staff to support its use by the general public and local schools and organizations.

- Provide information about the District's mission, resources, management practices, and goals in District signboards, facilities, and publications. Encourage publication of this information in the general media.
- Provide training for new docents and additional "refresher courses" to continue to help them provide interpretive services.
- Provide opportunities for the public to learn about natural resources and support resource management activities through the docent and volunteer programs.

Policy PI-2 Provide environmental education programming and outreach.

- Coordinate and cooperate with local agencies and organizations, particularly schools that would like to use District lands and facilities for **environmental education**, whenever appropriate.
- Involve school children in District-sponsored environmental projects and educational activities.
- Provide environmental education programs and materials to schools, groups, and organizations.

Policy PI-3 Provide other public **outreach.**

- Support and/or participate in special events and programs that foster public knowledge and appreciation of **open space** resources.
- Participate in multi-agency forums to share information and resources and explore partnership opportunities.
- Develop and use outreach opportunities to gain public support for resource management goals and policies.
- Work with the Public Affairs Department to increase public awareness of resource values.

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XI. CONSERVATION GRAZING MANAGEMENT

The greatest diversity within California's coastal grasslands can be seen in the forbs or wildflowers that emerge in the spring following winter rains. Sites with adequate management of non-native vegetation will reward these efforts with bountiful displays of colorful spring wildflowers.

BACKGROUND

The vegetation of the Santa Cruz Mountains is comprised of a rich and diverse assemblage of plant species. This wealth of diversity was most evident within the grassland **ecosystems** that evolved under a variety of disturbance pressures including fire and grazing by large herds of **ungulate animals**, which are now mostly extinct or locally extirpated. The **flora** that emerged has been described as one of the most diverse and species rich ecosystems in the United States

By some estimates, nearly 80 percent of the vegetation cover within California grasslands is exotic vegetation.

The arrival of early Spanish and Anglo settlers initiated a particularly dramatic change in species composition of California grasslands, primarily as a result of tilling the grasslands for agricultural crop production, reduction of **native** grazing animals and introduction of cattle herds brought over from Europe and let loose on the new rangeland. This introduction of **non-native** plants and animals, coupled with the concurrent suppression of fire on the landscape as the western United States was settled, resulted in the substantial replacement of the native grassland vegetation with a predominately **exotic**, annual flora. The exotic vegetation is often more competitive, productive, and prolific than the **native** plants within which it coexists, and tends to dominate and replace existing native grasses and wildflowers. Over the last 150 years, coastal grassland areas have also experienced large-scale conversion to agriculture or urban development. The remaining undeveloped grasslands face continued development pressure and are severely impacted by exotic, invasive organisms.

District lands currently contain approximately 5300 acres of grassland habitat. The largest contiguous grassland areas are within District lands in western San Mateo County.

The District's **open space** preserves contain large acreages of grasslands that in many areas have been degraded due to the pressures described above. Management of these grassland habitats is desirable to reduce the risk of wildfire and to maintain viable **native** plant communities. **Vegetation management** using **livestock conservation grazing** or other **resource management** tools can be a substitute for **native** grazing animals and recurring fire to achieve the District's objective of preserving, protecting and restoring the **natural** environment.

Livestock ranching is a small but vital part of the Bay Area's agricultural economy. As with any business that depends on local infrastructure and services, livestock ranching is increasingly threatened with each ranch that goes out of business. Every livestock rancher depends on services and supplies including veterinary care, feed sales and delivery, farm and ranch infrastructure supplies, and livestock transportation services. As land is taken out of ranching, all of these services and supplies are incrementally affected and may cease to operate, increasing the burden for families and businesses that choose to keep ranching.

Typical fencing used to control livestock movement that the District inherits as part of property acquisitions is five-strand barbed wire fencing. The District standard for new/replacement cattle fence construction is wildlife-friendly 5-strand fencing with a smooth bottom wire approximately 16" above the ground unless conditions warrant an alternative fence type. Other fencing types that may be used include four-strand barbed wire for interior fencing, wood rail fencing and temporary electric fencing that can be installed to seasonally restrict livestock to target areas or exclude livestock from sensitive areas. Wildlife-friendly fences enable virtually all wild animals to move through an area without harm and with minimal impediment.

In 2003, the District completed the Service Plan and accompanying Environmental Impact Report for the San Mateo Coastal Annexation Area expansion of the District's boundaries to include coastal San Mateo County. The Service Plan recognized the unique value of the San Mateo County coastal area and established Agricultural Policies to preserve and encourage viable agricultural use of land. The Policies and Implementation Measures established in this **Conservation Grazing** Management Policy are intended to supplement and complement the Agricultural Policies in the Service Plan. Furthermore, these **Conservation Grazing** Management Policies will be implemented in a manner that is consistent with the Service Plan.

CONSERATION GRAZING MANAGEMENT GOALS, POLICIES, AND IMPLEMENTATION MEASURES

Goal CGM- Where appropriate manage District land with livestock conservation grazing that is protective of natural resources and that is compatible with public access; to maintain and enhance the diversity of native plant and animal communities, manage vegetation fuel for fire protection, help sustain the local agricultural economy, and preserve and foster appreciation for the region's rural agricultural heritage.

Policy CGM-1 Ensure that **conservation grazing** is compatible with and supports wildlife and wildlife habitats.

- Inventory and assess sensitive habitats to identify areas requiring special management practices. The conservation of these areas will take precedence over other uses and management practices that are determined to have an adverse effect on these **resources**.

- Prepare site-specific grazing management plans by a certified range-land manager including **best management practices (BMPs)** for pre-serves where **conservation grazing** will be utilized as a resource management tool. The site-specific grazing management plan will be a component of the agricultural production plan developed through the Use and Management Planning process. The Use and Management Planning process provides for public input and Board approval of site-specific grazing management plans.

The goals of conservation grazing are to maintain and enhance biodiversity by moderating the impacts of exotic grasses, manage fuel loads to reduce risk of catastrophic wildfire, and to help sustain local agricultural heritage

- Manage agricultural leases and easements to protect and enhance **riparian** areas and to maximize the protection or **enhancement** of **water quality**. (See WR-4)
- Per the District's long-standing policy of protecting **native** predators, continue to prohibit the lethal take of predators in response to **livestock** depredation.

Policy CGM-2 Provide necessary infrastructure to support and improve **conservation grazing** management where appropriate.

- Utilize fencing that allows wildlife movement and fosters habitat connectivity. (See WM-3: Measure 3)
- Manage access to existing water features and where needed supply supplemental drinking water through stock ponds and water troughs to preserve clean water for **livestock**, protect water quality, and enhance habitat for wildlife. Provide wildlife escape ramps where necessary.
- Encourage and assist **conservation grazing** tenants on District land to provide range improvements to **restore** or conserve **wildland** resources and to en-hance range condition.
- Inventory and assess roads and trails on District lands to identify significant erosion and sediment sources – abandon and where feasible restore to a natural condition poorly designed or sited roads. (See WR-4)

Policy CGM-3 Monitor environmental response to **conservation grazing** on lands.

- Monitor forage utilization and distribution by **conservation grazing** animals to assure appropriate amounts of **residual dry matter (RDM)** remain on the

Residual Dry Matter (RDM) is a measure of the amount of vegetation left on the ground, typically measured at the end of the summer or fall. Appropriate levels of RDM strive to minimize thatch, which can inhibit new plant growth, while maintaining adequate levels of vegetation to prohibit soil erosion.

ground to achieve desired resource management objectives. In the course of RDM monitoring, evaluate and report on wildland fire **fuel** levels that may result in an increased risk of wildland fire (See WF policies).

- Monitor **livestock** use levels and **agricultural infrastructure** condition to ensure conformity with lease provisions to contribute to improved management.
- Monitor wildland conditions with an emphasis on documenting the location, distribution and abundance of native grasses, wildflowers, and other native flora and fauna
- Monitor water quality in ponds, **wetlands,** and **watercourses** with unrestricted **livestock** access.
- Monitor non-native vegetation response to **conservation grazing** with an emphasis on documenting the location, distribution and abundance of **target**, **invasive species**.
- Use information collected from monitoring to annually review rangeland conditions and response to **livestock conservation grazing**. Use **adaptive resource management decision making framework** within grazing management plans.

Fire reduction is a great concern for some landowners. However, cattle are not able to graze all land areas effectively for fire protection purposes, such as steep slopes or slopes partially vegetated with brush. In these instances, goats may be an effective alternative. Goat herds can be rented for a short period of time and can be moved with a goat herder and dog(s) along with portable fence enclosures. Goats and other small livestock must be penned in enclosures at night to protect them from predators.

Policy CGM-4 Utilize different **livestock** species to accomplish vegetation management objectives.

- Research the effective use of cattle, goats, sheep, and horses to manage vegetation on District lands.
- Utilize appropriate species depending on management needs.

Policy CGM-5 Preserve and foster existing and potential **conservation grazing** operations to help sustain the local agricultural economy.

- Establish longer term grazing leases to promote financial viability for the operators and efficient land stewardship for the District.
- Seek grants or other economic support for agricultural infrastructure maintenance and improvements.
- Ensure site-specific grazing management plans are economically feasible and practical for **conservation grazing** operators.

Policy CGM-6 Provide information to the public about the region's rural agricultural heritage. (See PI-1)

- Install display boards and give presentations highlighting historical and educational facts about ranching families and industry at appropriate sites.

Policy CGM-7 Provide public access in a manner that minimizes impacts on the **conservation grazing** operation. (See PI-1)

- **Conservation grazing** operators on District lands or lands under easement to the District shall be consulted when public access is being planned and considered for the property to minimize conflicts between the public and the **conservation grazing** operation.
- Prepare and distribute a brochure to educate visitors about etiquette for use of open space property with **livestock** animals.
- Prepare and distribute a brochure to educate visitors about etiquette for use of open space property with **livestock** animals.
- Install signage where appropriate to educate the public about the resource benefits of **conservation grazing** and to educate visitors about approaching animals, closing gates, and other etiquette appropriate for moving through lands with **livestock** animals.

Policy CGM-8 **Conservation grazing** operations on District lands in San Mateo County will be managed in accordance with the policies established in the Service Plan for the San Mateo Coastal Annexation Area.

- Consult with appropriate agencies and interest groups, including the San Mateo County Farm Bureau and San Mateo County Agricultural Advisory Committee in the development of site-specific Use and Management plans and agricultural production plan components in the Coastside Protection Area.

Policy CGM-9 Safeguard native plants and wildlife while promoting the economic sustainability of conservation cattle grazing as a **resource management** tool and reducing **predation** of **livestock**.

- Consider the economic impact of predation in setting lease rates for **conservation grazing** tenants.
- Provide economic relief for **conservation grazing** tenants who, as required per conditions of a Board of Directors approved lease, are performing **resource management** services and are in good standing with the District, in response to confirmed cattle losses from **predation** to sustain **conservation grazing** as a viable tool for natural **resource management**. Require cattle grazing tenants to document annual **livestock** losses due to both **predation** and non-predation-related causes.
- Support and promote scientific research on the effectiveness of wildlife and **livestock protection methods**, and their influence on wildlife behavior, grazing productivity, and **livestock** health. Periodically review research results and consider findings in future policy development.

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XII. FOREST MANAGEMENT

BACKGROUND

The term forest applies to habitats dominated by tree species with a continuous or nearly continuous canopy covering substantial portions of the landscape. Woodlands consist of scattered trees across the landscape intermixed with a significant habitat component of other vegetation types such as grassland.

As of 2007, District lands encompass approximately 30,000 acres of **forest** and **woodland habitat**. Approximately 11,500 acres consist of redwood and Douglas-fir associated **coniferous forest**, located primarily in the northern Skyline area of the District. These forests are often intermixed with a lesser component of **hardwood**, primarily tanoak, madrone, California bay, black oak, and various live oaks.

The remaining 18,500 acres consist of a variety of hardwood forest and woodlands. These consist of numerous oak species (coast live, canyon live, and Shreve oak, black oak, blue oak, valley oak), madrone, tanoak, California bay, California buckeye, and **riparian** species such as red and white alder, big-leaf maple, various willow species, California sycamore, and box elder.

Forest and woodlands within the District have been subject to significant historic modifications. Portions of the oak forests and woodlands have had a history of **livestock** grazing and **fuel wood** procurement. The effects of these uses are not well documented, but young dense **stands** (primarily live oak species) occur within the preserves in areas of prior disturbance. These young dense stands often occur along forest margins or have regenerated within areas that had been previously cleared. At the other end of the spectrum are beautiful stands of large old majestic oaks. Concerns about the reduction of oak forest and woodland within California often center on their conversion to urbanized uses or commercial agriculture. The primary role for the District is the preservation and protection of these forests and woodlands, particularly considering the heavy urban growth pressures within the San Francisco Bay Area.

Riparian hardwood forests have also been modified in areas by past land use practices. These practices have typically whittled away at the width of the corridors, in places narrowing the corridors to thin strips along the **edges** of creeks. When riparian forests are modified in this manner, it is common for the species composition to change to those species that prefer to be near the water (typically willow and alder), while reducing species that typically occupy elevated floodplains such as sycamore.

The proximity of the redwood and Douglas-fir forests in the Santa Cruz Mountains to the urban San Francisco Bay Area and associated ports of trade fostered the development of an early and intense commercial logging industry. Commercial timber harvest and milling activities were well underway beginning in the 1850's within the La Honda Creek, Purisima Creek Redwoods, and El Corte de Madera Creek Open Space Preserve areas. Timber harvest activities have generally altered the forest stands by reducing the size and age of the stands and increasing the density of the young growth. This is clearly evident when viewing the distribution of **old growth** redwood stumps within the forests. A second round of logging that focused on residual (left over) old growth and the second growth that re-sprouted from the late 1800's clear cuts began in the 1950's-1960's. Tractor logging continued within El Corte de Madera Creek and Purisima Creek **watersheds** throughout the 1970's and 1980's, resulting in third and fourth timber harvest entries into much of the areas that are now protected by the open space preserves.

Numerous roads were constructed to facilitate access to early timber (and grazing) operations on the properties now owned by the District. These roads were often constructed in locations, and utilizing methods that were insufficiently protective of **water quality** and aquatic resources. The elimination or conversion of non-essential roads and the judicious maintenance of essential roads will be necessary to protect water quality and aquatic resources.

Pathogens are a significant threat to the District forests. The most notable pathogen at present is Phytophthora *ramorum* which is responsible for Sudden Oak Death syndrome, commonly known as SOD. A number of oak species are susceptible to death and slow decline from SOD, particularly tanoak, and additional **host** species include many other forest trees and shrubs. SOD has the potential to seriously impact forests within the preserves and the region, presenting a number of social and ecological concerns.

All of the forest **ecosystems** within the District preserves evolved in association with periodic fire. **Fire suppression** activities within the Santa Cruz Mountains, as well as throughout the Western United States, have

also had an effect on District forests. The effects of fire suppression typically include an increase in forest density, a build up of forest floor **fuel loads**, and a decrease in herbaceous forest floor plant communities. **Forest management** actions can be undertaken to reduce the severity of fires within the forest ecosystem and watersheds when these fires occur. Prescriptive forest management can achieve conditions suitable for the reintroduction of fire into forest ecosystems, an ecological function that has been largely absent, except under typically severe conditions, for the past sixty years.

The District has preserved large blocks of forest and woodland. The overall extent of District land holdings within the greater Santa Cruz Mountain Bioregion is exceptionally important to regional **biodiversity** and well suited to regional ecosystem management. State, county and local parks, non profit and conservation organization owned properties and numerous conservation easements over both public and private properties, together with the District preserves, provide tremendous opportunities for regional forest preservation and **restoration**.

Active **conifer** forest management on public lands is typically limited to relatively small fuel management projects and controlled burns in old growth stands within some state parks. This limits the majority of these forests to more hands off management, requiring long periods of time where trees compete for food, water, and sunlight. During this time period, which can take hundreds of years, the dominant trees will persist, while the less dominant trees will be crowded out and die. During much of this transitional period, habitat complexity and biodiversity can remain relatively stagnant and simplified. Maintaining most of these protected forests under the same management paradigm has the potential to suppress regional biodiversity.

Late-seral and old growth forest characteristics typically include: large widely spaced trees, thick bark, large complex branches, large standing snags in various stages of decay, large downed logs on the forest floor, and a closed canopy. This complex structure results in a very wide variety of habitat conditions and results in tremendous biodiversity.

From a regional perspective, old growth and **late-seral** conifer forests are very limited in distribution. Late-seral forests, or **late-successional** forests, are older forests that begin to develop some characteristics similar to old growth forests. The initial development of late-seral redwood and Douglas-fir forests is generally considered to take place between 80 to 300 years, and continue to persist for centuries, with the oldest redwoods reaching an age of 1,000 to 2,000 years old. The District preserves have retained a significant "**biological legacy**" of residual (uncut) single old

growth trees and small stands of old growth, as well as a substantial older Douglas fir component. These biological legacies are known to harbor significant remaining habitat components that are used by wildlife, from the canopy species such as marbled murrelets down to soil microbes.

The District's conifer dominated Preserves offer the opportunity to manage **forest conditions** to accelerate late-seral habitat conditions to promote biologically diverse, dynamic forest habitat, increase the extent of this limited habitat, and accelerate the development of forest structure for the benefit of protected species and for improved fire resistance.

FOREST MANAGEMENT GOALS, POLICIES, AND IMPLEMENTATION MEASURES

Goal FM-	**Manage District land to retain and promote biologically diverse, dynamic forest conditions; maintain and enhance high quality forest and aquatic habitat; encourage and enhance the development of late-seral conifer forest; provide for visitor experiences within diverse forest habitat; and promote District and regional fire management objectives.**

Policy FM-1 Inventory and assess District forest and woodland.

- Inventory and assess existing District forest conditions. Inventories within hardwood stands should include forest age, structure, health, and an evaluation of regeneration (growth of seedlings and young trees). Inventories within conifer stands should have a particular emphasis on forest age and structural characteristics, identification of biological legacies, and the reconnection and restoration of late-seral habitat. Inventories should also include the identification and assessment of any effects of urbanization on the forests.
- Identify unique habitat features such as meadows, ponds, or other non-forested communities. Evaluate the need for management to

maintain landscape heterogeneity and specialized habitat for non-forest wildlife and vegetation.

- Inventory District forest wildlife with a particular emphasis on **special status** species, such as the marbled murrelet, spotted owl, Vaux's swift, numerous raptor species, and indicator species such as the pileated woodpecker.
- Inventory District forest to assess fuel loads and forest structure related to fire. Identify access issues and District and community/regional fire concerns.

Policy FM-2 Ensure that forest management activities are compatible with the protection of special status plant and animal species.

- Conduct time appropriate surveys for special status species to establish the presence or absence thereof, and identify essential habitat features (nest trees, roosts, sheltering trees, springs, and ponds).
- Manage forests to expand critical habitat for sensitive species by restoring forest structure and habitat elements utilized by sensitive species to develop and connect suitable habitat.
- Continue regular consultation with regulatory agencies and experts to develop plans to protect and **enhance** habitat for sensitive species.

Riparian ecosystems are streamside ecosystems that are extremely important to numerous forest plant and wildlife species. In addition to benefits to wildlife such as fish and amphibians, these ecosystems also play critical roles regarding forest hydrology and water quality. The protection and restoration of Riparian ecosystems is a primary component of Forest Management.

Policy FM-3 Ensure that forest management activities are compatible with riparian ecosystem and water resources protection and policies.

- Protect riparian ecosystems and habitat to maintain **natural** hydrologic process, water quality, and wildlife benefits. Maintain essential riparian functions, and if necessary enhance and restore riparian habitats.
- Inventory and assess roads and trails on District forestlands to identify significant erosion and sediment sources. Maintain essential roads to high standards, and eliminate or reduce to trail width all non-essential roads. (See Policies WR-3 and WR-4).

- Discourage forest management activities within riparian areas unless justified and implemented for the specific purpose of restoring degraded riparian habitat.

Late-seral redwood and Douglas-fir forests are generally considered to be some of the most fire resistant and resilient type of forest.

Policy FM-4 Manage District conifer forests to sustain and encourage the development of late-seral habitat conditions.

- Prepare Forest Management Plans for **high priority District forests** to establish habitat goals and appropriate management treatments. Utilize restoration ecologists, forest ecologists, Registered Professional Foresters, or other **resource management** professionals to prepare plans, as appropriate.
- Restore degraded forest habitats to promote the development of late-seral habitat, forest habitat complexity, and to enhance biodiversity, where existing stand conditions and access permit. Utilize state of the art silvicultural (forestry) practices to restore degraded forests.
- Protect existing residual old growth trees and stands, mature oaks, and most large, older Douglas fir trees. The conservation of these areas will take precedence over other uses and management practices that are determined to have an adverse effect on these resources.

Restoration forestry practices may result in timber that would be available for commercial sale. Revenue derived from commercial timber sales conducted in conjunction with restoration activities will be used for resource management activities (such as road upgrade projects, weed abatement projects, and long-term monitoring).

- Maintain and/or create large **snags** and downed wood for wildlife habitat where not a safety hazard.
- Foster relationships with educational institutions, forest scientists and forest professionals to inform District forest management decisions based upon sound, current science, and to contribute opportunities for continuing research of late-seral focused management. Seek grant opportunities and partnerships for forest research and monitoring.

Snags are dead standing trees that are important to a variety of species. As trees age and die, holes created by woodpeckers cavity decay, and broken branches create new habitat niches for a host of bird, bat, small mammal, amphibian, and insect species. Snags and large downed wood are critical components of high quality late-seral forest communities.

Policy FM-5 Provide necessary fire and fuel management practices to protect forest resources and public health and safety. (See WF policies)

- Maintain essential roads for emergency fire access, and forest management activities undertaken to reduce fire hazard.
- Maintain adequate fire clearance around District structures and facilities. (See WF-3 and WF-1: Measure 5)

Fire hazard reduction is a great concern for some landowners, particularly residential landowners. Fire can also be a significant threat to the environment, particularly water and aquatic resources.

Shaded fuel breaks are an example of a fuel reduction project that the District can undertake. They consist of areas where vegetation is thinned to break up horizontal connectivity, and lower growing "ladder fuels" that can connect ground fire to tree canopy are removed. Enough tall tree canopy is retained to maintain shade to discourage the re-growth of ladder fuels. These often require follow-up maintenance.

- Encourage neighboring property owners to maintain adequate fire clearance around existing development. Consult with regulatory agencies to encourage that construction of new development maintains fire agency recommended setbacks for fire clearance between new development and District forest and woodland.
- Evaluate the potential to reduce forest fuel loading through the removal of smaller trees to reduce forest floor fuel buildup and **ladder fuels**.
- Coordinate with **fire agencies** and local communities to define locations where fire protection infrastructure is desirable and practical.
- Reintroduce fire as a resource management tool to reduce forest floor fuels and reestablish fire for ecosystem health where stand conditions, access, and public safety permit. Coordinate with other agencies for planning and implementation.
- Seek grant opportunities and partnerships for fuel management projects and monitoring.

Policy FM-6 Protect forest health from intense wildfire, **pests,** and pathogens with high potential to cause damage.

- Evaluate potential for forest loss to intense wildfire, pests and pathogens where effective methods are available and justified.
- Limit the scale of clearings and light-gaps in forests to reduce potential for weed establishment. Where activities occur within the forest edges, weed treatments and monitoring will be a component of the treatment plan.
- Manage forest diseases when necessary to protect natural biological diversity and critical **ecosystem functions**. Regarding Sudden Oak Death (SOD): detect, report and monitor infested areas; utilize sanitation and **best management practices (BMPs)** to control the spread of the SOD pathogen; train staff and educate the public; and support SOD research to guide land management decisions (See VM-1 and WF policies).

Policy FM-7 Monitor wildlife, water quality, and vegetation response to forest management activities.

- Conduct pre and post project wildlife and vegetation surveys with emphasis on special status species.
- Monitor water quality upstream and downstream of forest management activities that have the potential to negatively affect water quality or aquatic resources.
- Periodically re-inventory forest conditions with a frequency adequate to monitor forest response to management.

Policy FM-8 Provide educational opportunities for the general public and recreational users regarding **forest** ecosystems and management.

- Place interpretive displays in accessible locations to inform and educate the public about forest ecosystems, and management techniques employed on District lands.
- Conduct public outreach to inform and gain support for District activities within the local community.
- Conduct interviews with individuals related to past land use and history of forested Preserves to compile historical details and perspectives on District forest land. Include history into **interpretation** and educational opportunities within the Preserves.

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XIII. ECOLOGICAL SUCCESSION

BACKGROUND

Ecological succession is the sequential development of plant and animal communities following disturbance. In a land management context, this natural process can be both positive and negative. For example, the natural recruitment of coyote brush in grassland areas on District lands is reducing the extent of this already-limited **habitat** type and has serious impacts on **native** plants and wildlife. Regrowth of mixed evergreen forest in previously-logged areas is threatening to shade out rare species. Ponds and seasonal **wetlands, which** are slowly filling in with sediment and converting to grassland and areas dominated by broadleaf tree species can become shaded out by coniferous forests. This policy addresses such undesirable habitat type conversions that result from the process of ecological succession.

The directional nature of succession was once thought to result in a stable, stationary species composition (known as the "climax community") over time. In reality, however, all natural systems are subject to disturbance and limited by seed availability and the process of succession may never reach completion. Early-succession species have specific life history strategies which allow them to take advantage of disturbance. Furthermore, some species, such as knobcone pine, King's Mountain manzanita, and many grassland plants, are ***disturbance-dependent****:* they require disturbance to maintain habitat conditions suitable for reproduction and establishment. Both natural and human disturbance drive species composition in **natural** habitats. Past disturbance regimes (either natural or historic and pre-historic land management) can be artificially re-created to maintain desired habitat types. More intensive management may also be necessary as climate change causes large-scale shifts in **plant community** composition and distribution.

Ecological disturbance is the disruption of an ecosystem's structure and function, generally with effects that last for time periods longer than a single growing season for vegetation.

Physical disturbances in our region include fire, windstorm, drought, flood, and earthquake.

Biogenic disturbances include the impacts of herbivorous insects, mammals, disease, and pathogens.

Anthropogenic disturbances include logging, development, agricultural land use conversion, and non-native invasive species introductions.

ECOLOGICAL SUCCESSION GOAL, POLICIES, AND IMPLEMENTATION MEASURES

Goal ES-	**Use sustainable land management techniques to maintain, restore, or simulate natural disturbance in priority habitats.**

As Alpine Pond, Horseshoe Lake, and other District ponds fill with sediment, open water habitat is rapidly transitioning to cattail marsh with little open water. Certain rare amphibians as well as many common wildlife species require open water for key portions of their life cycles.

Unique stands of knobcone pine, a fire-adapted species, in southern Sierra Azul Open Space Preserve will hold seeds in pine cones for up to 30 years waiting for a fire to release them. With the absence of fire, knobcone stands are not being replaced as older mature trees die off and their seeds are not released resulting in an overall decline of the species.

Policy ES-1 Manage historic grassland areas that are threatened by shrub encroachment. (See VM-1)

- Identify priority grasslands for management, focusing on those with cultural significance and/or a substantial component of native species.
- Identify the most cost-effective, safe, and least environmentally damaging management technique for shrub removal, including **livestock** grazing, mechanical removal, and **prescribed fire.**
- Prepare long-term plans for managed grassland areas to ensure that desired conditions are maintained.
- Monitor and manage grasslands for **invasive species** and biodiversity to promote use of grasslands by native and special status species

Policy ES-2 Preserve and **enhance** pond habitats and other wetlands.

- Inventory and assess ponds to identify opportunities for habitat maintenance and/or aesthetic enhancement.
- Monitor sensitive reptile and amphibian **populations** on District lands.
- Preserve pond habitats through maintenance of infrastructure such as: pond contours, depth, earthen berms, spillways and inlet and outlet features
- Remove sediment or invasive vegetation to provide improved habitat for sensitive species.

Policy ES-3 Facilitate regeneration of disturbance-dependent special status, rare, or unique plants.

- Research, document, and implement site specific fire prescriptions to improve regeneration of fire adapted and special status vegetation in fire-dependent ecosystems where feasible.
- Develop and implement an alternative management protocol to encourage seedling establishment of special status and disturbance adapted species in aging stands when regeneration by fire is not feasible.

Nearly all stands of the rare Kings Mountain manzanita on District lands are in danger of being shaded out by Douglas fir and other trees. No regeneration has been observed in these stands.

XIV. HABITAT CONNECTIVITY

BACKGROUND

Habitats are the conditions and locations in which plants and animals live and reproduce, and are a critical component of a naturally functioning **ecosystem**. Habitats come in many forms, but are traditionally thought of as the particular communities of plants and animals that together comprise the ideal conditions for one focal species or for a broad assembly of particular plants and animals. District **open space** lands are made up of a wide variety of habitats, including freshwater streams, redwood **forests**, oak **woodlands,** coastal grasslands, **chaparral**, and many others. In areas surrounding District Preserves, one finds many of these same communities. Connections that link otherwise isolated habitats are known as corridors, and effectively extend the range of a species from one location to many locations in accessible areas. **Wildlife corridors** may be extensive contiguous **natural** areas suitable for a wide-ranging organism, a stream with a continuous wide buffer of **riparian** vegetation, or even a tunnel or culvert beneath a highway that allows passage of animals.

Although the Santa Cruz Mountains are geographically separate from the nearby mountain ranges, they share many of the same species, and are interconnected through routes of migration and dispersal. These connections often referred to as "wildlife corridors," commonly follow watercourses into and out of the foothills and valleys. In the San Francisco Bay region and elsewhere, wildlife corridors are frequently intersected by roads and highways.

The District's Geographic Setting

The District's sphere of influence, spanning the San Francisco Peninsula from the Pacific Ocean in San Mateo County to the baylands in San Mateo and Santa Clara Counties, is drawn along both natural and political boundaries. The District encompasses much of the northern portion of the Santa Cruz Mountains, numerous foothills and ridges of that mountain system, and more than 50 miles of coastline, both on the Pacific Ocean and the San Francisco Bay. The Santa Cruz Mountains are a local spur of the Coast Range, and are physically separated from the larger system by the Golden Gate to the north, the Santa Clara Valley to the east and south, and the Pajaro Valley to the south. The closest adjacent mountains and foothills with a similar suite of resident species are the Gabilan Range and the Diablo Range, and it is with these regions that biological exchange is both most likely and most critical.

Habitats in the Santa Cruz Mountains are both connected to and isolated from comparable habitats in nearby areas. This means that interaction between local and neighboring plant and animal **populations** is governed by their need and ability to move across areas that are inhospitable or even hazardous to survival of the **population**. These **barriers** can take many forms, and have differing effects on various species. Furthermore, as humans modify the natural environment, pre-existing boundaries to plant and animal movement can change dramatically. Modified habitat connectivity may result from new roads or houses, changing vegetation, or even from the effects of climatic changes on habitat distribution. Habitat features are just one aspect of a functioning interdependent ecosystem; thus, the permeability of geographic barriers is a complex and ever-changing relationship. It is a function not only of the species' capacity for crossing barriers, but also of the obstacles themselves.

Basic Habitat Ecology

An ecosystem's many habitats form a complex mosaic on the landscape. They may gradually transform from one to another, or change suddenly at a natural or a man made **boundary**. Two or more habitats may coexist or form a relationship, as when a stream, a linear habitat for fish, insects, and riparian plants, flows through an oak woodland, which is found only where specific kinds of soil type, water availability, and weather conditions occur. Habitats may also be partially or completely interrupted, as when a broad river bisects a grassy plain, a highway passes through the redwoods, or a meadow forms in the woods.

Preserving contiguous natural habitats is key to preserving biodiversity in a changing world. When a species is reduced to a few isolated populations due to fragmentation of its habitat, a natural stressor such as a fire or drought can wipe out a significant portion of the remnant population, bringing it closer to extinction. Connected habitats help species respond to changes in their environment.

Both the relative size and extent of a habitat's connectivity to other habitats are key factors in its ability to support the plants and animals that depend on it, and in the variety of species, or **biodiversity,** it can support. Typically, the most resilient and diverse habitats are large areas connected by corridors along which wide-ranging animals can travel, plants can propagate, genetic interchange can occur, **populations** can move in response to environmental changes and natural disasters, and species at risk can be replenished from other areas. For habitats in the District, migratory and genetic linkage with neighboring mountain ranges, where many of the same plant and animals live and reproduce, is important for overall **population** health. Species living in small, isolated **patches** of habitat are more vulnerable to disease, population pressures, predation, and other

stresses. Such isolation can also lead to inbreeding, which compromises genetic diversity and contributes to instability of species **populations**. This need for habitat connectivity is particularly true of wide-ranging animals such as mountain lions, eagles, or salmon, but is also applicable at smaller scales. For example, movement across a small road can be critical for the newt that must locate a valuable food source or find a mate.

To support a viable **population** over the long term, a given species needs an uninterrupted patch of suitable habitat of a particular size. The needed size varies, but always greatly exceeds the range of one individual. This **core** habitat is bordered by **edges** that can fill some of an organism's needs, but do not support stable **populations**. The largest patches have a high proportion of core habitats, but also provide edge zones. Barriers to movement such as roads, homes, or walls cause **habitat fragmentation**, in which multiple smaller edge habitats are formed. Habitat fragmentation can greatly diminish the viability of the ecosystem. As habitats become fragmented, the amount of core habitat decreases while edge habitat increases. This can greatly reduce habitat viability for species with unique requirements such as nesting owls or murrelets, or increase predation by edge-adapted predators such as cats or raccoons.

The District's boundaries encompass many of the remaining undeveloped habitats within the San Francisco Peninsula. The main connection for the plants and animals inhabiting District habitats is through relatively narrow corridors at the southern end of the Santa Cruz Mountain Range and across the Santa Clara Valley. Smaller thoroughfares, residential construction, and some natural features are hindrances to the movement of smaller animals and distribution of plants.

Types of Movement and Barriers to Movement

Movement of plant and animal species occurs at every scale, from the small matter of crossing a trail to the significant task of climbing a mountain. Furthermore, movement of species can be described not only as locomotion, or movement of individuals, but also as dispersal of eggs, seeds, or larvae. Although the challenges to a single individual can be seen as an effective model for their whole species, habitat networks are more specifically relevant to **populations** than to individuals. Various species use these corridors frequently, seasonally, or only on rare occasions. Again, the large and wide-ranging animals utilize regional scale habitat networks most heavily, while smaller scale networks may occur between one stream and a woodland for frogs or among interconnected grasslands for a **population** of deer.

HABITAT CONNECTIVITY GOAL, POLICIES, AND IMPLEMENTATION MEASURES

Goal HC- Protect ecosystem integrity by maximizing habitat connectivity.

Wildlife corridors, or the paths of movement between patches of an animal's distribution, are only one component of an effectively connected habitat. As the science of biogeography and population dynamics develops, wildlife corridors have come to mean structures or narrow reserves set aside for crossing highways at pinch points or along established migration routes. Habitat networks are a more resilient and extensive linkage of suitable environments that support dynamic and mobile populations of plants and animals.

Policy HC-1 Identify and include habitat connectivity from a local and regional scale in strategic land acquisition planning.

- Maximize habitat connectivity for priority plant and wildlife species in new property purchases.
- Actively participate and coordinate with regional and local land preservation groups and resource agencies to develop strategic goals for protecting or purchasing critical habitat areas and/or movement corridors.
- Emphasize protection of extensive and interconnected open space habitats.

Policy HC-2 Identify and protect existing habitat networks to prevent further compromise to ecosystem integrity. (See WM-2: Measure3)

- Evaluate existing facilities and land uses that impact habitat connectivity and riparian corridors and prepare plans for protection or restoration, as appropriate.
- Identify wildlife movement patterns and high value habitat features and formulate site-specific habitat management goals.
- Encourage field research activities including collecting, trapping, and tracking in support of studies that can inform District management of natural **resources** and ecosystems.
- Incorporate construction practices that avoid the creation of unnecessary barriers to habitat connectivity. Where feasible, utilize removable

fencing, wildlife friendly silt trapping devices, and other design features that allow passage of plants and animals during and after project implementation

- Evaluate the existing habitat values of human-made structures prior to removal.
- Strive to connect isolated natural areas through movement corridors to facilitate connection across barrier(s).
- Identify unique or locally rare habitat types and **target** for protection. Strive to maximize habitat connectivity for locally rare habitats such as serpentine grassland, valley oak woodlands, coastal terrace prairie, etc.

Early results from the Bay Area Puma Project indicate that Highway 17 may act as barrier to movement within the Santa Cruz Mountains. If mountain lions are not able to actively cross this barrier, it can result in a loss of connectivity leading to an isolated population of lions on the San Francisco Peninsula. Over time this isolated population may lose genetic diversity and become vulnerable to disease, predation, and other stressors. Multiple agency and landowner cooperation are needed to effectively address this issue.

Policy HC-3 Collaborate with neighboring land holders and surrounding agencies to support regional efforts to establish and maintain habitat networks. (See WM-2: Measure 3 and WM-3: Measure 3)

- Advocate for land use plans and policies that preserve the District's biogeographic connectivity with the greater Santa Cruz Mountains and with the neighboring Gabilan and Diablo Ranges.
- Review and comment on land use decisions that impact habitat connectivity within the District's jurisdiction and bioregion, including construction or modification of roads and proposals for large scale developments.

Policy HC-4 Restore, maintain or enhance local habitat networks formed within or incorporating Preserves and other protected lands. (See WM-2: Measure 3 and WM-3: Measure 3)

- Review and comment on land use decisions that impact habitats contiguous to those located on District Preserves. Recommend and support measures to maintain connected and undegraded habitats where possible.
- Protect and restore known habitats of rare, endangered, or special status species, taking into consideration the legal protection, distribution and abundance, and risk to specific resources involved.

- Designate sensitive habitat areas and, if necessary, limit or exclude public access to these areas for resource protection.
- Evaluate impacts on wildlife movement and habitat connectivity when planning trails and other facilities.
- Identify and protect established wildlife crossings to allow movement across existing roads. Where appropriate, modify established crossings to improve habitat features.
- Collaborate with resource agencies to restore and enhance the habitats of protected and **special status** species known to utilize preserve areas.

Policy HC-5 Preserve and enhance riparian, stream, and other wetland habitat locally and at a **watershed** level to provide important habitat connections. (See WM-2: Measure 3)

- Inventory and assess stream reaches accessible to **anadromous** fisheries to identify impediments to fish passage and opportunities for habitat **enhancement**. Remove artificial barriers to fish passage where removal would enhance spawning and rearing habitats.
- Enhance spawning and rearing habitats for **native** fisheries through restoration. Prioritize restoration and enhancement of areas providing habitat to sensitive species.
- Restore hydrologic processes altered by human activity by installing erosion control materials and structures, and minimizing culverts and drainage diversions where appropriate, and using improved drainage structures that minimize alteration of hydrology.
- Participate in regional watershed management planning and restoration activities.
- Identify and remove invasive species in riparian, stream and wetland habitats that act as a barrier to wildlife use

Streams can be thought of as linear habitat corridors, particularly for fish that migrate from land to sea. Anadromous fish, such as steelhead trout, return from the open ocean as adults to freshwater streams to breed. Human activities have greatly altered and degraded many of the streams in the Bay Area primarily through barriers to fish passage, such as road culverts and dams and through degradation of spawning habitats by excessive sedimentation of spawning gravels.

XV. WILDLAND FIRE MANAGEMENT

BACKGROUND

The Mediterranean climate of California's San Francisco Bay Area affords District lands an unparalleled diversity of plants and **habitats**; from redwood forests on the coast and northern portions of the District to dry **chaparral** habitats and **hardwood** (oak, madrone) dominated forests in the southern end of the District. Given the diversity of rainfall, climate, vegetation, soil and geology, one constant emerges throughout the District (and in fact throughout California); all landscapes have been subject to periodic fires through time. The present and future will be no different.

To understand the role of **wildland** fire on District lands, it is important to understand the past. Native Americans within the area utilized fire as a tool for improving wildlife habitat for grazing animals (deer, elk, rabbits), maintaining productive vegetation communities for food procurement (grasslands, oak **woodlands**), to maintain travel routes, and to manage **pests.** Burning by Native Americans took place for thousands of years, a practice that significantly increased the frequency of fire locally. These practices, in addition to the benefits listed above, greatly reduced much of the **fuel load** on the ground and significantly reduced the severity of fires within these fire managed landscapes.

Many of the vegetation communities on District lands evolved with the occurrence of periodic fire and have acquired unique adaptations to withstand and regenerate after a fire. Without periodic fire, these plant communities build abnormally high and dangerous fuel levels and are susceptible to large scale destructive fire events. Fire is a **natural** occurrence on the landscape; our challenge is to find ways to live safely with fire.

From 1860 through the early 1920's unprecedented alterations took place within the forests of the Santa Cruz Mountains. The ancient "**old growth**" forests were mostly clear-cut and burned. This removed the largest, most fire-resistant trees from the forested landscape. The forest that has grown back typically consists of a much higher density of trees that are more susceptible to fire. This period of time also corresponded to the first wave

of development within the San Francisco Bay Region and ushered in a new paradigm for wildland fire response: immediate suppression.

This has increased the time interval between fires on most land to time periods substantially longer than Native American burning and natural lightning-caused fire. The result is a vegetated landscape that has largely been prevented from burning, and that has accumulated fuel loads and structural characteristics that have not occurred on the landscape for thousands of years, if ever.

The District was formed in response to the observed population growth and development pressure within the San Francisco Bay Region of the late 1900's. This has substantially reduced residential development in some areas, and significantly decreased the level of fire risk by precluding development that would have likely otherwise resulted in additional high risk communities. Nonetheless, there is some residential development (including some on District property) intermixed with District Preserves that deserve consideration.

The WUI is an area where urban ignition sources such as vehicles, equipment, burn piles, barbeques, chimneys, smoking, fireworks, etc. from adjacent residential properties and public streets pose a threat to Open Space lands. Residential structures can also supply fuel for fire that can cross into open space lands.

The **wildland-urban interface (WUI)** refers to areas where residential development, from a few scattered houses to larger subdivisions or communities, exist immediately adjacent to or nearby parks, open space preserves, or other relatively undeveloped "wildlands". Important issues within this interface include **defensible space** around residential structures, emergency vehicle access, and residential fire improvements such as water tanks, fire hydrants, sprinklers, and fire resistant construction techniques.

The District is an active participant in coordinating with various **fire agencies** and community fire planning efforts. District participation in these planning efforts will continue. These include the development of regional fire plans, **Fire Safe Council** meetings, and the preparation of **Community Wildfire Protection Plans (CWPPs)**. The District also coordinates with local fire agencies and other park agencies conducting and participating in **prescribed fire** for **resource management** purposes.

The District, for many years, has undertaken various wildland fire management practices to effectively manage fuel loads and decrease wildland fire risk. Among these, the District annually maintains a series of disc lines (where vegetation is mechanically disked with a tractor to reduce dry fuel along ignition sources such as roads); vegetation is mowed or brushed back from roads and trails; roads, parking areas, and Preserve entrances

are maintained to provide access for District patrol vehicles and other emergency vehicles; and vegetation is cleared from around District structures and residences. Preserve access points are closed when appropriate during periods of high fire risk. The District possesses a number of firefighting apparatus including a water tank truck, and smaller water tanks with hoses outfitted on Ranger vehicles, as well as portable water-pack/spray outfits for individual personnel. Fire training is also provided to District personnel who may be involved in combating wildland fire.

The District has an active **vegetation management** program that has been **targeting** invasive plant species that can be fire hazards, such as eucalyptus and French broom. Active **livestock** grazing is being maintained and has been re-introduced on some Preserves to reduce the fuel loads in the mostly **non-native** grasslands. **Conservation grazing** is being used to encourage the vigor of native grasses and **forbs** that typically produce less fuel (thatch). Given their year-round growth cycle, perennial native grasses maintain moisture later into the dry season, reducing fire hazard. The vegetation management program at the District also utilizes prescribed fire for managing invasive species in addition to fuel load reduction benefits.

The substantial **historic** alterations of the landscape, the history of **fire suppression**, and the numerous jurisdictions involved in wildland fire management and suppression, present challenges in managing wildland fire, but also present many opportunities. Effective wildland fire management actions can be undertaken to reduce the severity of fires within the WUI and within the District's **ecosystems** and **watersheds**, when fires inevitably occur. Additionally, active management can achieve conditions suitable for the reintroduction of fire into many ecosystems, an ecological function that has been absent, except under atypically severe conditions, for most of the past century. Prescribed fire is a powerful tool that not only has ecological benefit, but also significant wildland fire management benefit.

WILDLAND FIRE MANAGEMENT GOAL, POLICIES, AND IMPLEMENTATION MEASURES

Goal WF-	**Manage District land to reduce the severity of wildland fire and to reduce the impact of fire suppression activities within District Preserves and adjacent residential areas; manage habitats to support fire as a natural occurrence on the landscape; and promote District and regional fire management objectives.**

Policy WF-1 Implement necessary fire and fuel management practices to protect public health and safety, protect natural **resources**, and to reduce the impacts of wildland fire.

- Prepare wildland fire management plans for District lands that address, at a minimum, public safety, District staff and firefighter safety, District infrastructure including residences and roads, natural resource protection (particularly **special status** species), **cultural resources,** and vegetation management for fire protection and **fire behavior** and hazardous fuels modification.
- Identify, with input from responsible fire agencies and neighboring public agencies, essential roads for wildland fire access. Maintain designated roads for fire access and patrol purposes, and improve with surfacing, additional turnouts and safety zones when necessary.
- Coordinate with fire agencies and local communities to identify locations where additional fire infrastructure is desirable and practical (e.g. hydrants, water tanks, helicopter zones, safety zones, **fuel breaks**, consistent with the **incident command system (ICS**). Work cooperatively with these groups to install needed infrastructure.
- Work with Cal Fire and other appropriate fire management and regulatory agencies to develop and carry out plans that use prescribed burns to maintain and restore natural systems.
- Maintain adequate fire clearance around District structures and facilities. (See FM-5 and WF-4:Measure 5)
- Require lessees of District land or structures to maintain fire hazard reduction measures as directed.

- Prohibit activities that have a high risk of sparking fires during periods of **extreme fire hazard**.
- Close Preserve areas of particular concern during **extreme fire weather**, as appropriate, and increase patrol levels where appropriate.
- Seek grant opportunities and partnerships for fuel management and monitoring projects.

Policy WF-2 Aggressively support the immediate suppression of all unplanned fires that threaten human life, private property or public safety.

- Respond to wildland and structure fires on District lands in coordination with responding fire agencies.
- Prioritize and prepare Preserve specific wildland fire response plans that identify appropriate fire suppression activities for District lands in the event of a wildland fire. Plans should include detailed maps of infrastructure such as roads, fuel breaks, structures, water sources (hydrants, water tanks, ponds), as well as sensitive natural and cultural resources to be avoided during fire suppression activities.
- Direct bulldozer actions to areas identified in wildland fire response plans to minimize and reduce ground disturbance, erosion, and rehabilitation efforts wherever possible.
- Develop guidelines for appropriate rehabilitation measures to address erosion, **revegetation**, invasive species, trail and road stability, security, public safety, and natural and cultural resources following fires.

Defensible space is the area adjacent to a structure where basic wildfire protection practices are implemented, providing a key point of defense for an approaching wildland fire or area to escape from a structure fire. Cal Fire publishes guidelines for fuel (vegetation) treatments to create a perimeter around buildings and structures in order to maintain minimum conditions for firefighters to defend a property.

Policy WF-3 Work with adjacent landowners and fire agencies to maintain adequate fire clearance around qualifying structures. (See FM-5 and WF-1: Measure 5)

- Maintain a permit system that enables adjacent landowners to maintain defensible space clearance surrounding homes and other qualifying structures across property boundaries and onto District land as long as the activity is recommended by the local fire agency and is consistent with the District's resource management policies, including protection of environmentally sensitive habitat.
- Work with fire agencies and local governments to develop requirements for new development to maintain required fire clearance distance from District land wherever possible.

- Focus fuel management activities in areas adjacent to development, essential facilities and improvements, major egress and emergency routes, essential fuel breaks, and sensitive natural and cultural areas.
- Investigate alternative funding sources in conjunction with fire agencies and residential communities within the WUI adjacent to District Preserves to fund and implement fire hazard reduction projects.
- Work with fire agencies and residential communities to ensure that adequate evacuation routes and vegetation clearance around structures are maintained on adjacent non-District lands.
- Coordinate with fire agencies and local communities to define locations where community and regional fire protection infrastructure is desirable and practical.

Sudden Oak Death mortality is also a potential concern within the wildland- urban interface area, as well as within other areas of District Preserves. This concern is currently being studied by researchers in conjunction with District staff. These studies should provide additional insight into the potential fire hazard associated with SOD mortality and propose effective management options.

Policy WF-4 Manage District vegetation communities to reduce the risk of catastrophic fire and to maintain biological diversity. (See VM-1 and FM-6)

- Promote the **restoration** and development of late-seral forest communities.
- Evaluate the potential to reduce forest fuel loading through the removal of smaller trees to reduce forest floor fuel buildup and **ladder fuels**.
- Continue to utilize and expand the District's **conservation grazing** program to reduce grassland fuels, brush encroachment, and encourage the vigor of native grass and forb species.
- Manage forest diseases such as Sudden Oak Death (SOD).
- Manage scrub, shrub, and chaparral communities to maintain a mosaic of ages and species within strategic management corridors on roads, ridgetops, and near residential development or other critical infrastructure to **compartmentalize** preserves and reduce fuel loads.

Policy WF-5 Conduct prescribed burns to re-introduce fire into native ecosystems and maintain natural ecological processes on District lands.

- Continue to utilize fire as a resource management tool to reduce fuels and reestablish fire for **resource benefit** where vegetation conditions, access, and public safety permit. Coordinate with other agencies for planning and implementation.

- Continue to utilize prescribed fire to reduce and prevent unwanted fire damage resulting from excessive fuel load and altered **plant community** structure and to control invasive species.
- Conduct prescribed burns in an ecologically sound manner which mimic natural **fire regimes**, and to promote **biodiversity.**
- Conduct public **outreach** to recreational users, adjacent landowners and the general public through mailings, web site postings and press releases related to the benefits of prescribed fire and other fire management activities.

Policy WF-6 Foster and maintain interagency fire management partnerships.

- Annually coordinate with fire management and other resource agencies to discuss pre-fire planning conditions and needs in advance of the fire season.
- Participate in county **Fire Safe Councils** and Community Wildfire Protection Plan (CWPP) efforts.
- Train with fire agencies and participate in training burns when possible.
- Complete and distribute to fire agencies up-to-date maps of Preserve infrastructure including existing road network available for wildland fire management, helicopter landing zones, safety zones, evacuation routes, and other pertinent information.

Policy WF-7 Conduct research and monitoring to refine fire management practices.

- Monitor pre-project vegetation, soil, erosion, and **water quality** to establish baseline conditions for post project analysis.
- Monitor post fire and vegetation management projects to assess the achievement of project objectives and to identify potential impacts to vegetation, soil, erosion, and water quality.
- Conduct monitoring in a manner consistent with other land management agencies to obtain comparable data.
- Foster relationships with educational institutions, scientists and other land management professionals to inform District land management decisions based upon sound, current science, and to create opportunities for continuing research. Seek grants and pursue partnerships for research and monitoring.

- Integrate wildland fire management into District **interpretation** and education programs.

Policy WF-8 Wildland Fire management actions on District lands in the Coastside Protection Area will be in accordance with the policies established in the Service Plan for the San Mateo Coastal Annexation Area.

- In consultation with the County of San Mateo Environmental Services Department and fire agencies, determine whether the construction of dry hydrants on specific lands acquired is feasible in order to provide additional remote area water supplies for fire suppression activities
- Select native plant materials and/or seed mixes utilized at staging areas or along trails for their low maintenance and drought and fire resistant characteristics to minimize additional fuel available to wildland fires to the extent feasible.
- Where compatible with other trail characteristics, planners shall locate trail alignments and access points to allow trails to also serve as emergency access routes for patrol or emergency medical transport. Where feasible for more remote areas, emergency helicopter landing sites shall be provided.
- Coordinate with appropriate agencies, such as the County and Cal Fire to formalize mutual aid agreements.
- Consult with fire agencies in developing site-specific **fuel modification** and management programs for specific lands acquired as part of its Use and Management planning process, in addition to continuing the current District fuel management practices.
- Prohibit smoking, firearms, fireworks and off-road vehicle use and limit trail use, picnicking, and camping to designated activities.
- Develop and maintain staging areas and trail heads in accordance with the wildland fire **hazard mitigation** measures established in the Service Plan for the Coastside Protection Area.

XVI. CLIMATE CHANGE

BACKGROUND

Greenhouse gases, such as carbon dioxide, methane, and nitrous oxide, contribute to the atmospheric warming "greenhouse effect" by absorbing infrared radiation.

Climate change is directly affecting temperatures, precipitation, weather patterns, species ranges, wildfire risk, and sea levels, impacting the District's ability to meet its resource management goals. Human activities that put excess **greenhouse gases** into the atmosphere, such as burning fossil fuels for transportation and energy generation, are the leading cause of climate change.

Impacts on Natural Systems

According to the National Park Service, the wide range of climate change impacts in the Bay Area include the following:

- Increase in average annual temperatures of 1.2 degrees Celsius (2.2 degrees Fahrenheit) between 1960 and 2010
- Northern shifts in winter bird ranges of 0.5 kilometers (0.3 miles) per year between 1975 and 2004
- Upward shifts in elevation for 12 percent of endemic species and 27 percent of non-native species between the periods of 1895-1970 and 1971-2009
- Sea level rise of 22 centimeters (9 inches) between 1854 and 2016
- Decrease in coastal fog by 33 percent between the periods of 1901-1925 and 1951-2008
- Increase in heavy storms by 25 percent between the periods of 1901-1960 and 1991-2000
- Human-caused climate change accounted for 10-20% of the 2012-2014 drought
- Climate was the dominant factor controlling the extent of wildfire burn areas between 1916 and 2003, even during periods of active fire suppression

The Carbon Cycle

The carbon cycle is a natural process by which carbon moves between different stores or reservoirs, such as the atmosphere, oceans, sedimentary rocks, soils, and plant biomass. When burning fossil fuels, humans move a massive amount of carbon from the ground to the atmosphere, putting the carbon cycle out of balance and causing climate change. The two key approaches to solving climate change are 1) to avoid adding any more carbon to the atmospheric store and 2) to move carbon from the atmospheric store to safer stores, such as plant biomass and soils. Humans can avoid adding more carbon to the atmospheric store by reducing greenhouse gas emissions from fossil fuels and preventing the release of carbon in plants and soils. Humans can facilitate the movement of carbon from the atmosphere into plant biomass and soils, also known as **carbon sequestration**, through land conservation and management. The District stewards over 63,000 acres of open space lands, including redwood forests, which store large amounts of carbon in trees, other vegetation, and soils.

Carbon sequestration is the process by which carbon is removed from the atmosphere and stored elsewhere, such as in plants and soils.

CLIMATE CHANGE GOAL, POLICIES, AND IMPLEMENTATION MEASURES

Goal CC- Reduce agency-generated greenhouse gas emissions, increase carbon sequestration, and promote resilience to climate change impacts

Policy CC-1 Reduce administrative greenhouse gas (GHG) emissions 20% below 2016 baseline by 2022, 40% below 2016 baseline by 2030, and 80% below 2016 baseline by 2050, in line with the State of California's GHG reduction goals.

- Implement Climate Action Plan strategies to reduce or offset administrative GHG emissions from vehicles, equipment, facilities, employee commuting, and tenant residences.
- Periodically update GHG Inventory and track GHG reduction.
- Improve GHG Inventory data quality and tracking systems.
- Consider GHG emissions related to all policies, plans, decisions, and management practices, in addition to other factors.

The State of California set a goal to reduce GHG emissions 40% below 1990 baseline levels by 2030 and 80% by 2050 (AB 32). The District first inventoried GHG emissions in 2016 so that is the baseline for the District's reduction goals.

District GHG emissions are divided into administrative emissions, which come directly from District operations such as vehicles and facilities, and non-administrative emissions, which are related to District activities but the District has less control over. A numerical GHG reduction goal is set only for administrative emissions.

- ♦ Evaluate the full life-cycle footprint of equipment, services, and supplies, and choose lower impact/responsible services and supplies.
- ♦ Develop sustainability guidelines for facilities, operations, projects, and events.

Policy CC-2 Reduce non-administrative GHG emissions related to District activities, such as visitor transportation and **livestock**.

- ♦ Implement Climate Action Plan strategies to reduce or offset GHG emissions from visitor transportation to preserves.
- ♦ Implement Climate Action Plan strategies to reduce or offset GHG emissions from **livestock**, and research additional techniques or technologies.
- ♦ Where agricultural sustainability is not a leading factor, select appropriate **livestock** species to accomplish vegetation management objectives (See GM-4).

Policy CC-3 Increase **carbon sequestration** in vegetation and soils and minimize carbon release from wildfire.

- ♦ Manage conifer forests to sustain and encourage the development of late-seral habitat conditions (FM-4). Evaluate the potential to reduce forest fuel loading through the removal of smaller trees to reduce fuel buildup and ladder fuels (See FM-5).
- ♦ Manage vegetation communities to reduce the risk of catastrophic fire and to maintain biological diversity (WF-4). Conduct prescribed burns to re-introduce fire into native ecosystems and maintain natural ecological processes on District lands (See WF-5).
- ♦ Evaluate, study, and implement additional land management strategies to increase carbon sequestration in vegetation and soils.
- ♦ Improve data on carbon sequestration in District lands.
- ♦ Evaluate opportunities to create and sell carbon offsets on the California Cap and Trade market or other voluntary offset markets.

Resilience is the capacity of natural and human communities to withstand and bounce back from climate stress and hazardous events.

Policy CC-4 Prepare for climate change impacts and promote **resilience** for both natural and built environments.

- ♦ Prioritize ecosystem function, resilience, and ecological diversity focused on multiple species benefits, rather than aiming to prevent ecological change or return to past conditions.

- Incorporate climate change impacts on natural resources such as species range and phenology changes into restoration and monitoring activities. Utilize an adaptive management framework to adjust resource management methods and priorities as impacts start to occur and climate change knowledge and response options continue to increase (See GM-3).
- Support ecological functions and ecosystem services that protect the built environment from climate change impacts, such as flooding and increased wildland fire frequency and intensity.
- Incorporate climate change impacts to infrastructure, such as flooding, drought, and sea level rise, into planning, project design, and other relevant activities.
- Evaluate, study, and implement additional land management strategies to promote ecosystem resilience.

Policy CC-5 Lead by example and support state, regional, and community-scale action on reducing climate change impacts to ecosystem health and biodiversity, and increasing ecosystem resilience.

- Support and participate in regional climate change initiatives and burgeoning community of practice. Foster partnerships to respond to climate change collaboratively, and seek opportunities to share information with other agencies.
- Support and influence local and state climate change policies that are protective of ecosystem health and biodiversity. Seek grant opportunities to fund implementation of GHG reduction, carbon sequestration, and natural resource resilience efforts.
- Increase public awareness of climate change impacts and solutions the District is pursuing through education and outreach. Incorporate climate change into interpretive programming, facilities, and materials (See PI-1).
- Coordinate and cooperate with institutions, agencies, organizations, and individuals conducting research on climate change and resource management (See RC-2).

XVII. GLOSSARY

Agricultural Infrastructure – Improvements made to a property to support an agricultural operation such as fencing, roads, water supply systems and structures. (Conservation Grazing Management)

Anadromous – Fish, such as steelhead trout, that return from the open ocean as adults to freshwater streams to breed. (Water Resources, Habitat Connectivity)

Archaeological site – A site in which physical evidence of past prehistoric or historic human activity has been preserved. (Cultural Resources)

Artifacts – Objects created by humans or modified by human activity. (Cultural Resources)

Barrier – An impediment to migration, genetic exchange, dispersal, or other essential movement of an organism. Barriers may be of natural or human-made origin. (Habitat Connectivity)

Best Management Practices (BMPs) – District developed standard practices that identify the preferred manner in which an activity is to be performed in order to be protective of both human health and the environment. (Vegetation Management, Integrated Pest Management, Water Resources, Conservation Grazing Management, Forest Management)

Biodiversity – Describes the natural variety and abundance of plants and animals and the environments in which they live. U.S. Congressional Biodiversity Act, 1990 HR1268, defines biodiversity as “The full range of variety and variability within and among living organisms, and the ecological complexes in which they occur, and encompass ecosystem or community diversity, species diversity and genetic diversity.” (Vegetation Management, Integrated Pest Management, Water Resources, Forest Management, Ecological Succession, Habitat Connectivity, Wildland Fire)

Biological Legacies – The retention of forest components that were originally present within the forest, prior to large scale disturbance such as fire, or timber harvesting. Notable “legacy” components include: large live

trees (especially old growth) with mosses and lichen growth within the canopy, hollow cavities, and complex large branch structure; large pieces of wood on the forest floor; intact forest soil and associated fungi and microbes. These forest components have a profound influence on recovering forest ecosystems and are important considerations for habitat reconnection and restoration. (Forest Management)

Boundary – The area of border between habitat patches or vegetation types; a zone comprised of edges of adjacent ecosystems or land types. (Habitat Connectivity)

Carbon Sequestration – The process by which carbon is removed from the atmosphere and stored elsewhere, such as in plants and soils. (Climate Change)

Chaparral – Shrub and small tree dominated landscapes composed of species with small, thick, evergreen, leathery leaves that often grow dense and tangled. (Vegetation Management, Ecological Succession, Habitat Connectivity, Wildland Fire)

Community Wildfire Protection Plan (CWPP) – The Healthy Forests Restoration Act (HFRA), passed in 2003 by the federal government, established statutory incentives for the US Forest Service (USFS) and the Bureau of Land Management (BLM) to give consideration to the priorities of local communities as they develop and implement forest management and hazardous fuel reduction projects. In order for a community to take full advantage of this federal assistance, a community must first prepare a CWPP. CWPPs may address issues such as wildfire response, hazard mitigation, community preparedness, or structure protection—or all of the above. (Wildland Fire)

Compartmentalize – Using fire management techniques such as installation of shaded fuel breaks, or defensible space surrounding homes to separate a potentially large scale wildland fire into distinct smaller management areas separated by vegetation type, fuel loading, access, or terrain into pre-designated fire management units. (Wildland Fire)

Conifer, Coniferous – Cone bearing trees with needles or scale-like leaves, stay green throughout the year in California. Examples include:

coast redwood, Douglas fir, pine trees, and cypresses. Conifers are also referred to as softwood. (Forest Management, Ecological Succession)

Conservation Grazing – Conservation Grazing is the intentional use of grazing management to meet resource management objectives including protecting and enhancing habitat for native plants and animals that occur in grassland habitat and moderating the negative effects of invasive exotic plants on these species. (Wildland Fire, Conservation Grazing Management, Vegetation Management)

Contamination – Human-made waste that has polluted the environment making it unfit or unsafe. (Water Resources, Geology and Soils)

Core – The portion of an ecosystem or habitat where effects of the surrounding area are limited. (Habitat Connectivity)

Cultural Landscape – A landscape modified by past human activity or otherwise holding historical or prehistoric cultural importance. (Cultural Resources, Public Interpretation, Wildland Fire)

Cultural Resource – A structure, landscape feature, archaeological site, or other artifact of human activity in the past during prehistoric or historic periods. (Cultural Resources)

Cultural Resource Inventory – The District's inventory of cultural resources on District preserves. Information in this inventory may include site locations, descriptions, and photographs, as well as historical information on individual sites and preserves. (Cultural Resources)

Data Recovery – Research and recording techniques such as the excavation of archaeological sites or recording of architectural features prior to site disturbance. Data recovery is a common mitigation measure for projects that may have a substantial adverse impact on a significant cultural resource. (Cultural Resources)

Defensible Space – Defensible space is the area adjacent to a structure where basic wildfire protection practices are implemented, providing a key point of defense for an approaching wildland fire or area to escape from a structure fire. The California Department of Forestry and Fire Protection

(Cal Fire) publishes guidelines for fuel (vegetation) treatments to create a perimeter around buildings and structures in order to maintain minimum conditions for firefighters to defend a property. (Wildland Fire)

Disturbance (Ecological Disturbance) – The disruption of an ecosystem's structure and function, generally with effects that last for time periods longer than a single seasonal growing cycle for vegetation. (Wildlife Management, Integrated Pest Management, Water Resources, Geology and Soils, Ecological Succession)

Disturbance-dependent – Species that require disturbance to maintain habitat conditions suitable for reproduction and establishment. (Ecological Succession)

Ecological Succession – The sequential development of plant and animal communities following disturbance. (Ecological Succession)

Ecosystem – An area within the natural environment in which physical (abiotic) factors of the environment, such as rocks and soil, function together along with interdependent (biotic) organisms, such as plants and animals, within the same habitat. (Vegetation Management, Integrated Pest Management, Water Resources, Conservation Grazing Management, Forest Management, Ecological Succession, Habitat Connectivity, Wildland Fire)

Ecosystem Function – The interaction(s) or ecological processes that exists between organisms with one another and the physical environment, such as nutrient cycling, disturbance, soil development, water budgeting, and flammability. (Vegetation Management, Water Resources, Forest Management, Wildland Fire)

Edge – The portion of an ecosystem or habitat near its perimeter, where influences of the surroundings prevent development of interior/core-area environmental conditions. (Habitat Connectivity)

Enhancement – The process of altering a habitat to provide specific ecosystem functions. (Water Resources, Conservation Grazing Management, ecological Succession, Habitat Connectivity)

Enhance – To increase or improve a habitat in value or quality. (Vegetation Management, Wildlife Management, Water Resources, Conservation Grazing Management, Forest Management, Ecological Succession, Habitat Connectivity)

Environmental Education – A learning process that increases people's knowledge and awareness about the environment and associated challenges, develops the necessary skills and expertise to address the challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action. (Public Interpretation)

Exotic – Species that were not present in the Santa Cruz Mountains region of California prior to the large scale development of the American continent by European humans prior to 1769. (Conservation Grazing Management)

Extreme Fire Hazard/Weather – The National Weather Service, operating through cooperative agreement with the State of California, issues Red Flag Warnings during conditions of extreme fire weather. This alert is used by fire agencies to plan staffing levels and preparedness and set public use restrictions (such as campfires or the use of spark producing equipment). (Wildland Fire)

Five-Strand Barbed Wire Fencing – Fencing typically used in ranching operations to confine **livestock** to established areas, constructed of five evenly spaced rows of barbed wire stretched between posts comprised of wood or metal. (Conservation Grazing Management)

Flora – The plants of a particular region or period. (Conservation Grazing Management)

Fire Agencies – Agencies with jurisdiction to respond to wildland and structure fires on District lands and that may work in cooperation with the District in planning site-specific fuel and wildland fire management practices and in conducting training in fire and fuel management. They can include Cal Fire as well as local, regional, city, county and special district fire agencies. (Wildland Fire, Forest Management)

Fire Behavior – The manner in which a fire reacts to fuel, weather, topography, or fire suppression efforts. (Wildland Fire)

Fire Regime – The characteristic frequency, extent, intensity, severity, and seasonality of fires within an ecosystem. (Wildland Fire)

Fire Safe Councils – The Fire Safe Council is a coalition of public and private organizations with a common, shared interest in reducing losses from wildfires. (Wildland Fire)

Fire Suppression – Human efforts connected with fire-extinguishing operations, such as use of tools, engines, water or aircraft, or installation of fuel breaks, or removal of fuels surrounding homes or other structures. (Vegetation Management, Forest Management, Wildland Fire)

Food Web – The relationships between interconnected plants and animals in an ecosystem pertaining to how each organism gets their food and meets energy requirements. (Integrated Pest Management)

Forbs – A broad-leaved herb other than a grass, especially one growing in a field, prairie, or meadow. (Conservation Grazing Management, Wildland Fire)

Forest – Habitats dominated by tree species with a continuous or nearly continuous canopy covering substantial portions of the landscape. (Vegetation Management, Wildlife Management, Forest Management, Ecological Succession, Wildland Fire)

Forest Conditions – A characterization of forest age, structural complexity (height, spacing, multiple canopy levels), species composition, habitat suitability, biological legacies, fuel loads, diseases or pathogens, regeneration, and level of disturbance. (Forest Management)

Forest Management – The active stewardship of a forest or stand to achieve a desired future condition. (Forest Management)

Fuel – Combustible vegetation including live or dead forbs, shrubs, branches, trees, vines etc. (Vegetation Management, Conservation Grazing Management, Forest Management, Wildland Fire)

Fuel Break – A strip of land on which vegetation has been removed, reduced, thinned, or otherwise modified so that a fire burning into or up to it can be more readily controlled (Wildland Fire)

Fuel Load – The oven-dry weight of fuel per unit area. (Wildland Fire)

Fuel Modification – Breaking up, thinning, reducing, or otherwise modifying continuous fuels to prevent or reduce the spread of a wildfire. (Wildland Fire)

Fuel Wood – Woody vegetation or wood products, primarily used as fuel for heating, cooking, or industry. (Forest Management)

GIS (Geographic Information System) – A combined database and mapping system used for the storage, retrieval, and analysis of geographic data. (Integrated Pest Management, Research and Collection)

GIS Database – A database that contains information about the location of real-world features and the characteristics of those features. (Integrated Pest Management, Research and Collection)

Geologic Hazards – Hazards created by fault zones, landslide prone areas, and flood zones. (Geology and Soils)

Greenhouse Gases – Gases such as carbon dioxide, methane, and nitrous oxide that contribute to the atmospheric warming “greenhouse effect” by absorbing infrared radiation. (Climate Change)

Habitat – the combination of living and non-living factors that surround and potentially influence an organism; or species’ typical environment. (Vegetation Management, Wildlife Management, Integrated Pest Management, Water Resources, Scenic and Aesthetic, Conservation Grazing Management, Forest Management, Ecological Succession, Habitat Connectivity, Wildland Fire)

Habitat Fragmentation – the breaking up of a previously continuous habitat (or ecosystem) into spatially separated and smaller pieces. (Wildlife Management, Forest Management)

Hardwood – Broadleaf trees that usually produce flowers that ripen into fruits containing seeds. Local examples include: numerous oak species, madrone, tanoak, willows, and western sycamore. (Forest Management, Wildland Fire)

Hazard Mitigation – action taken to reduce or eliminate long-term risk to people and their property from hazards such as proximity of flammable vegetation, dead or dying tree limbs, or pollution or contamination in close proximity to homes or public facilities. (Wildland Fire)

High Priority District Forests – Forests that have been identified through inventories or other analysis as priority areas for forest management. Priority can be based on different management objectives such as: restoring degraded habitat, reconnecting late-seral habitat, and/or wildland- urban interface fire concerns. (Forest Management)

Historic – Dating from periods post-dating the use of written historical documents. In the American West, the historic period is generally considered to refer to all periods after European exploration and colonization of the region. (Water Resources, Scenic and Aesthetic, Cultural Resources, Forest Management, Ecological Succession, Wildland Fire)

Historical Rehabilitation – "The act or process of making possible a compatible use for a property through repair, alterations and additions while preserving those portions or features which convey its historical, cultural, or architectural values." (Definition from *Secretary of the Interior's Standards for Treatment of Historic Properties*) (Cultural Resources)

Host – A plant or animal that provides sustenance for another organism. (Integrated Pest Management)

Inbreeding Depression – The decrease in growth, survival and fertility of an individual often observed following mating among relatives or self-fertilization (in plants). (Wildlife Management)

Incident Command System (ICS) – a standardized, on-scene, all-hazard incident management concept. ICS allows its users to adopt an integrated organizational structure to match the complexities and demands of single

or multiple incidents without being hindered by jurisdictional boundaries. (Wildland Fire)

In Situ – "In place;" at the site of original deposition or discovery. (Cultural Resources)

Integrated Pest Management (IPM) – A long-term strategy that specifically reviews alternatives and monitors conditions to effectively control a target pest with minimum impact to human health, the environment, and non-target organisms. (Integrated Pest Management)

Interpretation – A communication method that aims to reveal meanings, connections, and relationships by firsthand experience, and by illustrative media. (Cultural Resources, Public Interpretation, Forest Management, Wildland Fire)

Interpretive Systems Plan (ISP) – An overarching analysis of the interpretive opportunities that exist throughout an agency's parks or preserves. (Public Interpretation)

Invasive Species – animal or plant species that take over sufficiently large areas to reduce biodiversity. (Integrated Pest Management, Conservation Grazing Management, Ecological Succession, Habitat Connectivity, Wildland Fire)

Ladder Fuels – Live or dead vegetation that allows a fire to ascend from low lying vegetation such as forbs and grasses, into the upper or uppermost vegetation such as taller shrubs and trees. Common fuel ladders include tall grasses, shrubs, and tree branches, both living and dead. (Forest Management, Wildland Fire)

Late-Seral – Stage of forest development dominated by large mature trees. Initial age development of this stage for redwood and Douglas-fir forests is generally considered to occur between 80- and 300 years. Trees and forest begin to develop some characteristics associated with old growth including large decadent trees, snags and large down logs. (Forest Management, Wildland Fire)

Late-Successional – Same as late-seral. (Forest Management)

Livestock – The horses, cattle, sheep, and other useful animals kept or raised on a farm or ranch. (Integrated Pest Management, Geology and Soils, Conservation Grazing Management, Forest Management, Ecological Succession, Wildland Fire)

Livestock Protection Methods – Wildlife and **livestock** conflict mitigation tools that promote the protection and continued conservation of wildlife while safeguarding **conservation grazing** as a management tool (Con-servation Grazing Management).

Native – Those elements of the natural world occurring within an ecosystem prior to disturbance from an outside event. (Vegetation Management, Wildlife Management, Integrated Pest Management, Water Resources, Geology and Soils, Scenic and Aesthetic, Cultural Resources, Research and Collection, Conservation Grazing Management, Ecological Succession, Habitat Connectivity, Wildland Fire)

Natural – Plant, animal, and microorganism life, native materials, and ecosystem processes that make up the physical world. (Vegetation Management, Wildlife Management, Integrated Pest Management, Water Resources, Geology and Soils, Scenic and Aesthetic, Cultural Resources, Research and Collection, Public Interpretation, Conservation Grazing Management, Forest Management, Ecological Succession, Habitat Connectivity, Wildland Fire)

Non-Native – Species which moved into, or were introduced into, preserve environments as a direct or indirect result of human activities. (Vegetation Management, Wildlife Management, Integrated Pest Management, Geology and Soils, Scenic and Aesthetic, Conservation Grazing Management, Ecological Succession, Wildland Fire)

Non-Target Organisms – those plants and animals that are not intentionally targeted by a pest management strategy in order to spare benign and often beneficial species. (Integrated Pest Management)

Northwest Information Center – A clearing house for historical and archaeological information associated with the California Historical Re-

sources Information System, which houses historical documents, site reports and other research pertaining to cultural resources in Northwest California. (Cultural Resources)

Old Growth – Stand or residual (uncut) trees in excess of 200 years old, often characterized by very large trees, large plated bark, broken, dead or forked tops, with a prevalence of mosses and lichens on large branches within the canopy. Old growth stands also typically include large snags and large downed logs. (Forest Management, Wildland Fire)

Open Space – Land and water areas that remain in a natural state and are minimally developed, and may include compatible agriculture uses. (Wildlife Management, Water Resources, Geology and Soils, Scenic and Aesthetic, Cultural Resources, Public Interpretation, Conservation Grazing Management, Forest Management, Ecological Succession, Habitat Connectivity, Wildland Fire)

Outreach – The communication of the District's mission and goals to a wide variety of audiences usually conducted away from the office or preserves. (Integrated Pest Management, Public Interpretation, Forest Management, Wildland Fire)

Patch – A relatively homogenous type of habitat that is spatially separated from other similar habitat and differs from its surroundings. (Habitat Connectivity)

Pathogen – A disease causing organism. (Vegetation Management, Forest Management)

Performance Measure(s) – Parameter(s) used to measure project success tied to project goals and objectives.

Pesticides – A broad term used to describe any material (natural, organic, or synthetic) used to control or prevent pests including herbicides (weed or plant killers), insecticides (insect killers), and rodenticides (rodent killers). (Integrated Pest Management)

Pests – Animals or plants that proliferate beyond natural control and interfere with the natural processes which would otherwise occur on open

space lands. (Integrated Pest Management, Forest Management, Wildland Fire)

Plant Community – A group of plants growing in an interrelated manner on a particular site. (Vegetation Management, Integrated Pest Management, Ecological Succession, Wildland Fire)

Population – the number of organisms in a particular species that occupy the same geographic region at the same time and are capable of interbreeding (Vegetation Management, Wildlife Management, Water Resources, Habitat Connectivity, Wildland Fire).

Predation – a biological interaction where a predator (an organism that is hunting or browsing) feeds on its prey (the organism that is hunted or consumed). (Integrated Pest Management, Wildlife Management, Habitat Connectivity)

Prehistoric – Dating from periods of human activity prior to the use of written history. In the American West, prehistory generally refers to all periods before European colonization of the region. (Cultural Resources)

Prescribed Fire – Fire applied to wildland ecosystems under specified fuel and weather conditions to accomplish predetermined resource management objective such as regeneration of sensitive species in a fire-adapted plant community. (Wildland Fire)

Programming – The regularly scheduled organized, topic-specific presentations or other delivery of information, including community outreach, education, interpretation, and docent led activities, or other special events. (Public Interpretation)

Residual Dry Matter (RDM) – A measure of the amount of vegetation left on the ground, typically measured at the end of the summer or fall. Appropriate levels of RDM strive to minimize thatch, which can inhibit new plant growth, while maintaining adequate levels of vegetation to prohibit soil erosion. (Conservation Grazing Management)

Resilience – The capacity of natural and human communities to withstand and bounce back from climate stress and hazardous events. (Climate Change)

Resource Integrity – The extent to which character-defining features of a resource or its research potential remain intact. (Cultural Resources)

Resource Management – Management of both natural and cultural resources. Natural resource management generally consists of protecting, restoring, enhancing and monitoring native vegetation and wildlife, and monitoring and protecting the quality of geological and hydrological conditions. Cultural resource management consists of identifying and evaluating archeological sites and cultural landscapes. (Vegetation Management, Geology and Soils, Research and Collection, Public Interpretation, Conservation Grazing Management, Forest Management, Wildland Fire)

Resources – Plants, animals, water, soil, terrain, geologic formations, historic, scenic, and cultural features. (Vegetation Management, Wildlife Management, Integrated Pest Management, Water Resources, Geology and Soils, Scenic and Aesthetic, Cultural Resources, Research and Collection, Public Interpretation, Conservation Grazing Management, Forest Management, Habitat Connectivity, Wildland Fire)

Restoration – The process of returning land that has been degraded and disturbed into functional habitat. (Vegetation Management, Integrated Pest Management, Water Resources, Research and Collection, Forest Management, Wildland Fire)

Restore – To bring back to or put back into a former or original state. (Vegetation Management, Geology and Soils, Public Interpretation, Conservation Grazing Management, Forest Management, Ecological Succession, Habitat Connectivity, Wildland Fire)

Revegetation – The process of replacing existing vegetation on a site with desired vegetation. (Vegetation Management, Geology and Soils, Wildland Fire)

Riparian – Terrestrial environments adjacent to lakes, streams, springs and estuaries where transported surface and subsurface fresh water provides soil moisture for vegetation. (Wildlife Management, Water Resources, Geology and Soils, Forest Management, Habitat Connectivity)

Significance – A measure of the importance of an archaeological or historical resource. The threshold of significance determines eligibility for state and national registers and whether a cultural resource must be considered in NEPA and CEQA documents related to a project. The criteria detailed in CEQA by which significance (See Appendix A) is determined differ for historic and archaeological resources but include the resource's age, integrity, association with important individuals or trends in local history, and potential to provide important information about the past. (Cultural Resources)

Snag – A standing dead or partially dead tree, important wildlife habitat for woodpeckers and other cavity nesting birds, and small mammals. (Wildlife Management, Forest Management)

Soil – Natural material that covers much of the earth's surface; consisting of rock and mineral particles often mixed with organic matter. (Vegetation Management, Wildlife Management, Integrated Pest Management, Water Resources, Conservation Grazing Management, Forest Management, Habitat Connectivity, Wildland Fire)

Special Status – Species that are state or federally listed as threatened, rare, endangered, species of special concern, candidate species or those plant species listed by the California Native Plant Society. (Vegetation Management, Wildlife Management, Water Resources, Forest Management, Ecological Succession, Habitat Connectivity, Wildland Fire)

Stand – An aggregation of trees occupying a specific area, similar in age, size, arrangement and composition, that is distinguishable from the forest in adjoining areas. (Forest Management)

Target Pests – Plant or animal species that have a negative impact on other organisms or the surrounding environment and are targeted for treatment. (Integrated Pest Management)

Ungulate Animals – Hoofed mammals, including ruminants, such as cattle, goats, and sheep, as well as horses, and donkeys. (Conservation Grazing Management)

Vector – An organism, such as a tick or mosquito, that is able to transport and transmit a pathogen to a host. (Integrated Pest Management)

Vegetation Management – The maintenance, establishment, or restoration of target vegetation that meets a preserve's management objectives. (Vegetation Management, Conservation Grazing Management, Wildland Fire)

Watercourse – A natural or artificial channel through which water flows. (Water Resources, Geology and Soils, Habitat Connectivity)

Waters – Areas of standing water, seasonal and permanent, such as lakes and ponds, as well as underground aquifers. (Water Resources)

Water Quality – The chemical, physical, and biological characteristics of water. Important issues related to forest management include water temperature, nutrients, and sediment inputs. (Wildlife Management, Water Resources, Conservation Grazing Management, Forest Management, Wildland Fire)

Watershed – A bounded hydrologic system, where all of the precipitation that falls drains into a single water feature, often a creek or stream. (Vegetation Management, Water Resources, Habitat Connectivity)

Wetlands – Areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted to life in saturated soil conditions (hydrophytes). (Wildlife Management, Integrated Pest Management, Geology and Soils, Conservation Grazing Management, Ecological Succession, Habitat Connectivity)

Wildland – Land in a natural uncultivated state that forms habitat for plants and wildlife. (Vegetation Management, Integrated Pest Management, Water Resources, Conservation Grazing Management, Wildland Fire)

Wildland-Urban Interface – The area where structures and other human development meet or intermingle with undeveloped wildland. (Wildland Fire)

Wildlife – A broad term that includes all living animals that have not been domesticated. (Vegetation Management, Integrated Pest Management, Water Resources, Scenic and Aesthetic, Research and Collection, Conservation Grazing Management, Forest Management, Habitat Connectivity, Wildland Fire)

Wildlife Corridors – Avenues along which wide-ranging animals can travel, plants can propagate, genetic interchange can occur, **populations** can move in response to environmental changes and natural disasters, and threatened species can be replenished from other areas. (Habitat Connectivity)

Woodland – A scattering of trees across a landscape intermixed with a significant component of another vegetation community, such as grass or shrub land. (Vegetation Management, Forest Management, Habitat Connectivity, Wildland Fire)

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APPENDIX A. CEQA CRITERIA

This appendix outlines the CEQA Criteria of Significance for Historic Resources and Archaeological Resources:

HISTORICAL RESOURCES

A historical resource may be considered significant under CEQA if it is listed on the National Register of Historic Places (NRHP), California Register for Historical Resources (CRHR), or a local register (e.g., a town or county register), if it is determined to be eligible for the CRHR by a qualified expert, or if a Lead Agency finds it to be historically significant based on substantial evidence.

A resource is considered eligible for listing on the CRHR if it meets one of the following criteria:

- Criterion 1: Associated with events that have made a significant contribution to the broad patterns of local or regional history or the cultural heritage of California or the United States.
- Criterion 2: Associated with the lives of persons important to local, California, or national history.
- Criterion 3: Embodies the distinctive characteristics of a type, period, region, or method of construction or represents the work of a master or possesses high artistic value.
- Criterion 4: Has yielded, or has the potential to yield, information important to the prehistory or history of the local area, California, or the nation.

ARCHAEOLOGICAL RESOURCES

In addition to the definition of historical resources above (which can include archaeological sites), the following criteria for unique archaeological resources (California Public Resources Code 21083.2) determine significance under CEQA:

A resource is considered a unique archaeological resource if it meets one of the following criteria:

- Contains information needed to answer important scientific research questions and that there is a demonstrable public interest in that information.
- Has a special and particular quality such as being the oldest of its type or the best available example of its type.
- Is directly associated with a scientifically recognized important prehistoric or historic event or person.

June 10, 2021

Matthew Sharp Chaney
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Dear Mr. Chaney,

This letter is written in support of the research proposed to Midpeninsula Regional Open Space District in "Developing and Evaluating and Practical Tools & Strategies for Preventing Carnivore-Livestock Conflict." The exact relationships and responsibilities for each collaborator will be outlined in a formal agreement, but we are each enthusiastic about the project, and committed to supporting and carrying out the propose research.

Sincerely,

Dr. Veronica Yovovich (PI, Panthera)

Dr. Carolyn Whitesell (Co-PI, UC ANR)

Dr. Mark Elbroch (Collaborator, Panthera)

Dr. Chris Wilmers (Collaborator, UCSC)

GRAZING MANAGEMENT POLICY AMENDMENT: WILDLIFE AND LIVESTOCK PROTECTION POLICY LITERATURE REVIEW

Created for the Midpeninsula Regional Open Space District

Created by Veronica Yovovich
in collaboration with Matthew Sharp Chaney, Kirk Lenington, Julie Andersen, and Elaina Cuzick

April 2019

Livestock and Carnivore Protection Policy Literature Review

Table of Contents

Executive Summary

In order to effectively manage livestock-carnivore interactions, it is important to understand how the ecological, legal, and management dynamics interact with one another. This review is designed to help District managers and producers evaluate which livestock protection tools may be most suitable for each particular operation on leased land.

This review can be broken down into the following five sections. The first provides an overview of relevant carnivore behavior and ecology for each of the three native focal species, mountain lion (*Puma concolor*), coyote (*Canis latrans*), and bobcat (*Lynx rufus*). Second is a summary of the laws and regulations governing the management of each of the native focal carnivore species, as well as an additional non-native species, domestic dog (*Canis familiaris*). This information serves to guide how various preventative tools may be legally implemented. Additional carnivore species (such as wolves and bears) are present in other parts of California, however, they are not present on District properties and are not covered by this review. The third section provides a review of direct (mortality and injuries) and indirect (weight loss, reduced reproductive potential, etc.) impacts to livestock that are incurred during livestock-carnivore interactions. Next follows an overview of policies implemented by other local land management agencies (such as East Bay MUD, East Bay Regional Parks, National Parks Service, etc.) that could serve as a model for the District. The final section, and bulk of the review, synthesizes research on a variety of conflict mitigation tools, ranging from visual and auditory frightening devices to lethal removal. Each method is described in detail, outlining the means of protection, suitability for which species of livestock, suitability for which species of carnivore, potential drawbacks and benefits, and scalability (as tenant operations vary from small 200 to 500 acre ranches with 20 to 100 cattle to large ranches covering over 3,000 acres with a few hundred cattle). The District defines livestock as horses, cattle, sheep, and other useful animals kept or raised on farms or ranches; there are tools outlined below designed to protect each of those species. The ultimate goal is to promote and implement practical, effective animal husbandry practices that will allow livestock and carnivores to coexist on District properties.

Introduction

Midpeninsula Regional Open Space District's (hereafter "the District") mission is to provide opportunities for public enjoyment and education while conserving and restoring open space in perpetuity. Preserving these wild habitats requires maintaining the diverse array of native plant and animal species that play important roles in overall ecosystem health. One way in which the District achieves this goal is by implementing conservation grazing activities that simultaneously maintain natural processes in a landscape that coevolved with large grazing animals (Edwards 1996), help mitigate the impacts of nonnative species (Stromberg et al. 2007), as well as support the deep historic roots of livestock ranching in the Central Coast. Preserving the local plant community provides the foundation on which native wildlife persist. Among the species that indirectly rely on these healthy rangelands are the native carnivores, such as

mountain lions, coyotes, and bobcats. These populations both rely on and contribute to maintaining habitat integrity by helping regulate prey populations (Miller et al. 2001), reducing pest species density and disease transmission to humans (Ostfeld and Holt 2004, O'Bryan et al. 2018), etc.

Balancing these varied, and sometimes at odds, components of healthy open space habitats requires careful, dynamic management. The District is dedicated to fostering viable livestock production alongside a healthy carnivore community. To this end, this document explores strategies for preventing negative interactions between livestock and carnivores, thereby promoting sustainable conservation while protecting domestic animals, native carnivores, and human livelihoods alike.

The most common livestock on District property is cattle, however there are smaller operations with llamas, alpacas, sheep, goats, pigs, donkeys, mules, horses, chickens, and other species may be present in the future. This review addresses strategies to keep each of these types of livestock safe from predation by mountain lions, coyotes, domestic dogs, and bobcats.

Much of the current research on depredation prevention in North America has focused on interactions between coyotes and sheep, wolves and cattle, or wolves and sheep. In addition, experimental studies evaluating tool efficacy are rare (Eklund et al. 2017), and were most often developed in other parts of the country. Though there has been little research on mountain lion predation on cattle, especially in California, this review extrapolates results from studies focusing on interactions between other species, and combines that information with distinct facets of mountain lion behavior and ecology to provide guidance where rigorously tested data are lacking.

This document is meant to be as comprehensive as possible to allow District staff and tenants to weigh potential options, but it is by no means exhaustive. This review is informed by scientific research wherever possible, however, there is a significant scarcity of rigorous experimental testing within the field of livestock-carnivore conflict prevention (Miller et al. 2016, van Eeden et al. 2018). While the lack of research limits our ability to fully evaluate the efficacy of each method and weigh them against one another, there is appreciable amount information available to guide producer decisions. It should also be noted that there are legal restrictions on activities; some tools and techniques may be legal on a state or federal level, however they may not be currently permitted under District policies. All activities should be pursued in coordination with the District and granted written permission before implemented.

I. Carnivore Natural History, Management, and Ecology

Coyotes

Coyotes are a plains and grassland adapted species whose flexibility has allowed them to thrive in a wide variety of habitats. Before European settlers first arrived to the U.S., coyotes were mostly limited to the Central U.S. and Mexico. As humans extirpated wolves and expanded agricultural land throughout the 1800s, new habitat opened up for coyotes. Despite

heavy persecution via poisoning, trapping, and hunting, coyotes successfully expanded their range across the U.S. and into much of Canada (Agocs 2007, Levy 2012).

As human and livestock populations grew, so did conflict with coyotes. Though up to 90 percent of their natural diet consists of small mammals (Bekoff 1977), coyotes can predate on small to medium livestock (such as sheep, calves, fowl, etc.), and harass larger animals (such as cattle). The traditional approach to solving these problems has been to reduce or eradicate coyotes with the goal of reducing depredations. However, in order for these programs to be successful, a significant portion of the coyote population, roughly 75 percent, needs to be eliminated each year (Connolly and Longhurst 1975). This kind of eradication program is resource intensive, not practical in most locations, and runs counter to the District's mission. In addition, public attitudes have shifted over time and acceptance of predator eradication programs has diminished, making it increasingly important to find new tools for preventing conflict (Andelt 1996, Reiter et al. 1999, Bruskotter et al. 2009, Slagle et al. 2016).

New research has also begun to shine light on the important ecological role coyotes play by regulating smaller carnivores and indirectly increasing songbird and water fowl diversity and abundance (Soule et al. 1988, Rogers and Caro 1998, Crooks and Soulé 1999). Coyotes can also benefit livestock and their human counterparts. Coyote removal can allow rodents and rabbits to become more abundant, in some cases to the point of competing with livestock for forage (Henke and Bryant 1999, Ranglack et al. 2015). In addition, rodents can also have significant negative economic impacts on California's agriculture (Gebhardt et al. 2011). Left intact, coyote populations control rodent and rabbit populations as their primary prey species, which can help alleviate rodent-caused economic burdens on agricultural producers. A benefit extending beyond rangeland managers, by helping control rodent populations, coyotes can reduce the prevalence of rodent-borne zoonotic diseases as well (Ostfeld and Holt 2004, O'Bryan et al. 2018).

Tenant survey respondents indicated that solo coyotes do not pose a significant threat to cattle, but that group hunting is an issue (see Supplementary Materials Tenant_Survey). Research on pack formation suggests that coyotes may coalesce in groups in response to decreases in small prey and switch to larger animals, such as deer (Bowen 1981). In order to prevent coyotes from forming social groups, it could be beneficial to look into whether small prey item abundance has decreased on District properties (such as from rodenticide use), and whether there are ways to avoid reducing lagomorph and rodent populations. Research suggests that coyotes prefer native prey, and bolstering these populations may reduce feeding on livestock (Linnell et al. 1995, Sacks and Neale 2002). Other research suggests that coyotes may form packs in order to ensure pup survival (Messier and Barrette 1982). One way to manage this aspect of pack formation could be to modify or halt activities that decrease pup survival (such as culling adults during breeding season, restricting domestic dog access to areas with known dens, rodenticide use, etc.).

Informal tenant reporting also suggests that livestock grazing in pastures containing coyote dens or in close proximity to den sites are at greater risk of being harassed or killed. Coyotes living on District property appear to routinely use established den sites for rearing pups

year after year, and many of these sites are readily identifiable (Chaney, personal communication). If a particular pair of resident coyotes has a history of living in the area without depredating livestock, it may be in the producer's best interest to let them be; as removing the pair would open the territory, and it could become occupied by coyotes with a greater tendency to prey on livestock. However, if there have been injuries or depredation incidents, CDFW personnel suggest disrupting denning behavior (collapsing the den or filling it in with rocks) close to pupping season (usually May through June). A variation that might more closely align with District objectives would be to disrupt the den site during a time of year when the site is vacant (usually August through February). With the established den rendered inoperable, the breeding pair may decide to choose a new location in an area with fewer livestock, thereby reducing local depredation risk. CDFW has no specific restrictions on how property owners may alter unoccupied coyote dens on their property. However, in locations where special status species occur, consultation with CDFW may be required before collapsing dens.

In general, coyote predation may be higher in pastures that contain rough terrain, creeks, or brush sufficient to conceal a coyote – therefore, stocking younger or sick calves in more open habitat (where possible) could help improve safety (Pearson and Caroline 1981) (see Altering Pasture Vegetation and Grazing Regimes below). Similar to mountain lions, coyotes are more effective predators on cattle in closed habitat and/or rugged conditions than in open areas (Hulet et al. 1987, Jones 1987). Coyotes select for newborns, calves, and birthing cattle over adults, making it prudent to keep these groups in open pastures, behind coyote-proof fences (see fencing section for description), or protected by some other method to decrease risk to predation (Jones 1987, USDA 2015a).

Mountain Lions

Historically, mountain lions had the widest distribution of any terrestrial mammal in the western hemisphere, occupying habitat from the Yukon to the southern tip of South America (Logan and Sweanor 2001). Native to California, including San Mateo, Santa Clara, and Santa Cruz Counties, they were once widely distributed across the state and resided in nearly any type of habitat, from the Mojave to the Sierra. As an effective ungulate predator, almost everywhere deer were found, mountain lions could be found too.

As European settlers moved West and their population in California grew, conflicts with mountain lions increased. Mountain lions and other carnivores were subject to government eradication programs in an attempt to reduce their potential impact on livestock. Starting in 1907, mountain lions were classified as a "bountied predator," and over 12,000 mountain lions were harvested before the bounty was lifted in 1963 (data available from CDFW). Habitat models created by CDFW estimate that California's mountain lion population could have been as high as 6,000 (CDFW 2018), but by 1921, they speculated that eradication efforts had successfully reduced this "varmint" down by as much as 90 percent of the natural population statewide (CDFG 1921). This large-scale population reduction made mountain lion occurrences

rare in many parts of the state, including San Mateo County, and is likely the source of the perception that mountain lions are a newcomer or introduced to the Central Coast, despite historic records indicating their longstanding presence (Lawrence 1913, CDFG 1921, MVZ 1940, Field, 2003, Williams 2003, Marciel 2006, Dougherty 2007).

The bounty was repealed in 1963, and the species was reclassified as a "non-protected mammal." Six years later, they were once again reclassified as a "game mammal" so that wildlife managers could use regulated hunting in an attempt to curtail livestock depredations. Proposition 117 was passed in 1990, designating mountain lions a “specially protected mammal.” Mountain lions were not state or federally threatened or endangered, but Californians decided to protect the state’s last remaining apex carnivore. This title confers special protections against take of any variety without a depredation permit. In the years since the bounty was lifted and protections were put in place, mountain lion populations have made a significant recovery.[1] This relatively recent population rebound has likely contributed to the rise in depredations and human encounters with mountain lions.

Despite the attention mountain lion management has received over the last 100 years, surprisingly little is known about the size of California’s mountain lion population. Their cryptic nature and lack of individually identifiable traits, makes mountain lions notoriously difficult to survey. Recent habitat models created by CDFW suggest the statewide population is close to 3,000 individuals, however further research is currently underway to create a more finely tuned estimate (Dellinger 2018).

Mountain lions prefer to hunt away from human development, and even in rural or exurban environments with abundant secondary prey, roughly 98 percent of the biomass consumed by mountain lions comes from deer (Yovovich 2016, Wilmers et al. 2013). Though mountain lions strongly select for deer, they may opportunistically eat other prey items, such as opossums, raccoons, feral pigs, elk, or domestic pets and livestock (Yovovich 2016). Like most other carnivores, they will also opportunistically scavenge carcasses they encounter.

When mountain lions take livestock, it is more common that they take sheep or goats. Less than 10 percent of statewide lethal take permits are cattle-related (Dellinger 2018), despite there being far more cattle than goats or sheep in California (CDFA 2014). In most cattle depredation cases, calves are taken when they are smaller than 140kg (308lbs) (Shaw 1977).

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[1] Monitoring mountain lion population size at the state level is a logistically difficult and resource intensive. Though there is little direct measure of mountain lion populations in California through time, by piecing together data from a variety of sources, one can piece together indirect estimates of population size and trajectory. Harvest rates are often used as an index for population trends when suitable monitoring data are not available (Cattadori et al. 2003). Holding hunting effort constant, a change in the ability for hunters to harvest animals indicates a change in the animal population. Using bounty records in this same way could reflect patterns in the mountain lion population. Data collected by the state show a marked decline in bounties collected between the early 1900s and when the practice was ended in 1963, indicating that the mountain lion population likely declined during this period. State records of mountain lions harvested between the late 1960s and now, this time through hunting and depredation permits, remain low until the late 1970s, then rise through the 90s, and level off in the mid 90s. This could indicate that the population was greatly reduced by the early 60s, began to recover in the 70s and 80s, reaching a high point in the 90s, and has leveled off to some degree since then. (Bounty records and depredation data are available from CDFW)

Keeping cattle in close proximity to human activities or in protective structures during vulnerable times can successfully prevent depredations (Shaw et al. 1988, Linnell et al. 1996, Larson 2018). Though more appropriate for small-scale livestock operations, this may be a useful tool for temporarily isolating and protecting injured, sick, or other high-risk individuals. Mountain lions rely on stealth when hunting, making habitats with thick vegetation a higher risk for livestock. Feeding and watering livestock in open habitat where there is little cover to hide and stalk within a close distance can help increase livestock safety.

Bobcats

Bobcats inhabit a wide variety of habitat types across southern Canada into central Mexico. They primarily feed on rabbits, and rodents, though they may also consume birds, insects, ungulate fawns, and small livestock or domestic animals. Bobcats can be significant predators to pronghorn or deer newborns/fawns; however, predation risk rapidly decreases as wild ungulate young grow (Linnell et al. 1995). Bobcat predation on wild ungulate young is typically higher in forests than in mountainous or open areas (Linnell et al. 1996).

Though bobcats may prey on wild ungulate young, there is little evidence that they pose much risk to livestock. Research at Hopland Research Extension Center suggests that bobcats may scavenge sheep carcasses, but are not likely to hunt medium to large livestock, not even lambs (Neale et al. 1998). There is scant information in the scientific literature about the relationship between beef cattle or calves and bobcats, which could indicate that there has been little conflict between the two. One study addressing this directly found that bobcats were not responsible for cattle depredations of any variety (Scasta et al. 2017). This result is reflected in the livestock operator surveys conducted by District staff (see Supplemental Material Tenant_Survey). With all of this in mind, it is very likely that cattle and calves are simply too large for bobcats to pose a significant threat, however, they could prove problematic to chickens, fowl, or other small livestock.

II. Legal Status and Regulations

Coyotes

In California, coyotes are designated as a nongame mammal and may be hunted any time of year with no limit on number, provided that all other hunting laws and local regulations are followed (CCR14 §472). Any body-gripping traps, including Conibear traps, and snares are prohibited for recreational or commercial purposes (FGC §3003.1 and CCR 14, §465.5). As nongame mammals, coyotes that injure livestock may be taken at any time or in any manner in accordance with the Fish and Game Code by the owner, tenant of the premises, or employees thereof (FGC §4152 and §4180) assuming no conflict with local ordinances or regulations. In San Mateo, Santa Cruz, or Santa Clara Counties, dogs may be used by federal and county animal damage control officers or permittees to pursue or take depredating coyotes (FGC §265). CDFW does not live trap and relocate problem coyotes.

Bobcats

Bobcats are considered non-game mammals in the state of California. As such, they may be hunted in season, and hunters with appropriate tags may take up to 5 bobcats of either sex per season (14 CCR §478(b)). FGC §3960.6 allows livestock operators to use livestock guarding dogs to protect their domestic animals and property from bobcats as long as the dogs are maintained within or in close proximity to the property.

A bobcat caught in the act of injuring or killing livestock may be taken immediately, as long as a permit is obtained within 24 hours of the incident (14 CCR §401(a)). This depredation permit allows a landowner to use up to three trailing hounds to pursue, haze, or lethally remove the offending bobcat. The permit is valid for up to 20 consecutive days and may be renewed if depredations continue (14 CCR §401(b), FGC §3960.2). It is illegal to use steel-jawed leghold traps or poison, and the animals must be dispatched in a humane manner in which death is delivered instantly. Third party compensation for performing depredation services is illegal (FGC § 3960.2).

Coyote and Bobcat Hazing and Hunting Regulations

In 1998, California voters passed Proposition 4, which banned the use of sodium cyanide and sodium fluoroacetate (Compound 1080), two poisons employed by federal USDA WS trappers for killing coyotes, bobcats, and other carnivores. It also prohibited the use of steel jawed leg-hold traps and body-gripping traps for commercial and recreational trapping (CDFG 1998). Both non-lethal (with the proper permits) and lethal snares remain legal for trapping, animal damage management, and predator control purposes.

Hazing is legally permitted by CDFW code (14 CCR § 251.1 § 251.1. Harassment of Animals), which states the following, “except as otherwise authorized in these regulations or in the Fish and Game Code, no person shall harass, herd or drive any game or nongame bird or mammal or furbearing mammal. For the purposes of this section, harass is defined as an intentional act which disrupts an animal's normal behavior patterns, which includes, but is not limited to, breeding, feeding or sheltering. This section does not apply to a landowner or tenant who drives or herds birds or mammals for the purpose of preventing damage to private or public property, including aquaculture and agriculture crops.” The CDFW code does not enumerate every legal tool, however, yelling; throwing rocks; advancing on coyotes; shooting them with a water gun, rubber bullets, or other less-than-lethal munitions are permissible; as are other non-lethal tools (Kasteen, personal communication; Monroe, personal communication).

Mountain Lions

Though California Department of Fish and Wildlife does not currently have a formal mountain lion management plan, laws do restrict how humans may interact with them. Proposition 117 (FGC §4800-4809), passed in 1990, designated mountain lions a “specially protected mammal” in California, permanently banning mountain lion hunting, possession, and

take of any variety. The only context in which take is legally permissible is if a mountain lion poses an immediate safety threat, or a mountain lion threatens a human's personal safety or the safety of their livestock or companion animals. In those cases, state law requires CDFW to issue a depredation permit for the offending animal, or appropriate responding agents can lethally remove an individual animal. A game warden or other authorized agent may visit the site in person to verify that the animal responsible for the incident was a mountain lion, however in some cases, a permit may be issued over the phone. A mountain lion caught in the act of injuring or killing livestock or domestic animals, may be lethally taken immediately by the owner of the property, an employee, or agent of the property owner, provided the incident is reported to CDFW within 72 hours. At that point, CDFW personnel will investigate and verify the incident (FGC §4800-4810).

A depredation permit allows one mountain lion to be killed or harassed, and expires 10 days after it is issued. The permittee is allowed to begin pursuing the mountain lion no greater than one mile from the depredation site, and the pursuit is limited to a 10-mile radius from the initial incident. Under a depredation permit, a mountain lion must be dispatched in an efficient and humane manner in which death is delivered instantly; they may not be poisoned, trapped by leg-hold or metal-jawed traps, or snares. If depredations continue to occur, the livestock operator may apply for additional permits (FGC §4800-4810).

There are two notable exceptions to the general depredation process, the Santa Ana Mountains and the Santa Monica Mountains. These two locations have a few characteristics in common; they are each home to an isolated population of mountain lions in danger of extirpation within the foreseeable future (Ernest et al. 2014, Benson et al. 2016), and a growing number of ranchette-style development and associated small-scale livestock. This intersection of vulnerable livestock and a precarious mountain lion population elicited special attention from state biologists. In 2017, CDFW decided to provide extra support to livestock operators in the region and redefine how the state manages depredation incidents in these two areas.

In these two locations, if a confirmed depredation event occurs (FGC §4803), CDFW will grant permission to the livestock operator to haze the depredating mountain lion if "the immediate pursuit will assist in the non-lethal removal of the mountain lion from the property" (FGC §4805). In addition, the responding agent will discuss potential preventative tools for preventing further depredation incidents. If a second depredation event occurs in a timeframe that "suggests an affinity for the site," the livestock operator is again granted permission to haze the offending individual and the issuing agent will suggest additional preventative tools. If a third event occurs in a similar time window, and the livestock operator requests a lethal removal permit, the permit will be granted.

In 2013, Senate Bill 132 (FGC §4801.5) was passed, creating new protocols and protections for "no harm no foul" mountain lions that wander into human-populated areas and do not pose an immediate public safety threat. This law allows CDFW staff to partner with other qualified organizations or individuals to safely tranquilize and transport mountain lions a safe distance from humans and re-release the individual into habitat from which it may have come. Animals are usually released in a location within their likely home range, which makes this tool

distinct from translocations in which animals are transported into new habitat with the goal of reestablishing that animal in a new territory where it is unlikely to encounter humans. In the case of translocations, animals may return to the area in which they were captured, resume their previously problematic behavior, and/or suffer high mortality rates in their new location. Translocation as a conflict management tool is resource intensive and does not improve the underlying husbandry context in which the issue arose (Linnell et al. 1997). CDFW does not currently use translocation as a tool for resolving conflicts between mountain lions and humans. As mentioned above, there are rare situations in which CDFW will move a mountain lion a short distance, such as in the event that a one is found in an urban or suburban area and it is displaying nonaggressive behavior. In such a case, local agents may tranquilize and move the mountain lion back into the nearest suitable habitat from which it most likely originated (with permission from the owner of the release site property).

Domestic Dogs

Fish and Game Code governs how to manage interactions between dogs and native ungulates (see FGC § 3961), while Civil Code manages dog-livestock interactions. Section 31103 states that "any dog entering any enclosed or unenclosed property upon which livestock or poultry are confined may be seized or killed by the owner or tenant of the property or by any employee of the owner or tenant," and goes on to say that "if a livestock owner suffers injuries from livestock killed by dogs and the owner cannot be identified, he may recover from the county in which the damages occurred." The dog owner may be liable for up to twice the amount of the actual damages inflicted by the dog (Cal. Food & Agric. Code § 31501). Civil Code (Ch 5 §31102) allows any person to kill dogs caught in the act of killing, wounding, or harassing livestock on land or premises which are not owned or possessed by the owner of the dog, or if proof is presented that conclusively demonstrates that the dog has been recently engaged in killing or wounding on land not owned or possessed by the dog's owner.

District Land Use Regulations

The District follows management policies that ensure proper care of the land, that provide public access appropriate to the nature of the land, and that are consistent with ecological values and public safety. All District lessees, contractors, consultants, agents and representatives shall abide by all provisions of the below ordinances unless the provision(s) conflicts with a written contract or agreement with the District. Some of these regulations directly relate to potential actions meant to deter depredation. Exceptions to these regulations can be made by written agreement. Pertinent ordinance sections are detailed below:

Section 403. Firearms, Traps, Weapons, and Dangerous Devices

403.1 General.

a) No person shall carry, possess, use, set, leave or deposit, fire or discharge, or cause to be fired or discharged, across, in, on, or into any portion of District Lands any gun or firearm, spear, missile, bow and arrow, cross bow, sling shot, trap, snare or hunting

device, ammunition, throwing knife, hatchet, axe, sword, machete, martial arts throwing device, any device capable of firing or launching a projectile, or any other weapon or device not otherwise specified, capable of injuring or killing any person or animal. Violation of this sub-section is punishable as a misdemeanor.

b) No person shall carry, possess, set, leave or deposit, fire or discharge, or cause to be fired or discharged, across, in, on, or into any portion of District Lands any paint ball gun, BB gun, air gun or similar device.

403.2 Exceptions. This section shall not apply to:

a) the possession of otherwise lawful unloaded firearms or dangerous weapons on public roads solely for the purpose of transporting such firearms or dangerous weapons through District Lands for lawful purposes;

b) the possession of otherwise lawful firearms or other dangerous weapons at a place of residence or business located on District Lands by a person in lawful possession of the residence or business;

c) the possession and use of such firearms or weapons granted by written permit for resource management or educational purposes

Section 700. Hunting, Fishing, Collecting, and Feeding

700.1 Hunting.

No person shall possess, hunt, pursue, molest, disturb, injure, trap, snare, take, net, poison, introduce, release or harm or attempt to hunt, pursue, molest, disturb, injure, trap, take, net, poison, introduce, release or harm any mammal or bird, or any other wild animal living or dead. This section shall include taking of any part of the mammal or bird. Violation of this sub-section is punishable as a misdemeanor

Section 701. Animals.

701.1 Dogs.

a) No person shall have more than three dogs per person within areas where dogs are allowed on District Lands.

b) No person shall allow or have a dog on District Lands except in those areas designated by the District. This subsection shall not apply to:

1) guide and service dogs under physical control, specifically trained to assist the blind, deaf, or disabled;

2) guide and service dogs in training to assist the blind, deaf, or disabled, and under physical control, and participating in a training program,

3) use authorized by written permit.

c) Leash Required.

No person shall allow or have a dog on District Lands, unless the dog is at all times under control, and on a leash not to exceed 6 feet, or on a self-retracting leash with a maximum extended length of 25 feet. The leash must be held by person responsible for the dog and must be made of material and construction sufficient to restrain the dog. Electronic or other "invisible leashes" do not meet the leash requirement. The self-retracting leash must have the capability of being retracted and locked in a position not to exceed 6 feet. Within a designated area, no person shall have or allow a dog on a lead greater than 6 feet when:

1) Within 100 feet of any parking area, trailhead, picnic area, campground, horse stable, public roadway, restroom, visitor center, ranger station, or other place or structure of public assembly;

2) Within 50 feet of any person that is not the person or persons who entered District lands with the dog; or

3) Within 50 feet of any District Water Area.

4) When the dog is not visible to the owner

d) Off-Leash Areas.

Dogs shall be permitted off leash only in areas specifically designated and signed by the District as off-leash areas. No person shall allow or have a dog in an off-leash area unless the dog is at all times under the verbal or radio collar control, and in sight of, its owner or person responsible for the dog. The owner or person responsible for the dog shall have a leash in his/her possession at all times.

e) Nuisance Dogs.

No person shall allow or have on District Lands a dog that is a nuisance to people, other animals, or property. This includes, but is not limited to: growling, excessive barking, scratching, jumping on any person or animal, or challenging in any manner, people, animals, or property.

f) Dogs in Water Areas.

No person responsible for a dog shall allow said dog to enter any District Water Area unless it is specifically designated to allow such entry.

g) Dangerous Dog.

No person shall allow or have on District Lands a dog that exhibits dangerous behavior including, but is not limited to: attacking, biting or causing injury to any person or animal. Violation of this section is a misdemeanor.

701.2 Disturbance or Injury to Wildlife.

No person shall allow a dog, cat, or domesticated animal, even if leashed, to disturb, chase, molest, injure, or take any kind of wildlife, whether living or dead, or remove, destroy, or in any manner disturb the natural habitat of any animal on District Lands. Violation of this sub-section is punishable as a misdemeanor.

701.3 Horses and Livestock.
No person shall keep, raise or allow cattle, horses, sheep, or other livestock on District Lands, unless pursuant to a lease, license, written permit, or other entitlement of use granted by the District. Violation of this sub-section is punishable as a misdemeanor.

701.4 Other Pets.
No person shall allow or have any pet, domesticated animal, or other animal on District Lands, unless specifically permitted by another section of these regulations.

III. Direct and Indirect Predation Impacts

Carnivores can have direct (such as injuring or killing) as well as indirect (such as harassing, persistent stress, etc.) impacts on livestock. Regardless of the outcome, these impacts can deliver significant economic costs to producers (Muhly and Musiani 2009). When ranchers are able to locate a carcass and determine whether the animal was lost to a carnivore, the economic impact to the producer can be quantified to some degree. However, indirect predation costs are far more complex. Recent research has begun to attempt to measure the impacts that carnivore presence and activities may have on livestock, and quantify the costs related to increases in stress, such as failure to gain weight, reduced reproductive output, additional livestock handling labor, etc. (Ramler et al. 2014). In addition, indirect costs may arise from lost genetic stock held within a depredated individual, training, and other difficult to measure internal factors. Every livestock animal represents generations of selective breeding. When that animal is killed, the profit from that individual is lost, and it also represents lost cost in the years invested by the rancher, as well as an opportunity cost to the future genetic potential of that lineage (Naughton-Treves et al. 2003). In fact, new research has shown that while ranches with resident wolves may not experience negative indirect impacts from wolf presence alone, ranches with a confirmed depredation incident may incur indirect costs greater than the cost of the depredation loss itself (Ramler et al. 2014).

National and Local Depredation Losses

Nationwide, and in California, non-carnivore sources of mortality, such as respiratory illness, foul weather, or calving related problems, dwarf the impact of predation (Table 1). In 2015, carnivore predation accounted for 2.4 percent of cattle mortality and 11.1 percent of calf mortality across the U.S., whereas non-carnivore sources accounted for 97.6 percent and 88.9 percent of cattle and calf mortality respectively. It is important to recognize, however, that depredation rates vary regionally and by livestock operation type. For example, beef calves and cattle may have depredation rates several times higher than dairy operations, and grizzly bear depredations are much more likely to be an issue in Idaho than in Oklahoma (USDA 2015a). On a more local scale, depredation rates can vary dramatically on a parcel-by-parcel basis (Treves et al. 2004). For example, overall livestock loss for the District as a whole has not exceeded 2 percent for any given year in the last 4 years. However, loss to a single producer has been as high as 6.98 percent in a year (Table 2).

In California, 1.1 percent of reported mature cattle mortality was attributed to carnivore predation, and 5.8 percent of reported calf mortalities were attributed to carnivore predation in 2015. Non-carnivore mortality sources accounted for 98.9 percent of adult cattle mortality, 94.2 percent of calf mortality. These various mortality sources amounted to an overall 2.4 percent of cattle inventory lost, and predation accounted for less than 0.1 percent of this overall lost inventory. For calves, non-carnivore mortality sources accounted for 6.6 percent overall calf crop loss, and predation accounted for 0.4 percent overall calf crop loss (Table 1). Even at such low rates, predation cost the state's livestock industry $1,896,631 in lost cattle and $4,789,565 in lost calves, and can have far greater proportional impact on individual operations (USDA 2015a).

Mortality Source	Percent Livestock Inventory Lost	
	Cattle	Calves
Predation	>0.1	0.4
Non-Predation	2.4	6.6
Respiratory Problems[1]	0.6	2
Mastitis	0.3	>0.1
Digestive Problems[2]	0.3	1.5

Table 1: Percent California's overall cattle and calf inventory loss derived from the most common mortality sources. Predation mortalities are the pooled losses to any carnivore found within California (wolves, mountain lions, bears, coyotes, domestic dogs, etc.). Non-predation mortalities are the pooled losses from any non-predation source (including respiratory issues, mastitis, lameness, etc.). At the state level, illnesses from respiratory or digestive issues are responsible for more calf and cattle deaths than depredations from mountain lions or coyotes, or all of the carnivore species combined. However, mortality sources on a local level may vary widely. (Data calculated from USDA 2015a)
[1]Such as pneumonia or shipping fever.
[2]Such as bloat, scours, parasites, enterotoxaemia, or acidosis.

On District grazing allotments, there has been a growing incidence of livestock depredation. Though livestock producers operating in the Central Coast have been ranching alongside carnivores for generations, and under District management since 2007, as local carnivore populations have recovered in recent years, depredations and other conflicts between livestock and carnivores have increased. In recognition of this growing trend, the District started a compensation program in 2013. Between the program's inception and 2017, overall carnivore-derived cattle mortality ranged from 0.18 to 1.18 percent between 2013 and 2017 (Table 2). This

costs the District an average of $2,760 a year in livestock compensation, and $19,319 total (Table 3). Tenants reported livestock harassment by groups of coyotes, but none was able to quantify the costs incurred (Supplementary Material Tenant_Survey). Some mentioned that they thought stress, failure to gain weight, and failure to rebreed were likely costs. None of the tenants surveyed listed increased labor or preventative tools as added costs (Appendix 1 and Appendix 2 for additional information on mountain lion depredations in California).

Year	Stocking Rate	Animals Lost				Percent Lost
		Steer	Heifers	Calves	Total	
2013	237	2	0	0	2	0.84
2014	509	0	4	2	6	1.18
2015	575	0	0	4	4	0.70
2016	554	0	0	1	1	0.18
2017	563	0	0	2	2	0.36
2018	623	0	0	7	9	1.18
Total	3,175	2	4	18	24	0.72

Table 2: Reported cattle losses to confirmed carnivore depredations on Midpeninsula Regional Open Space District grazing allotments (Supporting document Grazing_Data.xlsx and Depredation 2013 to 2017.xlsx). The percent loss is expressed as the overall loss for the District. Individual livestock operation loss ranged from 0 to 6.98% of livestock managed. Of the 22 total confirmed losses reported between 2013 and 2018, 16 were determined to be from mountain lions, and 6 were lost to coyotes.

Year	Animals Reimbursed			Reimbursement Costs
	Steer	Heifers	Calves	
2013	2	0	0	$1,890.00
2014	0	***6***	2	$7,330.00
2015	0	***4***	4	$4,308.00
2016	0	***1***	1	$693.00
2017	0	***2***	2	$1,399.00
2018	0	**0**	7	$3,699.00
			Total	$19,319.00

Yearly Average	$2,760.00

Table 3: Confirmed depredation reimbursement costs from Midpeninsula Regional Open Space District paid to tenants for 2013 to 2018 (Supporting document Predation reimbursement.xlsx and Depredation 2013 to 2017.xlsx). Bold and italicized numbers include heifers that were killed as well as those who were not killed but did lose their calves. As such, rent for heifers that lost calves was expunged.

While Tables 2 and 3 account for livestock killed by carnivores, harassment and injuries can bring about indirect costs such as failure to gain weight, spontaneous abortions, increased labor, and other expenses that are difficult to measure (Ramler et al. 2014). Data on livestock harassment and the resulting potential changes in stress, movement patterns, productivity, susceptibility to disease, etc. are poor and the overall picture is not well-understood (Ramler et al. 2014, Clark et al. 2017). Clark et al. (2017) found that cattle living in wolf country had shorter daily movement patterns than those living in wolf-free areas, but these results were not tied to any sort of fitness outcome. Other research found that wolf presence did not negatively impact cattle, however, they did find that the weight of calves living on ranches with a confirmed wolf depredation decreased by 3.5 percent, or 22 pounds, for that year (Ramler et al. 2014). This translated into an average of $6,679 loss across the 264-calf herd at the time of sale.

At this time, wolves are not an issue with which the District's producers need to be concerned, but there are no similar data available for cattle harassment by coyotes, bobcats, or mountain lions. One can imagine that wolves present a more extreme version of coyote damage, and this could provide a helpful context for anticipating potential damages on District properties.

The USDA (2015a) provides some data enumerating the cost of wounds dealt to cattle in California by carnivores. They estimate these costs at $550,000 for injured cattle and $571,000 for injured calves in California for 2015 (these estimates assume that the animals had no value after they were injured). Unfortunately, these costs are not broken down by carnivore species.

Impacts by Species

According to national data collected by the USDA (2015a), the four main carnivores discussed in this review can be ranked in order of potential negative impacts to cattle and calves as follows:

Coyotes >> Dogs > Mountain Lions > Bobcats

In California, where mountain lions are more common than in other parts of the country, the relative ranking changes slightly:

Coyotes > Mountain Lions > Dogs > Bobcats

According to the District's tenant survey, the ranking is as follows:

Mountain Lions > Coyotes > Dogs

Half of the tenants surveyed classified predation as a critically important management issue, two thirds ranked it as important, and the remaining tenant ranked predation as not important. Other than the producer who thought predation was not important, all of the tenants have had predation issues on leased land, and almost all of the conflict was with mountain lions. Some tenants felt that coyotes pose little threat to cattle unless they form packs, or attack young or sick calves. There was also concern expressed about the stress of coyotes harassing cattle. None of the District tenants surveyed gave accounts of incidents involving domestic dogs or bobcats.

Mountain Lions

The level of impact mountain lions have on livestock operations varies greatly depending on the habitat (open grassland, rugged mountains, etc.), livestock species (cattle, goats, or sheep), operation type (cow-calf, steer, etc.), and location (California, Iowa, Colorado, etc.). Accounting for less than 1 percent of cattle or calf deaths across the U. S., mountain lions do not appear to have a nationally significant impact on cattle operations (USDA 2015a). However, it is important to remember that mountain lions were extirpated from the Eastern U.S. and Midwest over a century ago; excluding livestock that do not live in mountain lion country will increase the percentage of cattle or calf deaths in this calculation considerably (Shaw et al. 1988, Cougar Network 2018).

In most western states with healthy mountain lion populations, cattle depredation is an infrequent issue. For example, mountain lion research conducted in Colorado found that with over 200 mountain lions collared, and ample cattle on open range, there was not a single incidence of loss to mountain lions between 2004 and 2013 (Logan, personal communication). In New Mexico, mountain lion researchers documented cattle, including newborn calves, and mountain lions sharing habitat without any cattle killed in 10 years of study (Logan and Sweanor 2001). In that area, herds were composed of cow-calf groups with few bulls.

However, research conducted in Arizona, where there is a more temperate climate and year-round grazing, found contrasting results. This work indicated that livestock operations with year-round grazing and early season calving may be more susceptible to depredations (Shaw et al. 1988) (For a chart of seasonal versus year-round grazers on District property, see Appendix 3). These data support observations on District properties were mountain lion depredations are the most common form of carnivore conflict and are the greatest concern with respect to depredation management (Supplemental Material Tenant_Survey).

Significant differences in mountain lion versus wolf hunting styles likely makes the indirect impacts mountain lions may have on livestock far lower than is the case with wolves. Wolves are cursorial predators, which means they use a prolonged chase that can last upwards of several miles to select and subdue their prey (Kauffman et al. 2007, Wikenros et al. 2009). Mountain lions, on the other hand, are ambush predators that rely on stealth and surprise to capture their prey (Williams et al. 2014). As such, mountain lions are much less likely to chase

or harass cattle and other livestock, and ranchers operating in mountain lion country are much less likely to suffer from these indirect predation costs.

Coyotes

Nationally, dogs and coyotes are responsible for more livestock depredations than all other carnivores combined (USDA 2015a, USDA 2015b). This elevated risk could be related to the fact that coyotes are also the most widely distributed carnivore in the U.S., so probability alone would work in their disfavor. That being said, coyotes can reach higher population densities than mountain lions, live in closer proximity to people, and make use of more marginal habitat, potentially putting them at greater odds with livestock (Fedriani et al. 2001, Gehrt et al. 2010). Though they tend to pose a more substantial risk to sheep and goats, among carnivore-derived mortality across the U.S. in 2015, coyotes accounted for the highest percentage of cattle (40.5 percent) and calf (53.1 percent) depredations (USDA 2015a). Coyotes present a higher danger to newborns, sick calves, and cows giving birth than to adult cattle, and tend to be more lethal to dairy calves than to beef calves (USDA 2015a). There are numerous mentions of coyotes harassing and/or injuring cattle in scientific literature, however, data on rates, impacts, and associated costs are scant (Dorrance 1982, Jones 1987, Shwiff et al. 2016, Larson 2018).

The size difference between cattle and coyotes may work in cattle's favor. Cattle often stand their ground and may even cooperatively charge coyotes threatening their calves. This type of aggressive behavior may also deter further harassment. In some situations, cattle have been added to groups of sheep to protect them against coyote predation (Hulet 1987).

Domestic Dogs

In some geographic locations, domestic dogs may pose a significant risk to livestock. In 2015, dogs were responsible for 11.3 percent of cattle and 6.6 percent of calf losses to predation, and in 2014, dogs were responsible for 21.4 percent of sheep and 10.3 percent of lamb depredations across the U.S. (USDA 2015a, USDA 2015b). Direct as well as indirect impacts on livestock by dogs can be significant, and in some areas, greater than other sources of predation (Young et al. 2011). Even when dogs fail to kill livestock, they can injure or persistently worry animals. Dog depredation or harassment is generally more of an issue on the urban-wildland interface, making it a potential concern for the District. Domestic dogs guilty of livestock harassment or depredation are often friendly to humans, increasing the difficult of determining the culprit. Further interfering with a proper identification, dogs can deliver injuries difficult to distinguish from other predators, and may participate in "excess killing" where multiple animals are injured or killed and not consumed (Jennens 1998). One study found that free-roaming domestic dogs consumed, and likely killed, more livestock than local wolves (Echegaray and Vilà 2010). In addition, dog predation may be a growing concern; California producers anecdotally report an increase in free-ranging dogs associated with marijuana production in some regions (Macon et al. 2017). Though dogs are not currently allowed on any of the preserves that have cattle, this could also be a future concern as this policy may change in the coming years.

Bobcats

Bobcats pose little threat to large livestock, especially cattle. As such, it is likely unnecessary to put specific animal husbandry practices in place to protect cattle or any other large livestock from bobcat depredations or even injury. In 2015, bobcat and lynx predation combined accounted for 1.4 percent of beef cattle predation losses nationally, and 0.0 percent in California (USDA 2015a). In 2014, bobcat and lynx predation accounted for 0.11 percent of lost lamb, and 0.2 percent of adult sheep crop nationally, and 0.0 percent in California (USDA 2015b). Other studies found that bobcats may scavenge livestock carcasses, but are unlikely to be responsible for killing any large livestock, such as cattle, sheep, or equines (Neale et al. 1998, Scasta et al. 2002). They may take smaller animals, such as chickens, turkeys, fowl, or piglets. These sentiments were shared by the District livestock operators surveyed, who said that bobcats may eat chickens, but were not considered a threat to cattle (Supplementary Material Tenant_Survey).

IV. Local Indemnification and Depredation Prevention Programs

Most local land management agencies do not have formal depredation prevention or response policies. For many of these agencies, depredations do not pose a significant challenge, allowing them to handle each depredation on case-by-case basis (e.g. EBMUD and NPS). For example, Point Reyes National Seashore and the Golden Gate National Recreation Area, operated by NPS, have had very little depredation pressure and have been able to deal with incidents as they arise. Others, on the other hand, have had significant depredation challenges and have designed policies to help support local livestock operators. Marin County implemented the most formal of these policies, a depredation prevention and indemnification program called the Marin County Livestock Protection Cost-Share and Livestock Loss Compensation Programs. This program compensated livestock operators for losses to carnivores and helps cost-share preventative tools for livestock protection.

National Park Service Point Reyes (NPS) Livestock Grazing

NPS operates 28,000 acres of rangeland with around 6,000 head of cattle run by 24 ranching families (six dairy operations and 18 beef), and a couple other smaller sheep and chicken operations in Marin County. Ranch size ranges from 30 to 35 head on 230 to 330 acres to 856 head on 1076 acres. There are bobcats, coyotes, and mountain lions in the area, but depredation has not been a significant issue in the recent past. Since 2011, there have been fewer than a dozen reported depredations. In each of these instances, coyotes took beef calves that had wandered away from the herd. There was one case that may have been a mountain lion, but the parties involved were unable to confirm the species of carnivore involved. Lethal removal is usually reserved for animals that pose an immediate human safety risk, rather than for depredation, and no animals have been lethally removed for livestock depredations since before 1997.

On these NPS lands, federal law supersedes state law, so CDFW does not have jurisdiction and the depredation policies governing the rest of California are not applicable. Incidents are reported to NPS and a course of action is decided for each individual situation. Any preventative tool is subject to review by NPS before it can be implemented. Livestock guarding dogs have been approved for one small sheep operation and one chicken operation. None of the other operations are currently utilizing any approved depredation prevention techniques, but NPS would consider other alternative tools, such as frightening devices, or livestock guarding donkeys or llamas.

The NPS Management Policies (2006) state, "native predators, scavengers and prey are all integral to healthy native ecosystems and are protected by NPS Management Policies. The occasional damage that is caused by wildlife, to fences, ranching structures, agricultural animals and livestock forage, is to be expected on permitted lands. Lessee shall not engage in any activity that causes harm to or destroys any wildlife. Conversely, Lessee shall not engage in any activity that purposely supports or increases populations of non-native or invasive animal species. On a case-by-case basis, the Lessor will evaluate incidences of depredation and choose a course of action. The nature of the course of action taken, if any, will be determined by the wildlife species, the extent and frequency of the damage and park-wide management objectives." On Point Reyes National Seashore and the Golden Gate National Recreation Area properties, ranchers are indirectly compensated for any predation costs they may incur by offering a reduced grazing fee of $7.00 per AUM. This reduced cost takes into account the overarching principle that local ranchers are operating under strict NPS guidelines and are not able to manage their operations with as much flexibly as they could under other land designations (Press, personal communication).

Local Compensation and Depredation Prevention – Marin County Program (MCP)

The Marin County Program was one generally focused on sheep depredations, however, the principles and structures may serve as a model for a program geared toward cattle or livestock more broadly. Before 1999, Marin County was spending $60,000 each year on lethal coyote control, however, livestock (mostly sheep) losses were still a regular occurrence (Agocs 2007). In 2001, the County decided to discontinue its contract with Wildlife Services (WS) and replaced it with a county-run preventative program originally designated the Marin County Strategic Plan for Protection of Livestock and Wildlife. The WS federal trapping program was phased out, however, the new program did not impede ranchers from lethally removing carnivores from their own property. Slated to run for a five-year pilot period, the program redirected county funding that would have supported USDA trappers into assistance for ranchers implementing non-lethal carnivore deterrent tools, such as livestock guarding dogs, fencing improvements, birthing sheds, etc. When the pilot program ended in 2005, the County shifted to approving funding on an annual basis, and now the MCP has become an established county program. Each year, the Marin County Department of Agriculture conducts a meeting with

ranchers to evaluate the program and to solicit recommended changes to program operations (Larson 2006, Fox 2008).

Indemnification Program Overview

The original county-run program design did not include an indemnification program, but one was added at the request of the local ranching community. In order to receive compensation for depredations, ranchers were required to be an active participant in the proactive cost-share predation prevention program and to have at least two non-lethal livestock predation deterrents in place. These deterrents were verified and documented during an onsite ranch visit by the County Agricultural Commissioner's office. Once a ranch has been deemed qualified for indemnification, any losses suffered from that date on are eligible for compensation. When losses occurred, livestock operators needed to report losses to the Marin County Agricultural Commissioner's office by telephone, as well as to the University of California Cooperative Extension (UCCE) through a monthly mailed "livestock loss" card. UCCE provided third party loss verification and maintained a central database for depredation records. When necessary, onsite verification visits were performed by the Marin County Agricultural Commissioner's office (Larson 2006, Fox 2008).

Depredation compensation payments were made for each animal based on market value (calculated on a 3-year average of market rates for lamb at a weight of *ca.* 100 lbs.), up to $2,000 per year for ranchers managing operations larger than 200 head, and up to $500 per year for ranchers managing fewer than 200 head. Operations below 200 head were not considered commercial and were ineligible to participate in the MCP. In addition, show animals and special breeding stock were not eligible for indemnification. Confirmed depredation payments were made twice a year, once in June and once in December, through the Marin County Agricultural Commissioner's office. If the cumulative market value for the animals lost that year exceeds the available funds, compensation payments were prorated. At the end of each year, ranchers were required to sign an affidavit verifying their livestock loss claims (Larson 2006, Fox 2008).

Cost-Share Program Overview

The initial proposal was to have cost-share funds administered by a third party, such as the California Woolgrowers Association. However, after meeting with local livestock operators, it was decided that Marin County Agricultural Commissioner's office would administer the program. The MCP was designed in collaboration with ranchers, the Agricultural Commissioner's office, and the Farm Advisors office. Projects eligible for cost-share reimbursement were any material or property improvements that deter depredation, such as fencing, barriers, and birthing sheds; as well as animal husbandry strategies such as shepherding, penning, livestock guardian animals, noisemakers, and any other non-lethal carnivore protection measures or animal husbandry practices (Larson 2006, Fox 2008).

To submit a reimbursement claim, livestock operators needed to complete a form documenting the specific activity employed, and the costs for which funds were being requested.

Ranchers were required to contact the Agricultural Commissioner's office and set up an on-site review to be conducted by either the Agricultural Commissioner's staff or the Cooperative Extension's local Livestock and Range Management Advisor. After the activities were verified, the County Inspector and/or the Livestock Advisor would submit the claim to the Agricultural Commissioner for review. Once approved, an invoice for the amount of the claim would be submitted to the Treasurer's office and a check in the name of the respective rancher was issued. Once a year, a County Inspector or the Livestock Advisor would visit each participating ranch to verify that subsidized predation deterrents were in place, as well as make recommendations for additional potential deterrents or animal husbandry practices (Larson 2006, Fox 2008).

The most common purchases that the program helped cost-share were fences (electric, patch, and cross fencing), livestock guardian animals (dogs and llamas), and protective pasture corrals. Ranchers utilizing guardian animals were eligible to receive $250 to help defray animal maintenance costs, such as vet bills and food. This $250 pool of funding for animal care counted towards the cap set for that livestock operation size ($2,000 for operations greater than 200 head and $500 for operations smaller than 200 head) (Larson 2006, Fox 2008).

Outcome

Nearly all of the commercial sheep operations in the region participated in the MCP (Fox 2008), however, by 2009 program officials decided that the benefits provided by the indemnification program were outweighed by the implementation cost. The compensation portion of the MCP was terminated, and funds were redirected to support cost-sharing preventative tools such as fencing improvements, shepherding, changes in animal husbandry, livestock guarding animals, etc.

Overall, this program has increased the use of non-lethal deterrents, reduced depredations, reduced lethal removal, and increased support for preventative tools (Fox 2008). A study on the program indicated that livestock losses decreased by over 25%, while program costs were reduced by nearly 20% per year (Agocs 2007, Fox 2008). Participating livestock operators indicated that they were with the MCP, with most ranchers reporting a high degree of satisfaction with the program's level of cost-sharing and depredation compensation rate. In addition, overall lethal carnivore removal decreased by over 50% (Fox 2008).

Key Points to Consider

As the MCP ultimately found, compensation schemes can be very expensive and difficult to administer. In many cases, locating dead livestock and having them inspected in the timeframe required for positive verification can be incredibly difficult (Linnell and Brøseth 2003). Some research goes so far as to suggest that compensation schemes may be counterproductive, rewarding passivity and failing to motivate producers to adopt effective mitigation strategies (Boitani et al. 2010). There are, however, ways to overcome some of these issues, such as attaching conditions on the payments (e.g. setting minimum husbandry requirements, or stepwise payments scaled to the level of preventative measures in place), cost-sharing, or compensating producers for carnivore presence rather than depredations. This last approach of conservation performance payment scheme could help encourage producers to adopt

carnivore-compatible husbandry practices by incentivizing coexistence. In this type of system, financial incentives reward stewardship that allows livestock and carnivores share habitat; the payments offset the risk, as well as the indirect impacts carnivores impose on livestock (see "Direct and Indirect Predation Impacts" above) rather than paying for difficult to measure damages after they are incurred. The main requirements for a payment-for-presence system are that the parties involved agree on a fair rate of payment, fiscal support for the payments is secured, and a system is put in place to accurately document carnivore activity.[2] In addition to promoting coexistence, a payment-for-presence program would support monitoring native wildlife on District properties, an outcome aligned with the District's mission.

V. Conflict Prevention Tools

Creating and maintaining a livestock operation in which livestock and carnivores may flourish is an iterative and dynamic process. It will involve producers leveraging intimate familiarity with their particular operation to select appropriate preventative tools, and adaptively managing their practice as new situations arise. There are many different strategies and tools available to help livestock operators protect their livestock and coexist with carnivores. These tools can work on one or more pathways by altering human behavior, carnivore behavior, and/or livestock husbandry practices (Shivik 2004). A lack of consensus on when a particular tool or set of tools will be most effective makes it difficult to determine when to use which approach. The practicality and efficacy of any particular tool will depend on the type of operation, livestock species and products being produced, topography, carnivore community, native ungulate community, producer familiarity with and confidence in a given tool, associated cost-benefit considerations, public perception, and many other factors (Miller et al. 2016, Eklund et al. 2017). For a summary table of tool efficacy for each carnivore species, see Appendix 4. Every ranch is different, and local producers must weigh a unique set of site-specific considerations when

[2] In order to create a successful conservation performance payment program, administrates must first select indicators of carnivore presence, decide how these indicators will be monitored, and determine how the monitoring results will be used to inform compensation payments. Other programs have used the presence of carnivore offspring as the indicator for carnivore presence (Zabel and Holm-Müller 2008), however, depending on the monitoring technique, it may prove logistically simpler to use any age individual. Carnivore presence could be monitored indirectly via camera traps or scats (e.g. surveys, such as in Gese 2001; or genotyping scats, such as in Prugh et al. 2005), or directly through mark-recapture (review in Gese 2001). For a review of monitoring methods, see Gese 2001 or Gompper et al. 2006. The amount of payment should be calculated by the monetary damage the offspring are expected to cause over the course of their life. Because depredation rates on District properties are relatively low, this calculated amount could be too small for a pay-for-presence program to be attractive to tenants. Benefits to a pay-for-presence program include compensating livestock producers for hard to document costs, such as livestock harassment; removing the burden of searching for animals killed by carnivores in the timeframe necessary for validation; removing the administrative burden of verifying predation events; eliminating potentially contentious verification events in which trust between producers and administrators may be eroded. The largest benefit this type of program creates is that it provides producers with a higher incentive to both keep carnivores alive, and to be proactive about protecting livestock.

selecting appropriate tools. It is also important to recognize that every producer has a unique perspective and set of experiences that make some tools more palatable than others.

Ultimately, the most reliably effective protection will likely come from applying multiple tools (Koehler et al. 1990, Shivik 2006, Miller et al. 2016, Stone et al. 2017). Carnivores are smart, adaptive, and have a great deal of motivation and time to dedicate to finding prey. The more impediments livestock producers can provide, the more incentive there will be for carnivores to hunt native prey instead of livestock. The tools that follow are potential options to consider; clearly not every tool will be practical or suitable to every operation.

Lethal Control

Improving animal husbandry practices can reduce carnivore predation on livestock, but there are certain situations in which lethal removal of habitual problem animals may be the most appropriate course of action. There are two forms of lethal control - indiscriminate hunting and targeted removal. Indiscriminate control operates on the principle that decreasing the overall carnivore populations reduces encounters between livestock and carnivores, making it less likely for negative interactions. This approach seldom reduces conflict and can actually increase depredations (Shaw et al. 1988, Conner et al. 1998, Harper et al. 2008, Peebles et al. 2013, Wielgus and Peebles 2014). Centuries of lethal control on coyotes (hunting, trapping, and bounties) have had little impact on coyote cattle depredations unless the population is reduced by greater than 75 percent each year (Connolly and Longhurst 1975, Boggess et al. 1978). Increasing mountain lion hunting quotas may cause nuisance complaints and livestock depredations to *increase* by 36 to 240 percent (Peebles et al. 2013), as hunting removes territory-holding adults and disrupts social structure. When a resident male is removed, his territory becomes vacant. Multiple males may disperse into that vacancy and compete for exclusive rights to the area, a process that may locally increase the mountain lion population until the territorial boundaries are resettled. Further exacerbating the situation, the open territory makes space for young dispersal-aged males (Lambert et al. 2006), a demographic more likely to run into conflict with people (Peebles et al. 2013). A similar pattern could occur in areas where there is heavy poaching or lethal removals under depredation permits.

Selective, targeted removal may be a more effective option. For this tool to be applied appropriately, certain criteria should be met to ensure that the tool is being used effectively, namely that 1) an individual is a repeat offender, and 2) the correct individual is targeted. Most carnivores will take easy to kill prey, such as livestock, when given the opportunity. In some situations, producers may experience "excess killing," when a carnivore kills more prey than it can practically consume in one night. This is certainly very upsetting and costly to the producer, however, it does not necessarily indicate the presence of a problem animal. Carnivores evolved to eat prey that can potentially escape, but when livestock are corralled or penned, they cannot retreat to safety. In this situation, the carnivore is presented with a novel situation far beyond the context in which it evolved. Natural carnivore behavior, pursuing and killing prey, in this scenario can result in killing an unnaturally high number of animals, as multiple confined

animals repeatedly trigger a predatory response from the carnivore. It is a mismatch between the context in which the carnivore evolved over millennia (available prey is dispersed and able to flee), and the context in which it now lives (livestock have lost some antipredator behaviors and are confined in relatively high numbers). The behavior is problematic, but it does not mean is that the individual itself is necessarily predisposed to causing further conflict (Linnell 1999). A carnivore exhibiting this natural behavior does not indicate the presence of a problem animal, instead it indicates the presence of a novel situation and highlights the importance of proper penning, fencing, and other animal husbandry practices needed to protect livestock.

A problem individual is one that has developed specialized skills that allows it to seek out and access well protected livestock, and the individual has demonstrated this ability on multiple occasions, especially when appropriate protective animal husbandry practices have been put into place. If lethal control is deemed appropriate for such a case, that specific animal needs to be properly identified and targeted appropriately. Neither mountain lions nor coyotes have spots, stripes, or other markings that facilitate individual identification. In addition, their population densities are high enough in the Central Coast that there are likely a few members of each species that occupy any given location. This makes targeting the appropriate perpetrator very difficult unless it is caught in the act. The following section on "Identifying Recidivists" explores tools for distinguishing individuals.

When the targeted individual is successfully removed, this can lead to a temporary reduction in depredations. Targeted removal outcomes practiced on coyotes were improved when the breeding individuals of the territory in which that depredation occurred were killed (Eklund et al. 2017). However, in most cases, without further changes in animal husbandry practices, further depredations are likely to occur (Linnell et al. 1996). Ultimately, the conflict is most often created by placing attractive and easy to kill prey in habitat occupied by opportunistic carnivores. An additional consideration, removing a specifically targeted individual can produce the same dynamics that occur when there is carnivore hunting – that is, when a territorial individual is removed, multiple young individuals may move in to fill the vacancy and cause additional conflicts.

As discussed above, carnivores play an important role in maintaining a healthy and balanced ecosystem, however, lethally removing a single individual carnivore in a stable population is unlikely to have a significant impact on the overall long-term ecosystem viability. In contrast, in systems where there are several threatening forces, such as habitat degradation, loss of connectivity, rodenticides or other environmental toxins, etc., the larger the impact will be for each individual removed. This is the case in the Santa Monica Mountains and the Santa Ana Mountains in Southern California. Urbanization, isolation, and lack of connectivity have driven what used to be thriving mountain lion population to the brink of local extinction (Ernest et al. 2014, Benson et al. 2016). In these two areas, livestock producers experiencing livestock or companion animal losses are given more extensive help in preventing further conflict before being issued lethal take permits only when a total of three depredation events occur.

Identifying Recidivists

In order to employ targeted lethal removal, it is necessary to be able to identify individual carnivores, determine that there is a behavioral pattern, and select that individual for intervention. It can be very difficult to identify individual members of a species that lacks unique features (such as coyotes and mountain lions), however, researchers have developed some methods that can facilitate this process. There are two main alternative pathways for identifying individuals; methods that allow remote identification in real time, and methods that enable identification after the fact.

Marks, Tags, and Collars

One set of tools for identifying animals in real time is to capture the offending animal and mark it with a collar, unique ear tag, or unique dye marking. These three strategies allow anyone observing the animal, be it through direct observation or via camera traps or other indirect means, to identify the individual. In order to employ these strategies, the animal must first be captured using CDFW-approved protocols, then processed by trained personnel that can safely set and monitor traps, as well as immobilize, handle, and release the animal.

Capturing animals is a resource intensive process, and is frequently unsuccessful. Cage traps set for mountain lions must be monitored every 20 minutes from the time they are opened at sunset, until an animal is caught or until they are closed (usually at sunrise). If trailing hounds are used, it requires specially trained dogs, the dog handler, and the gear and personnel for darting, extracting, and handling the mountain lion. Most hound capture days require long hours, often starting before sunrise and ending around dark. When trapping bobcats or coyotes, the process is much simpler and less time intensive, as the traps do not usually require as frequent monitoring, but it still make take many capture attempts before an animal is trapped. Capture success will be greatest if the animal is targeted soon after the depredation event; odds of capturing the offending individual drop significantly with each night that passes after the incident. Any area where trapping is being conducted should be closed to the public to avoid tampering with traps or trapped animals, driving wildlife away from traps, accidentally trapping pets, etc. The traps permitted by CDFW for capturing mountain lions, bobcats, or coyotes tend to be fairly selective when used properly, however, protocols should be in place for even occasional non-target capture situations. Some species may be safely handled without chemical immobilization, such as coyotes, while others need to be tranquilized, such as mountain lions and bobcats.

With a trapped animal in hand, it can be marked with a unique ear tag or fur dye that will allow it to be identified from a distance. Fur dye is a technique commonly used in species monitoring in which a unique marking is dyed onto an animal's fur, providing a large, easily visible, distinct identity that will last up to several months, depending on the type of dye, the environment, hair shedding schedule, etc. This method can be deployed quickly and inexpensively, and it is minimally invasive. Ear tags provide a permanent identification that is also commonly used in wildlife monitoring. It is marginally more invasive, provides a longer lasting mark, but care must be paid to other tags in the area to make sure that similar ear tags are

not deployed in overlapping territories. Though the tags often have a unique number printed on the tag itself, these number are often not visible from afar, so it may be necessary to use color, shape, and other features to distinguish between tags. If ear tags are not placed properly, they can tear out, injuring the animal and making it difficult to identify that individual.

Tracking collars are the most invasive of these tools, impose the greatest risk of injury to the animal, but they also provide the greatest amount of information about the animal and its habits. There is a wide range in collar types; more basic collars emit a high frequency radio signal that can be monitored with a handheld telemetry receiver, while others collect real time tracking data that can be monitored remotely. There are a corresponding variety of collar prices ranging from a couple hundred dollars to a few thousand dollars, depending on the features required. Collar battery life can last up to a couple years before the collar needs to be replaced, however, this timeline is highly dependent on the features being used and the size of the battery deployed; higher GPS acquisition rates and other energy intensive features dramatically shorten battery life. Fitting the collar properly is extremely important and should only be performed by trained personnel, as an ill-fitting collar can easily kill the animal that is wearing it.

In addition to being useful as a way to identify individuals, tracking collars can also be used as a preventative tool. High-end collars can be set to send an email alert when the animal wearing it enters a user-determined area, such as a particular pasture, allowing producers to proactively manage their livestock and respond to a potential threat. This is most useful when a high portion of the local carnivore community is collared; in places where only a small fraction of the carnivores are collared it could provide a false sense of security when a known collared animal is not in the area, and potentially encourage practices that leave livestock vulnerable to predation from unmarked carnivores.

Biopsy Darts and Environmental DNA

Another set of tools make it possible to identify individual carnivores by their unique genetic signature, either through sampling it from the animal directly (as in the case with biopsy darting), or by collecting it from the environment. Whichever the method used, nuclear DNA extracted and the genetic sequence contained within the sample provides a unique identity that may be compared to other samples to find matches.

If the genetic material is collected via a biopsy dart, the animal must first be captured, treed, or located in another situation in which it can be safely shot with a collection dart. It is more common to use this tool on bears or mountain lions and less common with bobcats and coyotes. When used with mountain lions, the most common method is to tree the individual with trailing hounds and then shoot it with a sampling dart once it is stationary in a tree. The dart itself is outfitted with a sharp sampling tip that extracts a small flesh punch and falls off after impact. The dart is recovered by tracking a small telemetry beacon in the base of the dart, or by finding it visually.

A variation on traditional biopsy darts is a blunt dart outfitted with sticky tape that collects a small number of hairs on impact (method described in detail in Valderrama et al.

1999). Biopsy darts are somewhat invasive, whereas the sticky dart is far less so. In either case, it is important for the animal to be stationary and oriented such that the person collecting the sample can get a clear shot at the animal's its caudal thigh, and that the dart gun is set for an appropriate pressure level; a poorly placed dart or a dart gun that is firing with too much force can turn a nonlethal projectile into a lethal one.

Collecting DNA from the environment is completely noninvasive; does not require the animal to be trapped, treed or stationary; and can be applied to any species. However, it can also be difficult to get high quality samples suitable for analysis. Usually DNA is collected from hair or scats, but it is possible to sample urine, shed skin, or saliva as well. Scats and carnivore hair often remain at kill sites and may be collected for analysis. The genetic material in hair is found in the follicle at the base of the hair. Several hairs with the follicle present are required for analysis; the greater the number of hairs available, the higher the chance of a successful analysis. Fecal DNA is collected from the outside of the scat where there are shed intestinal epithelial cells from the scat producer. There is also DNA from the prey, but there are methods for determining which DNA belongs to the scat producer. Saliva is also proving to be a successful sample material and can be collected from wounds left on the deceased animal. It is important to sample from hemorrhagic wounds, as those will reflect injuries inflicted when the animal was still alive rather than bites taken after the carcass was potentially scavenged by other carnivores (methods described in Mumma et al. 2013).

Regardless of the material used, there are a number of considerations that must be taken into account while designing data collection protocols and post processing. For example, the biologist needs to determine the number of microsatellites (short, repeated DNA sequences) necessary to be able to distinguish individuals. This number will depend on how closely related individuals are, how many individuals will be sampled, etc. In addition, how the sample is handled and stored will have a large impact on whether the sample can be successfully analyzed (specific methods are reviewed in Waits and Paetkau 2005).

Genetic tools are powerful, but implementation hurdles limit their practical utility. Genetic sampling is relatively new and growing field, and lab spaces set up to analyze genetic samples for outside entities are limited, expensive, and can take a long time for processing. Much of the current work currently conducted using eDNA occurs at university labs where the focus is on research. This tool could become more accessible to the District if the data were to align with lab research objectives, but as a management tool there are many logistical constraints.

Fencing

Separating livestock and wildlife with fencing has been one of the most common practices since livestock were first domesticated. Fences can provide protective physical barriers, psychological barriers (such as by delivering an unpleasant shock), or both. As is the case with other tools, practical considerations, such as habitat type, pasture size, livestock species and number, carnivore community, native ungulate community, topography, etc., are

especially influential in determining which type of fencing is most feasible and effective. Additional regulatory constraints, constructions and maintenance costs, etc. will further restrict fencing options. An important point to keep in mind is that nearly any fence that will successfully exclude carnivores will exclude other non-avian wildlife as well. This tool could be in conflict with District fencing guidelines that deem wildlife passage a high priority. Fencing capable of hindering carnivores will likely be most useful at a small spatial scale, so as to avoid obstructing local wildlife from utilizing large swaths of habitat on District land.

Most research to date has evaluated the efficacy of using fencing to prevent coyote and dog depredation (Thompson 1976, Gates et al. 1978, Wade 1982, Acorn and Dorrance 1994). Little work has been conducted to determine proper fence construction for excluding mountain lions (Linnell et al. 1996). Fencing is likely best employed in combination with other tools, however, if producers wish to use fencing as a standalone tool, they may find it to be most successful and cost-effective for preventing canid entry on small pastures with flat and relatively open habitat (Macon et al. 2017). Mountain lions are skilled climbers; they can scale nearly any type of fence practical for use in a livestock operation. Most electric fences are not high enough to be an effective tool for excluding mountain lions.

Fencing to exclude carnivores is likely an option best suited to small-scale use. Any fence appropriate for blocking carnivore passage will likely be effective at excluding other wildlife, which runs counter to the District's mission. Producers and the District must carefully weigh the tradeoff between the level of protection afforded by fencing and the cost of effectively losing that area as wildlife habitat. Impacts to non-target wildlife may be minimized by making sure that fences are well maintained, wires are kept taught, the top of the fence is clearly visible (fladry or flags may be used to increase visibility), installing sections of lay-down fence in seasonal pastures for when they are not in use, and that appropriate materials are used for game trails and other areas of high wildlife activity. However, any concessions afforded to other species will likely make it easier for carnivores to cross the fence line as well.

Permanent Wire Fencing

As a physical barrier, conventional 5- or 6-strand barbed wire fences may be effective at confining cattle to a pasture, but coyotes, dogs, and mountain lions can generally penetrate this type of fence. Many producers prefer permanent steel-wire net fences. An adult coyote can climb fences less than 66 inches high, and can fit through openings greater than 4 inches by 6 inches (Thompson 1976, Linnell et al. 1996). Combining conventional woven wire fencing outfitted with an electrified top strand to prevent climbing, or adding an exterior tripwire makes them more effective than traditional fencing alone (Gates et al. 1978; Acorn and Dorrance 1994). Coyotes are expert diggers; placing a barbed wire at ground level or using a buried wire apron can discourage this. However, these additional features can become expensive, even for small pastures. Such elaborate fencing materials tend to be expensive and may be best used in calving areas or other places where calves may be vulnerable to coyote and dog predation.

Permanent Electric Fencing

Depending on the type of fence used, this tool can provide livestock and carnivores with a physical and/or psychological barrier. These fences provide an unpleasant stimulus that is uncomfortable, but ultimately not actually harmful to livestock or wildlife. The number of wires required and voltage depends on the carnivore species the producer wishes to exclude. For coyotes, there are a few designs that are considered effective. Twelve-strand smooth wire fences with alternating hot and ground with an external electrified trip wire were deemed "coyote proof" (Gates et al. 1978). Similarly, 9-strand high-tensile smooth wires with alternating hot and ground were also deemed effective options (Acorn and Dorrance 1994). In either design, the bottom strand should be hot and placed no higher than 5 inches above the ground to ensure that a coyote attempting to dig beneath the fence will receive a shock (Acorn and Dorrance 1995). As vegetation allows, the lower the bottom hot wire can be, the better it will be for preventing digging. This type of fence can be difficult in rugged terrain, as it can be difficult to maintain tension on the wires to make sure they do not touch, and ensuring that wires are close enough together such that a coyote could gain entry. For any electric fence, reducing the spacing between wires and increasing the number of wires will make it more effective and also more expensive.

The most frequent problems encountered with permanent electric fences are 1) inadequate grounding, 2) the bottom hot wire is too high above ground level (>5 inches) to prevent coyotes from digging beneath the fence, 3) wires spaced more than 6 inches apart, 4) inadequate vegetation control causing short-circuiting, 5) issues with the energizer (Acorn and Dorrance 1995; Macon, personal communication). Dry soil conditions can also decrease electric fence efficacy.

Temporary Electric Fencing

Temporary electric fencing is a more common practice in sheep and goat husbandry than it is for cattle. Most temporary electric fences are constructed from strands of poly-wire or tape woven with steel wire to conduct electricity. As a part physical, part psychological barrier, it is important to train cattle before they will respect the boundary. Introducing large livestock to the fence in a damp area or after wetting the paddock soil can make training bouts more effective. In addition, cattle and horses have a more difficult time recognizing thin wire as a barrier; producers may increase their success by using electric tape as a visual cue (Macon, personal communication). These fences tend to have a shorter expected lifespan (3 to 7 years) than permanent fencing, however, upfront costs and construction tend to be much lower (Macon et al. 2017). To reduce labor, producers may set the ground rods strategically so the rods stay put as paddocks are rotated.

Standard electronet fencing constructed 5 feet high can effectively deter coyote and dog predation, however, this is unlikely to be a helpful tool for producers operating on open rangeland (Larson and Salmon 1988, Linnell et al. 1996). This tool may be more suitable for protecting calving grounds or other areas where cattle (calf specifically) or other livestock use is concentrated. When used in a very small area where an intruding mountain lion is nearly certain

to make contact with the fence, this tool can be effective protection for any type of livestock (Cavalcanti et al. 2012). Research on specific fence designs for mountain lions is lacking, but some producers have had luck with two types of designs. The first is electronet with 3 wires, and an additional external trip wire set 3 to 4 feet away from the perimeter fence. The external wire cannot be set any closer than 3 feet or a mountain lion will be able to clear both fences without receiving a shock. Second is 8-foot fence with an overhanging hot wire on top (UCANR 2017). Mountain lions may be able to scale the fence, but this design is devised to deliver a discouraging shock when they reach the top. Keep in mind, these two designs have been recommended by livestock producers and have not been experimentally tested.

Fladry and Turbo Fladry

Originally developed to funnel quarry for hunting, fladry is a cord from which brightly colored strips of cloth or plastic flags hang at regular intervals and flap in the wind to create a displeasing novel visual stimulus. Turbo fladry has an electrified wire running through the cord with the goal of adding an additional unpleasant physical stimulus. Studied extensively with wolves, the efficacy of this psychological barrier for other species is low or remains to be studied (Musiani et al. 2003, Shivik 2003, Miller et al. 2016). Fladry and turbo fladry rely on wariness to be effective. Though wolves are deterred by these flags blowing in the wind, coyotes may be too curious for these tools to provide much of a deterrent (Musiani et al. 2003, Shivik 2003). Results from studies looking at coyote responses to fladry have provided mixed results (Musiani et al. 2003, Shivik 2003, Young et al. 2015). However, over time, even wolves habituate to fladry and turbo fladry, making this tool appropriate for small scale, short duration use at best (Linnell et al. 1996, Musiani et al. 2003, Shivik 2003). It appears that no studies to date have assessed the potential influence fladry or turbo fladry on mountain lions, domestic dogs, or bobcats.

Night Penning

One of the most consistently effective methods for protecting livestock from predation is housing them in a fully enclosed structure during times when predation is highest (Linnell et al. 1996, Miller et al. 2016, Eklund et al. 2017). This period could be when carnivores are most active (usually from dusk until dawn each day), or it could be a life stage when livestock are particularly vulnerable (such as lambing or calving). With proper construction, protective structures can be used for nearly any type of livestock and any type of carnivore (including humans). Different carnivore species require specific building considerations. For example, coyotes and other canids are capable diggers, so effective enclosures require a solid floor, placing a barbed wire at ground level, or a buried wire apron. Mountain lions, on the other hand, do not dig, but are expert climbers. Enclosures designed to protect against mountain lions must have a sturdy roof and any openings must be too small for a mountain lion to gain entry (4 inches by 6 inches at most).

When using night pens for a prolonged period of time or with a large number of livestock, sanitation becomes an important consideration. Livestock may need more frequent anti-parasite treatment and the enclosure will need regular cleaning (Linnell et al. 1996). Small ruminants in particular, are susceptible to orthopedic infections that may be exacerbated by being enclosed with conspecifics. One potential solution is to place a therapeutic footbath at the pen entryways so animals' feet are cleaned and treated as they enter the enclosure.

Some fear that enclosing livestock restricts their access to forage and will reduce their ability to adequately gain weight. Research conducted on cattle and sheep suggest that they compensate for lost grazing time and are able to gain weight as well as they would if left unconfined (Linnell et al. 1996). Night penning also permits daily contact and inspection of livestock.

Though enclosures can provide extremely effective protection, they are only suitable for small-scale operations in which a human can be present each morning and evening to let animals in and out. In the future, there may be technological tools available to operate enclosures automatically or remotely, but these tools are not currently commercially available. Night penning is likely the most effective option for District tenants with chickens, alpacas, horses, or other small-scale livestock operations; this is not likely a suitable tool for cattle producers on open range.

Livestock Guarding Animals (LGA)

One of the oldest practices in the livestock protection toolbox, livestock guardian animals make also be one of the best tools for keeping livestock safe and healthy. More common in sheep and goat operations, these animals may be used with cattle as well. Benefits to using LGAs may include reduction in predation and labor, as well as more efficient pasture use, potentially without displacing predation risk onto neighboring pastures (Linnell et al. 1996, Webber et al. 2012, Miller et al. 2016). Similar to deciding on appropriate fencing, LGAs come in a wide variety of species and breeds, and choosing the right type of guardian animal, and number needed, will depend on a variety of criteria, such as the size and type of livestock operation, terrain, level of use by the general public, carnivore species present, etc. The cost to acquire and maintain LGAs varies greatly by species and breed, and requires proper training and years of commitment from the producer. Since people started using LGAs, they have employed a wide variety of species such as dogs, llamas, cattle, ostriches, and even baboons (cited in Linnell et al. 1996). This review will focus on the three most common species in North America, dogs, llamas, and donkeys. Livestock guarding dogs are likely the most effective option for protecting against the carnivores present on District properties. Llamas and donkeys are usually less expensive to acquire and maintain, easier to train, and live longer than dogs, but they are not as effective at protecting against mountain lions (Linnell et al. 1996, Smith et al. 2000, Miller et al. 2016, Macon et al. 2017, Scasta et al. 2017). There is an extensive literature on training livestock guarding animals, breed selection, care, and maintenance, the details of which are beyond the scope of this review (see Smith et al. 2000, Dawydiak and Sims 2003).

Livestock Guarding Dogs (LGDs)

There are many breeds of livestock guarding dogs that have been developed over thousands of years of selective breeding. Though many more exist, commonly found breeds in North America include Great Pyrenees, Bernese Mountain Dog, Anatolian Shepherd, Komondor, Akbash, and Maremma (Linnell et al. 1996). Animal Plant Inspection Services in collaboration with Utah State University is currently conducting research to determine whether additional breeds developed in other countries, such as Kangal, Karakachan, and Cao de Gado Transmontano, may provide reliable carnivore protection while remaining safe for use on public lands that overlap with human recreation (Kinka, personal communication). Much of the research on LGDs has focused on protecting sheep, however this is a tool that has been successfully used with cattle and other livestock species as well.

Likely to be the most effective for District producers, however, LGDs are the most expensive LGA in time and money. In order for them to be effective, LGDs must be properly trained and strongly bonded to the herd. The average time spent supervising, training, and feeding averages 9 to 10 hours each month (cited in Smith et al. 2010). If they are improperly trained and treated as pets, "the only thing they will effectively guard is the front porch" (Macon, personal communication). Initial costs range from $240 to $1000 depending on age and breed, and first year costs of shipping, food, vet bills, travel, damages caused by dogs, etc. average $700 to $900. Subsequent mean annual expenses range from $250 to $290 (cited in Smith et al. 2010). Not all dogs are appropriate for the job, roughly a quarter of LGDs injure or kill the livestock they are protecting, making selecting the right individual important. However, LGDs are more commonly used with sheep and goats, which may be easier for the dogs to harm than cattle. Depending on their personality, guarding dogs should be temporarily removed when using shepherding dogs, as conflict between the two may arise.

If properly trained and bonded, LGDs can be highly effective, reducing depredations by up to 100% (Linnell et al. 1996, Gehring et al. 2010, Smith et al. 2010, Miller et al. 2016). They are among the most highly praised tool available. In a survey of 400 producers using over 700 dogs, 82% of respondents deemed dogs an "economic asset" and 9% ranked them as a "break even" investment, and the remaining 9% categorized them as lower value (cited in Smith et al. 2010). Compared with other preventative tools, LGDs are likely the most effective tool for operations ranging from a few animals in a small paddock to large herds on open range (cited in Macon et al. 2017).

LGDs are effective against felids as well as other canids. Properly trained LGDs with appropriate dispositions can also be effective against free-ranging dog depredations, a concern for producers operating on the urban-wildland interface (Larson and Salomon 1988). LGDs can help keep encourage herding behavior in livestock, making this tool especially effective for large-scale open range situations, and helpful to for gathering and moving livestock. In addition, LGDs disrupt a carnivore's behavior without displacing it. That is, the carnivore can still live alongside the livestock operation and maintain its territory, so protection of one pasture does not necessarily mean increased predation on a neighboring pasture or ranch (Coppinger et al. 1988).

In effect, an LGD can "train" the local carnivores to respect the boundary between the dog and the carnivore. Together, the LGD and the resident carnivore, in turn, defend that area from intrusion by other members of the carnivore's species (Macon, personal communication).

A major concern for livestock operators working on District properties would be how LGDs interact with park visitors and domestic dogs. Different breeds of dogs differ in their level of aggression toward people, as do individuals within a breed. LGDs intended for use on District land where they may encounter members of the public and their pets need to be carefully screened, as overly aggressive LGDs could pose a significant risk to the public as well as companion animals. Producers may wish to post signs alerting the public to LGD presence, and temporarily bar domestic dog access. In order to bolster support and compliance, it may be wise to include information on the proactive conflict prevention program, and provide information on how to handle potential interactions with LGDs. The USDA has produced informational material to help avoid conflict between recreationalists and LGDs (USDA 2010a, USDA 2010b). Before considering LGDs, it would be prudent to consult the District's legal counsel for advice on potential liability created by their presence.

Llamas

Llamas are a member of the South American camelid family that includes alpaca and others. Though some people use alpaca as LGAs as well, llamas tend to be more territorial and aggressive than alpaca, making them better suited to livestock protection (Linnell et al. 1996). Some llamas are naturally aggressive towards dogs and coyotes; however, they are not an effective tool against mountain lions. This feature likely makes them ill-suited for use by District producers, unless threats shift and District producers find a growing need to protect against domestic dog predation. In addition, there is scant information on using llamas for protecting cattle. All of the following information is from studies addressing llamas protecting sheep. These results may or may not be transferable to cattle.

Gelded males are most commonly used and can be purchased for $700 to $800. Maintenance costs are low, as they have similar dietary and management requirements to cattle (other than needing to be sheared) (Smith et al. 2010). There is virtually no need for training, as llamas usually assimilate to sheep herds within a couple of hours to one week, however data are not available for bonding time between llamas and other species of livestock. Llamas may work best in small- to mid-sized operations on pastures up to 300 acres. Average operators recommend one gelded male llama for 250 to 300 sheep; using more than one llama per group often results in the llamas bonding with one another rather than to the herd (Andelt 2004). When confronting a carnivore, typical behaviors include alarm calling; approaching; chasing, kicking, spitting; or positioning themselves between the carnivore and the herd. It is important to note, llama's aggression towards canids makes them incompatible with LGDs or shepherding dogs. Llama size and alertness are positively correlated with aggression, making large, alert llamas likely to be the best guardians (cited in Macon et al. 2017).

Donkeys

Similar to llamas, donkeys tend to be used for protecting sheep more often than for protecting cattle, and most of the literature pertains to the former. Again, the principles may or may not be transferable to cattle operations.

Donkeys are less expensive to purchase than LGDs or llamas (between $65 and $250), and inexpensive to maintain ($66 per year on average, with a range of $0 to $300) (Smith et al. 2010). The most common varieties of donkeys used are standard or mammoth. Single jennies or gelded males are most effective, and generally need to be introduced to the herd between 3 to 6 months of age. Herd bonding should be solidified for 4 to 6 weeks before donkeys are turned on pasture with livestock. They are longer lived than LGDs, with an average life expectancy of 10-20 years. Llamas and donkeys are compatible with other depredation prevention, livestock management tools (other than shepherding dogs), and are less likely to wander beyond fence lines than LGDs (cited in Macon et al. 2017).

Typical guarding behaviors include braying, running towards or chasing the intruding carnivore, biting, and kicking. Individual donkey personality and propensity for aggression toward canids vary greatly, so introducing a donkey to a dog to evaluate their reaction before relying on that animal to protect livestock would be wise (Smith et al. 2010). Donkeys that display aggressive behavior to carnivores are most effective at deterring coyotes and dogs in small (up to 600 acres), relatively open pastures (Macon et al. 2017). Donkeys are less effective against mountain lions than LGDs.

Some donkeys are aggressive towards lambs or kids, so caution should be used when calving. It is often ineffective to use donkeys in pastures adjacent to other donkeys, horses, or mules, as they may bond with their fellow equines rather than with the target herd. Donkeys have similar dietary requirements to cattle; however, it is critical that donkeys do not have access to feeds with ruminant-only feed additives (like Bovatec, Rumensin, and other ionophores), which are extremely toxic to all equines.

Frightening Deterrents

Various frightening devices, primarily visual and auditory, have been used to prevent livestock depredation. Some carnivore species tend to avoid novel stimuli, such as randomly flashing lights (eg. Foxlights), radios, propane cannons, etc. Very little is known about the effect of acoustic and visual deterrents on livestock predation by mountain lions or bobcats, however, some research suggests that randomly emitting strobe/siren devices may temporarily deter coyote depredation. In one study with fenced-pastured sheep, coyotes were deterred for up to 91 days and reduced lamb losses by 44 to 95 percent (Linhart 1984, Linhart et al. 1992, Linnell et al. 1996). In another, random strobe lights were found to be effective at reducing coyote predation on sheep by 60 percent for the 3 months they were deployed (cited in Linnell et al. 1996). The only study addressing the efficacy of flashing lights on preventing mountain lion depredation found Foxlights to be an effective deterrent for protecting camelid bed sites for up to 4 months (Ohrens et al. 2018). A study measuring the efficacy of timed gas exploders set to go off every 7 to 8 minutes from dusk until dawn found that they were effective against coyote predation for an

average of 31 days to 6 weeks before animals became habituated to the sounds (cited in Linnell et al. 1996). Acoustic devices alone seem to be less effective, but they have only been rigorously tested on bears (Miller et al. 2016). Unfortunately, there has been little rigorous testing of these methods, and the few studies that exist are often hampered by small sample sizes, poor experimental control, lack of strong inference, and limited ability to reliably inform management (Miller et al. 2016, Eklund et al. 2017, van Eeden et al. 2018).

Some tools are designed to emit an unpleasant stimulus at random intervals, while others are triggered by animal presence. Foxlights, Predator Guard, and other similar devices belong in the former group of tools that randomly emit bright, displeasing lights from sunset until sunrise when most carnivores are most active. Motion-activated sprinklers, lights, and sound devices, on the other hand, are only triggered when an animal is present. Each of these tools provides a psychological barrier by making the immediately surrounding area more unpredictable and frightening, however motion-sensitive sprinklers are the only tool that deliver a physical penalty for trespass, which could increase the amount of time it takes for carnivores to habituate to them.

While deterrent devices may provide some immediate short-term protection, animals may become habituated to these tools in a matter of days or weeks, depending on the species and context in which they are being used. When used alone, these tools are likely best suited for high-risk, short-duration, small-scale use, such as calving paddocks (Koehler et al. 1990, Linnell et al. 1996, Shivik 2006, Miller et al. 2016, Ohrens et al. 2018). Combining acoustic and visual techniques may enhance efficacy and increase the time before carnivores habituate (Koehler et al. 1990, Miller et al. 2016). Additionally, tools that are behaviorally triggered (i.e. motion-sensitive devices), or provide a physical penalty (eg. sprinklers) are more likely to remain effective for a longer period of time (Shivik and Martin 2001).

Changing Cattle Breed or Operation

Generations of breeding have selected for livestock with traits that decrease their ability to identify, respond to, and avoid predation threats (Johansson 2001, Price 1999, Muhly 2010). Behavioral traits, such as docility, and physical traits, such as exaggerated meat growth, leave livestock more vulnerable than their wild ancestors (Flörcke and Grandin 2013). Switching from a more docile breed to one better equipped to protect itself could help prevent depredations. For example, changing from a gentle breed, like Hereford cattle, to a more territorial one, such as Raramuri Criollo or San Martineros, could provide more robust stock (Shaw et al. 1988). The USFWS is currently experimenting with a mixed herd of traditional beef cattle and Raramuri Criollo cattle (11 cows and 1 bull) to test whether mixing in this species of cattle will result in fewer losses to federally endangered Florida panthers. This experiment has only been running for a short duration and it is too early to tell whether this will be a successful strategy (Lotz, personal communication). Similarly, San Martineros, a little-known subspecies of Criollo cattle that descended from Spanish fighting bulls, are being introduced to mixed herds in Columbia. This breed is reportedly docile with humans, but fiercely defensive of their young and territory, even against carnivores (Economist 2017, Hoogesteijn and Hoogesteijn 2014). Maintaining

docile temperaments in cattle ranging on land shared with the general public is likely an important factor to keep in mind on District property; there is an important balance to be struck between reducing the changes of livestock predation and increasing the chances that a member of the public could be hurt by cattle.

In addition to changing cattle breed, altering the type of operation can also shift the level of predation risk. Some demographics are more vulnerable than others (newborns, calves, females giving birth), and converting from a cow-calf operation to steer only could reduce depredations and be effective on any spatial scale (Shaw 1977, Shaw et al. 1988). The idea is to stock animals that are large enough to be able to escape predation, which means running only cattle that have reached 140kg or greater (Shaw 1977). Again, these considerations need to be weighed against producer preferences and public safety. Combining different livestock types (such as mixing cattle and sheep) may decrease risk as well, this may be especially beneficial for the smaller livestock (USDA 2015a).

Altering Pasture Vegetation and Grazing Regimes

Ideal carnivore hunting habitat is often determined by a combination of habitat type, topography, prey species habits, and hunting modality. Coursing predators, such as wolves, prefer open habitat where they can locate their prey and chase them for long distances, during which time they may select for weaker members of the herd (Kauffman et al. 2007). Ambush predators, such as mountain lions, rely on more heavily structured environments in which they may conceal their presence and pounce on their prey at close range (Williams et al. 2014). Altering pasture vegetation on a scale that would alter predator-prey dynamics between livestock and native carnivores likely falls outside the mission of the District, however, there are actions that could be taken on a small scale.

Rather than altering the pasture vegetation, producers can use vegetation as a guide for where and how to graze particular areas. Depredations may occur in particular "hot spots" where topography, vegetation, and animal behavior coincide to produce locations where livestock are more vulnerable (Jackson et al. 1996, Linnell et al. 1996, Miller et al. 2016). In the Santa Cruz Mountains, this is likely to be areas with rough terrain and shrubby vegetation. Oak savanna, grasslands, and other open habitats are likely to be safer areas for livestock (Yovovich 2016). Livestock producers may wish to select open habitats for calving and grazing cattle until they reach a size less vulnerable to predation (>140kg), and avoid grazing young calves in shrubby pastures where possible (Shaw 1977).

Mapping depredation occurrences to look for spatial patterns could help inform stocking decisions as well. Areas deemed higher risk could be avoided or stocked with a less vulnerable livestock demographic, or more aggressive breeds or individuals could help improve livestock safety. For example, if producers wish to graze in shrubby habitat, they could replace cow-calf pairs with bulls or individuals they know to be more aggressive.

Altering Production Calendar

Carnivores tend to optimally forage, selecting prey that is easiest to find and subdue (Lima and Dill 1990). Most carnivores will select newborns and young juveniles over adult members of the same species, as they are generally easier catch to subdue. In addition, many species have a seasonal birth pulse during which time there may be an abundance of young animals afoot. Livestock producers able to time their own calving to coincide with deer fawning can take advantage of easy alternative prey source that may draw mountain lions and coyotes away from livestock (Shaw 1977, Shaw 1981, Linnell et al. 1995, Sacks and Neale 2002). However, synchronizing livestock calving with deer fawning is a strategy better suited to livestock producers East of the Sierra crest were spring calving is common. Livestock producers seek to align the peak energetic demands of their cattle with peak forage production; livestock will certainly need good quality forage, while protection from predation is less definite. In Coastal California, taking advantage of the highest quality forage requires calving in the fall. Deer fawn in late spring to early summer (Bowyer 1991), making it difficult to synchronize ungulate fawning with calving.

While synchronizing calving and deer fawning may not be a suitable option for Tenants, a different way to alter production calendars to protect livestock is to synchronize calf births with one another. When births are staggered, a resident carnivore can predate a calf in one pasture, and then move to the next pasture when the next calf is born. If all of the calves, kids, lambs, etc. are born at the same time, it reduces the opportunity for carnivores to rotate between pastures (cited in Linnell et al. 1996)

Bolstering Alternative Prey

Piggybacking on this idea that carnivores optimize their foraging strategies, increasing non-livestock prey numbers may increase the chances that carnivores will predate native prey and can provide some protection to livestock. Research has shown that the number of cattle taken by mountain lions is inversely related to local prey abundance (Shaw 1977, Shaw 1981). Similarly, research suggests that coyotes eat livestock opportunistically, and in proportion to their availability relative to alternative prey (Sacks and Neale 2002). In addition, coyotes are better suited to eating small prey than they are to hunting cattle, equines, camelids, or large pigs. Bolstering native alternative prey abundance could help take predation pressure off of livestock of any species by increasing the likelihood that coyotes and mountain lions will select more abundant wild prey over livestock (Linnell et al. 1995, Linnell et al. 1996, Sacks and Neale 2002).

Attractant Removal

Although they are primarily hunters, coyotes, mountain lions, dogs, and bobcats are all opportunistic scavengers as well. Dead and downed animals may attract these carnivores into areas where other livestock are grazing and can increase depredation (cited in Linnell et al. 1996). Removing sick, injured, and dead livestock may help reduce attractants that are appealing

to carnivores, and may prevent further injuries to live animals. Some evidence suggests that carnivores are attracted to bone yards and may be more likely to kill livestock grazing in adjacent pastures, and bone yards may attract livestock guarding dogs away from the livestock protection duties (cited in Macon et al. 2017). The risk to suffering additional depredations is highest immediately following an initial depredation, as the carnivore returns to feed and may injure or kill additional animals.

When possible, it is best to isolate sick or injured animals and place them in a protected area or structure. For animals that have already died, it is best to bury or remove the carcass as soon as possible, as is stated in the current District policy, to discourage carnivores from returning to the site to feed. On open range, it may be difficult or impossible to locate and retrieve carcasses. In addition, extracting and transporting carcasses to a rendering facility may be resource intensive and expensive (Antonelli et al. 2016). In these cases, the best option may be to bury carcasses as far as possible from live animals or recreational trails, while making sure to follow local laws dictating burial depth, regulations on limiting potential disease transmission, ensuring the site is appropriately far from waterways, etc.

Carcasses may be treated with lithium chloride, cupric sulphate, anthelmintic thiabendazole, emetine hydrochloride, or alpha-naphthyl-thiourea to reduce palatability, however producers will need to seek CDFW permission before applying any of these chemicals (cited in Linnell et al. 1996). These chemicals are known to cause severe nausea and could be a useful tool in conditioning carnivores against preying upon cattle, however, results on taste aversion conditioning have been mixed. If the chemicals and dosages are carefully selected, this technique is thought to have limited negative effects on non-target species (Linnell et al. 1996). Many of these chemicals have been safely used on a wide variety of species (For example, emetine hydrochloride has been safely used with coyotes, raccoons, opossums, striped skunks (cited in Linnell et al. 1996); lithium chloride has been safely used with coyotes, domestic dogs, bears (Linnell et al. 1996), amphibians and reptiles (Paradis and Cabanac 2004), and avian scavengers (Nicolaus et al. 1989); etc.). It is possible that emetic chemicals could cause aversive behavior in scavengers. Whether or not chemical aversion is a successful tool, it is best to remove a carcass where possible, as the smell of rotting meat may attract carnivores and cause further depredations even if the meat is not palatable.

Current District regulations regarding animal remains are as follows:

701.7 Depositing of Animal Remains.

No person shall bury, leave, scatter or otherwise deposit animal remains on District lands, except for cremated animal remains as specified in Section 807.

807. Scattering of Cremated Remains

807.1 Regulations for the Scattering of Cremated Remains.

No person shall scatter any cremated human or animal remains (cremains) without first having obtained a written permit from the District, and shall abide by the permit conditions which shall include, but not be limited to, the following conditions:

a) The scattering of cremains is prohibited: within 1,000 feet of any residence or dwelling, within 500 feet of any creek, stream, or other body of water, or within 50 feet of any road or trail.
b) Cremains must be scattered, must not be left in a pile, and must not be readily visible to the public.
c) No containers for the cremains, identification tags, vases, flower pots, or other associated non-organic materials, or non-native plants, may be left at the site.
d) No memorial, plaque, or other site marker may be left at the site.
e) Any person scattering cremains on District lands shall possess and present a valid District permit when scattering cremains.
f) The scattering of cremains for commercial purposes is prohibited.

The current lease agreement language concerning disposal of livestock carcasses for District grazing tenants varies by location/lease. At McDonald, Driscoll, Bluebrush, and Lobitos-Elkus grazing areas the language is as follows:

> **(f)Disposal of Livestock Carcasses**. Tenant shall remove from the Premises, or bury on the Premises in a manner and location satisfactory to District, any and all livestock that may die on the Premises. Tenant shall immediately notify District upon discovering any dead livestock on or near the Premises. Tenant's notification shall state the proposed method and location for disposing of the dead livestock. The proposed method and location shall be subject to approval by District and may include permission to discharge firearms on the Premises in furtherance of the disposal.

The Mindego and Apple Orchard grazing areas have the following lease agreement language:

> **(d) Disposal of Livestock Carcasses**. Tenant shall remove from the Premises, or bury on the Premises in a manner and location satisfactory to District, any and all livestock that may die on the Premises. Tenant shall immediately notify District upon discovering any dead livestock on or near the Premises.

The October Farm, Tunitas, and Big Dipper leases contain this language:

> **(d) Disposal of Livestock Carcasses**. Tenant shall remove from the Premises, any livestock that may die on the Premises. Tenant is strictly forbidden to bury livestock carcasses on any District land. Tenant shall immediately notify District upon discovering any dead livestock on or near the Premises.

This language may need to be revisited and revised if carcass burial is determined to be an acceptable method for reducing predation.

E-Shepherd Collars

Designed for sheep, this tool is an electronic collar that monitors the animal's movement, recognizes when it is running, and triggers an ultrasonic alarm along with a set of LEDs with the goal of deterring the carnivore. The collar is only effective for the individual wearing it, unless

the animal wearing the collar responds to a fellow animal being harassed and is close enough to the incident for the collar to discourage the predator. Collars cost roughly $130 (plus shipping from South Africa), manufacturers recommend 1 unit for every 10 sheep, and batteries last from 16 to 19 months (replacement batteries cost roughly $16 plus shipping). These collars have been successfully used on cattle in India and Nambia (Delport, personal communication), however, since the collars are triggered by fleeing behavior, this may not be an effective tool for use with ambush predators, such as mountain lions. E-Shepherd Collar manufactures make no claims on efficacy against free-roaming dogs. There are no data on the efficacy of these collars on any type of livestock operation, as these collars have not been subject to rigorous scientific testing to date.

Cowbells

Producers may outfit livestock with bells to help locate animals, or to alert shepherds to when an animal is being chased, but there are little data established on whether this practice helps deter predation. Bells on sheep alone had no impact on coyote predation (cited in Linnell et al. 1996). There were no data on whether livestock guarding dogs and bells could used together to help alert dogs to an animal in distress. There were also no data on whether cowbells could allow livestock to keep closer track of one another and aggregate when threatened. If a range rider, a shepherd who stays with livestock to protect them against predation, is within earshot of the herd, a loud bell could allow them to intervene in the event that a carnivore is harassing an animal or the herd, but this would require a person to be on site at all times, making it a very resource-intensive tool. As a standalone tool, cowbells are unlikely to be helpful for District producers unless the livestock were being grazed near a ranch home or other site where people would be within earshot.

Human Presence

Intermittent human presence among widely dispersed livestock and low-density carnivores is unlikely to have a significant positive impact (Linnell et al. 1996). However, human presence, via herding, range riding, etc., can be highly effective in preventing depredations, as the shepherd can keep the herd together, monitor their safety, and intervene in the event of an intrusion. Unfortunately, this tool is incredibly labor and cost intensive, and likely infeasible without some form of subsidy.

Some carnivores, mountain lions in particular, are somewhat sensitive to human presence and will avoid hunting in areas with high human activity (Wilmers et al. 2013). However, other carnivores may recognize that human activities are often restricted to daylight hours and may instead shift their activities to after sunset (cited in Macon et al. 2017). Similar to visual and auditory deterrents, it is important to alter human activities so carnivores do not become habituated to certain routines and able to respond to times when they know the shepherd is absent. The key is to create an unpredictable landscape that carnivores prefer to avoid.

Since wolves were reintroduced in the mid 1990s, range rider programs have become a relatively common form of shepherding in the Northern Rockies. Some ranchers perceive range rider programs to reduce depredations, as well as a variety of social benefits (including reduced stress, reduced trespass and littering, improved public perception, and community trust building). Easier to verify benefits include identifying and treating sick animals, as well as finding and removing carcasses (Parks 2015). Many range rider programs rely on guest worker (H-2A) shepherds, most of whom come from South America. Changes in U.S. immigration policies may influence access to guest workers and could significantly affect the cost of range riding programs (American Sheep Industry Association 2015).

Volunteer Range Shepherd Program

In addition to range riders, or perhaps as an alternative, some projects have had success with volunteer range shepherds. The Wood River Wolf Project (WRWP) in Idaho designed a program in which volunteer shepherds helped protect bands of sheep against predation from black bears, grizzlies, mountain lions, coyotes, bobcats, and of greatest concern, wolves. Wolves were reintroduced to Idaho in 1995 and 1996, and as their population increased, so did conflict with livestock. The Wood River watershed is home to the "sheep superhighway," one of the largest grazing sectors in the state, and also experienced some of the highest sheep losses to wolves. A collaboration between conservation organizations, ranchers, scientists, federal government agencies, and county officials, the WRWP was started to implement and test predation deterrent strategies in an attempt to ameliorate the growing conflict between livestock producers and carnivores. Ultimately, the strategies the WRWP put in place reduced their depredation rate to 90 percent lower than neighboring sheep grazing operations (WRWP 2018). One of the strategies they utilized to achieve this remarkable success was a volunteer range shepherd program intended to deter carnivores by increasing human presence near livestock.

The WRWP worked with herders who managed bands of 1,000 to 2,000 sheep, and organized a fleet of volunteers to support the herders. These volunteer shepherds provided predation deterrence by increasing human presence near sheep bands, as well as contributing non-technical support to field staff and herders by shuttling supplies to the herders; assisting with injured animals (sheep, guard dogs, herding dogs or horses); installing, monitoring, and collecting game cameras in the field; collecting and entering data; driving personnel to and from the field; transmitting information between herders and field staff; and implementing other nonlethal deterrents. The volunteer range shepherds performed scheduled duties, and in the event that wolves were detected nearby, they were rapidly deployed to guard a specific band. It should be noted that a program that incorporates impromptu scheduling requires a much larger supply of volunteers than a program that strictly relies on preplanned activities (Martin personal communication, WRWP 2018).

There are a few notable features that would need to be addressed make a program like the WRWP suitable for implementation on District properties. First, most of the livestock productions on District land are low-density cattle operations, whereas the WRWP runs bands of

grouped sheep. A single person is much more effective monitoring and protecting a concentrated group of animals than it is for a group scattered across the landscape. Second, the local wolf packs in the Wood River watershed had one or more members collared, enabling a level of monitoring not possible for livestock producers on District land. Third, livestock in the WRWP were owned by 4 producers and protection efforts were coordinated by a single entity with staff dedicated to conflict prevention. In contrast, the District has a greater number of producers and does not currently have staff capacity earmarked for coordinating livestock protection efforts.

Aside from increasing human presence on the landscape and thereby reducing predation, range riders or range shepherds could also provide additional benefits to producers, as well as the general public. Previous range rider and range shepherd program users have reported appreciating extra help detecting injured animals and carcasses; maintaining and monitor camera traps, fencing, and other preventative tools (Foxlights, motion-activated sprinklers, etc.); detecting and reporting lost ear tags; collecting data on carnivore presence and habitat use patterns; etc. Potential benefits to the public would include increasing potential recreational activities on District land, including access to restricted areas, horseback riding, citizen science opportunities, etc. Even more importantly, this type of partnership between livestock producers and an increasingly urban general public would also provide a rare opportunity to teach Bay Area residents about the value of grazing and ranching, two frequently undervalued and often vilified practices.

When employing range riders or volunteer shepherds is impractical for producers, there are other strategies they can use to increase human presence. Feeding livestock each day could encourage herd aggregation and herding behavior, and human scent could act as a carnivore deterrent. In addition, frequent monitoring helps identify sick or injured individuals that could attract carnivores. Producers on District lands could use areas with high human recreational use as a potential shield against predation. Vulnerable livestock (such as cow-calf pairs when calves are young) could be give preferential access to highly frequented trails or camping areas to capitalize on increased human presence.

Hazing

When an animal is in an area that overlaps with vulnerable livestock, or is performing an unwanted behavior, a producer can deter the animal with unpleasant stimuli. Potential methods could include, but are not limited to, making loud noises in the carnivore's vicinity, chasing with trucks or hounds, throwing rocks, shooting with less-than-lethal munitions, etc. The target species and context will determine which tools are most appropriate. Hazing can be implemented as a general practice whenever a carnivore is seen in certain areas, or performing certain behaviors; or it can be used to target a particularly bold or aggressive individual. The most important components to hazing are to make sure the animal associates the negative stimulus with the undesired activity, and to follow through until the behavior has ceased. Though behavior-dependent, individually tailored hazing deterrents may be effective. Tools that

rely on a direct interaction between a carnivore and a human potentially put both parties at risk of injury and are very resource intensive. Any person conducting hazing activities should be specially trained and following strict protocols. It would be wise to consult legal counsel before implementing any hazing program. In addition, potential hazing strategies are nearly limitless, and CDFW policy surrounding hazing is relatively vague; it would be prudent to consult local CDFW personnel before selecting any questionable methods.

Coyotes

When hazing coyotes, the person conducting the hazing activity should be sure to stand their ground; make eye contact to make sure the coyote is focused on them as the source of the disturbance. Hazing tools should be exaggerated, assertive, and when possible, should capitalize on as many senses as possible by using tools that involve sound, light, and motion. It is helpful to have variety in tools as well as the individuals administering the hazing. Coyotes can learn to recognize and avoid individual people, so varying both the tools and people involved or the clothing of the people involved (i.e. perform the hazing activity in street clothes rather than a uniform) will help avoid habituation and can decrease the number of hazing bouts necessary to teach the coyote to avoid the area more quickly.

If the coyote hesitates (freezes or moves away only a short distance), the person involved should intensify their efforts and advance toward it with the hazing tools (yelling, noisemaker, throwing rocks, waving arms, water gun, etc.). Always be sure to haze the animal until it has fully retreated to send a clear message that they should associate humans with discomfort.

It is critical to provide an escape path for the animal (i.e. never corner a coyote). It is most effective to haze on foot rather than from a building or a car where the coyote may not be able to see the person; the goal is to have the animal associate humans with danger, so it is best if they can clearly draw a link between the two. To ensure that coyotes do not return to displaying unacceptable behavior over time, it is helpful to maintain a practice of hazing in even casual interactions. Hazing should not take place if the coyote looks sick or injured, or if it has pups. In those cases, the best thing to do is to maintain eye contact and back away.

Mountain Lions

Mountain lions are very cryptic and secretive, making their behavior difficult to observe in a natural setting. As such, there is very little data on hazing practices and their efficacy; most of the information available comes from anecdotal reports. Washington Department of Fish and Wildlife uses Karelian bear dogs to haze bears, and on occasion, mountain lions, that have wandered into residential areas. They have been effective at reducing recidivism in bears, but there is insufficient data to determine whether this is an effective tool for mountain lions (Beausolei, personal communication). A study in Brazil found that targeted firecrackers and night patrolling were effective hazing tools for preventing jaguar and mountain lion depredations (Cavalcanti et al. 2012).

Increase Human Tolerance for Carnivores

Whether it is delivered when an animal is harvested, or prematurely from an unintended source, death will always be a certainty in livestock production. Perhaps more so than other sources, depredations are both an emotional and financial issue. Though it is difficult as an agency to tackle the emotional side of depredations, there are tools that can be used to lessen the financial burden. By removing some of the financial cost to operating livestock in carnivore country, perhaps the District can increase tolerance for carnivores and predation on livestock.

One option for improving producer experience with carnivores is to create or support labeling programs that allow producers access to markets where consumers are willing to pay a premium on products utilizing practices that support consumer values (in this case, carnivore friendly ranching). This has been very successful for promoting and mainstreaming practices such as organic, grass-fed, etc. For producers selling their beef locally, the Bay Area is likely a prime market for selling wildlife-friendly meat.

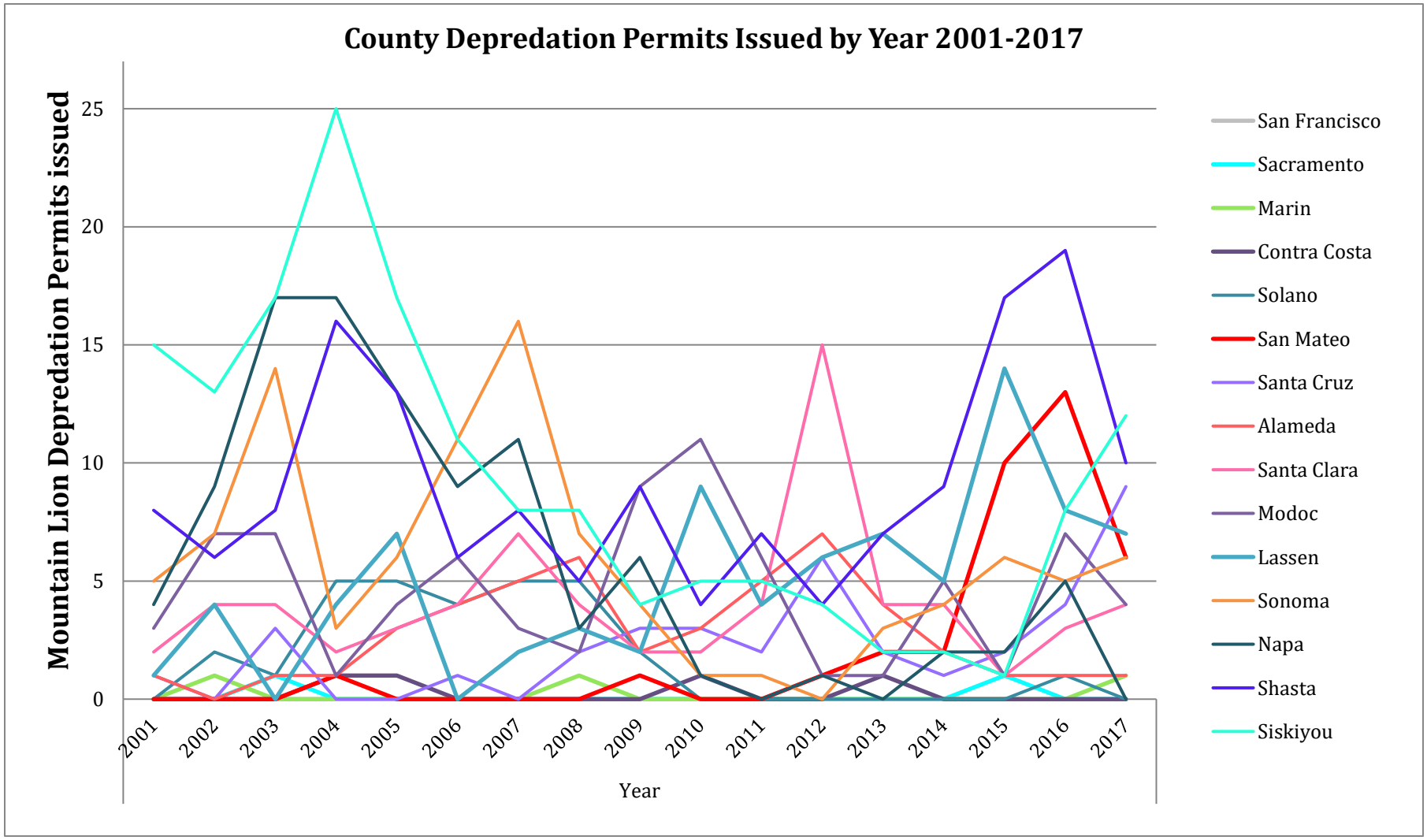
There are currently a few groups that certify and/or promote wildlife-friendly and/or carnivore friendly livestock management practices. For example, Wildlife Friendly Enterprise Network certifies a variety of livestock operation types and other agricultural producers from across the country who commit to a strict set of criteria to qualify for "Predator Friendly" status. Started in 1991, the program requires that participating producers employ only non-lethal preventative livestock predation deterrents. Each operation is audited and monitored annually to ensure that preventative practices remain in place. In turn, Wildlife Friendly Enterprise Network provides various marketing incentives for producers to join the program. Though this does not prevent conflict, it uses the market to help defray the cost of coexisting with carnivores and makes that relationship more profitable for producers. If producers operating on District lands can pass the cost of ranching alongside carnivores on to consumers willing to pay a premium on local products in which they believe, perhaps carnivores will become less of a burden to producers.

An alternative option for decreasing the cost of ranching alongside carnivores is to provide producers with reduced grazing fees. As mentioned above, this is a tool used at Point Reyes National Seashore, where livestock producers are indirectly compensated for costs associated with carnivores with a reduced grazing fee of $7.00 per AUM. The District currently charges a reduced fee of $16.15 per AUM in part to help defray costs associated with raising livestock in rugged carnivore habitat. Producers that run cattle on federal land under the Bureau of Land Management and Forest Service were charged a grazing fee of $1.87 per AUM for 2017 (BLM 2018). In contrast, this year the East Bay Regional Park District is charging $20.75 per AUM (EBRPD 2018, Defreese, personal communication); East Bay Municipal Utilities District is charging $26.40 per AUM (Swann, personal communication), and SFPUC is charging $19.90 per AUM (Dakin, personal communication).

Communicate Dog Restrictions to the Public

Though District tenants do not report dogs as their main concern, there are a few things that the District could to do keep dog issues to a minimum. It could be beneficial to communicate the logic behind the District's leash policies. On the District's website addressing dog rules and regulations (https://www.openspace.org/what-to-do/activities/dogs), there is no mention of being vigilant around cattle, and especially calves. The District is home to a vast network of trails, and much of the adherence to following park rules is done so voluntarily. It could build support and leash rule compliance to create online materials and/or signage that let dog owners appreciate their roles as rangeland stewards. Additionally, alerting the public to their level of potential liability should their dog injure livestock (see Legal Status and Regulations - Dogs above) could help prevent negative interactions.

Appendix


County Depredation Permits Issued by Year 2001-2017
Mountain Lion Depredation Permits issued
25
20
15
10
5
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
San Francisco
Sacramento
Marin
Contra Costa
Solano
San Mateo
Santa Cruz
Alameda
Santa Clara
Modoc
Lassen
Sonoma
Napa
Shasta
Siskiyou

Appendix 1: Reported depredation permits issued to each of the Bay Area counties and the counties in which wolves have had a significant presence. Overall, San Mateo County has lower reported depredation permits than neighboring counties, however, there has been an increase in the last 4 years (Data are available from CDFW 2018).

County	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Alameda	1	0	1	1	3	4	5	6	2	3	5	7	4	2	1	1	1
Alpine	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Amador	15	13	8	7	5	3	7	8	6	3	5	3	4	16	4	5	3
Butte	0	3	3	5	6	1	3	0	5	5	5	1	3	7	8	6	10
Calaveras	7	10	13	22	19	9	13	6	7	16	9	6	14	30	13	10	6
Colusa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1
Contra Costa	0	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	0
Del Norte	0	0	0	4	1	3	0	1	0	2	1	0	0	1	1	0	2
El Dorado	22	14	19	19	5	7	4	4	4	17	13	16	16	23	29	13	15
Fresno	3	4	1	2	1	1	2	4	0	2	1	2	2	4	7	2	2
Glenn	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Humboldt	6	4	8	12	9	11	10	5	8	8	6	6	3	3	8	0	10
Imperial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inyo	0	2	0	2	1	0	0	0	0	0	3	1	0	0	0	1	0
Kern	3	4	2	1	4	4	3	0	4	1	1	2	3	1	8	7	1
Kings	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lake	1	2	3	1	5	1	2	3	1	1	1	0	4	1	1	3	1
Lassen	1	4	0	4	7	0	2	3	2	9	4	6	7	5	14	8	7
Los Angeles	1	1	1	1	1	0	2	1	0	0	0	1	0	5	1	1	0
Madera	0	3	1	1	0	2	1	0	3	4	1	3	2	3	11	5	4
Marin	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Mariposa	2	3	0	2	5	3	10	2	3	2	7	8	5	12	11	8	11
Mendocino	26	35	20	31	18	10	17	9	5	6	13	7	5	4	7	21	13
Merced	0	0	0	0	0	0	1	0	0	1	0	1	1	0	0	1	0
Modoc	3	7	7	1	4	6	3	2	9	11	6	1	1	5	1	7	4
Mono	1	0	0	0	1	1	0	1	0	1	0	2	0	0	1	0	0
Monterey	2	8	5	7	6	2	13	2	5	0	3	3	5	7	4	8	2

Napa	4	9	17	17	13	9	11	3	6	1	0	1	0	2	2	5	0
Nevada	2	6	5	12	4	7	6	1	2	2	5	3	5	4	7	14	10
Orange	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2
Placer	7	5	3	2	0	4	1	0	1	4	2	4	1	4	7	5	4
Plumas	8	7	4	3	8	4	4	2	0	0	1	10	3	4	2	4	4
County	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Riverside	4	6	2	9	2	4	1	0	4	0	0	1	7	4	1	0	0
Sacramento	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
San Benito	1	0	0	0	0	0	1	0	0	0	4	0	0	0	0	0	0
San Bernardino	1	3	1	1	0	2	4	0	0	2	0	0	3	1	0	1	1
San Diego	7	4	1	0	0	1	1	0	0	0	2	2	2	5	2	6	2
San Francisco	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Joaquin	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Luis Obispo	3	5	7	16	8	9	6	6	2	1	7	3	10	11	24	6	7
San Mateo	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**2**	**2**	**10**	**13**	**6**
Santa Barbara	1	2	0	1	7	2	7	3	3	2	0	0	3	3	4	6	1
Santa Clara	2	4	4	2	3	4	7	4	2	2	4	15	4	4	1	3	4
Santa Cruz	1	0	3	0	0	1	0	2	3	3	2	6	2	1	2	4	9
Shasta	8	6	8	16	13	6	8	5	9	4	7	4	7	9	17	19	10
Sierra	2	1	1	0	0	0	2	1	1	0	1	0	0	1	0	0	1
Siskiyou	15	13	17	25	17	11	8	8	4	5	5	4	2	2	1	8	12
Solano	0	2	1	5	5	4	5	5	2	0	0	0	0	0	0	1	0
Sonoma	5	7	14	3	6	11	16	7	4	1	1	0	3	4	6	5	6
Stanislaus	1	0	0	1	1	2	2	4	2	0	0	0	1	2	0	0	0
Sutter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tehama	1	1	0	3	2	1	1	0	1	4	0	0	2	1	4	4	1
Trinity	9	8	9	8	10	11	10	9	11	5	4	4	2	2	4	0	2
Tulare	1	1	1	3	2	2	0	0	0	0	0	0	0	0	0	2	0
Tuolumne	10	8	12	5	5	3	10	23	10	5	2	1	14	18	20	12	11
Ventura	0	0	1	2	1	4	3	0	1	0	0	0	1	1	1	1	0

Yolo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Yuba	0	0	4	1	1	0	0	3	0	0	0	0	1	0	2	6	2

Appendix 2: Reported depredation permits issued for all counties in California from 2001 through 2017. It is important to note that not all depredations are reported; these data may not reflect every depredation incident that occurred within that county for a given year. It should also be noted that not all of the permits issued resulted in mountain lions being removed (These data were used to make the graph in Appendix 1 and are available from CDFW 2018).

Operation Timing	Acreage	Percent Grazed Acreage	AUM	Percent AUM	Operation Type	
					Stockers	Cow/Calf Pairs
Seasonal	2,096	19	1,096	23	1	3
Year-round	8,717	81	3,640	77	2	6

Appendix 3: Year-round and seasonal grazing on District properties. There are 10 properties that have cattle grazing, 4 of which are seasonal (representing 19 percent of grazed land), and the remaining 6 are year-round (representing 81 percent of grazed land). Both the type of operation and operation timing can influence predation risk. For example, whether an operation is running stockers versus cow/calf pairs (with higher predation risk for cow/calf pairs) or whether an operation is seasonal versus year-round (with higher predation risk for year-round operations). Factors may also interact, elevating or decreasing risk accordingly. For example, holding all other factors constant, the rank order of highest potential relative risk to least would be the following:

Year-round cow/calf pairs > seasonal cow/calf pairs > year-round stockers > seasonal stockers

Tool	Coyote	Mountain Lion	Bobcat	Dog
Targeted lethal removal	Results Vary	No Data	No Data	No Data
Permanent wire fencing	Moderately Effective	Not Effective	Not Effective	Effective
Permanent electric fencing	Effective	Moderately Effective	Effective	Effective
Temporary electric fencing	Effective	Results Vary	Effective	Effective
Fladry / Turbo fladry	Results Vary	No Data	No Data	No Data
Night penning	Effective	Effective	Effective	No Data+
Livestock guarding dogs	Effective	Effective	Effective	Effective
Llamas	Moderately Effective	Not Effective	No Data+	Effective
Donkeys	Effective	Moderately Effective	No Data+	Effective
Frightening deterrents	Moderately Effective	Moderately Effective ~	No Data+	No Data
Changing cattle breed	No Data+	No Data+	No Data+	No Data+
Altering pasture vegetation	No Data+	No Data+	No Data+	No Data
Altering production calendar	Moderately Effective	Moderately Effective	Moderately Effective	No Data*
Bolstering alternative prey	Moderately Effective	Moderately Effective	No Data+	No Data
Attractant removal	Effective	Effective	Effective	No Data+
E-shepherd collar	No Data+	No Data*	No Data	No Data+
Cowbell	No Data*	No Data*	No Data*	No Data*
Human presence	Results Vary	No Data+	No Data+	No Data
Hazing	Effective	No Data	No Data	No Data

Appendix 4: Livestock protection toolkit. The practicality and efficacy of any particular tool will depend on the type and scale of the operation, livestock species, duration of use, etc. In addition, each tool may have very specific implementation instructions, and deviation from those guidelines may render the tool ineffective.

+ Likely moderately effective to effective

* Likely ineffective

Appendix 5: Acronyms and Abbreviations

AUM	Animal Unit Month
BLM	Bureau of Land Management
CDFW	California Department of Fish and Wildlife (2013- present)
CDFG	California Department of Fish and Game (1909-2012)
CCR	California Code of Regulations
District	Midpeninsula Regional Open Space District
DNA	Deoxyribonucleic acid
EBMUD	East Bay Municipal Utilities District
FGC	Fish and Game Code
GPS	Global Positioning System
LGA	Livestock Guarding Animal
LED	Light emitting diode
LGD	Livestock Guarding Dog or Livestock Guardian Dog
MCP	Marin County Program
MVZ	Museum of Vertebrate Zoology
NPS	National Park Service
SFPUC	San Francisco Public Utilities Commission
UCANR	University of California Agriculture and Natural Resources
UCCE	University of California Cooperative Extension
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
WS	Wildlife Services
WRWP	Wood River Wolf Project

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