GRASSLAND MANAGEMENT PLAN FOR
PALO CORONA REGIONAL PARK

Prepared for:

Monterey Peninsula Regional Park District
60 Garden Court, Suite 325
Monterey, CA 93940

Prepared by:

Jodi M. McGraw, Ph.D.
Population and Community Ecologist
PO Box 883
Boulder Creek, CA 95006

With Assistance from:

Keith Guenther
Wildland Solutions
PO Box 710
Brewster, WA 98812

Funded by:

The Nature Conservancy
99 Pacific Street, 200G
Monterey, CA 93940

The Big Sur Land Trust
PO Box 221864
Carmel, CA 93922

February 26, 2007

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ACKNOWLEDGEMENTS

This plan was developed through collaboration by several organizations working to conserve biodiversity in the grasslands and aquatic systems of Palo Corona Regional Park.

Representatives and contractors of The Nature Conservancy (TNC), The Big Sur Land Trust (BSLT), and the Monterey Peninsula Regional Parks District (MPRPD) provided input and guidance throughout development of the plan. Dr. Caroline Christian (formerly with TNC), Susanna Danner (formerly with BSLT), and Tim Jensen (MRPPD) provided guidance on the plan's scope and content. Dr. Caroline Christian, Susanna Danner, Lynn Overtree (MPRPD), Valentine Hemingway (consultant, UC Santa Cruz), and Dr. Grey Hayes (independent consultant) provided essential background information about the ecology, threats, and management of the grasslands and aquatic systems that was used to inform development of the the plan goals and strategies. In addition to informative site tours describing the natural history of the site, Lynn Overtree provided a relational database and geographic information system data for the park's species, communities, and infrastructure, which she compiled during her work as manager of the site.

Keith Guenther (consultant, Wildland Solutions) developed key components of the grazing strategy through critical analysis of the characteristics of the grasslands and adjacent communities, existing livestock operation infrastructure, and other site factors that influence the effects of cattle and their effectiveness as a management tool. Mr. Guenther also developed the proposed methods for monitoring grazing intensity, and contributed to the geographic information system that was used to develop the plan and that will aid plan implementation.

The plan was greatly improved by comments received from Scott Butterfield (TNC), Heather Brady (BSLT), Laura Smith (TNC), Lynn Overtree, Keith Guenther, and Tim Jensen.

The author is very appreciative of all of the assistance received, and for the opportunity to collaborate with a fabulous team on such an important project.

EXECUTIVE SUMMARY

Located south of the Carmel River in Monterey County, the 4,300 acres Palo Corona Regional Park (PCRP) is owned by the Monterey Peninsula Regional Park District, which manages it with funding and planning assistance from The Big Sur Land Trust and The Nature Conservancy. The park has extraordinary conservation value due to its large size, adjacency to 13 other protected areas, diverse mosaic of ecological communities, and populations of several rare and endangered species. Of particular conservation concern are the coastal terrace prairie grasslands, ponds, and riparian and riverine systems, which are diverse and support several rare or endangered species. Based on a synthesis of available information about the ecology of the communities and species, this plan recommends strategies and best management practices for the maintenance of biodiversity within these systems (Table ES-1), and describes adaptive management components designed to enhance management success.

Proper management of the PCRP grasslands should maintain or enhance their distribution, native plant community structure and composition, and special status species populations. As a landscape-level management tool, cattle grazing limits woody plant encroachment, removes litter (decaying vegetation) that inhibits plant establishment, and increases the diversity and abundance of native grassland grasses and forbs. Grazing also facilitates fire management within the park by preventing the accumulation of fine fuels that pose a fire risk.

To attain specific grassland goals and objectives, grazing prescriptions identifying the season and intensity of use were developed for four grassland associations identified in this plan, which differ in terms of species composition and threats (Figure ES-1). For the estimated 590 acres of ridge grasslands, a relatively low productivity association, conservative intensity (25-50% forage utilization), early season (November-March) grazing is recommended to increase native plant diversity and abundance by reducing competition from the exotic annual grasses—the preferred cattle forage early in the season. Variable use due to differences in soils, terrain, and distance from water is predicted to create low structure conditions required by species such as the California horned lark, as well as habitat for merlins, northern harriers, and other species that prefer moderately tall grass.

Conservative intensity, early season grazing is also recommended for the 350 acres of subshrub grasslands, which support populations of seacliff buckwheat—a host plant for the federally threatened Smith's blue butterfly. Such grazing is predicted to increase buckwheat populations by reducing competition from exotic annual grasses for scarce soil resources. During the early season, the butterflies occur as pupae in the litter beneath their host plants, where they are unlikely to be negatively impacted by cattle.

In the alluvial canyon grasslands, which occur on eroded soil deposited on canyon slopes amidst patches of redwood forest, conservative intensity, early season grazing is prescribed can prevent litter accumulation, deter shrub encroachment, and promote populations of the rare Hutchinson's larkspur. During the cool, wet weather of the early season, cattle will remain on the exposed grassland ridges and slopes and avoid the steep canyons located in the center and southern portion of the park. Cattle should be expeditiously moved through canyons bottoms to further limit their impacts on riparian and riverine communities in this area.

In the northern portion of the park, a mix of grazing prescriptions is recommended to create a mosaic of grassland conditions and attain specific management objectives within the moist perennial grasslands. In this highly productive and diverse association dominated by perennial grasses and forbs, winter-spring grazing (February-June) should suppress populations of invasive exotic forbs (e.g. mustard and poison hemlock). Summer use (July -August) following early season grazing is prescribed to reduce shrub encroachment. A range of conservative to heavy intensity grazing is prescribed within this association to create low structure conditions that support San Francisco popcorn flower and burrowing owls, and taller grass conditions appropriate for grasshopper sparrows, white-tailed kites, and marsh microseris.

While cattle grazing provides a low cost, effective tool for landscape-level grassland management, it will not be sufficient to address all of the threats to the rare species and communities. Exotic plant management combining manual and chemical treatments is recommended to control invasive exotic plants, including French broom, wild radish, and thistles. Targeted control of coyote brush and Monterey pine can prevent grassland conversion to coastal scrub and Monterey pine forest. An integrated fire plan would compliment this plan's management prescriptions and further its goals for the grassland species and communities.

This plan also prescribes management strategies designed to maintain or enhance the areal extent, natural community structure and composition, and special status species populations within the PCRP ponds, springs, and riparian and riverine systems. The ponds support populations of two federally threatened amphibians, California red-legged frog and California tiger salamander. Recommended pond and spring management includes: fencing ponds and springs to exclude cattle; eradication of invasive aquatic plants (e.g. yellowflag iris); manual vegetation removal and dredging to maintain pond conditions required by the special status amphibians; French broom control to enhance upland habitat for California tiger salamander; and best management practices to prevent the spread of emergent amphibian diseases.

To increase the area and width of riparian vegetation and protect stream habitat, cessation of grazing is recommended for two pastures located adjacent to Monastery Creek and the Carmel River. Streams located in the northern grassland management areas should be fenced to exclude cattle. Eradication of Cape ivy from the park will further protect the riparian and riverine areas.

A suite of infrastructure improvements and maintenance techniques are needed to implement the grazing strategies and prevent unintended negative impacts of livestock on the natural systems and park visitors in PCRP. Specific measures include: install new fences to create the desired management unit (i.e. pasture) configuration, refurbish or replace troughs to include wildlife escapes and float valves; create and distribute materials to educate park visitors about the role of cattle grazing in park management and provide guidelines for visitor safety around cattle.

Monitoring is recommended to evaluate effectiveness of the prescribed management strategies. Uncertainty about management effects renders monitoring essential to long term success toward the biological goals and objectives. Monitoring results and new information should be integrated into the plan through an adaptive management process that will enhance success toward the conservation goals and objectives for these rare species and communities of Palo Corona Regional Park.

Table ES-1: Special status species and recommended management within the grasslands, riparian areas, and ponds and springs of Palo Corona Regional Park. Details provided in text.

			Recommended Management Strategies			
Community	**Acres**	**Special Status Species**	**Cattle Grazing**	**Invasive Exotic Species**	**Vegetation**	**Other**
Moist Perennial Grassland	485	marsh microseris, Pacific Grove clover, San Francisco popcorn flower, white-tailed kite	Use a variety of grazing prescriptions to control invasive species, reduce exotic grasses, and create mosaic of grassland heights to promote diversity	Eradicate jubata grass; control thistles, French broom, Harding grass, and invasive forbs	Prevent Monterey pine encroachment	
Alluvial canyon grasslands	11	Huthinson's larkspur	Use conservative intensity, early season grazing to tip competitive balance to native herbs			
Subshrub grassland	353	Lewis's clarkia, large-flower linanthus, Douglas's spineflower, Smith's blue butterfly	Use conservative intensity, early season grazing to tip competitive balance to native herbs			
Ridge grassland	590	Pinnacles buckwheat, California horned lark, California horned lizard	Use conservative intensity, early season grazing to tip competitive balance to native herbs			
General grasslands	1439	California condor, northern harrier, burrowing owl, merlin, golden eagle	Above prescriptions will also deter shrub encroachment, reduce litter accumulation, and reduce fire risk.	Reduce abundance of exotic annual grasses	Prevent coyote brush encroachment	Prescription fire to maintain large, contiguous grassland habitat areas
Riparian	29	steelhead trout, tricolored blackbird	Eliminate grazing from 2 pastures near streams; create exclosures; graze in the early season and use cattle riders to limit access to unfenced streams	Eradicate cape ivy		
Ponds and springs	10 ponds, 24 springs	California red-legged frog, California tiger salamander	Prevent uncontrolled cattle access to ponds and springs	Eradicate yellowflag iris; control French broom adjacent to ponds; prevent exotic animal colonization	Use manual vegetation removal to maintain pond conditions for amphibians	Prevent amphibian disease spread; limit visitor pond access; address pond sedimentation

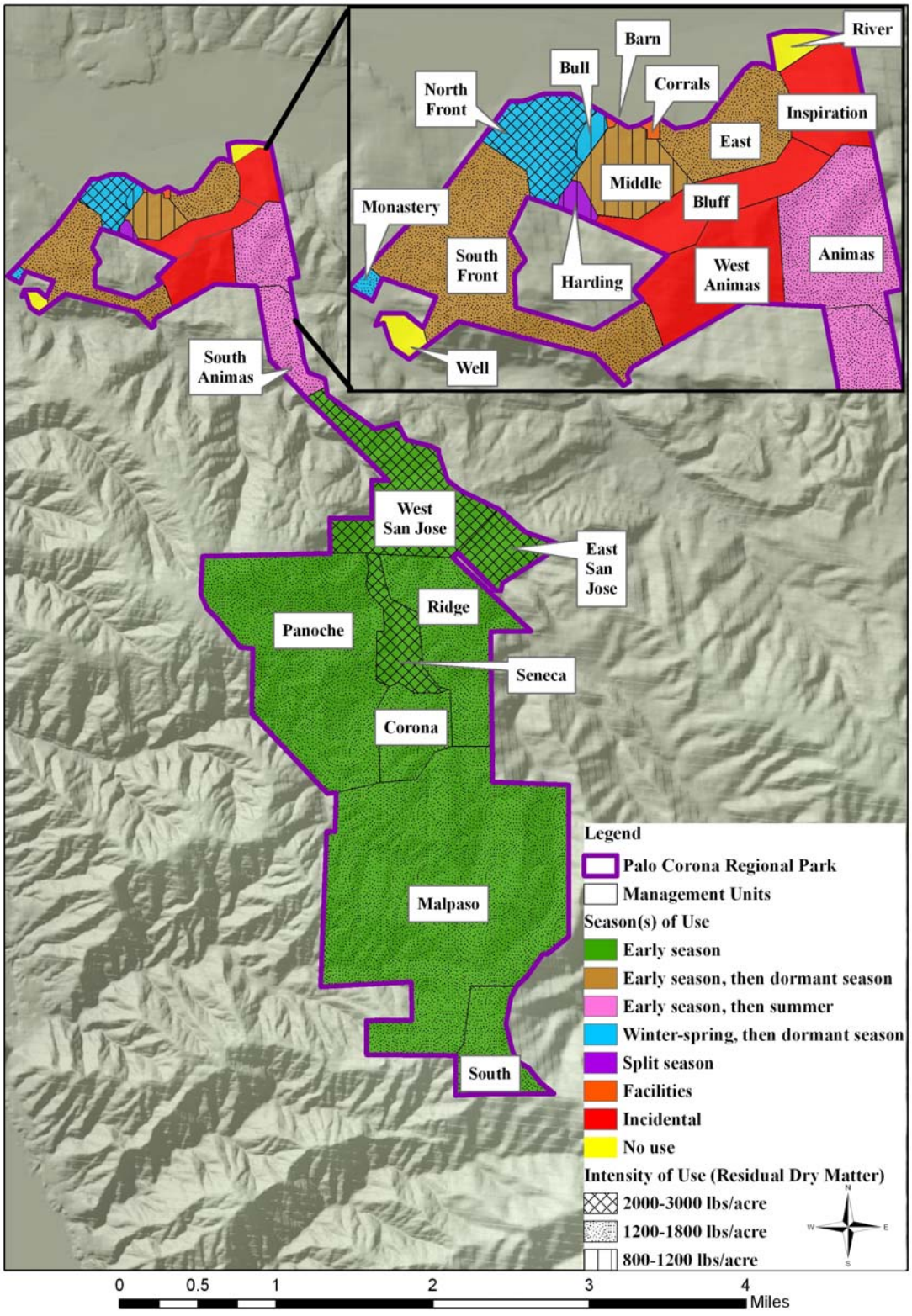

Figure ES-1: Cattle grazing season of use and intensity prescriptions for the management units of Palo Corona Regional Park. Map prepared by Jodi McGraw.

SUMMARY

Palo Corona is a 4,300 acre regional park located just south of the Carmel River in Monterey County, central coastal California. Owned by the Monterey Peninsula Regional Park District, which manages the site with funding and planning assistance from The Big Sur Land Trust and The Nature Conservancy, Palo Corona Regional Park (PCRP) has extraordinary value for conservation, due to its large size, location adjacent to 13 other protected areas, diverse mosaic of ecological communities, and populations of several rare and endangered species.

Of particular conservation importance are the 1,400 acres of coastal terrace prairie grasslands—a unique and diverse community that supports a high proportion of endemic plants. Due to widespread loss and fragmentation of the coastal terrace prairie and grasslands state-wide, several grassland species within PCRP are recognized as rare or endangered. In addition, PCRP contains ponds that support populations of two threatened amphibians, California red-legged frog and California tiger salamander, as well as coastal streams that contain Sycamore woodlands and runs of the federally threatened steelhead trout.

Preservation of biodiversity within PCRP's grasslands, ponds, and riparian and riverine systems will require proactive management to address the threats confronting these systems, which include exotic species, fire exclusion, and incompatible grazing practices. This plan recommends management by providing the following:

- A synthesis of the available information about the conservation targets
- Biological goals and objectives that identify the desired future condition for the conservation targets
- Management strategies and techniques developed based on available scientific information that are designed to attain the biological goals
- Monitoring and adaptive management components to evaluate the effects and effectiveness of management and incorporate new scientific information in order to facilitate long-term success toward the biological goals.

GRASSLANDS

As identified and described in this plan, PCRP supports four grassland associations that differ in species composition, ecology, and threats. For each, specific goals, objectives and management strategies have been developed.

Moist Perennial Grasslands

The PCRP supports 485 acres of grasslands dominated by perennial grasses and herbs. Located in the northern half of the park, these productive moist perennial grasslands occur primarily on fine-textured loam soils within reach of the coastal fog. They support a wealth of native plants and animals, and several special status species including San Francisco popcorn flower, marsh microseris, burrowing owl, merlin, and white-tailed kite. The persistence of these grasslands and the species they support is threatened by fire exclusion, invasive exotic plants, and inappropriate grazing practices.

Goals and Objectives

Goal 1: Maintain or enhance the distribution, native plant community structure and species composition, and special status species populations of the moist perennial grasslands.

Objective 1.1: Maintain in perpetuity an estimated 300 acres of moist perennial grassland.

The coastal grasslands within PCRP are susceptible to conversion to shrubland or woodland via encroachment of woody vegetation. Historically, shrub and tree encroachment would have been limited by recurring wildfire and year-round grazing. Given the rarity of the coastal grasslands and its associated species, management should maintain the areal extent (area covered by) of this community. It is also important to maintain large, contiguous grassland areas required by grassland species including northern harriers.

As an exception, an estimated 19 acres of moist perennial grassland in five units are recommended to be allowed to naturally succeed other community type (riparian woodland, coastal scrub, Monterey Pine forest) in order to reduce the impacts of grazing and associated vegetation management (i.e. mowing) on the riverine and riparian system and to avoid unnecessary management costs. These are: River Unit (9 acres), West Animas Unit (6 acres), Well Unit (2 acres), Bluff Unit (3 acres), Inspiration Unit (1acre).

Objective 1.2: Create and maintain a mosaic of grassland structure, which includes both open, short-grass conditions and dense, tall-grass conditions.

Grassland plants and animals that require low litter, low plant cover, and short vegetation height conditions include burrowing owl, San Francisco popcorn flower and Pacific Grove clover, as well as many other native annual forbs. Other grassland species including grasshopper sparrows, northern harriers, and white-tailed kites favor moderate to tall vegetation height, which can also support many small mammals, such as voles (*Microtus californicus*).

Objective 1.3: Maintain or increase the absolute cover and species richness of native grassland herbs within the moist perennial grassland by maintaining or reducing the cover of herbaceous exotic plants.

The moist perennial grasslands have been invaded by exotic grasses and forbs that compete with native grassland species, reducing their abundance. Though eradication of these species is not possible, management techniques that tip the competitive balance from exotic plants to native species can enhance abundance and richness of native species.

Objective 1.4: Maintain native shrubs and trees at or below 30% absolute cover within the moist perennial grassland.

Native woody plants including coyote brush and Monterey pine degrade habitat for grassland plants that are outcompeted by woody vegetation and animals adapted to open grassland habitat. Over time, they can convert grassland to coastal scrub or Monterey pine forest. Some occurrence of shrubs within the grasslands can favor animal species, such as grasshopper sparrows, which use shrubs for perches. Maintaining some woody plant cover while preventing excessive encroachment will promote diversity in these grasslands.

Objective 1.5: Control (<5% cover) or eliminate the invasive exotic plant species from the moist perennial grasslands, including French broom, poison hemlock, non-native thistles, Harding grass, wild mustard, and wild radish.

Large, invasive exotic species compete with native grassland herbs and alter the grassland habitat structure. Unmanaged, they can spread and become dominant within the grasslands.

Management Strategies

A suite of coordinated management strategies including cattle grazing, exotic plant management, and vegetation management is designed to attain the goals and objectives for the moist perennial grasslands. Given the uncertainty of predicting the effects of grazing, monitoring should be used to evaluate effectiveness of grazing as a management tool.

Grazing Management: A multifaceted grazing regime within the moist perennial grasslands is designed to reduce the cover of herbaceous exotic plants including invasive herbs; reduce the cover of woody plants, including French broom; and increase the cover and richness of native grassland herbs, while creating a mosaic of vegetation structure conditions that facilitates total diversity.

Early Season Grazing: In the estimated 430 acres of moist perennial grassland contained in the South Front, Middle, East, Animas, South Animas, Ridge, West San Jose, and East San Jose Units, early season cattle grazing (November-March) is recommended to increase the diversity and abundance of native herbs by reducing competition from exotic herbs. A mix of conservative and moderate intensity grazing in these units can create both high structure conditions required for white tailed kites and northern harriers, and marsh microseris, and low structure conditions required by burrowing owl and San Francisco popcorn flower.

Winter-Spring Grazing: In the estimated 57 acres of moist perennial grassland contained in the North Front, Bull, and Monastery Units, grazing should be avoided between November and January, so that perennial herbs and annual grasses can suppress establishment and growth of late-season invasive exotic forbs (radish, mustard, and poison hemlock) and thistles. A mix of conservative and moderate intensity grazing are recommended between February and June to reduce growth of the exotic grasses and forbs, thus promoting the abundance of native grasslands species.

Dormant Season Grazing: In the estimated 233 acres of moist perennial grasslands located in the northern units (South Front, North Front, Monastery, Bull, Middle, and East), cattle should be reintroduced for a 2-3 week period between July-October, as needed, to further

reduce annual grass cover. Such summer grazing in the Ridge Unit could negatively impact the adjacent forests and shrublands and will likely be unnecessary due to reduced productivity in this portion of the park.

Early Summer Grazing: In the estimated 72 acres of moist perennial grassland located in the Animas and South Animas Units, cattle should be reintroduced between July and August. Such dormant season grazing is designed to reduce abundance of the invasive French broom as well as coyote brush while avoiding impacts to native bunchgrasses during their growth and flowering in spring.

Split-Season Grazing: In the 6 acre Harding Unit, grazing should be deferred until February to facilitate the growth of exotic annual grasses that will reduce establishment and growth of Harding grass. Grazing cattle between February and March will directly negatively affect this perennial grass by reducing its growth and reproduction. Removing cattle between April and June reduces the deleterious effects of grazing on the native perennial herbs, which experience peak growth and flowering at that time, and native annual forbs that would be in flower. Returning cattle during the summer (July-October) to graze on Harding grass will reduce its fecundity.

Vegetation Management: A vegetation management program is designed to supplement the effects of grazing at preventing encroachment of coyote brush and French broom, and controlling invasive herbs including Harding grass, wild mustard, wild radish, poison hemlock, and thistles.

Woody Plant Encroachment**:** Every five years or as needed, Monterey pines, coyote brush, French broom, or other dominant woody plant species that establish within the moist perennial grasslands should be removed either by pulling (weed wrench) or cutting and applying topical herbicide (e.g. glyphosate) to the cambium.

Invasive Species: Invasive exotic plants in the moist perennial grasslands should be controlled through a combination of mowing, manual removal, and selective herbicide use to complement grazing prescriptions.

Fire Management: Prescribed fire can prevent conversion of moist perennial grasslands to shrubland or woodland and periodically remove litter that accumulates on the soil surface, to create open soil conditions required by certain species. A fire management plan should be developed to provide prescribed burn guidance, inform visitors and the public on the use of fire as a management tool, as well as address wildfire management within the park.

Alluvial Canyon Grasslands

Patches of grassland habitat occur on alluvial deposits within the dense forests that line the steep canyons in the center and southern portion of PCRP. Little is known about their species composition and ecology; however, they are thought to support unique assemblages of shade-tolerant herbs, including Hutchinson's larkspur, a rare herb endemic to Monterey. At present, only 11 acres of this association are mapped as occurring within in the park. Like other

grasslands, their persistence is likely threatened by fire exclusion, invasive exotic plants, and inappropriate grazing practices.

Goals and Objectives

Goal 2: Maintain or enhance the distribution, native plant community structure and species composition, and special status species populations in the alluvial canyon grasslands.

Objective 2.1: Increase understanding of the distribution and floristic composition of alluvial canyon grasslands within the PCRP.

Information about the distribution and species composition of these unique grasslands could facilitate management planning. A spring-summer survey should be used to identify the locations supporting this association and determine the dominant, indicator, and special status species it supports.

Objective 2.2: Maintain in perpetuity the current occurrence of alluvial canyon grasslands.

Management should include efforts to maintain habitat of this unique assemblage. Information about its distribution and species composition will facilitate assessment of threats (e.g. exotic plants) and development of management strategies.

Objective 2.3: Maintain or increase the absolute cover and species richness of native grassland herbs within the alluvial canyon grasslands.

This unique assemblage should be managed to maintain or increase native species cover, which is likely impacted by exotic herb competition.

Objective 2.4 Maintain native shrubs and trees at or below 30% absolute cover within the alluvial canyon grasslands.

Owing to the mesic conditions in which they occur and their small size (and thus high perimeter to area ratio), the small patches of alluvial canyon grasslands may be susceptible to invasion by woody plants and thus type conversion to shrubland or woodland. Alternatively, unstable soil conditions due to the steep slopes might inhibit shrub and tree establishment, thus maintaining this association.

Objective 2.5: Control (<5% cover) or eliminate invasive exotic plant species from the alluvial canyon grasslands.

Any invasive exotic plants within the alluvial canyon grasslands should be eradicated or controlled to reduce their impacts on native herbaceous plants and avoid degradation of animal habitat.

Objective 2.6: Minimize erosion caused by cattle grazing on steep slopes and prevent sedimentation of adjacent streams.

Due to their steep slopes, the alluvial canyon grasslands are susceptible to erosion which could be exacerbated by cattle grazing. Owing to their location adjacent to streams that support steelhead, which are negatively impacted by sedimentation, management should minimize erosion within these areas.

Management Strategies

Based on available information, the alluvial canyon grasslands are to be managed using cattle grazing, exotic plant management, and vegetation management to attain the goals and objectives. Additional information about the species composition and ecology of these grasslands should be incorporated into the plan as it is developed

Grazing Management: In the estimated 11 acres of alluvial canyon grassland contained in the Panoche and Ridge Units, conservative intensity, early season cattle grazing (November-March) is recommended to reduce competition of annual grasses and forbs on native herbs. This grazing regime is designed to reduce impacts of grazing on grazing-intolerant plants that occupy these grasslands, including Hutchinson's larkspur, as well as perennial grasses and forbs that would be impacted by late season and year round grazing.

Vegetation Management: By limiting grazing to the early season in order to avoid negative impacts on native perennial grasses and herbs, the effectiveness of grazing at preventing shrub encroachment may be reduced. Every five years or as needed, coyote brush or other dominant woody species that establish within the alluvial canyon grasslands should be removed by either pulling (weed wrench) or cutting and applying topical herbicide to the cambium.

Fire Management: A prescription burn program would be highly beneficial to prevent conversion of alluvial canyon grasslands to shrubland or woodland and periodically remove litter that accumulates on the soil surface, to create open soil conditions required by certain species.

Subshrub Grasslands

The rounded hills in the central portion of the park support 350 acres of grassland containing coastal terrace prairie herbs and coastal scrub subshrubs, including silver bush lupine, California broom, and seacliff buckwheat. This association occurs on coarser textured loam soils located on hilltops that receive less fog than the northern terraces, resulting in drier, lower productivity conditions. Owing to the presence of seacliff buckwheat, this association supports populations of Smith's blue butterfly, a federally threatened lycenid butterfly endemic to the central coast. It also supports populations of several rare herbs, including large flower linanthus, Douglas's spineflower, and Lewis's clarkia. Persistence of these species and the unique grassland association is threatened by fire exclusion, exotic plants, and inappropriate grazing practices.

Goals and Objectives

Goal 3: Maintain or enhance the distribution, native plant community structure and species composition, and special status species populations of the subshrub grasslands.

Objective 3.1: Maintain the current occurrence of subshrub grasslands, which are estimated to cover 350 acres.

Management should include efforts to maintain habitat of the subshrub grasslands, which are predicted to be susceptible to native shrub encroachment in the absence of fire or other disturbance, and thus potential conversion to either coastal scrub or chaparral.

Objective 3.2: Maintain or increase the absolute cover and species richness of native grassland herbs within the subshrub grasslands.

The subshrub grasslands have been invaded by exotic annual grasses and forbs that compete with native herb and subshrubs and might degrade habitat for Smith's blue butterfly by reducing abundance of its host plant, seacliff buckwheat. Though eradication of these species is infeasible, management techniques that can tip the competitive balance from exotic plants to native species can enhance abundance and richness of native species.

Objective 3.3 Maintain or enhance cover of seacliff buckwheat within the subshrub grasslands to provide habitat for Smith's blue butterfly.

The subshrub grasslands provide important habitat for Smith's blue butterfly, a federally threatened species that uses seacliff buckwheat as a food source and reproduction site. Management should promote establishment and growth of this subshrub in order to maintain or increase its populations.

Objective 3.4 Maintain native shrubs and trees at or below 20% absolute cover within the subshrub grasslands.

The subshrub grasslands are moderately susceptible to invasion by coyote brush and thus type conversion to shrubland. Shrub cover should be maintained at or below 20% to minimize impacts to native grassland species, maintain appropriate habitat for Smith's blue butterfly, and prevent conversion of grassland habitat.

Management Strategies

Three coordinated management strategies are recommended to attain the goals and objectives for the subshrub grasslands.

Cattle Grazing: In the estimated 350 acres of subshrub grassland contained in the Panoche Unit, conservative intensity, early season cattle grazing (November-March) is recommended to reduce competition of annual grasses and forbs on native herbs and subshrubs. This is hypothesized to maintain or increase populations of seacliff buckwheat, a host plant for Smith's

blue butterfly. At this time, the rare butterfly is in the pupal stage (chrysalis) underneath its host plant in the litter. Because cattle will preferentially forage on the new growth of exotic annual herbs during this time, direct negative effects of cattle on the Smith's blue butterfly that might result from trampling and consumption are predicted to be avoided by early season grazing. Such early season grazing will also limit degradation of streams supporting steelhead trout, as cattle will forage on the warmer slopes and avoid the cool canyons during the winter months.

Vegetation Management: By limiting grazing to the early season in order to avoid negative impacts on native perennial grasses, subshrubs, Smith's blue butterfly, and streams that are predicted to result from late and dormant season grazing, the effectiveness of grazing at preventing shrub encroachment may be reduced. Every five years or as needed, coyote brush or other dominant woody species that establish within the subshrub grasslands will require removal either through pulling (weed wrench) or cutting and applying topical herbicide (e.g. glyphosate) to the cambium.

Fire Management: Prescribed fire can prevent conversion of the subshrub grasslands to shrubland or woodland and periodically remove litter that accumulates on the soil surface, to create open soil conditions required by certain species. A fire management plan should be developed to provide prescribed burn guidance, inform visitors and the public on the use of fire as a management tool within this grassland association, as well as address wildfire management within the park.

Ridge Grasslands

The ridges in the southern portion of the park support 590 acres of grassland comprised of herbaceous plants adapted to the droughtier, lower nutrient soils and limited coastal fog which create lower productivity conditions. The large expanses of grassland provide habitat for several animals that require large open areas, including golden eagle and merlin, and they may provide important habitat for California condors, which have recently began breeding in Monterey County. The ridge grasslands support Pinnacles buckwheat, an endangered herb, and breeding population of the California horned lark. Persistence of these species and the ridge grasslands is threatened by fire exclusion, exotic plants, and inappropriate grazing practices.

Goals and Objectives

Goal 4: Maintain or enhance the distribution, native plant community structure and species composition, and special status species populations within the ridge grasslands.

Objective 4.1: Maintain the current occurrence of ridge grasslands, which are estimated to cover 590 acres.

The ridge grasslands occur as large patches of grassland habitat that are important for grassland animal species, including merlin, golden eagle, horned lark, coast horned lizard, and perhaps California condor. Management should focus on maintaining these large contiguous areas of grassland habitat.

Objective 4.2: Maintain or increase the absolute cover and species richness of native grassland herbs within the ridge grasslands.

The ridge grasslands have been invaded by exotic annual grasses and forbs that compete with native herbs. Management should endeavor to tip the competitive balance from exotic plants to native species and enhance the abundance and richness of native species.

Objective 4.3 Maintain native shrubs and trees at or below 10% absolute cover within the ridge grasslands.

Though ridge grasslands appear less susceptible to woody plant encroachment compared to the more mesic grassland associations, management might be needed to maintain low cover of woody plants that could spread into the grasslands from the forest and shrubland edges and degrade habitat for species that require open grassland.

Management Strategies

Three coordinated management strategies are recommended to attain the goals and objectives for the ridge grasslands.

Cattle Grazing: In the estimated 590 acres of ridge grassland contained in the Malpaso, Corona, and South units, use conservative intensity, early season cattle grazing (November-March) is recommended to reduce competition of annual grasses and forbs on native herbs. This grazing regime is designed to reduce impacts of grazing on native perennial grasses associated with late season and dormant season grazing, and the negative impacts of grazing on oak acorn crops in the adjacent oak woodlands and hardwood forests associated with dormant season grazing. By limiting use to the cooler months, this prescription will also reduce cattle use and degradation of streams supporting steelhead trout.

Vegetation Management: Woody species that establish within the ridge grasslands at levels exceeding the objective (10%) should be removed every five years through either pulling (weed wrench) or cutting and applying topical herbicide (e.g. glyphosate) to the cambium.

Fire Management: As with the other grassland associations, prescribed fire can prevent conversion of the ridge grasslands to shrubland or woodland and periodically remove litter that accumulates on the soil surface, to create open soil conditions required by certain species. A fire management plan should be developed to provide prescribed burn guidance, inform visitors and the public on the use of fire as a management tool within this grassland association, as well as address wildfire management within the park.

PONDS AND SPRINGS

Palo Corona Regional Parks contains 10 ponds and 24 springs that add to the diversity of the park by supporting aquatic and wetland species, including two species of federally threatened amphibians: California red-legged frog and California tiger salamander. Ponds and springs also provide water for terrestrial animal species. The pond and springs are being impacted by exotic plants and inappropriate grazing practices, while exotic animals and emergent wildlife diseases also threaten the persistence of native species in the ponds.

Goals and Objectives

Goal 6: Maintain or enhance the areal extent, natural community structure and composition, and special status species populations of the ponds and springs.

Objective 5.1: Maintain or increase the size of the wetted area and depth of the 7 ponds occupied by special status amphibians.

Ponds support aquatic and wetland plants and provide important breeding habitat for aquatic species. Management may be required to address sedimentation, which reduces pond size and depth, degrades pond habitat, and could ultimately result in succession of ponds to meadows.

Objective 5.2: Promote aquatic and wetland plant establishment and growth in approximately 50% of each pond, with the vegetated portion of the pond including both shallow and deep water.

Aquatic species require a diversity of habitat conditions, including water depth, vegetation and food items, with special status amphibians requiring different habitat conditions during different life stages. In the absence of disturbance, a variety of emergent and wetland plants establish within the ponds and can become dense. Such vegetation is an important component of habitat for special status species, including tricolored blackbird, which nests in bulrushes and willows, and California red-legged frog and California tiger salamander, which require vegetation for cover and breeding. However, dense vegetation can also degrade habitat for the special status amphibians by reducing water temperature and thus slowing development, and reducing the extent of deep water. Creating and maintaining a mosaic of open water and vegetated habitat conditions within and on the banks of ponds will promote diversity of aquatic and wetland plants and animals, and provide suitable habitat for amphibian eggs, larva, and adults.

Objective 5.3: Eradicate or control (<5% cover) invasive exotic plant species occurring within ponds, including yellowflag iris.

Exotic aquatic plants compete with native plants and their dense growth can degrade habitat for native pond animals, including the special status amphibians. Presently, water iris is the only known invasive aquatic species.

Objective 5.4: Maintain ponds free of exotic aquatic animals, including bull frogs, fish, turtles, and salamanders.

Exotic animals compete with and predate upon native animals and can reduce populations of special status pond species. Though presently not known to occur within the PCRP, bull frogs and introduced salamanders are known to occur in ponds on adjacent properties, including the Santa Lucia Conservancy, from which they could disperse into the PCRP.

Objective 5.5: Restore grassland habitat adjacent to ponds for California tiger salamander and increase pond connectivity by eradicating or controlling (<5% cover) French broom around ponds and preventing accidental collapse of burrows.

California tiger salamanders prefer upland habitat dominated by herbaceous plants, including grasslands. These habitats support a greater abundance of ground squirrels and pocket gophers, the burrows of which California tiger salamanders use an estimated 11 months of each year. French broom around and between Salamander, Dead Pig, and Roadrunner Ponds degrades upland habitat and likely deters migration among habitats. Such migration is essential for recolonization of ponds where the species might have been or could become extirpated, thus maintaining the metapopulation at PCRP. Driving roads adjacent to ponds can collapse burrows used by native amphibians.

Objective 5.6: Reduce the potential for spread of amphibian disease among ponds.

Persistence of native animal populations may be threatened by emergent wildlife disease, including chytrid fungus and ranaviruses which can reduce the demographic performance of individuals. These diseases have been observed in a subset of the ponds examined at PCRP.

Objective 5.7: Increase the cover and species richness of native wetland plants in and around the 24 springs.

Native wetland plants associated with springs add to the diversity of native species within PCRP and create habitat for animal species adapted to conditions in and near springs, including pacific tree frogs. Cattle degrade springs and wetlands through trampling and herbivory.

Management Strategies

A variety of coordinated management techniques will be needed to attain the biological goals and objectives for the ponds and springs.

Ponds and Spring Fences: Cattle should be excluded from ponds by installing fences with large gates that provide access by management crews and small equipment. Alternative water for livestock should be provided at least 50 feet away from the pond. Springs and the adjacent, inundated area including the run off path, should also be fenced to exclude cattle. Pipes will be used to transport spring water to a cattle trough located outside of the fenced exclosure.

Pond Sediment Management: As needed to maintain or increase water area and depth, dredging should be conducted through the following strategies to minimize impacts to special status species and habitats:

- Sediment should be removed from no more than 50% of a pond each year
- No more than two ponds should be dredged each year.
- Dredging should be conducted between late August and the first hard rain (i.e. 1")
- A biologist with appropriate state and federal permits should enter the pond ahead of equipment in attempt to scare adult amphibians from disturbance area

Vegetation Management: A vegetation management program is designed to promote native plant diversity and maintain diverse habitat conditions for native animals within ponds.

Pond Exotic Plant Management: Yellowflag iris should be eradicated from Animas pond through hand removal of all biomass, following techniques designed to minimize impacts to special status amphibians and native vegetation.

French broom should be removed around and between ponds through the following techniques implemented between late August and the first hard rain, except as noted, in order to minimize potential for direct impacts on special status species.

- Within 50 feet of the ponds, pull French broom, and then use flaming in the winter (January-February) to kill emerging seedlings.
- In monocultures between ponds, mow and/or apply herbicide (e.g. roundup) to kill plants in monocultures.

Native Plant Management: As needed to maintain open areas, aquatic and/or wetland vegetation should be removed using the following techniques designed to minimize impacts to special status species:

- Conduct work between late August and the first hard rain
- A biologist with appropriate state and federal permits should enter the pond ahead of equipment in attempt to scare adult amphibians from disturbance area
- Manually remove vegetation through cutting or pulling
- Remove all invasive exotic plants
- Remove native plants as needed to maintain a mosaic of habitat conditions, including open shallow water, open deep water, vegetated shallow water, and vegetated deep water.
- Maintain relatively large contiguous patches of native emergent vegetation for tricolor blackbirds

Cattle Grazing: In addition to grazing cattle during the early season (November-March) to reduce exotic herbs, cattle should be reintroduced to the South Animas Unit, which contains Roadrunner pond, during July and August in order to reduce French broom establishment. The removal of cattle between April and June is designed to reduce impacts of grazing on the growth and reproduction of the native perennial grasses.

Concerns about the negative effects of cattle access to San Jose Creek prevented this strategy being recommended for West San Jose Unit, which contains Dead Pig and Salamander Pond. If

techniques such as riding can be used to limit cattle use to upland grassland habitat, cattle might similarly be introduced into West San Jose Unit to facilitate French broom control.

Exotic Animal Management: Ponds should be monitored annually to detect exotic animals colonization. Exotic animals should be eradicated using methods that will minimize negative effects on native pond animals and pond habitat conditions.

Road Use Near Ponds: Ranchers, land managers, and researchers should avoid driving on roads adjacent to ponds, particularly the road on the north bank of Salamander pond, in order to minimize accidental collapse of burrows used by amphibians including California tiger salamander. Where feasible, roads near ponds should be rerouted to occur at least 100 feet away from ponds.

Amphibian Disease Spread: Ranchers, park staff, and researchers should follow best management practices designed to prevent the spread of disease among ponds (Appendix F).

Public Access to Ponds: Trails should be located away from ponds and fences should be erected around ponds to reduce public contact with pond habitat and species. This will reduce potential for disease spread between ponds, and avoid direct impacts of visitors on the special status amphibians and their habitat.

RIVERINE AND RIPARIAN

Palo Corona Regional Parks contains over 13 miles of streams that provide habitat for aquatic species, including the South-Central California Coast Evolutionary Significant Unit of steelhead trout and California red-legged frog. The riparian vegetation along the streams, which includes sycamore woodland, black cottonwood woodland, and mixed willows, protects the riverine systems and provides important habitat for small mammals and birds, including tricolored blackbirds. The streams and riparian vegetation within PCRP is threatened by exotic plants and inappropriate grazing practices.

Goals and Objectives

Goal 6: Enhance the areal extent, community structure, and species composition, and habitat conditions for special status species of the riverine and riparian systems.

Objective 6.1: Increase the areal extent of riparian vegetation.

Vegetation along streams is critical to maintaining aquatic habitat because it provides food inputs, stabilizes stream banks, and creates shade, which moderates water temperature. Riparian vegetation also provides important habitat for breeding and migrating birds, as well as animal species adapted to the relatively mesic conditions. The width of the riparian corridor influences bird diversity and nesting success for many species. Increasing the area of mixed willow series, could enhance nesting habitat for tricolored blackbirds and perhaps yellow warblers.

Objective 6.2: Eliminate or reduce stream bank erosion and stream sedimentation which degrade habitat for aquatic species, including steelhead.

Cattle access to streams removes riparian vegetation and erodes stream banks, increasing water temperature fluctuations, destroying in-stream habitat (e.g. pools), and increasing sediment that eliminates the gravel beds required for success of steelhead redds (nests).

Objective 6.3: Eradicate or control (<5% cover) invasive exotic plant species occurring within riparian and riverine systems, including poison hemlock, bull thistle, and Cape ivy.

Invasive exotic plant species degrade riparian and riverine habitat, particularly in the northern portion of the park where poison hemlock, bull thistle, and Cape ivy occur. Discontinuing cattle grazing will likely allow these species to increase in abundance, particularly that of poison hemlock which has formed a nearly impenetrable stand along River Pond which was fenced to exclude cattle. Dominant trees of the riparian woodland, including sycamore, black cottonwood and willow, might eventually create low light conditions that preclude establishment of these species. However, in the short term, the exotics may create dense stands that inhibit riparian woodland plant establishment.

Management Strategies

Three main management techniques are needed to attain the biological goals and objectives for the riparian and riverine systems.

Riparian Unit Management: To promote expansion of riparian woodland, cattle grazing and mowing should be discontinued in two management units that contain riparian vegetation adjacent to small patches of moist perennial grasslands. The River Unit is in floodplain of the Carmel River, which is lined with black cottonwood, sycamore, and mixed willows. The Well Unit is adjacent to mixed willow woodland. These units support only small patches (<10 acres) of moist perennial grassland that require grazing and mowing to prevent succession to riparian vegetation and coastal scrub. Cessation of grazing and mowing will promote expansion of the riparian woodland.

Cattle Grazing: In the following management units with streams supporting steelhead trout, cattle use should be restricted to early season (November-March) and water should be provided in troughs located at least 100 feet from the stream corridor: West San Jose, East San Jose, Seneca. Riders should move cattle as quickly as feasible across San Jose Creek and along Seneca Creek, to minimize their use of the streams and riparian areas.

Exotic Plant Management: Cape ivy should be eradicated from the park, where it presently occurs within riparian areas, using manual removal techniques. Other invasive plants in riparian areas, including poison hemlock and thistles, should be controlled.

FACILITIES MANAGEMENT

Successful use of cattle grazing as a management tool to facilitate biological goals and objectives within PCRP will require implementation of strategies designed to minimize the negative impacts of a cattle operation on the conservation targets, native ecosystems, and visitors within the park. The following describes the main goal of facilities management, and the management techniques designed to attain each specific objective.

Goals, Objectives and Management Strategies

Goal 7: Facilitate success of grazing as a management tool while minimizing negative impacts of a cattle operation on the conservation targets, native ecosystems, and park visitors.

Objective 7.1: Create and maintain a system of fences and gates that allows implementation of the grazing strategy by securely containing cattle within the management units, while minimizing negative impacts to wildlife.

Effective perimeter fences are needed to prevent cattle trespass onto adjacent properties. Fences separating the management units are needed to effectively implement the grazing prescriptions and minimize impacts to conservation targets and other components of the park ecosystem. New interior fences need to be installed to implement the grazing strategy developed for this plan. In addition, existing perimeter and interior fences require repair to prevent breaches.

New Interior Fences: New interior fencing should be installed to create the management unit configuration required to implement the recommended grazing strategy, as follows:

- Install an estimated 800 foot fence across the southwest corner of the Middle Unit to create the 6-acre Harding Unit, to be separately managed to reduce abundance of the invasive exotic Harding grass.
- Install an estimated 1,400 foot fence to separate the current Front pasture into North and South Units, allowing differential management of the moist perennial grasslands it contains.
- Install an estimated 2,000 foot fence to create the Seneca Unit from the northern portion of the existing Corona pasture and the eastern edge of the Panoche pasture.

Fences should be installed following the Natural Resources Conservation Service's Conservation Practice Specifications for fences to ensure fence effectiveness and facilitate durability (Appendix E).

To facilitate wildlife movement, new fences as well as repaired fence segments (below) should be constructed per the following:

- The lowest wire strand should be 18" off the ground, allowing wildlife to duck the fence.
- The bottom and top wire should be smooth, rather than barbed, to reduce impacts to wildlife.

Fence Breeches: Identify and repair breech points and other problem areas (i.e. dilapidated fence segments) within the perimeter and interior fences. Repaired fence segments should be created following the NRCS specifications and wildlife protection mechanisms described above.

Road Gates: Secure gates are needed to restrict vehicle movement into the park and between management units, while containing livestock. Gates should be locked and used only by authorized personnel. Visitors should use alternative fence crossings (below).

Fence Crossings: Appropriate fence crossings should be installed at locations where trails identified in the trails plan cross perimeter and interior fences. The nature of the gate or crossing will depend on the use that the trail will receive (i.e. pedestrian only vs. multi-use). These should be identified in a separate trails plan being developed for the park.

Additional Cattle Exclosures: Additional fencing should be installed to exclude cattle from areas where their use would degrade public enjoyment of the park facilities, such as picnic areas and campgrounds. These areas should be identified in a park facility and management plan to be developed at a later date. Alternative grassland management techniques, including mowing might be needed to maintain vegetation within these areas.

Objective 7.3: Maintain roads following best management practices and techniques designed to reduce impacts on the conservation targets and public recreation.

At present, PCRP contains an estimated 47 miles of roads, many of which were not designed or constructed using current standards developed to reduce erosion and maintenance. Road use and maintenance can degrade habitat for special status species, such as when road spoils are deposited on seaside buckwheat or cause sedimentation within steelhead streams.

Roads and Hydrology Plan: To address road maintenance and use, a roads and hydrology plan should be created. The plan should be coordinated with the fire management plan, trails plan, and this grassland and grazing plan, to ensure that the various uses of the road system are considered in designating locations where roads should be retained.

Objective 7.4: Create and maintain water troughs that allow grazing as a management tool while avoiding inadvertent negative impacts of the livestock operation on native animals.

Functional and well-distributed cattle troughs will be essential to successful implementation of the grazing strategy. Cattle preferentially forage within close proximity to water, with areas in steep terrain more than 1 mile away from water receiving little or no use. Some variability in use will create heterogeneous habitat conditions that can promote diversity. However, if the unused grassland is large, cattle grazing will be less effective at promoting native plant diversity and abundance, and reducing shrub encroachment. Given this, well dispersed water sources are desirable.

Cattle troughs can provide water and breeding habitat for wildlife. Appropriate trough design and maintenance techniques can minimize potential negative effects of troughs on native species.

Trough Locations: Troughs should be located grasslands to facilitate grazing objectives and avoid impacts to other communities. Water should be located within a mile of grassland habitat, where feasible.

Trough Maintenance: As needed, troughs should be cleaned during the late summer and early fall to avoid impacts to breeding amphibians during the breeding season (March-August).

Troughs Design: Troughs should feature ramps, emergent rock piles, or other mechanisms that allow animals to escape troughs and avoid drowning. Float valves should be placed in all troughs to minimize water use from springs.

Objective 7.5: Locate salt and supplements to encourage cattle use of grassland patches and minimize negative impacts associated with concentrated cattle use.

Salt and mineral supplements are placed throughout the ranch for livestock health and to obtain better distribution of forage use. Owing to increased visitation at salt licks and supplement feeders, the impacts of cattle due to trampling and herbivory can be more intense.

Salt and Mineral Supplement Placement: In order to enhance their effectiveness and minimize their negative impacts, salt and mineral supplement feeders should be located in the following areas:

- areas of relatively high exotic plant abundance that might not otherwise receive use due to distance from water or other factors
- flat areas and moderate slopes (<20º), avoiding steep slopes
- away from water sources (>100 yards), including streams, ponds, troughs, and springs
- away from special status plant species occurrences and Smith Blue butterfly habitat (>100 yards).

Objective 7.6: Avoid supplemental feeding of cattle within the management units.

Providing cattle with supplemental feed such as hay within the management units should be avoided, as concentrated use leads to excess trampling, damage to plants and soil, and degradation of grassland habitat, and hay can introduce exotic plants.

Supplemental Feeding: Supplemental feeding of cattle should be confined to the corrals.

Objective 7.7: Protect native wildlife regarded as a nuisance or harm to cattle.

Cattle operators might wish to reduce populations of native animal species that they view as a nuisance, such as ground squirrels, or a threat, such as coyotes and mountain lions. These animals should be protected within the park.

Native Wildlife Protection: Native wildlife should neither be killed nor harmed as part of the cattle operation. Where feasible, dead cattle should be left in place for use by native scavengers, including California condors.

Objective 7.8: Enhance public understanding of and support for the use of grazing as a management tool.

Visitors unaccustomed to cattle grazing in parks will require information about cattle grazing as a management tool and guidelines for their safety when recreating around cattle.

Public Information: Public information similar in content to that used by the East Bay Regional Parks District to educate the public about the role of grazing in maintaining parks should be developed and distributed via a variety of media, including:

- The Monterey Peninsula Regional Park District website
- The park brochure provided at park entrance(s)
- One or more interpretive signs posted at areas of high visitor use where cattle grazing will be observed, such as the northern coastal terraces where cattle will graze later into the season.

MONITORING AND ADAPTIVE MANAGEMENT

Management within the PCRP should be implemented within an adaptive management framework designed to enhance long term success toward the biological goals and objectives. In adaptive management, monitoring is used to evaluate the effectiveness of management strategies and inform changes to management.

Implementation monitoring is recommended to evaluate whether the grazing is being implemented with the prescribed seasonality and intensity. Season of use should be monitored through a grazing log maintained by the cattle operator, and inspections to document the seasonal status and movements of cattle among the management units. To evaluate success of the cattle operator at attaining desired intensity of use, grassland habitat should be mapped according to predefined residual dry matter (RDM) classes. The resultant map can be used to calculate RDM within the management unit, and assess the extent to which use reflected the RDM prescription for the unit.

Biological effectiveness monitoring is recommended to examine the effectiveness of grazing, exotic plant management, and vegetation management at attaining the plant community structure and species composition objectives identified for the four grassland associations. Areal extent monitoring can be used to identify and track the location and extent of grasslands within the PCRP, and thus success toward the goal of maintaining or increasing the area of grasslands within the park. Quantitative monitoring should be used to track the abundance and richness of native grassland plants, the frequency and abundance of invasive exotic plants, and the abundance of woody vegetation encroaching from adjacent shrubland and woodlands. By

conducting the monitoring as a large-scale ecological experiment, long-term quantitative monitoring allows examination of the effects of grazing on various aspects of grassland community structure and species composition, and increase understanding of the ecology of this important system for conservation.

Biological effectiveness monitoring of the ponds should be used to determine the status and trends in the abundance of larval amphibians and breeding frogs, track pond conditions that might affect amphibian habitat, evaluate the effects of grazing cessation on the aquatic and wetland communities, and determine the need for remedial management to maintain a mosaic of habitat conditions that will promote diversity and maintain amphibian populations.

Monitoring results should be used to inform changes to the management plan, which will also adapt to changes in the conditions of the conservation targets or other aspects of the park. Similarly, management strategies should also be revised to incorporate new information, including new management techniques, and the ecology of the systems and special status species, such as results of the current research examining the effects of grazing on Smith's blue butterfly. This adaptive approach will enhance long term success toward the biological goals and objectives for the conservation of the grasslands and aquatic systems within Palo Corona Regional Park.

CHAPTER 1: INTRODUCTION

1.1 PLAN BACKGROUND

Palo Corona Regional Park is a biologically rich area of exceptional conservation value. Owing to its variable geology, topography, and soils, the 4,300-acre park supports a mosaic of native communities that includes ancient redwood forests in the deep, coastal canyons, coastal prairies on the tall bald hills, and wide expanses of dense coastal scrub, maritime chaparral, and hardwood forests. These communities support more than 400 species of native plants and a wealth of native animals, including 31 species that are recognized as rare or endangered (Overtree 2006).

Regarded locally as "the Gateway to Big Sur", Palo Corona Regional Park connects 13 other ecologically important protected lands (Figure 1-1). Together, these lands create a large expanse of protected habitat that will facilitate long-term persistence of many species, including those with large home ranges such as the golden eagle and California condor. Because of its natural diversity, scenic beauty, and location adjacent to other public lands, Palo Corona Regional Park will also provide highly enjoyable recreational opportunities.

Though protected from development, native biodiversity within Palo Corona Regional Park is threatened by factors that degrade habitat conditions, including fire exclusion and exotic plants and animals. Of particular concern is the role of these factors in degrading the park's coastal terrace prairie grasslands—a unique community found only along the central and northern California coast within reach of the summer fog (Heady et al. 1988). These grasslands support a diverse assemblage of endemic annual and perennial forbs (Stromberg et al. 2002). Naturally rare, much of the original coastal terrace prairie on the central coast of California has been converted for development and agriculture. As a result, the 1,400 acres of coastal terrace prairie grasslands protected within Palo Corona Regional Park are of global as well as regional and state-wide conservation importance.

Active management is needed to maintain biodiversity in the coastal terrace prairie. In the absence of recurring fire, which creates and maintains this coastal grassland, woody plant species from the adjacent coastal scrub and Monterey pine forest become established within the grassland, outcompete native herbaceous plants, and over time, convert grasslands to shrubland or woodland (McBride and Heady 1968, McBride 1974, Heady et al. 1988). This results in loss of habitat required by numerous rare grassland animals, including northern harrier, white-tailed kite, and grasshopper sparrow (CPIF 2000).

The persistence of native grassland species is also threatened by exotic plants. Though they support a relatively high diversity and abundance of native herbs and forbs, the coastal terrace prairies have been invaded and in many places become dominated by exotic grasses and forbs (Stromberg et al. 2002). These exotic plants compete with native grassland herbs for scarce soil resources and light, reducing their abundance and diversity (Corbin and D'Antonio 2004). In the highly productive coastal grasslands, exotic plants also contribute to the accumulation of dense litter (thatch) on the soil surface. Such litter inhibits establishment of many native grassland herbs (Young and Evans 1989, Facelli and Pickett 1991), and can create a fire hazard.

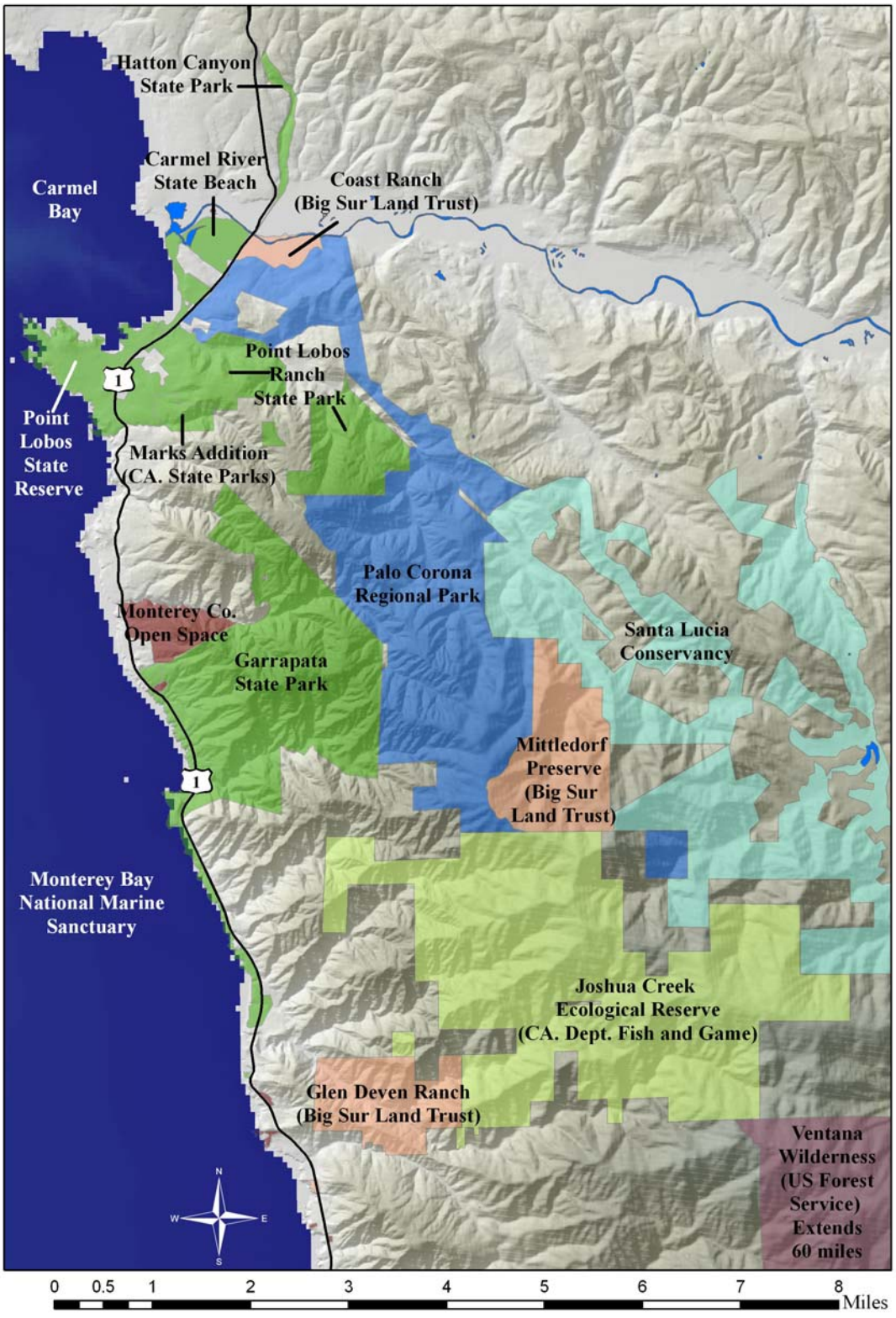

Figure 1-1: Location of Palo Corona Regional Park with respect to other protected lands. Map prepared by Jodi McGraw with GIS data provided by L. Overtree (2006)

Researchers looking for techniques to enhance the structure and species composition of California's grasslands are increasingly recognizing the advantages of cattle grazing for landscape scale management (Huntsinger et al. *in press,* Hayes and Holl 2003, Marty 2005). Cattle can reduce the growth, abundance, and competitive effects of the abundant exotic annual grasses, and in doing so, tip the balance toward native grassland herbs (Corbin et al. 2004, Marty 2005). By preventing a build up of litter, cattle grazing can create open soil conditions required for the establishment of many native forbs, particularly annual wildflowers, thus promoting grassland plant diversity (Hayes and Holl 2003). Cattle grazing has also been found to control invasive exotic plants, including several species found in Palo Corona, by reducing their growth and fecundity, and thus limiting their abundance and rate of spread (Bossard et al. 2000, Tu et al. 2001, Holloran et al. 2004). Cattle can also reduce grassland encroachment by native shrubs and trees and thus slow and in some cases prevent conversion of grassland to shrubland or woodland (Heady et al. 1988). Finally, by preventing the accumulation of fine fuels and limiting the encroachment of woody vegetation, cattle grazing can reduce the risk of catastrophic wildfires.

Because of these benefits for grassland species, cattle grazing has been regarded as a management tool for the maintenance of native biodiversity in protected grassland areas, including parks, water district lands, and ecological reserve (Huntsinger et al. *in press;* Table 1-1). This trend has been viewed skeptically by some members of the conservation community who are concerned about livestock grazing on public lands. These concerns largely result from the checkered history of private grazing on federal lands throughout the western United States. where in most cases, the main goal of grazing was cattle production, with concern for land management often secondary and typically limited to protecting future range conditions, rather than the integrity of the natural systems. Such grazing often took place in arid grasslands and other systems where grazing was not needed as a management tool. Instead, the effects of cattle were largely negative, and included reducing populations of native plants, competing with native animals for scarce water and food, facilitating the invasion and spread of exotic plant species, and degrading riverine and riparian habitats (Belsky et al. 1993, Fleichner 1994, Painter 1995).

Table 1-1: Management agencies and organizations using livestock grazing as a management tool in the San Francisco and Monterey Bay Area, with emphasis on organizations managing coastal terrace prairie using grazing.

Type	Organization	Description
Public Agencies	East Bay Regional Park District	20 parks with coastal and valley grasslands
	Santa Clara Open Space Authority	Grasslands and oak savannas
	San Francisco Water Department	Coastal grasslands
	Alameda County Water District	Coastal grasslands
	Ca. Dept. of Fish and Game	Grassland conservation bank for burrowing owl
	Point Reyes National Seashore	Coastal terrace prairie
	University of California, Santa Cruz	Coastal terrace prairie
Private Organizations	Wildlands Inc.	Coastal terrace prairie
	Elkhorn Slough Foundation	Coastal terrace prairie
	The Land Trust of Santa Cruz County	Coastal terrace prairie

Recognizing the value of grazing as a landscape level management tool to maintain the grasslands of PCRP, The Big Sur Land Trust, The Nature Conservancy, and the Monterey Peninsula Regional Park District, who partnered with other agencies to preserve the park, also acknowledge the potential for cattle to have negative effects within the park. To address this concern, they decided that grazing should be implemented following a carefully developed science-based management plan. Furthermore, these organizations recognized that grazing impacts are not black and white, but instead depend on aspects of the community being grazed, including species composition, productivity, and evolutionary history with herbivory, and characteristics of the grazing operation, including seasonality and intensity. Moreover, these factors interact in complex ways and may vary through time (i.e. due to weather), making grazing impacts difficult to predict (D'Antonio et al. 2001). As a result, they called for the development of an adaptive plan, in which management techniques would be monitored in order to determine both their effectiveness at attaining the goals and objectives for the park, and potential unanticipated effects. In this adaptive plan, the results of monitoring as well as newly available scientific research are used to inform the need for modifications to the management strategy.

Table 1-2: Description and mission of the three organizations that partnered to prepare this plan.

Organization	Description and Mission
The Big Sur Land Trust	A regional nonprofit organization whose mission is to conserve the significant lands and waters of California's Central Coast for all generations.
The Nature Conservancy	An international nonprofit membership organization, whose mission is to preserve plants, animals, and natural communities by protecting the lands and waters they need to survive.
Monterey Peninsula Regional Parks District	A public agency whose mission is to acquire and maintain open space lands for public benefit and enjoyment, to protect the natural character and community value of those lands in perpetuity with best management practices, and to provide educational and interpretive services which open minds to an appreciation and understanding of open space.

1.2 Management Plan Goals and Objectives

As part of the cooperative management agreement for Palo Corona Regional Park and consistent with their organization's missions (Table 1-2), The Big Sur Land Trust, Monterey Peninsula Regional Park District, and The Nature Conservancy collaborated to prepare this plan, which is designed to facilitate the maintenance of native biodiversity in three target systems: the coastal terrace prairie grasslands, ponds and springs, and riparian and riverine. The following are the specific goals and objectives for this plan.

Goal: Develop a management plan designed to enhance native biodiversity in the coastal terrace prairie, ponds and springs, and riparian and riverine systems within Palo Corona Regional

Park. The plan will include ecologically-based and practical grazing strategies to be implemented as part of an adaptive management program, through which monitoring is used to evaluate effectiveness of management, incorporate new information, adapt to changing conditions, and refine strategies over time in order to enhance attainment of the ecological goals and objectives for the systems.

Objective 1: Establish a scientific basis for management planning by synthesizing available information about the biology of the systems and species within the site.

Objective 2: Develop goals and objectives for the conservation targets within the system based on an understanding of their conservation ecology, including status and threats.

Objective 3: Develop management strategies including grazing prescriptions, exotic plant management techniques, and other steps to facilitate the biological goals and objectives, based on ecological understanding of the site and research conducted in similar systems.

Objective 4: Examine the existing infrastructure that will support cattle grazing and identify infrastructure improvements needed to implement the prescribed cattle grazing.

Objective 5: Create a monitoring program designed to evaluate effectiveness of the grassland management strategies.

Objective 6: Outline elements of an adaptive management process through which management will be modified as needed to facilitate long-term success of the biological goals and objectives.

1.3 PLAN COMPONENTS AND ORGANIZATION

The plan chapters contain the main components of the plan.

Chapter 2 provides background information about the park environment that is designed to facilitate development and implementation of the management strategies. It also identifies the plan's conservation targets and describes known threats to their persistence.

Chapter 3 provides the biological goals and objectives for management of the conservation targets within the PCRP. For each objective, the plan provides a brief rationale for its importance.

Chapters 4 through 6 identify the management strategies and techniques for the grasslands (Chapter 4), ponds and springs (Chapter 5), and riparian and riverine (Chapter 6).

Chapter 7 identifies additional management techniques that are designed to facilitate successful implementation of the grazing strategy, and the plan in general.

Chapter 8 describes the adaptive management process through which management should be implemented, and the monitoring techniques that are recommended to track management and evaluate effectiveness of the management techniques at attaining the biological goals and objectives.

The Appendices contain additional information designed to facilitate evaluation and implementation of the management plan.

Appendix A contains an assessment of the relationships between the ecological communities and the soils of the PCRP, with emphasis on evaluating potential role of soil conditions in influencing the distribution of the grassland associations.

Appendix B contains a synthesis of available information about the 10 ponds within the PCRP. It is intended to provide readers with additional background about the ponds beyond that which is contained in Chapter 2, to facilitate understanding of the pond management strategies and techniques described in Chapter 5.

Appendix C provides a similar synthesis for the streams of the PCRP, and contains available information about the ecological communities through which they flow and the biological aspects of the riparian and riverine communities.

Appendix D contains a description of the special status species found within the grasslands and aquatic systems of PCRP, and provides an assessment of the impacts of grazing on their populations. It also includes grazing impact tables used to develop the grazing prescriptions for the grasslands, based on known and hypothesized effects of cattle according to the seasonality and intensity of use.

Appendix E contains the Natural Resources Conservation Service's California Conservation Practice Specification for Fences (NRCS-CA 2000). This information is provided to aid installation and repair of fences that are used to implement the grazing strategy and protect ponds, springs, and riparian areas.

Appendix F contains recommended guidelines for park staff and contractors to avoid spreading emergent wildlife diseases that threaten the special status amphibians within the ponds of Palo Corona Regional Park (Hemingway and Chabre 2006).

CHAPTER 2: PALO CORONA REGIONAL PARK

Development and implementation of management strategies to promote the conservation goals and objectives within Palo Corona Regional Park requires consideration of several aspects of the park, including its geography, land use history, ecological communities, disturbance ecology, and the conservation targets.

2.1 LOCATION

Palo Corona is a 4,300-acre regional park located south of the City of Carmel in central coastal Monterey County. The six mile long property extends from the Carmel River floodplain in the north, to the Joshua Creek Canyon Ecological Reserve of the California Department of Fish and Game (CDFG) to the south. Palo Corona Regional Park (PCRP) is adjacent to numerous public and private conservation lands as well as large, private cattle ranches and low density residential developments. It connects 13 separate wilderness areas and parks, including Point Lobos State Reserve, Carmel River State Beach, Garrapata State Park, Hatton Canyon State Park, Joshua Creek Canyon Ecological Reserve, Los Padres National Forest and the Ventana Wilderness (Figure 1-1).

For purposes of this plan, PCRP has been divided into 24 management units that partition the park to facilitate implementation of the grazing component of the management strategy. They are used to reference the locations of various landscape features discussed in this section (Figure 2-1).

2.2 LAND USE

The historical, current, and adjacent land use have implications for effective management of the grasslands and aquatic systems within Palo Corona Regional Park.

Historical

Throughout much of its history following European settlement, the land within PCRP has been grazed by livestock, primarily cattle. Palo Corona Regional Park is largely within the boundaries of two historic ranchos, Rancho San Jose y Sur Chiquito and Rancho El Potrero de San Carlos, which were established in the 1830s for cattle grazing. In the late 1800s, the land supported a dairy owned by Joseph Gregg. Beginning in 1927 when Mr. Gregg's daughter sold the property to Sidney Fish, he returned it to use as a cattle ranch.

In 1996, the land that is now PCRP was sold to Craig McCaw, a businessman who contracted with local experts to manage the land for its natural resource values. Recognizing the importance of ongoing livestock grazing to maintain the grasslands, cattle grazing was included as a component of an overall management strategy for the property (Overtree 2001).

Identifying the high conservation value of the property, particularly for its rare grassland communities and species, The Big Sur Land Trust and The Nature Conservancy partnered with several state agencies to jointly purchase the land in 2002, as part of a larger acquisition that

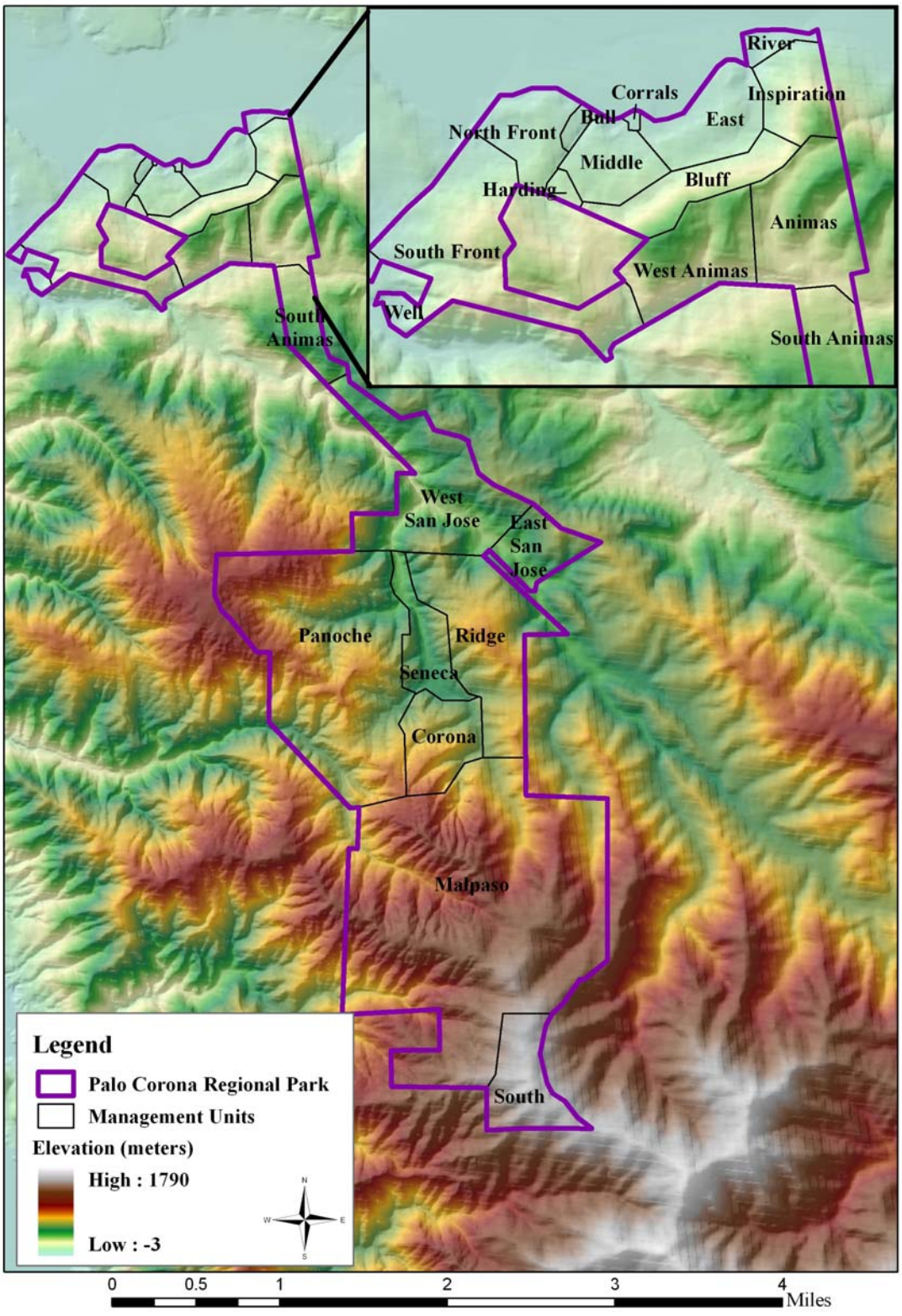

Figure 2-1: Topography and management units within Palo Corona Regional Park. Map prepared by Jodi McGraw with GIS data provided by Guenther (2006).

included an additional, 5,500 acres to the south. In 2004, the land was transferred to Monterey Peninsula Regional Park District (MPRPD) and was named Palo Corona Regional Park (PCRP).

Current

Palo Corona Regional Park is owned and managed by the Monterey Regional Park District (MPRPD), a special district established in 1972 to acquire and maintain open space lands for public benefit and enjoyment within 500 square miles that includes the Monterey Peninsula, Carmel Valley, and the Big Sur Coast. As part of the MPRPD, Palo Corona Regional Park is to be maintained for public benefit and enjoyment and managed to protect the natural character and community value in perpetuity with best management practices. Specifically, the park is to be managed to provide opportunities for recreation and research while conserving the natural resources.

Public access to PCRP is currently limited to pedestrians who can receive a permit to enter the northern portion of the park, with access prohibited south of Animas Pond. In the long term, PCRP is to be open for passive recreation which could include mountain biking, horseback riding, and hiking on established trails. Strategies to manage the grasslands to conserve and promote native biodiversity must be developed through consideration of these uses.

Adjacent

Palo Corona Regional Park is adjacent to public and private conservation lands (e.g. reserves), parks, private cattle ranches, and low density residential development (Figure 1-1). Grassland management activities must be developed with consideration of their impacts on adjacent lands.

2.3 TOPOGRAPHY

Palo Corona Regional Park is located at the northern tip of the Santa Lucia Mountains, a 105-mile long, north-west trending range extending along the Pacific Coast from Monterey to San Luis Obispo. Within PCRP, elevation ranges between 30 feet near the banks of the Carmel River, to 2,972 feet atop Palo Corona Peak located in the southern portion of the park.

The northern portion of the park consists of low elevation coastal terraces adjacent to the Carmel River floodplain. Steep mountainous terrain, characterized by rounded ridges, steep slopes (>30%), and narrow canyons occur within the central and southern portions of the park (Figure 2-1).

Within PCRP, the grasslands occur throughout the elevation range, with the coastal terraces in the north and the rounded ridges in the center and south supporting different grassland associations (Section 2.8).

2.4 GEOLOGY

North of San Jose Creek, PCRP contains Holocene deposits and formations. The land adjacent to the Carmel River consists of colluvium—unconsolidated silt, sand, and gravel deposited by the river. North of San Jose Creek and east of Highway 1, PCRP contains Pleistocene coastal terraces comprised of unconsolidated, moderately well-sorted marine sand, which contain discontinuous layers of gravel. At higher elevations, these terraces give way to an Oligocene arkosic (rich in feldspar) marine sandstone known as the Vaqueros Formation (Clark et al. 1987).

The mountains south of San Jose Creek consist of igneous rock formations from the Cretaceous period. East of the Carmel Highlands, Palo Corona contains the porphyritic granodiorite of Monterey, a light grey to medium pink, medium grained rock. Further south, this formation gives way to the granodiorite of Cachagua, a reddish brown crumbled granite that results from weathering. Still further south, up to Palo Corona peak, PCRP consist of a Hornblende-biotite quartz diorite of Soberanes Point, which is a medium to dark gray quartz diorite that has medium to coarse-grains with abundant hornblende and biotite. These rock formations are subject to landslides as a result of weathering, and scattered landslides have been mapped throughout the PCRP (Clark et al. 1987).

A variety of geologic formations within PCRP support grasslands, which can be found on the coastal terraces, rounded hills, and steep canyon slopes. The grassland associations differ in species composition, as discussed in Section 2.8.1.

2.5 WATERSHEDS

Palo Corona contains land that is a part of 10 watersheds (Table 2-1). It includes nearly all of the land within the Seneca Watershed and the majority of the Van Winkley Watershed, both of which drain to San Jose Creek. Grassland habitat comprises a significant portion of many of the watersheds, and dominates the Malpaso watershed. Several streams on the property comprise critical habitat for steelhead trout, including Carmel River, San Jose Creek (including Seneca and Williams Creeks), and Malpaso Creek (Section 2.8).

2.6 CLIMATE

Like the rest of central coastal California, Palo Corona Regional Park experiences a maritime, mediterranean climate, characterized by the following:

- cool, wet winters
- warm, dry summers
- winter rainy season (November-April) with summer drought (June-September)
- mean annual temperature of 55ºF
- mean annual precipitation of approximately 18 inches
- high interannual variability in rainfall
- coastal fog, especially during the morning in the early summer months (June-July)

Owing to its large size and variable topography, PCRP experiences variation in climate. Most notably, the northern coastal terraces and stream drainages experience cooler summer high

Table 2-1: Watersheds within Palo Corona Regional Park, showing the percent of the entire watershed that is included within the park, the number of acres of grassland within the park, and the acres and percent of the watershed within the park that supports grasslands.

		Size (acres)		Percent of Watershed	Grasslands in PCRP Watershed	
NAME	Drains To	Total Watershed	Within PCRP	that is within PCRP	Acres	Percent of Watershed
San Jose	Ocean	4,745	672	14	135	20
Animas	San Jose	991	297	30	72	24
Seneca	San Jose	1,510	1,463	97	455	31
Van Winkley	San Jose	552	293	53	53	18
Carmel River	Carmel River	1,540	422	27	193	46
Malpaso	Malpaso	2,185	603	28	364	60
Soberanes	Soberanes	1,991	452	23	89	20
Williams	San Jose	1,256	37	3	6	16
Doud	Doud	1,834	25	1	16	61
Granite	Granite	1,006	57	6	4	7

temperatures owing to greater fog cover, when compared to the higher elevation mountains where fog dissipates earlier in the day. Due to the orographic effect, the higher elevation mountains in the southern portion of the park receive higher rainfall (22.5 inches/year) than the lower elevation slopes in the north (18 inches/year). The variation in climate interacts with soil conditions to influence plant species composition within the grasslands of the PCRP (Section 2.8.1).

2.7 SOILS

Palo Corona Regional Park contains 19 named soils (including complexes), 15 of which cover more than 10 acres (USDA 1978). All 15 of the dominant soil types are mapped as supporting some grassland; however, three soil types support 79% of the grassland habitat of the PCRP: Sheridan coarse sandy loam (49%), Cienega gravelly sandy loam (17%), and Santa Ynez fine sandy loam (13%; Appendix A).

Owing to their different geologic formations and thus parent material, the soils in the north differ from those in the south. Most soils within both areas are classified as loams (Table A-1). However, soils in the north have a finer texture (i.e. greater proportion of silt and clay) than the southern soils, which have a higher proportion of sand as well as gravel, reflecting their derivation from the igneous rocks in the region (Section 2.4). The dominant soil types within the north are shaly clay loams (Santa Lucia and Reliz) and silt loam (Gazos), while the dominant soils of the central and southern mountainous region are sandy loam (Sheridan), gravelly sandy loam (Cienega), and gravelly loam (Gamboa, Sur, and Junipero; USDA 1978; Appendix A).

These differences in soil conditions combine with the differences in microclimate (Section 2.6) to give rise to the variation in grassland species composition between the northern and central and southern grasslands within the PCRP (Section 2.8.1).

2.8 ECOLOGICAL COMMUNITIES

Palo Corona Regional Park contains nine main ecological communities, which were delineated in this plan based on plant community composition and structure (i.e. vegetation; Table 2-2). These communities were mapped through a combination of aerial imagery analysis and field observations, which were also used to delineate bare ground (e.g. rock outcrops), ponds, and areas of human activity within the park (Overtree 2006; Figure 2-2). There was no minimum mapping unit in delimiting the plant communities, and the resultant maps contain a very high level of resolution, with mapped areas as small as nine square feet.

Within some of the community types delineated, subtypes were distinguished based on dominant species, as described below. The following sections describe the ecological communities of the PCRP, with greater detail provided for the grasslands, riparian and riverine systems, and ponds, which are the conservation targets of this plan.

2.8.1 Grasslands

Definition**:** Areas within the PCRP that are dominated by herbaceous plants, including forbs (broadleaf herbs) and graminoids (grasses, rushes, and sedges) are referred to in this plan as grasslands. These coastal grasslands can generally be distinguished floristically from the valley grasslands that dominate inland portions of California, including those located within Carmel Valley (Heady 1988, Stromberg et al. 2002). Specifically, the coastal grasslands are dominated by three main native perennial grasses, California oatgrass (*Danthonia californica*), purple needlegrass (*Nassella pulchra*), and red fescue (*Festuca rubra*), whereas purple needlegrass is the sole perennial dominant in the inland grassands. In addition, the coastal grasslands have overall higher species richness and a lower abundance of exotic annual forbs when compared to the inland grasslands (Stromberg et al. 2002).

Within the PCRP, the coastal grasslands can be further differentiated based on plant species composition, giving rise to four main associations, which are defined for purposes of this plan.

Distribution**:** The PCRP supports approximately 1,430 acres of grasslands. They occur in two major biogeographic regions within the park: the coastal terraces in the north, and the canyon slopes and bald hills in the center and south (Figure 2-2). Due primarily to differences in soils and microclimate, these areas support differing assemblages or grasslands species (Figure 2-3).

Structure**:** The grasslands consist of sparse to dense herbaceous cover dominated by graminoids (grasses, rushes, and sedges) and forbs. Subshrubs and shrubs occur at varying abundance within the grassland, with greater abundance occurring in areas where grasslands intergrade with adjacent shrub dominated communities, including coastal scrub. Similarly, scattered trees have become established within the grasslands from the adjacent forests and woodlands.

Within the PCRP grasslands, herbaceous plant density varies and is likely influenced by several factors including microclimate and soil conditions, which interact to influence moisture regimes. Though the higher elevation grasslands in the south receive greater precipitation, the northern

Table 2-2: General attributes of the ecological communities within the Palo Corona Regional Park. Details provided in text.

Community	Acres	PCRP Distribution	General Structure	Dominant Species
Moist Perennial Grassland	485	northern coastal terraces	Dense grasses and forbs with patchy rushes	*Danthonia californica, Lolium multiflorum, Plantago lanceolata*
Alluvial canyon grassland	11	steep canyons in center of park	Dense herbaceous cover in small patches of vertical grassland	Unknown
Subshrub grassland	353	southern ridges	Moderate cover of herbs with sparse cover of suffrutescents	*Eriogonum parvifolium, Lotus scoparius, Lupinus albifrons,*
Ridge grassland	590	central ridges	Moderate grass and forb cover	*Bromus diandrus, Cynosurus echinatus, Erodium botrys, Lupinus nanus*
Coastal Scrub	600	patchy throughout	Dense, medium-height, soft-woody shrubs	*Baccharis pilularis, Eriogonum parviflorum, Mimulus aurantiacus, Artemisia californica, Salvia mellifera*
Chaparral	388	central ridges and upper slopes	Dense, medium-tall hard wood shrubs	*Adenostoma fasciculatum, Arctostaphylos tomentosa, Garrya elliptica*
Oak Woodland	122	small, isolated patches	Variable oak canopy with herbaceous understory	*Quercus agrifolia, Toxicodendron diversiloba, Stachys bullata*
Hardwood Forest	638	southern slopes and canyons	Hardwood tree canopy with sparse undestory	*Lithocarpus densiflorus, Umbellularia californica, Quercus* spp.
Monterey Pine Forest	75	northern cliffs	Continuous canopy of closed cone conifers with dense understorv of shrubs and herbs	*Pinus radiata, Quercus agrifolia, Mimulus aurantiacus, Rhamnus californica*
Redwood Forest	903	central and southern canyons	Tall, dense conifer canopy with sparse shrub/herb understory	*Sequoia sempervirens, Lithocarpus densiflorus, Polystichum munitum*
Riparian	24	patchily along streams and in draws	Dense trees and shrubs along streams	*Salix lasiolepis, Acer macrophyllum, Populus balsamifera ssp. trichocarpa, Platanus racemosa*
Ponds	10 ponds	throughout	Areas of still or slow water with herbaceous vegetation	*Juncus* spp., *Scirpus* spp., *Salix lasiolepis, Lemna* spp.

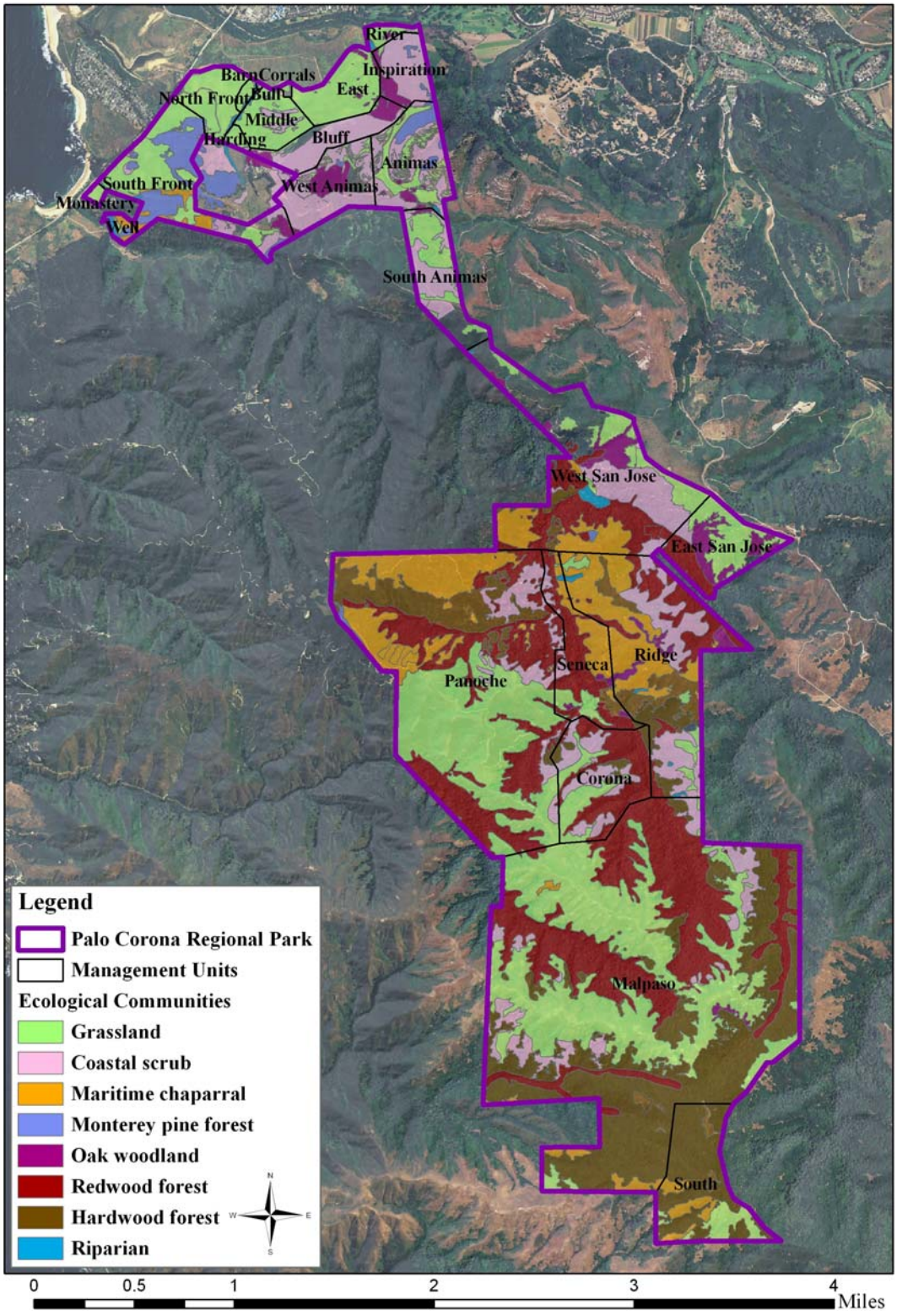

Figure 2-2: Ecological communities within Palo Corona Regional Park. Map prepared by Jodi McGraw with GIS data provided by Overtree (2006).

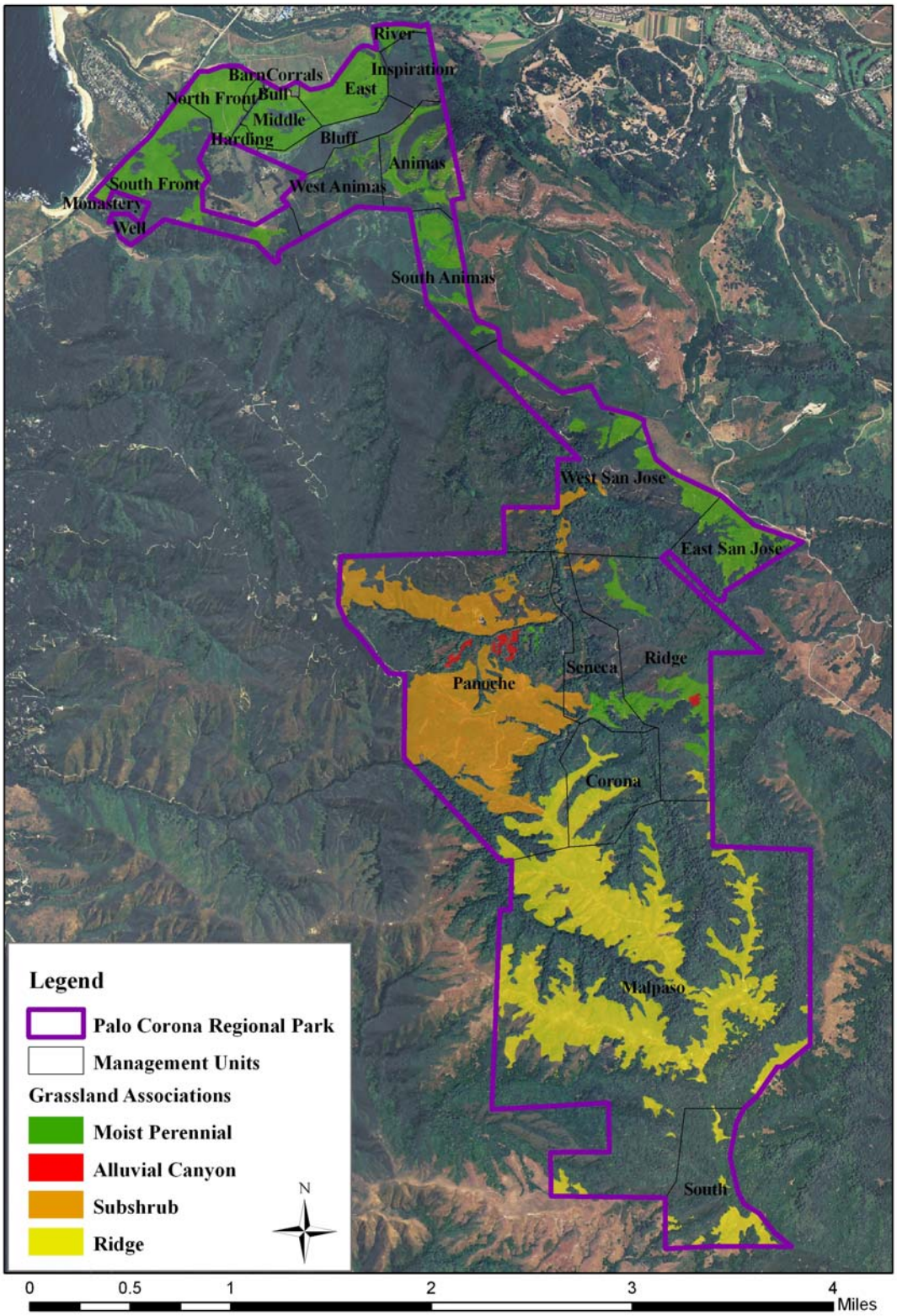

Figure 2-3: Four grassland associations within Palo Corona Regional Park. Map prepared by Jodi McGraw with GIS data provided by Overtree (2006) and Guenther (2006).

grasslands occur on soils with greater silt and clay content, which increases soil moisture as well as nutrient availability. As a result, the moist northern grasslands are more productive than the drier grasslands in the central and southern portion of the park.

Herbaceous plant height depends on the factors affecting productivity, as well as the species pools and aspects of the grazing regime. In the absence of grazing, grass height is greater in the north, owing to greater productivity and abundance of taller species, including perennial forbs and grasses. Grasslands in the center and south, particularly the ridge grasslands, generally support shorter-statured species.

Composition**:** The grasslands support diverse assemblages of herbaceous plant species which vary within the PCRP as a result of differences in soil conditions, microclimate, historic land use, and the introduction of exotic plants. For purposes of this plan, four main grassland associations were identified.

Moist perennial grasslands occur on 485 acres (11%) of the PCRP, where they are found on the northern coastal terraces and the central ridges and valleys. They are dominated by native perennial grasses including California oatgrass and tufted hairgrass (*Deschampsia caespitosa* ssp. *holciformus*), and native perennial forbs including coyote thistle (*Eryngium armatum*), dwarf brodiaea (*Brodiaea terrestris),* narrow-leaf mules ears (*Wyethia angustifolia*), and blue dicks (*Dichelostemma capitatum*). Native annual forbs occur at overall low abundance and are primarily restricted to areas of short vegetation height and low litter cover. Exotic grasses are patchily abundant and include the perennials tall fescue (*Festuca arundinacea*) and Harding grass (*Phalaris aquatica)* and the annual species Italian ryegrass (*Lolium multiflorum*), foxtail (*Hordeum murinum*), smooth brome (*Bromus hordeaceus)*, rip-gut brome (*Bromus diandrus*), *Vulpia* spp., and rattlesnake grass (*Briza maxima).* Exotic forbs include perennial species such as English plantain (*Plantago lanceolata*), rough cat's ears (*Hypochaeris radicata*), and annual species including clovers (*Trifolium dubium, T. subterraneum*), wild geranium (*Geranium dissectum*), and mouse-ear chickweed (*Cerastium glomeratum*) (G. Hayes, unpublished data).

An estimated 140 acres (29%) of the moist perennial grasslands within the PCRP support very low abundance of native grassland species and are instead dominated by exotic herbs. These occur on the northern terraces adjacent to the barn and corral and near the Corona Ranch in the center of the park. Perennial grasses include Harding grass and tall fescue. Exotic annual grasses include rip gut brome, smooth brome, rat tail fescue, Italian ryegrass and wild oats. Exotic forbs in this association include English plantain, sheep sorrel, and non-native clovers (*Trifolium* spp.). Native grasses and native forbs occurring at low abundance include California oatgrass, purple needle grass, meadow barley (*Hordeum brachyantherum*), and California poppy (*Eschscholzia californica*) (Denise Duffy & Assoc. 2004).

Alluvial Canyon Grasslands occur on the steep canyon slopes within the central portion of the park. Little is presently known about the ecology, distribution, and species composition of this association, however, which merits further study (G. Hayes, pers. com. 2007). These grasslands occur as small patches within the dominant redwood forest and hardwood forest. Often located on the lower portion of the slopes, these alluvial canyon grasslands are thought to be created and maintained by erosion of sediment which prevents woody plant establishment.

Currently, they are known to occupy 11 acres on the north-facing slope above Panoche Creek, though other steep slopes in cool canyons may also support these grasslands. They are thought to support species adapted to cooler, moister, lower light conditions, such as grass species within the genera *Melica, Elymus,* and *Poa*.

Subshrub Grasslands occur on the rounded hilltops in the central portion of the park where they occupy an estimated 354 acres (8%) of the park. The subshrub grasslands support substantial cover of suffrutescent species—perennial plants with woody bases and herbaceous upper growth—including seacliff buckwheat (*Eriogonum parvifolium*), California broom (*Lotus scoparius*) and silver bush lupine (*Lupinus albifrons*). Herbaceous plant species include those adapted to drier conditions created by the coarser soil relative to the moist perennial grasslands. Perennial grass species observed in this association include California oatgrass, purple needle grass, and bent grass (*Agrostis pallens*). Exotic annual grasses include rat-tail fescue and rip-gut brome. Forbs include California poppy (*Eschscholzia californica*), sheep sorrel, and English plantain.

Ridge Grasslands occur on the bald hills in the southern portion of the park where they occupy an estimated 588 acres (14%) of the park. These grasslands support plant species adapted to drier conditions and lower nutrient soils, when compared to the moist perennial grasslands. Native perennial grass species include purple-needle grass and June grass (*Koeleria macrantha*). Native forbs include California poppy, clarkia (*Clakia* spp.), and lupine (*Lupinus nanus*). Exotic species include primarily exotic annual grasses such as rip-gut brome, wild oats, rat-tail fescue, and hedgehog dog-tail grass (*Cynosurus echinatus*), and annual forbs such as filaree (*Erodium cicutarium* and *E. botrys*) and wild geranium.

2.8.2 Coastal Scrub

Definition: Areas within the PCRP that are dominated by short to medium height, soft-woody shrubs are referred to as coastal scrub. Though the coastal scrub within the PCRP has not been floristically studied, most of it would likely be classified within the California Manual of Vegetation as part of the Coyote brush series (Sawyer and Keeler-Wolf 1995).

Distribution**:** Coastal scrub covers an estimated 600 acres (14%) of the PCRP, where it is found throughout much of the length of the park. In the north, coastal scrub is currently primarily limited to the steep cliffs above the coastal terraces. In the central and south-central portions of the park, coastal scrub is found primarily on hillslopes, occurring only occasionally on ridges which are instead dominated by grasslands. In both areas, coastal scrub often intergrades with grasslands (Figure 2-2). The current distribution of coastal scrub within the PCRP reflects historical land management to increase the area of grassland and thus forage for cattle, by using chaining to convert coastal scrub to grasslands and cattle grazing and/or mowing to prevent coastal shrub encroachment into the grassland patches (L. Overtree, pers. comm. 2006).

Structure: Coastal scrub consists of sparse to dense cover of soft-wood (mesophyllic) shrubs that produce basal branches from a root crown. Herbs occur between and to a lesser extent beneath the shrubs, and include annual and perennial grasses and forbs. The density of shrubs relative to herbs is likely influenced by abiotic factors, including slope, aspect, and soil conditions, as well

as disturbance history (i.e. fire, clearing), with shrub cover increasing with time since disturbance.

Composition**:** Coastal scrub is dominated by coyote brush (*Baccharis pilularis*), sticky monkeyflower (*Mimulus aurantiacus*), California sagebrush (*Artemesia californica*), seacliff buckwheat, and California broom (Overtree 2006). Found primarily on shaly clay loam soils (Santa Lucia/Reliz) and silt loam, the coastal scrub stands in the north are dominated by coyote brush and in places have been invaded by poison hemlock (*Conium maculatum*) and French broom (*Genista monspessulana*). Coastal scrub in the central and southern portion of the park occurs primarily on stony loamy sand soil (Juniper/Sur complex) and coarse and gravelly sandy loams (Sheridan and Cieneba).

2.8.3 Chaparral

Definition: Areas within PCRP that are dominated by medium to tall, schlerophyllous (hard-leaved), woody shrubs are referred to as chaparral. Two main chaparral associations have been distinguished within the park. Chamise chaparral is dominated by chamise (*Adenostoma fasciculatum*), while central maritime chaparral also contains shrub species endemic to central coastal California areas within reach of the summer fog, including Monterey ceanothus (*Ceanothus cuneatus* ssp. *rigidus*) and Hooker's manzanita (*Arctostaphylos hookeri* ssp. *hookeri*).

Chaparral can be distinguished from coastal scrub, the other shrub-dominated community within the PCRP, by the following: chaparral supports a dense cover of taller, woody, evergreen shrubs while coastal scrub supports shorter-statured shrubs that are less woody and oftentimes drought deciduous (Keeley and Keeley 1987).

Distribution: Chaparral covers an estimated 390 acres (9%) of the PCRP, where it is found primarily on the coarser-grained, droughty soils, including: Cieneba, a gravelly sandy loam (59% of chaparral); Sheridan, a coarse sandy loam (22%); and the Junipero/Sur complex, which is comprised of stony, loamy sand soils (13%; Appendix A). Most of the chaparral (290 acres; 75%) is found in the Seneca Watershed, on the ridges and hillslopes above Panoche Creek, and the west-facing slope above Seneca Creek (Figure 2-2), where it is adjacent to native grasslands, redwood forest, and coastal scrub. A small patch (~ 15 acres) of maritime chaparral occurs on the cliffs above the coastal terraces in the northern portion of the park, adjacent to the Monterey pine forest. Additionally, several small patches of maritime chaparral totaling ~30 acres intergrade within hardwood forest in the southern end of the PCRP (South Unit).

Structure: Chaparral consists of a dense canopy of sclerophyllous shrubs with minimal herbaceous plant cover occurring in gaps within the shrub canopy. Shrub density increases with time since fire until it forms an impenetrable thicket of nearly 100% canopy cover, with bare ground persisting only on rock outcrops. .

Composition: The chaparral within the PCRP is dominated by chamise, Monterey ceanothus, woolly-leaf manzanita (*Arctostaphylos tomentosa*) silk tassel (*Garrya elliptica*), chinquapin (*Chrysolepis chrysolphylla* var. *minor*), sticky monkeyflower, and peak rush rose (*Helianthemum*

scoparium). Chaparral herbs include the federally endangered Yadon's piperia (*Piperia yadonii*; Overtree 2006).

2.8.4 Oak Woodland

Taxonomy: Areas within PCRP that support sparse to dense canopy cover (>50%) of coast live oak (*Quercus agrifolia*) are referred to as oak woodland. This community could be classified within the California Manual of Vegetation as part of the Coast Live Oak Series (Sawyer and Keeler-Wolf 1995). Areas supporting other oak species (*Quercus* spp.) are classified as hardwood forest.

Distribution: Oak woodland covers approximately 122 acres (3%) of PCRP. It occurs in small patches (<20 acres) located primarily on ridges and slopes throughout the length of the park where it is found on a variety of soil types (Table A-1). Oak woodland intergrades with a variety of communities including grasslands, coastal scrub, and hardwood forest.

Structure: Oak woodland consists of a moderate or dense canopy of coast live oak. Understory cover of herbs, shrubs, and vines varies, and is more abundant under oaks within the grassland (i.e. oak savanna), which support herbs adapted to lower light, and deeper litter conditions. In dense stands, deep litter and low light conditions limit understory plant establishment and growth.

Composition: Tree cover in the oak woodland is dominated by coast live oak. Understory species are shade tolerant shrubs and herbs, including poison oak (*Toxicodendron diversilobum*), oso berry (*Oemleria cerasiformes)*, baby blue eyes (*Nemophila menziessii*), columbine (*Aquilegia formosa),* and California hedgenettle (*Stachys bullata*; Overtree 2006).

2.8.5 Hardwood Forest

Taxonomy: Areas within PCRP that support dense canopy cover (>50%) of mixed hardwood trees are referred to as hardwood forest. The PCRP hardwood forest could be variously classified within the California Manual of Vegetation as part of the California Bay Series, Interior Live Oak Series, and Tan Oak Series (Sawyer and Keeler-Wolf 1995).

Distribution: Hardwood forest covers approximately 640 acres (15%) of PCRP. It occurs in the southern half of the park where it is found on a variety of coarse-grained loam soils (Figure 2-2; Table A-1). In the narrow canyons of the PCRP, hardwood forest occurs upslope of the redwood forest. Further upslope, hardwood forest intergrades with coastal scrub and grasslands, which dominate the ridgetops.

Structure: Hardwood forests consist of a dense canopy (>75%) of evergreen, hardwood trees. Understory cover of herbs, shrubs, and vines varies, but is greatly reduced within dense stands where litter depth and low light conditions limit understory plant establishment and growth.

Composition: The dominant trees within the hardwood forest are California bay (*Umbellularia californica),* pacific madrone (*Arbutus menziessii*), tan oak (*Lithocarpus densiflorus*), coast live oak, and interior live oak (*Quercus wislizenii*).

2.8.6 Redwood Forest

Definition: Forests within the PCRP that are dominated by coast redwood (*Sequoia sempervirens*) are referred to as redwood forest. Most of the PCRP redwood forest would be classified within the California Manual of Vegetation as part of the Redwood Series (Sawyer and Keeler-Wolf 1995).

Distribution: Redwood forest covers approximately 900 acres (22%) of PCRP. It is found primarily within the southern half of the park where it occurs on gravelly loam soil (Gamboa/Sur/Juniper complex; 46%) and coarse sandy loam soil (Sheridan; 36%) located primarily on the lower slopes of the steep canyons. Redwood forest often intergrades with hardwood forest, which occurs on the higher elevation slopes. Patches of redwood forest associated with springs or moist canyon draws are found adjacent to the grasslands on the bald hills in the southern portion of the park (Figure 2-2).

Structure: Redwood forests consist of a dense, tall canopy of conifers and both deciduous and evergreen hardwood trees. Understory cover of shrubs, herbs, and vines varies depending on litter depth and light availability.

Composition: The redwood forest is dominated by coast redwood, with tan oak and California bay also occurring in the canopy. Understory species include a variety of herbaceous plants adapted to low light, dense litter conditions, including sword fern *(Polystichum munitum)* redwood sorrel (*Oxalis oregano*), and Pacific starflower (*Trientalis latifolia*).

2.8.7 Monterey Pine Forest

Definition: Forests within the PCRP that are dominated by Monterey pine (*Pinus radiata*) are referred to here as Monterey pine forest. This forest would be classified within the California Manual of Vegetation as part of the Monterey Pine Series (Sawyer and Keeler-Wolf 1995).

Distribution: Monterey pine forest covers approximately 67 acres (<2%) of PCRP. It occurs primarily within the northern portion of the park, with a southeastern population located at the confluence of Seneca Creek with San Jose Creek. Within PCRP, Monterey pine forest occurs primarily on western slopes and rocky ridgetops on three main soil types: Gazos Silt Loam (40%), Cieneba gravelly sandy loam (28%), and Santa Lucia/Reliz complex shaly clay loam (22%; Appendix A). Monterey pine forest intergrades with the moist perennial grassland, coastal scrub, and chaparral (Figure 2-2).

Structure: Monterey pine forest consists of a dense canopy of moderately tall (~100 feet) coniferous trees, with an understory of scattered to moderately dense shrubs and trees. Herbs and vines occur at varying densities depending on light availability and litter depth, which are a function of time since fire (McGraw et al. 2006).

Composition: Monterey pine forest consists of a dense canopy of Monterey pines, with scattered coast live oak in the subcanopy along with shade tolerant shrubs including poison oak, coffee berry (*Rhamnus californicus),* fuscia-flowered gooseberry (*Ribes speciosum*), and sticky monkeyflower. Herbaceous plants include California blackberry (*Rubus ursinus*) and shade-tolerant herbs including bent grass, blue wild rye (*Elymus glaucus)*, and coast sanicle (*Sanicula laciniata*).

2.8.7 Ponds and Springs

Definitions: Areas within PCRP that contain very slow moving or standing water during at least part of the year, except perhaps during prolonged droughts, are referred to as ponds. Perennial ponds have at least some standing water throughout the year while seasonal ponds are dry during a portion of the dry season during most years. Areas where the surface of the aquifer meets the ground surface, such that water flows out of the ground are referred to as springs.

Distribution: The PCRP contains 24 known springs and 10 ponds-- six perennial ponds and four seasonal ponds (Table 2-3). The ponds are found throughout the park, while the springs primarily occur in the mountainous central and southern portions of the park (Figure 2-4).

Pond Structure and Composition: Within the PCRP, all of the ponds were created as water sources for livestock through one of three methods: installation of dams within streams, installation of dams at the outflow of a spring, or excavation of a catchment basin to collect rainfall and run off.

Several of the ponds support plant species adapted to the altered hydrology, including submerged and emergent aquatic species and wetlands plants adapted to saturated soil conditions along the pond banks (Table 2-3; Appendix C). The occurrence of aquatic and wetland plants depends on abiotic conditions and grazing; ponds with steep banks and ponds accessible by cattle support reduced cover aquatic and emergent vegetation compared to ponds with gradual slopes and those fenced to exclude livestock.

The PCRP ponds support four amphibian species that require slow or standing water in order to complete their life history, including two special status species: California red-legged frog and California tiger salamander (Table 2-3). Non-native bull frogs (*Rana catesbeiana*), which predate upon and compete with the native amphibians, were observed within the River Pond (Overtree 2001); however, they were not detected during surveys conducted as part of a two-year study examining the distribution, abundance, and incidence of disease within amphibians in PCRP (Hemingway and Doak 2006).

Springs: The 24 known springs have been developed so as to provide water for livestock. Development has included digging out the spring to increase flow, and piping water to watering troughs for the livestock. The springs have not recently been evaluated such that current information about their condition and status is not available (L. Overtree, pers. com. 2007)

Table 2-3a: Ponds within Palo Corona Regional Park. Details provided in Appendix B.

Pond Name	Type	Creation Method	Management Unit(s)	Estimated Size area (sqft)	Estimated Size depth (max. ft)	Fenced?	Vegetation Aquatic	Vegetation Banks	Vegetation Adj. Upland
Entrance	perennial	catchment basin	N. Front, S. Front	5,400	8	Yes (2001)	cluster of rushes	rushes	moist perennial grassland
Boundary	seasonal	in-stream dam	Harding, N. Front	5400	3	Yes (2006)	sparse rushes	sparse rushes	grasslands
Animas	perennial	in-stream dam	Animas	13,000	5	Yes	dense rush, iris, duckweed	willow woodland	grassland, oak woodland, coastal scrub
Roadrunner	seasonal	catchment basin	South Animas	2,150		No	none	coyote bush (50%), rushes and grasses (30%)	grassland and coastal scrub
Dead Pig	perennial	catchment basin	W. San Jose	11,000	6.5	No	rushes (30%)	French broom (70%) and willows (30%)	oak woodland, invaded coastal scrub
Salamander	perennial	catchment basin	W. San Jose	27,000	6.5	No	submerged aquatic (25%) and rushes (20%)	Rushes/grasses (70%) and French broom (30%)	coastal scrub invaded by French broom
River	seasonal	spring dam	River	3,500		Yes	dense rush, cattail	dense willows	grassland, riparian
Wire Corrals	seasonal	catchment basin	Malpaso	1,100	6.5	No	submerged aquatic (10%); trace floating	rushes and grasses (100%)	ridge grassland
Van Winkley's	perennial	in-stream dam	Malpaso	850	1.5	No	none	none	hardwood forest
Echo Ridge	perennial	spring dam	Malpaso	540	0.3	No	unknown	rushes	ridge grassland, hardwood forest

Table 2-3b: Occurrence of amphibian species and diseases within the ponds of Palo Corona Regional Park. (Hemingway and Doak 2006)

Pond Name	California Red-Legged Frog	California Tiger Salamander	California Newt	Pacific Treefrog	Chytrid Fungus
Entrance	X			X	X
Boundary	X		X	X	
Animas	X		unknown[1]	X	X
Roadrunner	X	X	X	X	
Dead Pig	X		X	X	X
Salamander	X		X	X	X
River	X		unknown	X	
Wire Corrals	unknown	unlikely[2]	unknown	X	Not examined[3]
Van Winkley's	unlikely	unlikely	unlikely	unlikely	Not examined
Echo Ridge	unlikely	unlikely	unknown	X	Not examined

[1] Unknown: Area examined but evidence inconclusive.
[2] Unlikely: Area not examined but occurrence deemed unlikely due to inappropriate habitat conditions
[3] Not examined: Area not examined as part of study

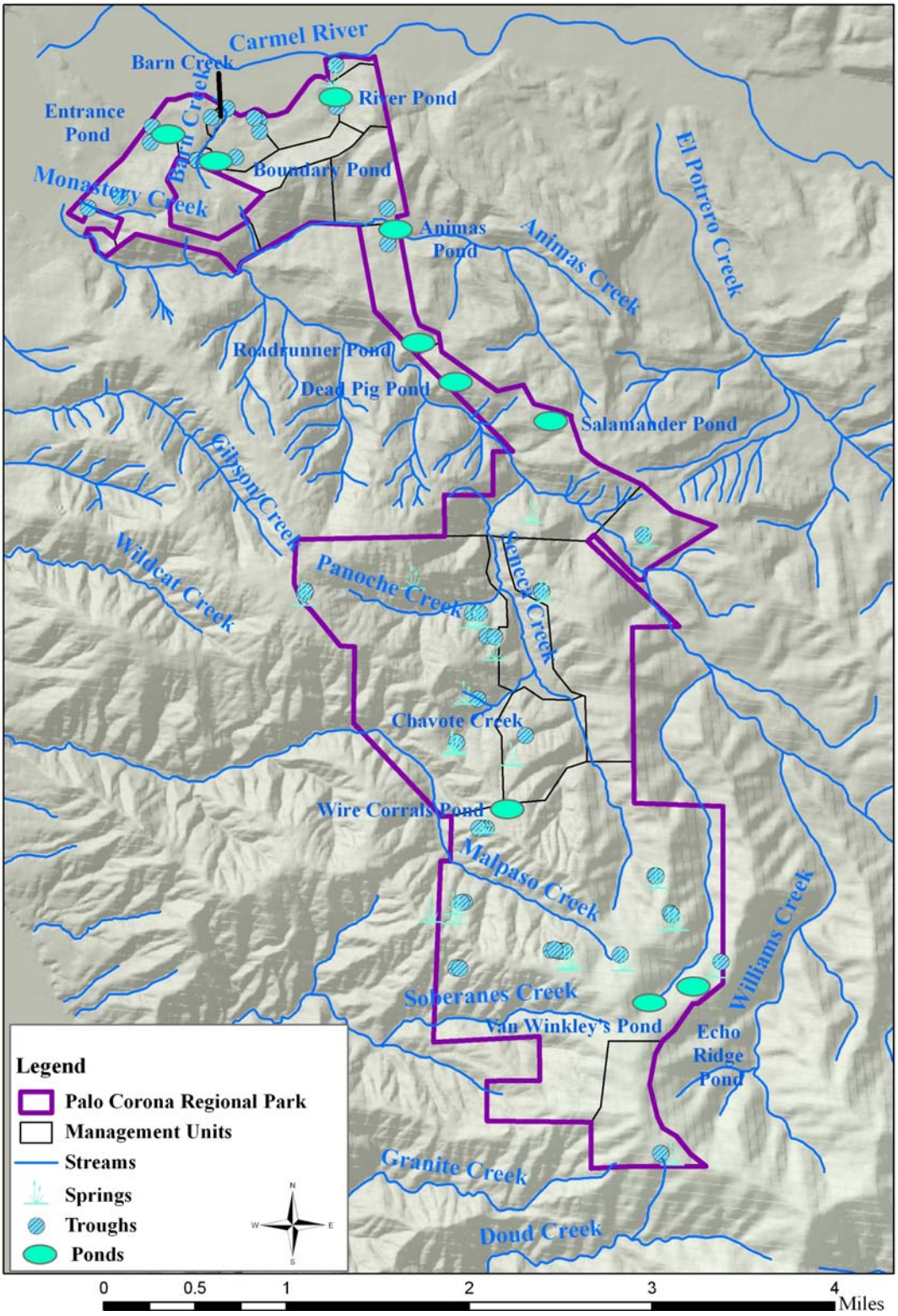

Figure 2-4: Ponds, springs, and streams within Palo Corona Regional Park. Map prepared by Jodi McGraw with GIS data provided by Overtree (2006) and Guenther (2006).

2.8.8 Riparian Communities

Definition: Areas within the PCRP that contain flowing water for at least part of the year constitute the riverine systems. The PCRP supports perennial coastal streams, which continue to flow, albeit with reduced volume, during the summer drought. The park also has ephemeral streams, which flow during and after rainfall events, with the amount and duration of flowing water determined largely by the quantity of precipitation, drainage area drained, and the geology.

Owing to the presence of water, the area adjacent to both perennial and intermittent streams within the PCRP supports different structure and composition of plant species, which is referred to as riparian vegetation. The riparian areas within the PCRP support small patches of riparian woodlands that would likely be classified as Black Cottonwood Series, California sycamore series, and mixed willow series (Sawyer and Keeler-Wolf 1995). More research is needed to characterize the riparian communities within PCRP.

Distribution: The PCRP contains an estimated 13.8 miles of streams and 24 acres of mapped riparian vegetation (Table 2-4; Figure 2-2, Figure 2-4). Additional riparian vegetation may occur within steep canyons which are not readily accessible or readily discernable in aerial imagery.

Structure and Composition: Northern streams flowing primarily through grasslands and coastal scrub support distinctive riparian vegetation dominated by arroyo willow (*Salix lasiolepis)*—a large shrub or short tree that grows within and adjacent to the wetted channel. Along with herbs, vines, and shrubs, willows can form dense thickets that extend down to the ground and provide important structure for animals.

Streams in the central and southern portion of the park typically flow through narrow canyons supporting redwood forest as well as hardwood forest in upper reaches. Riparian areas, which support California sycamore (*Platanus racemosa*), arroyo willow, red alder (*Alnus rhombifolia*), big leaf maple (*Acer macrophyllum*), and American dogwood (*Cornus sericea*), as well as coast redwood, occur in moist draws and in association with springs upslope of the canyons.

2.9 SPECIAL STATUS SPECIES

Palo Corona Regional Park supports known populations of 16 plant species (Table 2-5) and 14 animal species (Table 2-6) that are rare, threatened, or endangered, and therefore have been designated some type of special status under California and/or Federal laws. Of these, eight of the plants and all 14 of the animal species occur in one or more communities influenced by cattle grazing: grasslands, riparian, and ponds (Figure 2-5). These species are described in Appendix D, which also contains an analysis of their response to grazing.

Table2-4: Streams within Palo Corona Regional Park. Details provided in Appendix C.

Stream Name	Flows To	Stream Type	Total Stream Length (ft)	Within PCRP		Management Unit(s)	Riparian Vegetation	Special Status Species
				Stream Length (ft)	Percent in PCRP			
Carmel River	Ocean	perennial	144,000	1,470	<1	River	black cottonwood	steelhead, CRLF[1]
Barn Creek	Carmel River	ephemeral	4,798	2,898	60	Harding, N. Front, Middle, Bull. Barn	mixed willow	
Monastery Creek	Ocean	ephemeral	2,339	1,911	82	S. Front, Monastery	mixed willow	
Animas Creek	San Jose Creek	perennial	13,770	4,074	30	Animas, S. Animas, W. Animas, S. Front	mixed willow	CRLF[1]
San Jose Creek	Ocean	perennial	58,233	16,024	28	E. San Jose, W. San Jose, S. Front, Well		steelhead, CRLF[1]
Seneca Creek	San Jose Creek	perennial	17,445	16,525	95	Malpaso, Ridge, Corona, Seneca		steelhead
Panoche Creek	Seneca Creek	perennial	4,842	4,849	100	Panoche, Seneca		
Chavote Creek	Seneca Creek	perennial	2,387	2,397	100	Panoche, Seneca		
Van Winkley Creek	San Jose Creek	perennial	11,283	6,418	57	Malpaso		
Malpaso Creek	Ocean	perennial	24,103	9,283	39	Malpaso, Panoche		steelhead
Soberanes Creek	Ocean	perennial	23,010	5,848	25	Malpaso		
Doud Tributary	Doud Creek	intermmittent reach	2,645	223	8	South		
Granite Creek	Ocean	intermmittent	18,459	208	1	South		
	Total		**327,315**	**72,129**				

[1] CRLF: California red-legged frog

Table 2-5: Rare plants of Palo Corona Regional Park, and their known or hypothesized occurrence within areas influenced by cattle.

Common Name	Species	Conservation Status[1]	PCRP Communities	Occurs in Area Influenced by Cattle?
marsh microseris	*Microseris paludosa*	List 1B	moist perennial grassland	Yes
Pacific Grove clover [2]	*Trifolium polyodon*	List 1B	moist perennial grassland	Yes[1]
San Francisco popcorn flower	*Plagiobothrys reticululatus* var. *rossianorum*	CE	moist perennial grassland	Yes
Hutchinson's larkspur	*Delphinium hutchensoniae*	List 1B	alluvial canyon grassland; chaparral	Yes
large flower linanthus	*Linanthus grandiflorus*	List 4	subshrub grasslands	Yes
Lewis clarkia	*Clarkia lewisii*	List 4	subshrub grasslands, chaparral, coastal scrub	Yes
Douglas's spineflower	*Chorizanthe douglasii*	List 4	subshrub grasslands, chaparral, coastal scrub	Yes
Pinnacles buckwheat	*Eriogonum nortonii*	List 1B	ridge grasslands, chaparral	Yes
Hooker's manzanita	*Arctostaphylos hookeri ssp. hookeri*	List 1B	chaparral	No
Monterey ceanothus	*Ceanothus cuneatus var. rigidus*	List 4	chaparral	No
small-leaved lomatium	*Lomatium parvifolium*	List 4	Monterey pine forest	No
Rattan's monkeyflower	*Mimulus rattanii*	CNPS List 4	coastal scrub	No
Yadon's piperia	*Piperia yadonii*	FE, CNPS List 1B	chaparral; Monterey pine forest	No
Monterey pine	*Pinus radiata*	List 1B	Monterey pine forest	No
Monterey cypress	*Cupressus macrocarpa*	List 1B	Monterey pine forest	No
Michael's piperia	*Piperia michaeli*	List 4	hardwood forest	No

[1] FE: Federally Endangered
CE: California Endangered
CNPS List 1B: rare or endangered in California and elsehwere (CNPS 2001)
CNPS List 4: plants of limited distribution (CNPS 2001)

[2] Not currently known to occur within PCRP, though appropriate habitat exists.

Table 2-6: Rare animals of Palo Corona Regional Park, and their known or hypothesized occurrence within areas influenced by cattle.

Common Name	Species	Conservation Status[1]	PCRP Communities	Occurs in Area Influenced by Cattle?
Smith's blue butterfly	*Euphilotes enoptes smithi*	FT	coastal scrub, Grasslands with *Eriogonum*	Yes
steelhead trout	*Oncorhynchus mykiss irideus*	FT	Carmel River, San Jose Creek Cr, Malpaso Cr.	Yes
California Tiger Salamander	*Ambystoma californiense*	FT	ponds and grasslands	Yes
California Red-Legged Frog	*Rana aurora draytonii*	FT	ponds and adjacent areas	Yes
California horned lizard	*Phrynosoma coronatum frontale*	CSC; FSC	ridge grasslands	Yes
California condor	*Gymnogyps californianus*	FE; CE	various, incl. grasslands	Yes
golden eagle	*Aquila chrysaetos*	CSC	grasslands	Yes
white-tailed kite	*Elanus leucurus*	CA FPS	grasslands	Yes
northern harrier	*Circus cyaneus*	CSC	grasslands; wetlands	Yes
merlin	*Falco columbarius*	CSC	various	Yes
burrowing owl	*Athene cunicularia*	CSC	grasslands	Yes
California horned lark	*Eremophila alpestris actia*	CSC	grasslands	Yes
loggerhead shrike	*Lanius ludovicianus*	CSC; FSC	various, incl. grasslands and ponds	Yes
tricolored blackbird	*Agelaius tricolor*	CSC; FSC	riparian woodland; ponds	Yes

[1] FE: Federally Endangered
FT: Federally Threatened
FSC: Federal Species of Concern
CA FPS: California Fully Protected Species
CE: California Endangered
CSC: California Species of Special Concern

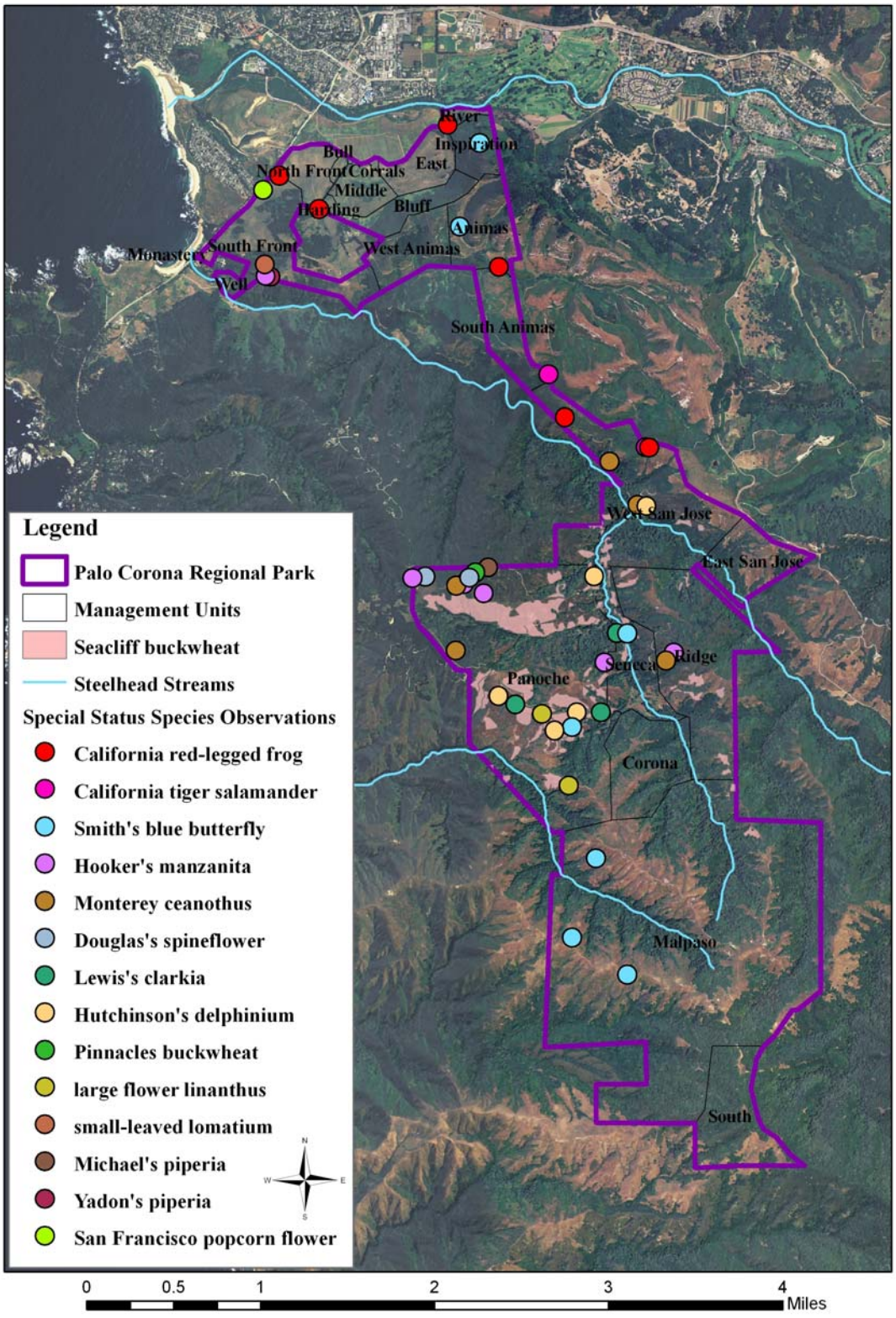

Figure 2-5: Known special status species occurrences within Palo Corona Regional Park. Map prepared by Jodi McGraw with GIS data provided by Overtree (2006) and the California Natural Diversity Database (2006).

2.10 GRASSLAND DISTURBANCE ECOLOGY

The grasslands and associated communities and species of Palo Corona Regional Park have evolved in response to a variety of disturbances—factors that remove established plants and animals, free up resources, and reset successional trajectories through which one community converts to another over time due to gradual changes in abiotic conditions and species composition (Sousa 1984). The primary disturbance factors that have influenced the distribution, species composition and ecology of the PCRP grassland communities are fire and grazing by large mammals. In addition, the grasslands within the park have experienced a history of anthropogenic vegetation management treatments, including mowing.

2.10.1 Fire

The coastal communities of PCRP are adapted to recurring fires, which remove established vegetation, alter nutrient cycling and pools, and create opportunities for the establishment of early succession species. In the grasslands, surface fires remove undecomposed biomass on the soil surface (i.e. litter or residual dry matter), and kill woody plants. In doing so, fires create open conditions required by many grassland species, including annual forbs and many birds, and prevented grassland succession to shrubland and woodland (McBride 1974).

2.10.1.1 Historical Fire Regime

Though there is little direct information about the history of fire within the region, researchers have used a variety of information about climate and human land use to describe the likely fire regime—aspects of the recurring fires including their seasonality, type, frequency, severity, and size—for plant communities within the Monterey Bay Area. Naturally occurring grassland fires would predominantly occur during the summer dry season, specifically June-July and September-October, when the occurrence of lightening is greatest, and fuel moisture and humidity are low (Greenlee and Langenheim 1990). Grassland fires would be surface fires, which burn live and decomposing vegetation aboveground. Their size and severity or impacts in terms of mortality likely varied from complete incineration within a contiguous grassland patch, to patchy burns that left some living vegetation and unburned fuels (Greenlee and Langenheim 1990).

The frequency of grassland fire has varied through time as a result of human activity. Prior to human habitation, the coastal grasslands were hypothesized to have burned every 1-15 years as a result of lightening strikes that ignited fires on the tall peaks. When humans entered the area an estimated 11,000 years ago, coastal grasslands are thought to have burned every 1-2 years as Native Americans used fire to maintain open conditions within grasslands for hunting. Aboriginal burning is thought to have declined following colonization by the Spanish in the 1700, as ranchers limited grassland fires in order to protect forage, resulting in a mean fire return interval of 1-15 years. Spanish ranchers initiated the process of burning coastal scrub and chaparral adjacent to grasslands to increase rangeland, which continued into the early 1900s. Beginning in 1929, laws prohibiting deliberate massive burning led to a reduction in the frequency of grassland fire to an estimated 20-30 years (Greenlee and Langenheim 1990).

Currently, there is little available information about the specific attributes of the fire regime of PCRP. Owing to is historical occupation by Native Americans and Spanish ranchers, it is hypothesized to have featured a regime similar to that described above for coastal grasslands in the Monterey Bay Area. The California fire history database has no fire records for the PCRP (California Department of Forestry and Fire Protection 2003). This is likely the result of incomplete records, which may have excluded small wildfires (i.e. <300 acres). In 1999, a lightning strike fire burned 20 acres of grassland on Malpaso Ridge in the southern portion of the park before being extinguished (Overtree 2001).

On behalf of the Monterey Peninsula Regional Parks District, North Tree Fire is currently preparing a fuels management plan for PCRP. This planning process should provide additional information about the historical fire regime in the park.

2.10.1.2 Fire Effects

Through a variety of direct and indirect mechanisms, fire can exert both positive and negative effects on grassland habitat structure and species composition (Table 2-7). Predicting the net effect of fire can be difficult. Development of prescription fire programs to enhance grassland habitat requires careful consideration of the potential effects, and should include monitoring to evaluate effectiveness at attaining management goals.

Table 2-7: General known and hypothesized positive and negative effects of fire on grasslands (Clark 1989, Smith 2005).

Mechanism	Positive Effects	Negative Effects
Remove established plants and litter	Create habitat for low structure animals (e.g. burrowing owls)	Remove native grassland plants, kill less vagile animals
	Create open conditions for disturbance-adapted plants (e.g. annual forbs)	Degrade habitat for high structure animals
	Remove exotic plants	Promote ruderal exotic plants
	Remove woody vegetation; prevent conversion of grasslands	Remove woody vegetation used by certain grassland species Cause soil erosion
Stimulate seed germination	Promote establishment of fire-adapted native plants	Promote establishment of fire-adapted exotic plant species
Reduce soil fertility	Reduce invasibility by certain exotic plants resulting from increased nutrient availability	Reduce soil nutrients available to native plants
Reduce soil pathogens	Increase native plant performance	Increase exotic plant performance

2.10.2 Grazing

The coastal grasslands within the PCRP have a long history of grazing by large mammals (Section 2.2). The consequences of livestock grazing in terms of herbivory and trampling have implications for plant community structure and species composition.

2.10.2.1 Historical Grazing Regime

As with fire, there is little direct evidence for specific aspects of the historical coastal grassland grazing regime, such as the animal class, seasonality, intensity (e.g. stocking rate), and frequency of grazing.

Until 10,000 years ago, large mammals including camel, ground sloths, and mastodons are thought to have grazed and browsed the California landscape, which included grasslands, though information about their specific composition is limited (Edwards 1996). Until the middle of the nineteenth century, tule elk, pronghorn, and grizzly bears are thought to have frequented grasslands, though their habitat use and foraging patterns, and thus effects on grassland plants, are unknown (Barry et al. 2006). Specifically, it is unclear whether tule elk used these grasslands, or might have limited their distribution to the extensive marshes and wetlands of the Central Valley (Wagner 1989).

Beginning in the 1830s, the grasslands within what is now Palo Corona Regional Park began to be used for domestic livestock, including beef and dairy cattle. For much of this time, there is little information about aspects of the grazing regime, including the intensity of use (e.g. stocking rates). Grazing is thought to have occurred year round, though there is no specific information about seasonal use patterns.

Beginning approximately 20 years ago, the current lessee, Gerry Paddock, began to run a cow-calf operation with fall calving on site. An estimated 100-130 cow/calf pairs were grazed year round, though the cattle may have spent part of this time on nearby and adjacent lands also leased by Mr. Paddock, including the Doud and Riley Ranches (L. Overtree, pers com. 2006).

As part of Mr. Paddock's operation, cattle were generally moved throughout the ranch as a single herd. Beginning in August, the cattle were moved into the northern pastures to facilitate calving. Supplemental feeding occurred between late fall and the development of sufficient forage in the winter. After branding in January and February, the cattle were pushed back to the central and southern pastures provided that there was sufficient forage. If not, supplemental feed would again be provided. In April and May, the herd would be retuned to the northern pastures to sell the calves, after which the cows would return to the central and southern portions of the ranch until the September calving season (L. Overtree, pers com. 2006).

2.10.2.2 Grazing Effects

Grazing by herds of large mammals creates disturbance as a result of two main mechanisms, herbivory and mechanical disturbance (i.e. trampling and rubbing), which have both direct and

indirect effects that influence grassland communities and species positively and negatively. Table 2-8 lists the main factors which interact to influence grazing effects on plant species.

Predicting the effects of grazing in grasslands is difficult, as aspects of the community interact with aspects of the grazing regime to influence the net effect, which would differ for the varying components of the system such as different guilds of plants (e.g. perennial grasses, annual forbs) and different species, depending on whether they have adaptations to trampling and herbivory (D'Antonio et al. 2001).

Appendix D contains an assessment of the known and hypothesized impacts of cattle grazing on the special status species of PCRP. The available information was summarized into grazing impact tables, which illustrate the anticipated effects of grazing on the target components of each of the four grassland associations and the aquatic systems, based on the season of use and the intensity of use (Tables D1 through D-5). Given the uncertainty of predicting grazing effects, care must be used in using grazing as a management tool, with monitoring used to evaluate effectiveness and other impacts of livestock (Huntsinger et al. *in press*).

Table 2-8: Aspects of a site and livestock operation that independently and interactively influence grazing effects on grassland plants. (*sensu* D'Antonio et al. 2001)

Site Factors	Livestock Operation Factors
Evolutionary history with grazers	Species
Abiotic environment (soils, aspect, topography)	Animal class (size and life stage)
Land use history (cultivation, fire and grazing history)	Intensity (e.g. stocking rate)
Species pools	Seasonality
Regional climate (e.g. arid, mesic, etc.)	Duration
Interannual variability in weather (e.g. precipitation)	Frequency
Response variable being examined (plant species, guild, growth form; diversity, abundance, or performance)	Grazing System (i.e. interactions between intensity, seasonality, frequency, and duration)
Area within habitat being examined (e.g. proximity to water)	Livestock management techniques (e.g. herding to diffuse use, prevent use of sensitive areas)

2.10.3 Vegetation Management

In addition to grazing, managers have used a variety of techniques to maintain the rangeland conditions suitable for cattle grazing, and more recently, to enhance conservation of the PCRP grasslands (Overtree 2001). Recent emphasis within the grasslands has been focused on

controlling invasive exotic plants, including French broom, thistles, poison hemlock, and Harding grass. Techniques used have included mowing, manual cutting (i.e. with chainsaws), and herbicide application (spraying and topical; Overtree 2001). Aspects of these treatments including their timing and areal extent have been variable.

2.11 CONSERVATION TARGETS

Palo Corona Regional Park is of high regional, state, and global conservation importance owing primarily to the grasslands and aquatic systems, and the numerous special status species that they support. Conservation of these targets was an important objective of preserving the PCRP, which connects 13 separate wilderness areas and parks, many of which also support these conservation targets. Unfortunately, factors that degrade habitat can threaten the maintenance of biodiversity even within protected parks and reserves.

This section describes the conservation targets in terms of their conservation value and threats. It also identifies nested targets—species that occur within a target community that are of conservation concern (Table 2-9).

2.11.1 Grasslands

Conservation Value

The PCRP's estimated 1,430 acres of coastal prairie grasslands are an important conservation target due to their regional and statewide conservation value. Owing to their often flat topography and productive soils, much of California's grassland habitat has been converted to farmland or development. One consequence of the resultant fragmentation of grassland habitat is the widespread suppression of historical fire regimes, which can result in conversion of grasslands to shrublands and woodlands. Some of the largest, unfragmented grasslands occur in large ranches such as the former Palo Corona Ranch. Only 4% of California grasslands are protected within formally designated reserves (Davis et al. 1998). As a result, California's native grasslands are one of the most rare and endangered ecosystems (Peters and Noss 1995).

Much of California's grasslands have been degraded by the invasion of exotic plants, particularly exotic grasses and forbs, which reduce the diversity and abundance of native grassland plants, and alter habitat conditions for grassland animals. Of the remaining 10 million acres of grassland within California, less than 10,000 acres (1%) support native perennial grassland (Jantz et al. 2006).

California's coastal terrace prairie grasslands support some of the highest concentrations of native grassland species. Named for their common occurrence on uplifted marine terraces, these grassland associations are found between California's Channel Islands and southern Oregon, where they occur within approximately 60 miles from the coast (Heady et al. 1988). When compared to the valley grasslands in California, the coastal terrace prairie grasslands support a relatively high abundance of native species, including remnant populations of perennial grasses such as California oatgrass, California hairgrass, red fescue (*Festuca rubra*), and purple needlegrass (Stromberg et al. 2002, Hayes and Holl 1993).

Table 2-9: Conservation Targets and their threats within the Palo Corona Regional Park Grasslands and Grazing Plan.

	Nested Targets		Threats		
Community	**Plants**	**Animals**	**Exotic Species**	**Fire Exclusion**	**Incompatible Grazing Practices**
Moist Perennial Grassland	marsh microseris, Pacific Grove clover[1], San Francisco popcorn flower	white-tailed kite	Annual and perennial herbs, invasive forbs, French broom	Facilitates conversion to shrubland and woodland	Year-round grazing impacts native herbs and subshrubs; Intense grazing causes soil loss and promotes the invasion and spread of invasive plants; Cessation of grazing allows dense litter accumulation that inhibits annual forbs, reduces diversity, and can facilitate type conversion and loss of habitat for grassland species
Alluvial canyon grasslands	Huthinson's larkspur		Annual and perennial herbs	Facilitates conversion to shrubland and woodland	
Subshrub grassland	Lewis's clarkia, large-flower linanthus, Douglas's spineflower	Smith's blue butterfly	Annual and perennial grasses and forbs	Facilitates conversion to shrubland and woodland	
Ridge grassland	Pinnacles buckwheat	California horned lark, California horned lizard	Annual and perennial grasses and forbs	Facilitates conversion to shrubland and woodland	
General grasslands		California condor, northern harrier, burrowing owl, merlin, golden eagle	Annual and perennial herbs, invasive forbs, French broom	Facilitates conversion to shrubland and woodland	
Riparian	Riparian woodland	steelhead trout, tri-color blackbird	Cape ivy, poison hemlock, and non-native thistles		Herbivory, trampling remove riparian plants, increase sedimentation; degrade habitat for steelhead
Ponds	aquatic and wetland plants	California red-legged frog, California tiger salamander	Yellowflag iris, French broom in upland areas; potential for exotic aquatic animals	Increases woody plant cover; degrades upland habitat for California tiger salamander	Herbivory, trampling remove aquatic plants, kill amphibians; increases pond sedimentation; reduces water quality

[1] Not currently known to occur within PCRP, though appropriate habitat exists.

Though by no means uninvaded, the coastal grasslands support a high diversity and abundance of native grassland plants (Stromberg et al. 2002). This may be in part a result of enhanced competitiveness of the perennial grasses native to the coastal grasslands, relative to those in the interior grasslands (Corbin and D'Antonio 2004), due in part to their more effective use of summer fog (Corbin et al. 2005).

Nested Targets

Habitat conversion, fragmentation, and degradation have threatened persistence of many species native to California's grasslands, including endemic species found nowhere else in the world. Within the PCRP, the grasslands support 18 known species that have been recognized under state and federal law as being rare or endangered (Tables 2-5 and 2-6). Management designed to maintain a mosaic of grassland habitat conditions and promote the abundance and diversity of native plant species is hypothesized to facilitate populations of these nested conservation targets.

Threats

Native biodiversity within the PCRP grasslands is or has been threatened by five main factors: disruption of natural fire regimes, the invasion of exotic plant species, historic cultivation, incompatible grazing practices, and exotic animals (Table 2-9).

Fire Exclusion: Fires are estimated to have historically burned coastal grasslands in the Monterey Bay Area once ever 1-15 years (Greenlee and Langenheim 1990). Such fires remove undecomposed plant matter (litter) that otherwise accumulates on the soil surface and inhibits germination of many native grassland species, particularly the annual forbs (Hayes and Holl 2003). Recurring fires also historically killed shrubs and trees that established within the grassland from adjacent shrublands and woodlands. These woody plants compete with native grassland herbs through creation of shade and litter. In the absence of fire, grasslands would convert to shrublands or woodlands (McBride and Head 1968, McBride 1974).

Suppression of fires ignited by lightning strikes can therefore degrade habitat for grassland species by allowing accumulation of dense leaf litter on the soil surface, and enabling establishment of competitive shrubs and trees. The magnitude of these effects may differ among the four grassland assemblages, owing to their variation in soils and microclimate that influences productivity. Fire suppression also allows accumulation of fuels that can ultimately facilitate more intense and severe fires, which can negatively impact native plants and animals as well as human property and lives. By reducing litter accumulation and slowing woody plant encroachment, grazing can mimic the benefits of fire for certain grassland species (McBride 1974).

Exotic Plants: Grasslands within the PCRP have been invaded by numerous non-native plant species (Table 2-10). These species threaten persistence of native plant populations by competing for resources (water, nutrients, and light) and altering ecosystems processes including nutrient cycling and disturbance regimes, such as fire. Exotic plant species impact native animals by altering habitat conditions, and in some cases facilitating the invasion of non-native animals.

Table 2-10: Known exotic plant species of the grasslands, riparian and riverine system, and ponds and springs within Palo Corona Regional Park, listed according to their threat rating by the California Invasive Plant Council (CalIPC 2006).

Species	Common Name	CalIPC Rating	Communities	Life Form and History
Cortaderia jubata	jubata grass	high	grasslands	per. bunchgrass
Delairea odorata	Cape ivy	high	riparian	per. climbing
Genista monspessulana	French broom	high	moist per. grassland	shrub
Avena spp.	wild oats	moderate	grasslands	annual grass
Brassica nigra	black mustard	moderate	moist per. grassland	annual forb
Bromus diandrus	rip gut brome	moderate	grasslands	annual grass
Carduus pycnocephalus	Italian thistle	moderate	moist per. grassland	annual forb
Cirsium vulgare	bull thistle	moderate	moist per. grassland	biennial forb
Conium maculatum	poison hemlock	moderate	moist per. grassland, riparian, ponds	biennial forb
Cynosurus echinatus	hedgehog dogtail grass	moderate	ridge grassland	annual grass
Hypochaeris radicata	rough cat's ears	moderate	moist per. grassland	perennial forb
Lolium multiflorum	annual ryegrass	moderate	moist per. grassland	annual grass
Phalaris aquatica	Harding grass	moderate	moist per. grassland	per. bunchgrass
Rumex acetosella	sheep sorrel	moderate	grasslands	perennial forb
Vulpia myuros	rat-tail fescue	moderate	grasslands	annual grass
Briza maxima	rattlesnake grass	limited	grasslands	annual grass
Bromus hordeaceus	smooth brome	limited	grasslands	annual grass
Erodium spp.	filaree	limited	grasslands	annual forb
Geranium dissectum	wild geranium	limited	grasslands	annual forb
Hordeum murinum	foxtail	limited	grasslands	annual grass
Hypochaeris glabra	smooth cat's ears	limited	grasslands	perennial forb
Iris pseudocarus	yellowflag iris	limited	ponds	perennial forb
Medicago polymorpha	bur clover	limited	grasslands	annual forb
Plantago lanceolata	English plantain	limited	grasslands	perennial forb
Raphanus sativus	radish	limited	moist per. grassland	annual forb
Silybum marianum	milk thistle	limited	moist per. grassland	ann/per. herb
Anagallis arvensis	scarlet pimpernel	not listed	grasslands	annual forb
Briza minor	little rattlesnake grass	not listed	grasslands	annual grass
Cerastium glomeratum	mouse-ear chickweed	not listed	grasslands	annual forb
Trifolium dubium	shamrock clover	not listed	grasslands	annual forb
Trifolium subteranneum	subterannean clover	not listed	moist per. grassland	annual forb

Several exotic plant species within the PCRP grasslands have been identified by the California Invasive Plant Council (Cal IPC) as "invasive non-native plants that threaten wildlands"—non-native plants that displace native species, hybridize with native species, alter biological communities, or alter ecosystem processes within wildland systems (CalIPC 2006).

Cultivation: Portions of the grasslands within PCRP were historically farmed. Tilling, seeding, and perhaps fertilization associated with cultivation displaces native plants and animal species. Following cessation of cultivation, old fields can be recolonized by native species, though research suggests that alterations to soil structure and seed availability may limit their ability to recover their natural structure and species composition (Stromberg and Griffin 1996).

Incompatible Grazing Practices: Livestock grazing influences the structure and composition of natural communities through a variety of direct and indirect mechanisms, resulting in both negative and positive impacts for native species that can vary depending on site conditions and characteristics of the grazing regime (Table 2-8). As a result, the consequences of grazing, or cessation of grazing in historic ranchlands, can be difficult to predict. The hypothesized impacts of grazing are assessed for each of the grassland conservation targets (Appendix D).

Exotic Animal Species: The grasslands within PCRP support populations of three exotic animals: wild pig (*Sus scrofa*), European starling (*Sturnus vulgaris*), and wild turkey (*Meleagris gallopavo)*. Wild pigs can impact native plants as well as animal habitats through their digging, which removes plants and facilitates establishment of exotic species (Kotanen 1997). Starlings, which occur in relatively small flocks near the northern corrals and wire corrals in the Malpaso Unit, could usurp the nests of native cavity nesting birds, such as wood peckers (Koenig 2003). The impacts of wild turkeys on native species have not been studied. These large ground-foraging birds could impact native plants and animals through predation, and their soil disturbance could promote establishment of invasive exotic plants.

2.11.2 Ponds and Springs

Conservation Value

The ponds and springs within the PCRP provide important habitat for fresh water aquatic species and wetlands species, which require open water and/or saturated soil conditions for at least part of the year. These aquatic habitats are also important for many terrestrial species that require free water and therefore access these systems intermittently. Hot spots for native biodiversity, these aquatic, wetland, and riparian areas are important conservation targets both state-wide and regionally (Table 2-9).

Nested Targets

Within the PCRP, the ponds support two animal species recognized under state and federal law as threatened species: California red-legged frog and California tiger salamander. In addition, tricolored blackbirds may use emergent aquatic vegetation within the ponds as breeding habitat.

Management of ponds and springs is designed to maintain habitat that supports populations of these special status species.

Threats

Native biodiversity within the PCRP ponds and springs is or has been threatened by four main factors: incompatible grazing practices, alterations to the natural hydrology, the invasion of exotic plants, and the invasion of exotic animals (Table 2-9).

Incompatible Grazing Practices: Though the ponds were created for use by cattle, ponds, adjacent wetlands, and springs, are impacted by ongoing use by cattle via a variety of mechanisms, including:

- Cattle trample and eat plants in ponds, springs, and wetlands, thus removing habitat and food required by aquatic species
- Cattle degrade water quality, through sedimentation and defecation. This alters nutrient balances and can lead to eutrophication and create algal blooms, which alter native food webs and dissolved oxygen concentrations
- Cattle intake of water reduces the quantity of water available to terrestrial species, and the duration of pond and wetland inundation required by aquatic species and wetland plants and animals

Alteration to Natural Hydrology: The springs within PCRP have been altered to provide water to cattle, including by:

- digging them out, to increase surface flow
- channelizing flow to human-created ponds
- diverting flows to tanks via pipelines

These alterations can degrade habitat for native plant and animal species by reducing soil moisture for wetland plants and reducing the availability of free water for animals.

Exotic Plants: The springs and ponds have been invaded by plants adapted to mesic conditions and standing water, including aquatic yellow iris (*Iris pseudocarus*), bull thistle, and poison hemlock (Table 2-10). In addition, French broom dominates the upland habitat adjacent to several ponds (Table 2-3). Yellowflag iris became abundant in Animas Pond where concern that it was reducing open water habitat required by California red-legged frog led managers to manually remove the exotic species from the pond in fall 2006 (L. Overtree, pers. com. 2006).

Exotic Animal Species: The invasion of exotic animal species into the PCRP would threaten population persistence of the two threatened amphibians and could reduce native biodiversity as a whole. A recent survey of the ponds found no known occurrences of exotic animals. However, ongoing monitoring is recommended to prevent establishment of exotic species, including not only bullfrogs but also non-native turtles, salamanders, and fish. These species could colonize the ponds on adjacent properties, or be deliberately introduced by park visitors (Hemingway and Doak 2006).

2.11.3 Riparian and Riverine

Conservation Value

The riparian and riverine systems within the PCRP provide important habitat for steelhead trout, water for terrestrial species, and habitat for numerous species that use riparian areas, both full time residents, such as deer and raccoons, and migratory species such as the yellow warbler.

Throughout California, riparian and riverine habitats have been greatly reduced as a result of habitat conversion due to development, power generation, flood control, and industrial and municipal uses. An estimated 70-90% of the remaining systems have been degraded by water diversions, road building, channelization, timber harvest, and livestock grazing (Kauffman et al 1997). Hot spots for native biodiversity, riparian areas are important conservation targets both state-wide and regionally (RHJV 2004).

Nested Targets

Within the PCRP, the riverine and riparian system supports steelhead trout and tricolored blackbirds: species recognized under state and federal law as being rare or endangered (Table 2-6). The Carmel River, San Jose Creek, and Malpaso Creek support critical habitat for the South-Central California Coast evolutionary significant unit of the steelhead trout. Tricolored blackbirds may use the riparian forest along the Carmel River for nesting. Management of the aquatic systems including ponds, springs, riparian, and riverine areas is designed to maintain habitat that supports populations of these special status species.

Threats

Native biodiversity within the riparian and riverine areas is or has been threatened by three main factors: incompatible grazing practices, alterations to the natural hydrology, and the invasion of exotic plants.

Incompatible Grazing Practices: Throughout much of the nearly 200-year history of cattle grazing within the PCRP, cattle have had access to the riparian and riverine areas. Many stream reaches might have received little cattle use due to steep terrain, dense vegetation or other factors that limit access. However, streams in gentle rolling terrain, particularly those with standing pools of water, are likely to have received a long history of use by cattle which drink, feed on riparian plants, and standing in streams and riparian areas to seek relief from hot temperatures.

Cattle can degrade riverine systems through a variety of mechanisms, including:

- Removing in-stream and emergent vegetation, and thus habitat and food required by aquatic species;
- Degrading water quality, through sedimentation and defecation, which alter nutrient balances, create algal blooms, alter native food webs and reduce dissolved oxygen concentrations;

- Reducing water quantity and thus its availability to aquatic species, particularly seasonally (Belsky et al. 1999).

Cattle grazing has also been shown to alter riparian habitat by:

- Removing established riparian vegetation, particularly the herbaceous and shrub components, and precluding plant re-establishment through herbivory and trampling;
- Destabilizing slopes and thus precluding plant establishment along the banks (Fleischner 1994, Belsky et al. 1999).

Reduction in the cover of riparian plant species negatively affects riverine systems by:

- Causing water temperatures to fluctuate outside of the historical range to which native species are adapted. This effect can be especially detrimental for salmonids such as steelhead;
- Reducing dissolved oxygen as a result of increased temperature;
- Reducing in-stream woody debris and plant cover which provides habitat for aquatic and terrestrial species;
- Reducing allochthonous inputs (e.g. leaves), thus altering riverine food webs;
- Reducing riverine prey, thus altering terrestrial food webs (Belsky et al. 1999, Sabo and Powers 2002).

Alteration to Natural Hydrology: The streams within the PCRP have been altered by a variety of factors which can influence their biological attributes including habitat conditions for aquatic species and riparian conditions. These include:

- Damming to create ponds;
- Diversions to provide water for livestock and agricultural use;
- Construction of roads within and across the stream channel.

Through a variety of direct and indirect mechanisms, these alterations can degrade habitat for native plant and animal species, including by:

- Altering water flow regimes, including flooding and other disturbance;
- Altering water quality, including temperature, chemistry, and dissolved oxygen;.
- Altering in-stream and riparian vegetation, which provides food and habitat for animals.

Exotic Plants: The riparian areas within the PCRP have been invaded by exotic plant species adapted to high soil moisture, low light conditions, including poison hemlock and Cape ivy (*Delairea odorata*; Table 2-10). Cape ivy is capable of completely covering riparian vegetation, including woodlands. At present, it is limited to small patches along Highway 1, the Carmel River (River Unit) and in Monastery Canyon (Monastery Unit; Overtree 2001).

CHAPTER 3: MANAGEMENT GOALS AND OBJECTIVES

The overall goal of management within the PCRP is to maintain or enhance the grassland communities, ponds and springs, and riparian and riverine systems, by providing a cost-effective means to reduce one or more threats to the targets at the landscape scale, including exotic plant species and fire exclusion, while minimizing the potential negative impacts of management on non-target systems and public enjoyment of the park.

For each conservation target, the goals and objectives address three main approaches to preserving native biodiversity within the PCRP:

1. Maintain or increase the distribution and extent of the target communities
2. Maintain or enhance native community structure and species composition within the target communities
3. Maintain appropriate habitat conditions for special status species within the target communities.

Additionally, goals and objectives have been developed to minimize impacts of management operations on the conservation targets, ecosystem, and public use of the park.

Each of the eight main goals has a series of objectives--the specific measurable standard, desired state, or threshold values, desired to achieve the goal. For each objective, this section provides a brief rationale for its importance. Management strategies to attain these objectives are provided in Chapters 4-6.

3.1 GRASSLANDS

In order to address specific conservation targets and threats within the unique grassland associations, goals and objectives have been developed for each.

3.1.1 Moist Perennial Grasslands

Goal 1: Maintain or enhance the distribution, native plant community structure and species composition, and special status species populations of the moist perennial grasslands.

Objective 1.1: Maintain in perpetuity an estimated 485 acres of moist perennial grassland.

The coastal grasslands within PCRP are susceptible to conversion to shrubland or woodland via encroachment of woody vegetation. Historically, shrub and tree encroachment would have been limited by recurring wildfire and year-round grazing. Given the rarity of the coastal grasslands, management should maintain the areal extent and occurrence of large grassland patches.

As an exception, an estimated 19 acres of moist perennial grassland in five units should be allowed to naturally succeed to other community type (riparian woodland, coastal scrub, Monterey Pine forest) in order to reduce the impacts of grazing and associated vegetation management (i.e. mowing) on riverine and riparian system and to avoid unnecessary

management costs. These are: River Unit (9 acres), West Animas Unit (6 acres), Well Unit (2 acres), Bluff Unit (3 acres), Inspiration Unit (1acre).

Objective 1.2: Create and maintain a mosaic of grassland structure, which includes both open, short-grass conditions and dense, tall-grass conditions.

Grassland plants and animals that require low litter, low plant cover, and short vegetation height conditions include burrowing owl, San Francisco popcorn flower and Pacific Grove clover, as well as many other native annual forbs. Other grassland species including grasshopper sparrows, northern harriers, and white-tailed kites favor moderate to tall vegetation height, which can also support many small mammals, such as voles (*Microtus californicus*).

Objective 1.3: Maintain or increase the absolute cover and species richness of native grassland herbs within the moist perennial grassland by maintaining or reducing the cover of herbaceous exotic plants.

The moist perennial grasslands have been invaded by exotic grasses and forbs that compete with native grassland species, reducing their growth and abundance. Though eradication of these species is not possible, management techniques that can tip the competitive balance from exotic plants to native species can increase the abundance and richness of native species.

Objective 1.4: Maintain native shrubs and trees at or below 30% absolute cover within the moist perennial grassland.

Native woody plants including coyote brush and Monterey pine degrade habitat for grassland plants that are outcompeted by woody vegetation and animals adapted to open grassland habitat. Over time, they can convert grassland to coastal scrub or Monterey pine forest. Some occurrence of shrubs within the grasslands can favor animal species, such as grasshopper sparrows, which use shrubs for perches. Maintaining some woody plant cover while preventing excessive encroachment will promote diversity in these grasslands.

Objective 1.5: Control (<5% cover) or eliminate the invasive exotic plant species from the moist perennial grasslands, including French broom, poison hemlock, non-native thistles, Harding grass, wild mustard, and wild radish.

Large, invasive exotic species compete with native grassland herbs and alter the grassland habitat structure. Unmanaged, they can spread and become dominant in grasslands.

3.1.2 Alluvial Canyon Grasslands

Goal 2: Maintain or enhance the distribution, native plant community structure and species composition, and special status species populations of the alluvial canyon grasslands.

Objective 2.1: Increase understanding of the distribution and floristic composition of alluvial canyon grasslands within the PCRP.

Information about the distribution and species composition of these unique grasslands could facilitate management planning. A spring-summer survey should be used to identify the locations supporting this association and determine the dominant, indicator, and special status species it supports.

Objective 2.2: Maintain in perpetuity the current occurrence of alluvial canyon grasslands.

Management should include efforts to maintain habitat of this unique assemblage. Information about its distribution and species composition will facilitate assessment of threats (e.g. exotic plants) and development of management strategies.

Objective 2.3: Maintain or increase the absolute cover and species richness of native grassland herbs within the alluvial canyon grasslands.

This unique assemblage should be managed to maintain or increase native species cover, which is likely impacted by exotic annual herb competition.

Objective 2.4 Maintain native shrubs and trees at or below 30% absolute cover within the alluvial canyon grasslands.

Owing to the mesic conditions in which they occur and their small size (and thus high perimeter to area ratio), the small patches of alluvial canyon grasslands may be susceptible to invasion by woody plants and thus type conversion to shrubland or woodland. Alternatively, unstable soil conditions due to the steep slopes might inhibit shrub and tree establishment, thus maintaining this association.

Objective 2.5: Control (<5% cover) or eliminate invasive exotic plant species from the alluvial canyon grasslands.

Any invasive exotic plants within the alluvial canyon grasslands should be eradicated or controlled to reduce their impacts on native herbaceous plants and avoid degradation of animal habitat.

Objective 2.6: Minimize erosion caused by cattle grazing on steep slopes and prevent sedimentation of adjacent streams.

Due to their steep slopes, the alluvial canyon grasslands are susceptible to erosion which could be exacerbated by cattle grazing. Owing to their location adjacent to streams that support steelhead, which are negatively impacted by sedimentation, management should minimize erosion within these areas.

3.1.3 Subshrub Grasslands

Goal 3: Maintain or enhance the distribution, native plant community structure and species composition, and special status species populations of the subshrub grasslands.

Objective 3.1: Maintain the current occurrence of subshrub grasslands, which are estimated to cover 350 acres.

Management should include efforts to maintain habitat of the subshrub grasslands, which are predicted to be susceptible to native shrub encroachment in the absence of fire or other disturbance, and thus potential conversion to either coastal scrub or chaparral.

Objective 3.2: Maintain or increase the absolute cover and species richness of native grassland herbs within the subshrub grasslands.

The subshrub grasslands have been invaded by exotic annual grasses and forbs that compete with native herb and subshrubs and may degrade habitat for Smith's blue butterfly by reducing the abundance of its host plant. Though eradication of these species is infeasible, management techniques that can tip the competitive balance from exotic plants to native species can enhance abundance and richness of native species.

Objective 3.3 Maintain or enhance cover of seacliff buckwheat within the subshrub grasslands to provided habitat for Smith's blue butterfly.

The subshrub grasslands provide important habitat for Smith's blue butterfly, a federally threatened species that uses seacliff buckwheat as a food source and reproduction site. Management should promote establishment and growth of this subshrub in order to maintain or increase its population.

Objective 3.4 Maintain native shrubs and trees at or below 20% absolute cover within the subshrub grasslands.

The subshrub grasslands are moderately susceptible to invasion by coyote brush and thus type conversion to coastal scrub. Shrub cover should be maintained at or below 20% to minimize impacts to native grassland species, maintain appropriate habitat for Smith's blue butterfly.

3.1.4 Ridge Grasslands

Goal 4: Maintain or enhance the distribution, native plant community structure and species composition, and special status species populations of the ridge grasslands.

Objective 4.1: Maintain the current occurrence of ridge grasslands, which are estimated to cover 590 acres.

The ridge grasslands occur as large patches of grassland habitat that are important for grassland animal species, including merlin, golden eagle, horned lark, coast horned lizard, and perhaps California condor. Management should focus on maintaining these large contiguous areas of grassland habitat.

Objective 4.2: Maintain or increase the absolute cover and species richness of native grassland herbs within the ridge grasslands.

The ridge grasslands have been invaded by exotic annual grasses and forbs that compete with native herbs. Management should endeavor to tip the competitive balance from exotic plants to native species and increase the abundance and richness of native species.

Objective 4.3 Maintain native shrubs and trees at or below 10% absolute cover within the ridge grasslands.

Though ridge grasslands appear less susceptible to woody plant encroachment compared to the more mesic grassland associations, management might be needed to maintain low cover of woody plants that could spread into the grasslands from the forest and shrubland edges and degrade habitat for species that require open grassland.

3.2 PONDS AND SPRINGS

Goal 5: Maintain or enhance the areal extent, native community structure and composition, and special status species populations of the ponds and springs.

Objective 5.1: Maintain or increase the size of the wetted area and depth of the 7 ponds occupied by special status amphibians.

Ponds support aquatic and wetland plants and provide important breeding habitat for aquatic species. Management may be required to address sedimentation, which reduces pond size and depth, degrades pond habitat, and could ultimately result in succession of ponds to meadows.

Objective 5.2: Promote growth of aquatic and wetland plants in approximately 50% of each pond, with the vegetated portion of the pond including both shallow and deep water.

Aquatic species require a diversity of habitat conditions, including variable water depth, vegetation structure, and food items. The special status amphibians require different habitat conditions during their different life stages (e.g. egg, juvenile, adult; Hemingway and Doak 2006). In the absence of disturbance, emergent and wetland vegetation can become dense. Such vegetation is an important component of habitat for special status species, including tricolored blackbird, which nests in bulrushes and willows, and California red-legged frog and California tiger salamander, which require vegetation for cover and breeding. However, dense vegetation can also degrade habitat for the special status amphibians by reducing water temperature and thus slowing development, and reducing the extent of deep water. Creating

and maintaining a mosaic of open water and vegetated habitat conditions within and on the banks of ponds will increase the diversity of aquatic and wetland plants and animals, and provide suitable habitat for amphibian eggs, larva, and adults.

Objective 5.3: Eradicate or control (<5% cover) invasive exotic plant species occurring within ponds, including yellowflag iris.

Exotic aquatic plants compete with native plants and their dense growth can degrade habitat for native pond animals, including the special status amphibians. Presently, water iris is the only known invasive aquatic species.

Objective 5.4: Maintain ponds free of exotic aquatic animals, including bull frogs, fish, turtles, and salamanders.

Exotic animals compete with and predate upon native animals and can reduce populations of special status pond species. Though presently not known to occur within the PCRP, bull frogs and introduced salamanders (e.g. eastern tiger salamanders) are known to occur in ponds on adjacent properties, including the Santa Lucia Conservancy, from which they could disperse into the PCRP.

Objective 5.5: Enhance grassland habitat adjacent to ponds for California tiger salamander and facilitate connectivity among ponds by eradicating or controlling (<5% cover) French broom around ponds and preventing accidental collapse of burrows.

California tiger salamanders prefer upland habitat dominated by herbaceous plants, including grasslands. These habitats support a greater abundance of ground squirrels and pocket gophers, the burrows of which California tiger salamanders use an estimated 11 months of each year. French broom around and between Salamander, Dead Pig, and Roadrunner Ponds degrades upland habitat and likely prevents a physical barrier to migration among habitats. Such migration is essential for recolonization of ponds where the species might have been or could become extirpated, thus maintaining the metapopulation at PCRP. Driving roads adjacent to ponds can collapse burrows used by native amphibians.

Objective 5.6: Reduce the potential for spread of amphibian disease among ponds.

Persistence of native animal populations may be threatened by emergent wildlife disease, including chytrid fungus and ranaviruses which can reduce the demographic performance of individuals. These diseases have been observed in a subset of the ponds examined at PCRP.

Objective 5.7: Increase the cover and species richness of native wetland plants in and around the 24 springs.

Native wetland plants associated with springs add to the diversity of native species within PCRP and create habitat for animal species adapted to conditions in and near springs, including pacific tree frogs. Cattle degrade springs and wetlands through trampling and herbivory.

3.3 RIPARIAN AND RIVERINE

Goal 7: Enhance the areal extent, natural community structure and species composition, and habitat conditions for special status species of the riverine and riparian systems.

Objective 6.1: Increase the areal extent of native riparian vegetation.

Vegetation along streams is critical to maintaining aquatic habitat by providing, food inputs, stream banks stabilization, and shade, which moderates water temperatures. Riparian vegetation also provides important habitat for breeding and migrating birds, as well other animal species adapted to the relatively mesic conditions. The width of the riparian corridor influences bird diversity and nesting success for many species. Increasing the area of mixed willow series, could enhance nesting habitat for tricolored blackbirds and perhaps yellow warblers.

Objective 6.2: Eliminate or reduce stream bank erosion and stream sedimentation which degrade habitat for aquatic species, including steelhead.

Cattle access to streams removes riparian vegetation and erodes stream banks, increasing water temperature fluctuations, destroying in-stream habitat (e.g. pools), and increasing sediment that eliminates the gravel beds required for success of steelhead redds (nests).

Objective 6.3: Eradicate or control (<5% cover) invasive exotic plant species occurring within riparian and riverine systems, including poison hemlock, bull thistle, and Cape ivy.

Invasive exotic plant species degrade riparian and riverine habitat, particularly in the northern portion of the park where poison hemlock, bull thistle, and Cape ivy occur. Discontinuing cattle grazing will likely allow these species to increase in abundance, particularly that of poison hemlock which has formed a nearly impenetrable stand along River Pond which was fenced to exclude cattle. Dominant trees of the riparian woodland, including sycamore, black cottonwood and willow, may eventually create low light conditions that preclude establishment of these ruderal (i.e. early successional) species. However, in the short term, the exotics may create dense stands that inhibit riparian woodland plant establishment.

3.4 FACILITIES MANAGEMENT

Goal 7: Minimize negative impacts of the ranch operation on the conservation targets, native ecosystems, and park visitors.

Objective 7.1: Create and maintain a system of fences and gates that allows implementation of the grazing strategy by securely containing cattle within the management units, while minimizing negative impacts to wildlife.

Effective perimeter fences are needed to prevent cattle trespass onto adjacent properties, while fences separating the management units are needed to effectively implement the grazing strategy and minimize impacts to conservation targets and other components of the park ecosystem. New interior fences need to be installed to implement the grazing strategy developed for this plan. In addition, existing perimeter and interior fences require repair to prevent breaches.

Objective 7.2: Install gates and other fence crossings along trails that will minimize the likelihood that the public will disrupt the grazing strategy and will facilitate public enjoyment of the park.

Secure gates are needed to allow pedestrian and vehicle movement into the park and between management units, while containing livestock. Gates should be designed to facilitate park visitor use.

Objective 7.3: Maintain roads following best management practices and techniques designed to reduce impacts on the conservation targets and public recreation.

Some of the roads within PCRP will need to be maintained to facilitate park management as well as research. Road maintenance can have negative effects on the conservation targets and natural systems within the park. A roads plan should be developed to reduce negative impacts associated with road maintenance.

Objective 7.4: Maintain troughs using best management practices to reduce inadvertent negative impacts on native animals.

Troughs are used by native animals including amphibians (e.g. pacific tree frogs) that use them as breeding ponds, and terrestrial species (e.g. birds), which use them as a source of free water. Trough design and maintenance should minimize potential inadvertent negative effects on native animal species.

Objective 7.5: Locate salt and supplements so as to facilitate cattle use of grassland patches and minimize negative impacts associated with concentrated cattle use.

Salt and mineral supplements are placed throughout the ranch for livestock health and to obtain better distribution of forage use. Owing to increased visitation at salt licks and mineral supplement feeders, the impacts of cattle due to trampling and herbivory can be more intense.

Objective 7.6: Avoid supplemental feeding of cattle within the management units.

Providing cattle with supplemental feed such as hay within the management units should be avoided, as concentrated use leads to excess trampling, damage to plants and soil, and degradation of grassland habitat.

Objective 7.7: Protect native wildlife regarded as a nuisance or harm to cattle.

Cattle operators might wish to reduce populations of native animal species that they view as a nuisance, such as ground squirrels, or a threat, such as coyotes and mountain lions. These animals should be protected within the park.

CHAPTER 4: GRASSLAND MANAGEMENT STRATEGIES AND TECHNIQUES

In order to attain the biological goals and objectives for the grassland associations of Palo Corona Regional Park (Section 3.1), three main management strategies are recommended to address the threats to native biodiversity:

1. Cattle grazing
2. Exotic plant management
3. Native vegetation management

The following sections describe the specific recommended techniques for each of the three main strategies, and provide the ecological rationale for each. Table 4-1 identifies the biological objectives within the grassland that each management technique is designed to facilitate. A prescribed burn program developed as part of an overall fire plan for the park would further facilitate success toward several of the biological goals and objectives for the grasslands, as well as other communities (e.g. maritime chaparral) within PCRP.

Several of the exotic plant management techniques described here are also recommended to manage the ponds and springs (Chapter 5) and riparian and riverine systems (Chapter 6).

4.1 CATTLE GRAZING

Cattle grazing is recommended as a landscape-level tool to facilitate many of the management objectives for the grasslands. Within the grassland associations, cattle grazing can be used to accomplish one of more of the following objectives alone or in concert with additional management (e.g. exotic plant removal):

1. Promote native grassland herbs and subshrubs by reducing exotic herb competition.
2. Enhance control of invasive exotic plants, including French broom, poison hemlock, thistles, and other invasive forbs.
3. Maintain the grassland habitat by reducing the rate and extent of native and exotic woody plant encroachment and thus conversion of grasslands to shrubland or woodland.
4. Create short habitat structure and open soil conditions required by certain grassland species (e.g. burrowing owl, San Francisco popcorn flower).

The effectiveness of grazing at attaining these management objectives depends on the characteristics of the grassland association, including species composition, productivity, and susceptibility to shrub encroachment, as well as two critical aspects of the grazing prescription: seasonality and intensity of grazing. The following sections describe how prescriptions were developed based on the known and hypothesized impacts of grazing, which differ depending on seasonality and intensity. Appendix D provides the detailed analysis of the grazing impacts in the grassland associations, which was used to develop the grazing prescriptions.

4.1.1 Season of Grazing

This section first describes the ecological basis for consideration of season of use in developing grazing prescriptions, then describes the five season of use treatments proposed for the four grassland associations within the PCRP.

Table 4-1: Management strategies and techniques designed to attain the goals and objectives in the four grassland associations. ■ Denotes a technique that has high likelihood of promoting the objective, while ◘ denotes a strategy that is likely to support success toward the objective. Details provided in text.

Grassland Association	Biological Objective	Grazing					Exotic Plant Control						Woody Plant Control	
		Early Season	Winter-Spring	Dormant Season	Summer	Split Season	French broom	Mustard, Radish	Poison Hemlock	Thistles	Harding Grass		Coyote Brush	Monterey Pine
Moist Perennial	1.1 *Maintain the current areal extent (485 acres).*	◘	◘	■	◘	■	■						■	■
	1.2 *Create, maintain a mosaic of grassland structure.*	■	■	■	■	■								
	1.3 *Maintain or increase the cover and diversity of native grassland herbs.*	■	◘	◘	◘	◘	■	■	■	■	■		■	■
	1.4 *Maintain shrubs, trees below 30% cover.*	◘	◘	■	◘	■	■						■	■
	1.5 *Control or eradicate the invasive exotic plants.*	◘	■	◘	◘	■	■	■	■	■	■			
Alluvial Canyon	2.1 *Increase understanding of the association.*													
	2.2 *Maintain the current areal extent (11 acres).*	◘											■	
	2.3 *Maintain or increase the cover and diversity of native grassland herbs.*	■											■	
	2.4 *Maintain native shrubs, trees below 30% cover.*	◘												
	2.5 *Minimize erosion on steep slopes and prevent stream sedimentation.*	■												
Subshrub	3.1 *Maintain the current areal extent (350 acres).*	◘											■	
	3.2 *Maintain or increase the cover and diversity of native grassland herbs.*	■											■	
	3.3 *Maintain or enhance cover of seacliff buckwheat.*	■												
	3.4 *Maintain native shrubs, trees below 20% cover.*	◘												
Ridge	4.1 *Maintain the current areal extent (590 acres).*	◘											■	
	4.2 *Maintain or increase the cover and diversity of native grassland herbs.*	■											■	
	4.3 *Maintain native shrubs, trees below 10% cover.*	◘												

4.1.1.1 The Role of Season of Grazing in Influencing Grazing Impacts

Like any disturbance, grazing has different impacts on natural systems depending on the season in which it occurs. Season of use influences grazing impacts because of two main factors.

1. Herbivory and trampling affect plants and animals differently depending on their life stage.
2. Cattle behave differently during different seasons.

4.1.1.1.1. **Animal and Plant Life Stages**

Cattle herbivory and trampling affect plants and animals differently depending on their life stage. For plants, the season of grazing influences plant performance depending on when herbivory and trampling occur within the species phenology—the annual 'schedule' of plant establishment, growth, and reproduction (flowering and fruit production) that a given plant species follows as a result of its response to light, temperature, and other cues that changes seasonally. Generally speaking, herbivory and trampling that remove biomass can have the most detrimental effects on plants during the following stages:

- Seedlings/juveniles: young plants have limited growth stores from which to recover; herbivory can cause mortality.
- Peak growth: when plants are shunting belowground resources to aboveground growth, herbivory can deplete those resources.
- Reproduction: removal of flowers or fruits can reduce fecundity.

The seasonal impacts of herbivory and trampling also depend on a plant species life history—the pattern of establishment, growth and reproduction that occurs throughout a plant's life span. In general, annual plants that complete their lifecycle in one year are more greatly impacted by grazing than perennial species, which live more than one year. This is primarily a function of their growth stores, with annuals having typically little biomass from which to recover following herbivory, and having less rigid growth structure and thus greater susceptibility to mortality due to trampling, than perennial species.

Because plants within the PCRP grasslands have different phenologies and life histories, as well as different growth forms, which also influence grazing impacts (Noy-Meir 1989, Kimball and Schiffman 2003), they differ in their seasonal response to grazing. Managing grazing in grasslands where exotic plant species have become dominant focuses on maximizing the direct negative effects of cattle herbivory and trampling on exotic plant species while minimizing these same effects on native plants, in order to "tip the balance" back toward native species (Corbin et al. 2004).

Cattle impact native animals by altering plant structure and species composition, and thus habitat conditions for animals. Cattle can also directly impact native animals through trampling, and in some cases consumption. Animal susceptibility to mortality caused by cattle is typically greatest during egg and juvenile stages, when animals are less vagile (mobile). In PCRP, the following seasonal direct impacts of cattle on the special status species were identified:

1. Ground-nesting grassland birds are most susceptible to trampling when they are nesting, between April and August (CPIF 2000)

2. Amphibians are most susceptible as eggs and tadpoles, between the first hard rain in fall and August (Hemingway and Doak 2006).
3. Smith's blue butterfly eggs and larva attached to seacliff buckwheat flowers and leaves between July and September could be inadvertently consumed by cattle (Arnold 1983).
4. Steelhead eggs in redds between December and April.

4.1.1.1.2 **Cattle Behavior**

The season of grazing also affects cattle impacts by influencing their foraging and other behaviors. First, cattle preferentially forage on grasses, rather than forbs or other herbs and shrubs, and they prefer new growth over old or dry matter. Their foraging preference was taken into account in devising this plan through consideration of the following:

1. Early in the season (November to March), cattle will primarily eat newly establishing grass species, many of which are exotic annuals.
2. During the middle of spring (April to May), cattle will forage on the new growth of perennial grasses
3. During the dormant season (June through October), cattle will forage on new growth produced by shrubs, the flowering stalks of perennial herbs, and even the fruits of species such as acorns from oaks.

During the late spring, summer, and early fall, cattle water demands increase with the rising temperatures, such that cattle must access water more frequently. This has several consequences for the impacts of cattle herbivory and trampling, which include:

- Reducing the distance from water within which cattle will forage.
- Increasing the concentration of use near water.
- Increasing trampling due to more frequent trips to water.
- Increasing use of riparian areas, ponds, and springs, if they are accessible.
- Increasing trampling under trees where cattle seek shade.

These factors were all considered in developing the season of use prescriptions for PCRP.

4.1.1.2 Season of Use Treatments for Palo Corona Regional Park

Based on aspects of the grassland associations and seasonal use, five season of use grazing prescriptions were developed. All five season of use prescriptions are proposed for the moist perennial grasslands in the center and northern portion of the park. There, the season of use prescriptions are proposed to be applied individually or in coordination within a given management unit in order to facilitate the biological objectives. A single prescription is proposed for the alluvial canyon, subshrub, and ridge grasslands in the center and southern portion of the park (Table 4-2).

In this plan, season of use prescriptions are defined using two methods:

1. Calendar dates
2. Seasonal events

Table 4-2: Season of use prescriptions for cattle grazing within each of the 24 management units within Palo Corona Regional Park. Details described in text.

Unit	Grassland Dominant Type	Area Acres	Area % of Unit	Month Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct
Harding	Moist perennial	6	85												
North Front	Moist perennial	48	90												
Monastery	Moist perennial	4	89												
Bull	Moist perennial	5	81												
S. Front	Moist perennial	74	44												
Middle	Moist perennial	40	78												
East	Moist perennial	62	90												
Animas	Moist perennial	37	33												
S. Animas	Moist perennial	34	38												
West San Jose	Moist perennial	61	17												
East San Jose	Moist perennial	46	47												
Seneca	Moist perennial	19	16												
Ridge	Moist perennial	54	16												
Panoche	Subshrub	380	46												
Corona	Ridge	32	21												
Malpaso	Ridge	486	33												
South	Ridge	28	17												
West Animas	Moist perennial	6	7	Incidental Use											
Bluff	Moist perennial	3	6	Incidental Use											
Inspiration	Moist perennial	1	2	Incidental Use											
Corral	Moist perennial	1	56	Facilities											
Barn	Moist perennial	0	100	Facilities											
River	Moist perennial	8	63	No Use											
Well	Moist perennial	1	9	No Use											

	Cattle use
	Cattle use as needed to attain residual dry matter goals
Facilities	Cattle use as needed to implement grazing strategy and conduct livestock operation
Incidental Use	Cattle use limited to temporary movement through management unit; should not be in for more than 1 week per yea
No Use	No cattle access

Calendar dates are intended to demarcate seasonal changes in weather (e.g. onset of germinating rains), plant phenology (e.g. bunchgrass flowering), and animal behavior (e.g. grassland bird nesting). In many cases, interannual variability in weather will result in variability in timing of these events, such that adhering to calendar dates in implementing season of use prescriptions will result in the grazing not being well-timed with the seasonal changes. In such cases where timing of grazing is deemed crucial, season of use prescriptions are tied directly to one or more seasonal changes. Where shifts in seasonality are not anticipated to result in ecologically significant changes in the effects of grazing, calendar dates are used to facilitate successful implementation of the grazing strategy and evaluation of its effects and effectiveness through monitoring.

4.1.1.2.1 Early Season Grazing

Description: Cattle are grazed during the early growth period, beginning when 1" of new grass has been produced, and ending on March 30.

Objectives: Early season grazing is designed to promote native grassland plants, including both herbs and subshrubs, by reducing the abundance and competitive effects of exotic annual grasses and forbs. Additional benefits include:

- Reduction in the amount of biomass and thus litter
- Reduction in the growth and performance of invasive exotic species.

Rationale: During the early season, cattle are hypothesized to disproportionately negatively affect exotic herbs, which experience peak growth and are the preferred forage for the cattle at this time. By reducing overall biomass, early season grazing will also reduce litter accumulation, which will also promote the native annual forbs.

Waiting to turn out cattle until at least 1" of new growth has been produced will prevent cattle grazing on dormant perennial plants, which could reduce their growth and survival. Removal of cattle before April is designed to achieve the following:

- Reduce cattle herbivory on the flowering annual forbs (April-June)
- Reduce cattle herbivory on native perennial forbs and bunchgrasses, which have peak growth from April to May, and flower in the late spring and early summer (May-July).
- Reduce cattle herbivory on native subshrubs, which grow and flower between April and August. This will also reduce impacts on Smith's blue butterfly, which is a pupae in the litter beneath shrubs and thus unlikely to be trampled or eaten by cattle in the early season.
- Prevent trampling of ground-nesting grassland birds (April-August).
- Reduce cattle use of adjacent woodlands and streams, which would provide relief from the hotter temperatures of late spring and summer.

Application: Early season grazing is the sole recommended prescription for the alluvial canyon, subshrub and ridge grasslands (Table 4-2). In these grasslands, grazing is designed primarily to tip the balance toward native herbs by reducing the abundance of exotic annual species, and by reducing the amount of litter which can inhibit native herb establishment. These associations are less productive than the moist perennial grasslands, such that even limited duration grazing is

predicted to prevent litter accumulation in typical rainfall years. Invasive exotic species and shrub encroachment do not pose as large of a current threat in these grasslands as they do in the northern moist perennial grasslands, perhaps owing to their reduced productivity.

Early season grazing is also the sole season of use proposed for the moist perennial grasslands in the center of the park near San Jose Creek and its tributaries, in order to avoid impacts of grazing on steelhead trout (Table 4-2).

Finally, early season grazing is recommended for use in conjunction with other season of use prescriptions within a portion of the moist perennial grasslands, as described below (Table 4-2)

4.1.1.2.2 Winter-Spring Grazing

Description: Cattle are grazed between February 1 and June 30.

Objectives: Cattle grazing between February and June is hypothesized to facilitate control of invasive exotic forbs including mustard, radish, poison hemlock, and thistles.
Additional benefits include:

- Reduction in the amount of biomass and thus litter
- Reduction in the growth and performance of exotic annual grasses and forbs.

Rationale: Deferring grazing in areas with infestations of invasive exotic forbs until February is hypothesized to indirectly reduce their abundance by facilitating populations of exotic annual grasses, which will compete with the invasive exotic forbs for soil resources and space. Grazing between February and June is thought to directly negatively affect the invasive exotic forbs by reducing their growth and reproduction.

Application: This strategy is proposed for moist perennial grasslands with a high abundance of invasive exotic forbs, where the potential negative effects of grazing on native forbs and perennial grasses associated with late spring grazing are minimal (Table 4-2).

4.1.1.2.3 Dormant Season Grazing

Description: Cattle are grazed for up to three weeks (per management unit) between July 1 and October 31 as needed to attain the intensity goals.

Objectives: Short duration grazing during the dormant season is proposed to prevent accumulation of litter on the soil surface, to create open conditions required for native annual forbs, including San Francisco popcorn flower, and to reduce grassland herb height in order to facilitate birds that prefer low structure, such as the burrowing owl (Appendix D). This treatment is used to supplement growing season grazing in moderate to high productivity years, when growing season grazing is not sufficient to create low structure and open conditions. As an additional benefit, this grazing will reduce the growth and performance of the invasive exotic forbs.

Rationale: In the high productivity moist perennial grasslands, growing season grazing may not be sufficient to create and maintain low vegetation height and open soil conditions in a portion of the PCRP as desired to benefit native annual forbs and grassland bird species. Grazing for a short period during the dormant period is hypothesized to result in cattle foraging on the remaining growth of the exotic annual grasses, though some impacts to native herbs will also occur in order to create the low structure conditions.

Application: This strategy is proposed as a supplement to early season and winter spring grazing for the moist perennial grasslands on the northern coastal terraces (Table 4-2).

4.1.1.2.4 Summer Grazing

Description: Cattle are grazed between July 1 and August 31.

Objectives: In areas of grassland that are highly susceptible to invasion by invasive French broom and coyote brush, cattle can be reintroduced between July and August after early season grazing. Additional benefits include:

- Reduction in the growth and performance of late-season forbs and other invasive herbs.
- Reduction in the amount of litter to create open conditions.

Rationale: During the summer, cattle are hypothesized to eat the new growth of shrubs, thus reducing their growth and fecundity. In doing so, summer grazing will help prevent type conversion of grasslands to coastal scrub and control French broom. This treatment is used to supplement early season grazing to enhance native herbaceous plant abundance and diversity. Removing cattle during April and June will minimize the deleterious effects of grazing on the native perennial grasses, which will be experiencing peak growth (April) and flowering (June). It will also reduce the direct negative impacts of grazing on native annual forbs that would be in flower during late spring (April-June).

Application: This strategy is proposed for the portion of the moist perennial grasslands on the northern coastal terraces that is less dominated by invasive exotic forbs (Table 4-2).

4.1.1.2.5 Split Season Grazing

Description: Cattle are grazed between February 1 and March 31, and then again July 1 to October 31.

Objectives: This technique is designed to control Harding grass, an invasive perennial bunchgrass. Additional benefits include:

- Reduction in the growth and performance of late-season forbs and other invasive herbs.
- Reduction in the amount of litter to create open conditions.
- Creation of short stature grassland conditions required by some grassland species, including burrowing owl and San Francisco popcorn flower.

Rationale: In areas infested by Harding grass, deferring grazing until February is hypothesized to indirectly reduce the invasive species' establishment and growth by facilitating populations of

exotic annual grasses, which will compete with the invasive grass for soil resources and space. Grazing between February and March is thought to directly negatively affect the perennial grass by reducing its growth and reproduction. Removing cattle between April and June is designed to avoid the deleterious effects of grazing on the native perennial herbs, which will be experiencing peak growth and flowering at that time, and native annual forbs that would be in flower. Cattle are returned during the summer (July-October) to graze on Harding grass and further reduce its performance (i.e. growth and fecundity). At present, native perennial grass abundance in these areas is low. Restoration of this area might ultimately require seedling or planting of native perennial grasses in addition to grazing and other treatments to control Harding grass.

Application: This strategy is proposed for Harding Unit, which should be created to contain the Harding grass infestation on the coastal terrace in the northern section of the park (Table 4-2).

4.1.2 Grazing Intensity

The intensity of grazing influences grazing impacts, by influencing the extent to which cattle remove biomass and cause other impacts, such as soil disturbance. Intensity can be measured in terms of various aspects of grazing, including density of grazing animals (e.g. stocking rate). For purposes of this plan, grazing intensity is based on the amount of residual dry matter (RDM) that remains on the soil surface at the end of the grazing year in October. The RDM is largely influenced by the annual productivity of the grassland and the percent of forage utilization.

Residual dry matter was chosen as a measure for intensity for the following interrelated reasons.

1. RDM has been found to directly influence the composition and structure of grasslands, and thus directly relates to several plan biological objectives (e.g. maintain or enhance grassland herb diversity) (Heady 1956)
2. RDM protects soil from erosion and nutrient loss, such that intensity thresholds based on RDM can be used to protect ecosystem functions (Bartolome et al 1980)..
3. RDM can be readily measured as part of monitoring to evaluate successful implementation of the intensity component of a grazing prescription (Guenther 2006).
4. RDM can be quantified and used to evaluate effectiveness of the grazing prescription at attaining the biological goals and objectives of grazing (e.g. 1,000 lbs per acre RDM is hypothesized to increase establishment of native annual forbs).
5. RDM explicitly incorporates variation in annual productivity due to interannual variability in weather (i.e. precipitation). In contrast, using set stocking rates would result in inter-annual variability in grazing intensity in terms of impacts to plant species.

For each of the four grassland associations, mean annual productivity was estimated based on forage production observed during prior monitoring of the PCRP (Guenther 2006). Due to variation in geology, topography, soils, and microclimate, grassland productivity is thought to differ among the four main grassland associations within the PCRP (Section 2.8.1). Because of their narrow distribution, the alluvial canyon grasslands have not been previously evaluated for production (Guenther 2006) and little is known about their species composition (Section 2.8.1). Based on their occurrence on moist slopes located near the moist perennial grassland, their productivity is estimated to be similar to the moist perennial grassland. The range of RDM

values was calculated for the four categories of forage utilization based on estimated annual productivity (Table 4-3).

Table 4-3: Residual dry matter associated with four grazing intensity categories based on percent utilization in the four grassland associations based on their estimated annual production. Details provided in text.

		Range of RDM Values (lbs/acre)			
Grassland Association	**Estimated Production (lbs/acre)**	**Light (<25%)**	**Conservative (25-50%)**	**Moderate (51-75)**	**Heavy (>75%)**
Moist perennial	4000	3000-4000	2000-3000	1000-2000	<1000
Alluvial canyon	4000	3000-4000	2000-3000	1000-2000	<1000
Subshrub	2000	1500-2000	1000-1500	500-1000	< 500
Ridge	2000	1500-2000	1000-1500	500-1000	< 500

To meet the biological goals and objectives, varying intensity is recommended in order to create a mosaic of tall and short structure in the moist perennial grasslands, which will maximize diversity. For each unit, a target intensity was assigned in terms of RDM, and then a range created around the value to allow for interannual variation in conditions and provide flexibility to the cattle operator (Table 4-4). For example, for a prescribed RDM of 1,500 lbs/acre, the range used to monitor successful implementation would be 1,200 – 1,800 lbs/acre (Section 8.2).

To facilitate implementation of the desired grazing intensity, an initial stocking level was estimated for each management unit (Table 4-4). First, the area of useable grassland was determine by deducting from the total grassland acreage the area that cattle are unlikely to use, because of excessive slopes or distance from water. Second, the average annual productivity of the grasslands within each unit was estimated based on known aspects of species composition, soils, precipitation, and observed forage production (Guenther 2006). Third, to determine the forage available, the midpoint of the range of desired residual dry matter (RDM) was deducted from the productivity. For example, if the grassland is predicted to produce 4,000 lbs per acre and the range of desired RDM is 800-1200, then the available forage was 4,000 lbs/acre-1,000 lbs/acre or 3,000 lbs/acre. The number of animal units that could be supported on an acre of grassland in each unit was then calculated by dividing the available forage by the monthly estimated forage requirements of each animal unit, 800 lbs, where an animal unit is a bull or a cow/calf pair. The total number of animal units per management unit, which is the animal units per acre multiplied by the number of acres, was then divided by the months of use prescribed for the unit (Table 4-2) to calculate a monthly stocking rate—the number of animal units that are recommended for a each unit during each month of the prescribed season of use, in order to attain the desired intensity of use (Table 4-4).

Table 4-4: Estimated stocking rate for each of the 24 management units within Palo Corona Regional Park, calculated based on the following: usuable acres of grassland; prescribed intensity, in terms of residual dry matter (RDM); productivity of the grassland; and animal unit months (AUMs), based on productivity; and months of prescribed cattle use (Table 4-2). Details described in text.

	Grassland			Prescribed	Pounds/Acre of Biomass			AUMs			
Unit	Dominant Association	Total Acres	Useable Acres[1]	Intensity (RDM)	Productivity	Mean Residual	Available Forage	per acre[2]	total	Months of Use[3]	Initial Stocking Rate*
Harding	Moist perennial	6	6	800-1200	4000	1000	3000	4	23	6	4
N. Front	Moist perennial	48	48	2000-3000	4000	2500	1500	2	90	5	18
Monastery	Moist perennial	4	4	1200-1800	4000	1500	2500	3	13	5	3
Bull	Moist perennial	5	5	800-1200	4000	1000	3000	4	19	5	4
S. Front	Moist perennial	74	60	1200-1800	4000	1500	2500	3	188	5	38
Middle	Moist perennial	40	40	800-1200	4000	1000	3000	4	150	5	30
East	Moist perennial	62	62	1200-1800	4000	1500	2500	3	194	5	39
Animas	Moist perennial	37	20	1200-1800	4000	1500	2500	3	63	10	6
S. Animas	Moist perennial	34	34	1200-1800	2500	1500	1000	1	43	7	6
W. San Jose	Moist perennial	61	50	2000-3000	4000	2500	1500	2	94	5	19
E. San Jose	Moist perennial	46	40	2000-3000	4000	2500	1500	2	75	5	15
Seneca	Moist perennial	19	10	2000-3000	3000	2500	500	1	6	5	1
Ridge	Moist perennial	54	45	1200-1800	4000	1500	2500	3	141	5	28
Panoche	Subshrub	380	190	1200-1800	2000	1500	500	1	119	5	24
Corona	Ridge	32	32	1200-1800	2300	1500	800	1	32	5	6
Malpaso	Ridge	486	243	1200-1800	2000	1500	500	1	152	5	30
South	Ridge	28	28	1200-1800	2000	1500	500	1	18	5	4
W. Animas	Moist perennial	6				Incidental Use[o]					
Bluff	Moist perennial	3				Incidental Use[o]					
Inspiration	Moist perennial	1				Incidental Use[o]					
Corral	Moist perennial	1				Facilities^					
Barn	Moist perennial	0				Facilities^					
River	Moist perennial	8				No Use[a]					
Well	Moist perennial	1				No Use[a]					

[1] Acres of grassland hypothesized to be used by cattle. Steep slopes, or areas far from water were considered unusable for purposes of estimating AUMs.

[2] Animal units per acre, based on the assumption that each animal unit (i.e. cow/calf pair or a bull) requires 800 lbs of forage per month

[3] Months of use are from the Season of Use Prescription in Table 4-2.

* Stocking rate estimated by dividing the total AUMs by the months of use

[o] Cattle use limited to temporary movement through management unit; should not be in for more than 1 week

^ Cattle use as needed to implement grazing strategy and conduct livestock operation

[a] No cattle access

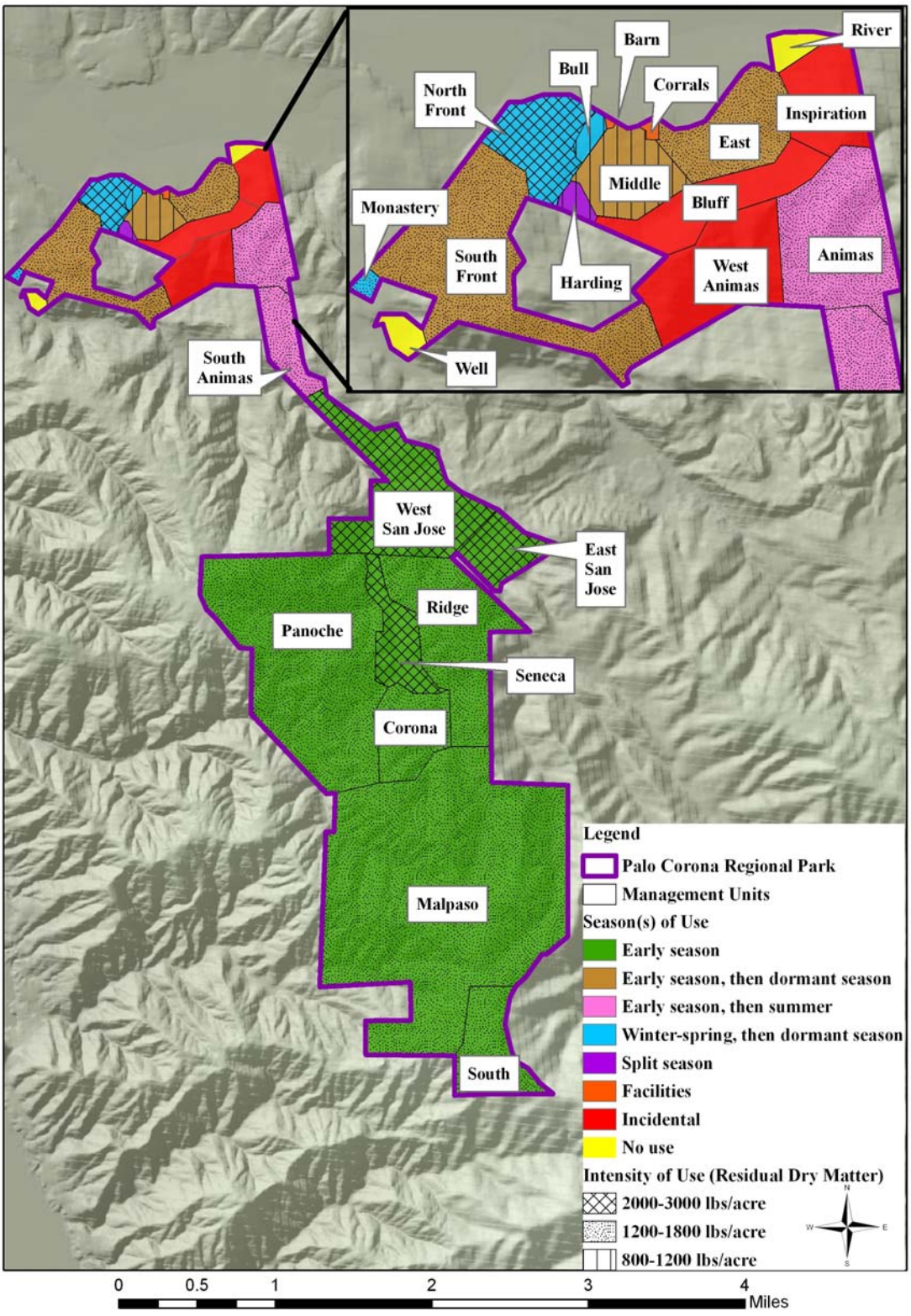

Figure 4-1: Cattle grazing season of use and intensity prescriptions for the management units of Palo Corona Regional Park. Map prepared by Jodi McGraw.

4.1.3 Cattle Grazing Prescriptions

Cattle grazing prescriptions, which identify the season and intensity of use for each management unit, were developed through consideration of the ecological conditions of the grassland (composition, exotic plant infestations, etc.) and the management goals and objectives (Chapter 3). Table 4-2 provides the season of use. Table 4-4 lists the prescribed intensity of use. Figure 4-1 illustrates the seasonality and intensity of use for the management units.

4.2 VEGETATION MANAGEMENT

While cattle grazing provides a low cost management tool for influencing the composition and structure of the grassland communities at a large spatial scale, the grazing techniques will not be sufficient to attain the biological goals and objectives for the grasslands. Instead, additional vegetation management will be required to address two main threats to the conservation targets:

1. Invasion and spread of invasive exotic plant species.
2. Encroachment of woody plants from adjacent vegetation and thus conversion of grassland communities to shrublands or woodlands.

The vegetation management strategies were developed through consideration of the ecology of the plant species being controlled and the structure and species composition of the community in which they are being managed. Each was designed with the following objectives:

- Minimize impacts to the conservation targets and other natural resources within the park.
- Minimize resources (staff time and materials) required to implement the strategy.
- Minimize negative impacts to public enjoyment of the park.

4.2.1 Exotic Plant Management

Of the 31 species of exotic plants known to occur within the grasslands and aquatic systems of PCRP (Table 2-10), 10 species were identified as meriting species-specific management in order to promote success toward the biological goals and objectives of the park (Table 4-6). These species were selected based on one or more of the following criteria:

- High current negative impact on the conservation targets, and therefore high potential benefit from their control.
- High potential negative impact on the conservation targets resulting from future spread.
- Available techniques for eradication or control.

Species that occurred with a limited distribution are designated for eradication from the park. Those for which eradication would be infeasible without extensive resources, and for which control could benefit the conservation targets were designated for control (Table 4-6). Early detection and eradication should be used to prevent the invasion and spread of new invasive species.

Table 4-5: Treatments proposed for exotic plant species targetted for eradication or control within the grasslands, riparian and riverine system, and ponds and springs within Palo Corona Regional Park (Bossard et al. 2000, Tu et al. 2001, Holloran et al. 2004).

Goal	Species	Common Name	Life Form and History	Communities	Treatment
eradicate	*Cortaderia jubata*	jubata grass	large perennial bunchgrass	grasslands	Adults: Cut (chain saw); remove biomass including inflorescences. Remove root mass or apply herbicide. Seedlings: dig or pull
	Delairea odorata	Cape ivy	climbing perennial vine	riparian	Work upstream to downstream to manually remove aboveground biomass;dig out stolons. Remove all biomass from site.
	Iris pseudocarus	yellowflag iris	perennial from rhizomes	ponds	Hand pull and dig to remove all material, including rhizomes.
	Genista monspessulana	French broom	shrub	moist per. grassland; uplands adajcent to ponds	Extensive monocultures in uplands: Mow (Aug-Oct) then spray and cut stumps annually. Isolated individuals or stands in sensitive areas: Pull with a weed wrench, or cut and immediately apply herbicide (e.g. glyphosate) to cambium. Seedlings: Flame dense patches of seedlings.
control	*Brassica nigra*	black mustard	annual herb	moist perennial grassland	Extensive patches: Mow close to ground before fruits are produced. Isolated plants: Before fruits develop, pull by hand or with weed wrench, or cut below root crown.
	Raphanus sativus	radish	annual herb	moist perennial grassland	Same as for mustard.
	Conium maculatum	poison hemlock	biennial herb	moist perennial grassland	Same as for mustard.
	Carduus pycnocephalus	Italian thistle	annual herb	moist perennial grassland	Extensive patches: Mow close to ground in mid-May. Isolated plants: Hand pull or cut at base once bolted.
	Cirsium vulgare	bull thistle	biennial herb	moist perennial grassland; riparian	Extensive patches: Mow close to ground in mid-May. Isolated plants: Hand pull or cut 1-2" below ground remove from site.
	Silybum marianum	milk thistle	annual/biennial herb	moist perennial grassland	Same as for bull thistle
	Phalaris aquatica	Harding grass	large perennial bunchgrass	moist perennial grassland	Extensive patches: Mow as needed in addition to grazing to reduce growth and prevent flowering. Isolated patches: Cut around base of clump with Pulaski and dig our roots; remove all material.

The following sections describe management techniques proposed to eradicate and control exotic plants from the PCRP, developed based on available information about effective exotic plant management techniques (Bossard et al. 2000, Tu et al. 2001, Holloran et al. 2004).

4.2.1.1 Eradicate Invasive Species of Limited Distribution

Management within PCRP should focus on eradicating three invasive plant species: Cape ivy, jubata grass, and yellowflag iris.

Cape Ivy

Description: Cape ivy (*Delairea odorata*) is a climbing perennial vine in the sunflower family (Asteraceae) that is found primarily in moist sites along the coast and in riparian areas. It grows rapidly and reproduces primarily vegetatively (seeds are sterile) by rooting from stems, stolons, or even petioles (leaf stems), which can be dispersed by streams (Holloran 2004).

Distribution: Within PCRP, Cape ivy occurs in three main locations: along Highway 1, along the Carmel River, and in Monastery Canyon. According to the Palo Corona Ranch Management Plan, previous control efforts have removal and spraying in the Carmel River and Highway 1 locations, but not Monastery Canyon (Overtree 2001).

Threats: Cape ivy can create dense mats that kill riparian vegetation, including woody plants as well as herbs. Alkaloids in leaves are thought to be toxic to fish and can degrade in-stream habitat (Holloran et al. 2004).

Management Goal: Its current limited distribution and low abundance makes eradication of Cape ivy feasible, while its large potential for negative impact within the riparian areas renders eradication a priority.

Management Strategies: Plants can be manually removed by cutting, pulling, and rolling up the vines, with effort extended to remove all biomass from the site, including all stem and root fragments. Painting stems with herbicide can prevent regrowth (Holloran et al. 2004).

Jubata grass

Description: Jubata grass (*Cortaderia jubata*) is a large (5-7' tall), fast-growing perennial grass (Poaceae) that forms large clumps in coastal areas, particularly disturbed slopes and cliffs. It reproduces from abundant wind-dispersed seed and can also spread from tillers or plant fragments (Bossard 2000, Holloran 2004).

Distribution: Jubata grass occurs in small patches throughout the PCRP, including a seep in Malpso Ridge, the wellfield, and the riparian area of Monastery Canyon (Overtree 2001). Previous management has included cutting and spraying jubata grass in a subset of its known locations (Overtree 2001).

Threats: Jubata grass is a large, dense grass that outcompetes native herbs and can displace woody vegetation over time. It can create dense, monotypic stands particularly in areas of soil disturbance (e.g. landslides).

Management Goal: Because jubata grass currently occurs within a limited distribution and at relatively low abundance, its eradication is feasible. Because it can have large impacts when abundant, eradication is a priority.

Management Strategies: Plants can be manually removed by cutting using a chainsaw. The root mass either needs to be removed or herbicide applied to the top of the cut stems to ensure mortality (Holloran et al. 2004).

Yellowflag Iris

Description: Yellowflag iris (*Iris pseudocarus*) is a perennial forb in the iris family (Iridaceae) that occurs along shorelines and in wetlands, where it can form dense, monotypic stands by reproducing rapidly via rhizomes.

Distribution: Yellowflag iris is currently known only from Animas Pond. In fall 2006, it was treated through hand removal. Successful eradication will likely require follow up treatments.

Threats: Yellowflag iris can form dense stands that outcompete native aquatic and wetland plants, reduce open water for amphibians, and reduce overall water quantity in ponds (Hemingway and Doak 2006).

Management Goal: Its current limited distribution and low abundance makes eradication of yellowflag iris feasible, while its large negative impact renders eradication a priority.

Management Strategies: Plants can be manually removed by pulling and digging to remove all material, including rhizomes. Follow up treatments will likely be required. The root mass either needs to be removed or herbicide applied to the top of the cut stems to ensure mortality (Holloran et al. 2004).

Minimize Negative Effects: To avoid impacting the California red-legged frog and California tiger salamander, treatment should be conducted between late August and the onset of the fall rain which typically occurs between mid-October and mid-November. During this time, California tiger salamander is in its upland habitats, and the California red-legged frog, as well as other native amphibians, is less susceptible to mortality associated with human trampling in and alongside the ponds (V. Hemingway, pers com. 2006). Impacts to adult amphibians can be further minimized by having a biologist with appropriate permits (i.e. CDFG and USFWS permits) enter the treatment area in advance of crews, to encourage amphibians to vacate the area prior to treatment.

4.2.1.2 Control Invasive Species

Management within PCRP should include control of seven invasive plant species that have large impacts on the grasslands and aquatic systems.

French broom

Description: French broom (*Genista monspessulana*) is a shrub in the pea family (Fabaceae) that invades grasslands, coastal scrub, and woodlands, oftentimes spreading along disturbed areas such as trail sides, stream banks, and roads. These tall shrubs (6-10') can live up to 17 years and begin producing prodigious amounts of seed beginning in their second year. They flower between March and June and set seed between June and August. French broom can form dense monotypic stands in grasslands (Brossard et al 2000, Holloran et al. 2004).

Distribution: French broom is widespread throughout the central and northern portions of PCRP, where it is patchily abundant. The Palo Corona Ranch management plan identified 13 main locations within which a tiered series of management steps should be applied (Overtree 2001).

Threats: French broom can rapidly form dense stands which outcompete native grassland herbs and convert grasslands to exotic-dominated shrublands. French broom infestations near ponds are a threat to the special status amphibians, particularly California tiger salamander, which prefers grasslands as the upland habitat adjacent to breeding ponds.

Management Goal: Due to its widespread distribution, patchy abundance, long-lived seed bank (est. 20 years), and occurrence within adjacent properties, French broom is unlikely to be feasibly eradicated from PCRP (Holloran et al. 2004). Instead, the goal of management should be to prevent its spread and reduce its impacts on native systems by controlling its abundance.

Management Strategies: Management of French broom will likely require a multi-faceted approach, with treatments differing depending on the extent of the infestation and the community in which it occurs.

Isolated individuals: Individual plants including those on the periphery of dense stands can be removed through pulling with a weed wrench, with the goal being to remove the entire plant including the main taproot. Pulling is easier during the rainy season when the moist soil facilitates successful removal of the root system (Holloran et al. 2004).

Extensive Monocultures in Uplands: In large, dense patches where manual removal might be infeasible, initial treatment could include cutting with a mower or tractor driven implement. In order to prevent resprouting, the cut stumps must be sprayed or receive a topical application of herbicide (e.g. glyphosate) to the cambium. Follow up treatment will be required to kill new seedlings, preferably through flaming (weed blanching) in the winter rainy season (Holloran et al. 2004).

Monocultures Near Ponds: To avoid potential negative impacts associated with mowing near ponds, all French broom within a 20' of a pond should be removed by hand, as recommended above for isolated individuals (V. Hemingway, pers comm. 2006).

Minimize Negative Effects: Mowing should be conducted outside of the bird breeding season (i.e. September to March) in order to avoid impacts to birds that might nest in dense French broom stands. To avoid impacting the special status amphibians, treatment near ponds should be conducted between late August and the onset of the fall rain which typically occurs between mid-October and mid-November. During this time, California tiger salamander is in its upland habitats, and the California red-legged frog, as well as other native amphibians, is less susceptible to mortality associated with human trampling in and alongside the ponds. Impacts to adult amphibians can be further minimized by having a biologist with appropriate permits (i.e. CDFG and USFWS permits) enter the treatment area in advance of crews, to encourage amphibians to vacate the area prior to treatment.

Black Mustard

Description: Black mustard (*Brassica nigra*) is an annual herb in the mustard family (Brassicaceae) that invades grasslands and disturbed areas. This tall (2-6') herb flowers from March to June and reproduces from seed which forms a seed bank, though longevity is unknown.

Distribution: Black mustard is patchily abundant within the moist perennial grasslands of the northern portions of PCRP.

Threats: Black mustard can form moderately dense stands and outcompete native grassland herbs. It also produces tall, fine fuels which can prevent a fire hazard.

Management Goal: Due to patchy abundance and occurrence within adjacent properties, black mustard would likely prove difficult to eradicate from the PCRP. However, controlling its distribution and abundance can reduce competition with native grassland herbs and reduce the threat of fire.

Management Strategies:

Isolated individuals: Individual plants including those occurring on the periphery of dense stands can be pulled using a weed wrench, or cut below the root crown with a pick or shovel before fruits develop.

Extensive Monocultures: In large, dense patches of mustard or co-occurring invasive species (i.e. radish, poison hemlock), mowing just prior to fruit development (May-June) can prevent seed production and, over time, greatly reduce plant abundance.

Minimize Negative Effects: Mowing prior to April will prevent impacts to grassland birds that might nest in dense patches of mustard and other invasive herbs which provide cover. If mowing must occur during the nesting season (April-August), the treatment area should be evaluated to

determine whether there are nesting birds. Manual removal of other treatments should be used around potential nest sites.

Wild Radish

Description: Wild radish (*Raphanus sativus*) is an annual herb in the mustard family (Brassicaceae) that invades grasslands and disturbed areas such as roadsides, but can also invade wetland areas and riparian corridors. This tall (3-6') herb flowers from April to June and reproduces from seed which forms a seed bank, though longevity is unknown (Holloran et al. 2004).

Distribution: Wild radish is patchily abundant within the moist perennial grasslands in the northern portion of PCRP.

Threats: Along with black mustard, wild radish can form moderately dense stands in grasslands, and outcompete native grassland herbs. It can also compete with riparian herbs and shrubs in the mixed willow association.

Management Goal: Due to patchy abundance and occurrence within adjacent properties, wild radish would likely prove difficult to eradicate from the PCRP. However, controlling its distribution and abundance can reduce competition with native grassland plants and reduce the threat of wildfire.

Management Strategies: Proposed management for wild radish is the same as that for black mustard.

Isolated individuals: Individual plants including those occurring on the periphery of dense stands can be pulled using a weed wrench, or cut below the root crown with a pick or shovel before fruits develop.

Extensive Monocultures: In large, dense patches of radish or co-occurring invasive species (i.e. black mustard and poison hemlock), mowing just prior to fruit development (May-June) can prevent seed production and, over time, greatly reduce plant abundance.

Minimize Negative Effects: Mowing prior to April will prevent impacts to grassland birds that might nest in dense patches of mustard and other invasive herbs provide that provide cover. If mowing during the nesting season (April-August), check the treatment area to determine whether there are nesting birds and if so, use manual removal around potential nest sites.

Poison Hemlock

Description: Poison hemlock (*Conium maculatum*) is a biennial (occasionally perennial) herb in the carrot family (Apiaceae) that invades grasslands, coastal scrub, and riparian areas, as well as disturbed areas such as roadsides. This tall (3-8') herb flowers between June and July and produces abundant fruits dispersed by water, animals, and vehicles and machinery between August and September (Holloran et al. 2004).

Distribution: Poison hemlock is patchily abundant within the moist perennial grasslands and riparian areas within the northern portions of PCRP, as well as the adjacent coastal scrub.

Threats: This large forb outcompetes native grassland herbs. It is also poisonous to animals including cattle. As a result, its spread reduces the effectiveness of cattle grazing as a management tool.

Management Goal: Due to patchy abundance and occurrence within adjacent properties, poison hemlock would be difficult to eradicate from the PCRP. However, controlling its distribution and abundance can facilitate grassland management objectives as well as success of the livestock operation.

Management Strategies: Proposed management for poison hemlock is similar to that for black mustard and wild radish, with which it co-occurs in portions of the moist perennial grassland.

Isolated individuals: Individual plants including those occurring on the periphery of dense stands, in adjacent coastal scrub or oak woodland, in the riparian areas (incl. ponds), and areas which cannot be mowed can be pulled using a weed wrench, or cut below the root crown with a pick or shovel before fruits develop.

Extensive Monocultures: In large, dense patches of poison hemlock, particularly where it co-occurs with other invasive species, mowing prior to fruit development can prevent seed production and, over time, greatly reduce plant abundance.

Monocultures Near Ponds: To avoid potential negative impacts associated with mowing near ponds, poison hemlock within a 20' of a pond should be removed by hand, as recommended above for isolated individuals (V. Hemingway, pers comm. 2006).

Minimize Negative Effects: Mowing prior to April will prevent impacts to grassland birds that might nest in dense patches of mustard and other invasive herbs provide that provide cover. If mowing during the nesting season (April-August), check the treatment area to determine whether there are nesting birds and if so, use manual removal around potential nest sites.

Thistles

Description: Three invasive thistles in the sunflower family (Asteraceae) are targets for control within the grasslands.

1. Italian thistle (*Carduus pycnocephalus*) is an annual or biennial forb that invades grasslands and riparian areas, particularly those that are overgrazed or frequently disturbed. It grows to be 1-6' tall and flowers between September and December.

2. Bull thistle (*Cirsium vulgare*) is a biennial forb that invades native grasslands, as well as disturbed areas and forest clearings. The 2-5' tall herb flowers between June and September of its second year and produces abundant, wind-dispersed seed.

3. Milk thistle (*Silybum marianum*) is an annual or biennial herb that invades grasslands, particularly disturbed or heavily grazed areas (Holloran et al. 2004).

Distribution: Invasive thistles are patchily abundant within the moist perennial grasslands and riparian areas within the northern portions of PCRP.

Threats: Thistles produce relatively large basal rosettes of leaves and can outcompete native grasslands herbs.

Management Goal: Due to their patchy abundance and occurrence within adjacent properties, invasive thistles could be difficult to eradicate from the PCRP. However, controlling their abundance can facilitate grassland management objectives.

Management Strategies: Proposed management for exotic thistles is similar to that of other invasive forbs, with which the thistles can co-occur in portions of the moist perennial grassland.

Isolated individuals: Individual plants including those occurring on the periphery of dense stands, under trees, or in riparian areas (incl. ponds), and areas which cannot be mowed can be pulled or cut below the root crown with a pick or shovel before fruits develop.

Extensive Monocultures: In large, dense thistle patches, or where thistles co-occur with poison hemlock, mustard, and radish, mowing in May prior to fruit development can prevent seed production and, over time, greatly reduce plant abundance.

Minimize Negative Effects: Prior to mowing during the ground bird nesting season (April-August), check the treatment area to determine whether there are nesting birds and if so, use manual removal around potential nest sites.

Harding Grass

Description: Harding grass (*Phalaris aquatica*) is a perennial bunchgrass that invades grasslands in coastal areas. When in flower between May and June, this large grass can be up to 4' tall. It produces via seed, which is produced between May and September, as well as tillers (Holloran et al. 2004).

Distribution: Harding grass is patchily abundant within the moist perennial grasslands in the northern portion of PCRP. A few scattered plants have been observed within the subshrub and ridge grasslands in the center and south.

Threats: Harding grass forms dense tussocks that compete with native grassland herbs for scarce soil resources, light, and space.

Management Goal: Harding grass would likely be difficult to eradicate completely from the PCRP, due to its abundance in the northern management units. However, it should be eradicated from the central and southern portions of the park, where it currently occurs at low abundance.

Control of Harding grass in the north can reduce competition with native grassland herbs, thus increasing their abundance.

Management Strategies:

Isolated individuals: Individual plants including those occurring on the periphery of dense patches in the moist perennial grasslands, and isolated tussocks in the central and southern portion of the park, can be physically removed by cutting around the base of the tussock with a Pulaski or other tool, and digging out the roots. All material should be removed from the site to avoid resprouting (Holloran et al. 2004).

Extensive Monocultures: In large, dense patches of Harding grass, mowing can be used to supplement summer grazing, as needed, to prevent seed formation.

Minimize Negative Effects: Supplemental mowing should occur after August, in order to avoid nesting grassland birds. If mowing during the nesting season (April-August), the treatment area should be checked to determine whether there are nesting birds and if so, manual removal or other treatments used around potential nest sites.

4.2.2 Management of Encroaching Woody Plants

In the absence of recurring fire, shrubs and trees from the adjacent communities can become established within the grasslands of the PCPR. Over time, woody plant encroachment can convert the grasslands to shrublands or woodlands (McBride and Heady 1968, McBride 1974). Two native woody plants identified as threats to grassland community structure and composition are coyote brush and Monterey pine.

4.2.2.1 Coyote Brush

Description: Coyote brush (*Baccharis pilularis*) is a soft-wooded shrub that dominates the coastal scrub in central coastal California and is regarded as a component of the coastal terrace prairie (Stromberg et al. 2002). In the absence of fire, coyote brush will establish at high density, converting coastal grasslands to coastal scrub (McBride and Heady 1968).

Distribution: Coyote brush is a dominant plant within the coastal scrub, and occurs at varying densities within patches of moist perennial grassland and subshrub grassland. It is uncommon in the ridge grassland association in the south. In the central portion of the park, coyote brush establishment within grasslands might occur at greater frequency on the cooler, north-facing slopes, where abundance appears to be greater than ridgetops and south-facing slopes.

Threats: Coyote bush competes with native grassland herbs. When cover exceeds an estimated 30%, it can degrade habitat for grassland birds including northern harrier, white-tailed kite, golden eagle, horned lark, merlin, and burrowing owl, which require open grassland structure (Dechant et al. 1998a,1998b,2000; CPIF 2000).

Management Goal: Consistent with the grassland biological objectives (Section 3.1), the goal for management of native woody vegetation is to limit its overall cover within the grasslands, to 30% within the moist perennial grasslands, 20% in the subshrub grasslands, and 10% in the ridge grasslands. In the subshrub and ridge grasslands, woody cover will primarily be comprised of coyote brush, while Monterey pines will contribute to woody plant encroachment in the moist perennial grasslands.

Management Strategies:

Isolated individuals: Individual coyote brush plants can be removed through cutting with a chainsaw, and then applying topical herbicide (e.g. glyphosate) to the cambium to prevent resprouting.

Extensive Monocultures: Large, dense patches of coyote brush can be mowed. To avoid repeated mowing, cut plants should be treated with herbicide (e.g. glyhposate). Such vegetation management should not be used to convert coastal scrub to grassland, as doing so will impact habitat for coastal scrub species, and will likely necessitate repeated, costly mowing to maintain open, herb-dominated conditions.

Minimize Negative Effects: Mowing should avoid the nesting season for grassland birds (April-August), and impacting native grassland subshrubs including silver bush lupine.

4.2.2.2 Monterey Pine

Description: Monterey pine (*Pinus radiata*) is a closed cone conifer that is endemic to four main populations along the California's central coast and the islands off Baja California, where it occurs in cool, foggy coastal areas. Due to its limited geographic range and narrow habitat specificity, the native stands of this relict pine are regarded as rare or endangered by the California Native Plant Society, with the Monterey pine forest recognized as a rare community type by the California Natural Diversity Database. The Monterey Peninsula supports the largest native population.

Distribution: The PCRP supports 67 acres of Monterey pine forest within the northern portion of the park, north of San Jose and Animas Creeks, where it typically occurs on western slopes. Where Monterey pine forest intergrades with the moist perennial grasslands, small Monterey pines are observed establishing within the grassland habitat.

Threats: Monterey pine is a large tree that creates shade and litter that will restrict the distribution of many native grassland herbs adapted to open canopy conditions. As with coyote brush, encroaching trees can degrade habitat for grassland birds including northern harrier, white-tailed kite, golden eagle, horned lark, merlin, and burrowing owl, which require open grassland structure.

Management Goal: Consistent with the biological objectives (Section 3), the goal for management of the moist perennial grasslands is to limit woody vegetation to 30%.

Management Strategies:

Areas supporting dense, contiguous stands of Monterey pine should be managed as Monterey pine forest. Individual Monterey pines that establish within the grasslands should be removed through cutting with a chainsaw. Biomass should be hauled off site to avoid increased fuels associated with leaving dead trees or wood chips on site.

CHAPTER 5: POND AND SPRING MANAGEMENT STRATEGIES AND TECHNIQUES

This section describes the management strategies and techniques designed to attain the goals and objectives for the ponds and springs (Section 3.2).

The ponds within the PCRP that were created to provide water for livestock have become been colonized by aquatic and wetland plant and animal species (Section 2.8, Appendix B). A recent study examining amphibian populations within the PCRP ponds concluded that ongoing use of the ponds as water sources for cattle degrades habitat by reducing native plant cover and causing erosion and sedimentation. The study noted that cattle might also directly impact amphibians through trampling of egg masses as well as tadpoles and adults which can be slow moving and attempt to hide rather than flee when approached. At the same time, cessation of grazing could degrade amphibian habitat, by facilitating growth of dense aquatic and wetland plant species, which can reduce the areal extent and depth of open water habitat (Hemingway and Doak 2006).

Based in part on the recommendations from the amphibian study (Hemingway and Doak 2006), and the *Palo Corona Ranch Management Plan* (Overtree 2001), the following management is recommended to attain the biological goals and objectives for the ponds and springs.

5.1 POND FENCES

Description: Fences should be installed around the perimeter of the pond, providing a 10-20 foot buffer from the maximum wetted diameter to allow growth of wetland and upland plants around the pond banks. An interior fence is installed to bisect the pond, with the fence located so as to create areas of deep and shallow water within each half. Exterior fences should include large gates which allow access to both sides of the pond. In ponds that are visible from trails, split rail fences should be constructed to enhance the aesthetic enjoyment of the pond (Overtree 2001).
Alternative water for livestock should be provided in troughs located at least 25' away from the pond.

Objectives: Fencing ponds to prevent cattle access will accomplish the following:

- Increase cover of aquatic and wetland plants that provide habitat for special status amphibians as well as birds such as tricolored blackbird
- Prevent mortality to amphibians caused by cattle trampling
- Reduce pond bank erosion and sedimentation, due to cattle trampling and removal of vegetation
- Increase water quality by preventing cattle defecation and turbidity due to trampling.

Rationale: Fencing ponds prevents the negative effects of cattle, while gates allow managers to conduct pond projects as needed to maintain habitat conditions, as described below.

Application: This strategy is proposed for the seven unfenced ponds (Table 2-3). Priority should be given to Roadrunner, Dead Pig, and Salamander ponds, which support California red-

Table 5-1: Management strategies and techniques designed to attain the goals and objectives in the ponds and springs. ■ Denotes a technique that has high likelihood of promoting the objective, while ◘ denotes a strategy that is likely to support success toward the objective. Details provided in text.

Biological Objective	Fencing Ponds	Address Pond Sedimentation	Manage Aquatic Vegetation	Eradicate Yellowflag Iris	Eradicate Exotic Animals	Control French broom	Implement Disease Prevention BMPs
5.1 *Maintain or increase the size of the wetted area and depth of the 7 ponds occupied by special status amphibians.*	■	■	■	■		◘	
5.2 *Facilitate aquatic and wetland plants in approximately 50% of each pond, with the vegetated portion of the pond including both shallow and deep water.*	■	■	■	■		◘	
5.3 *Eradicate or control (<5% cover) invasive exotic plant species occurring within ponds, including yellowflag iris.*				■		■	
5.4 *Maintain ponds free of exotic aquatic animals, including bull frogs, fish, turtles, and salamanders.*					■	■	
5.5 *Enhance grassland habitat adjacent to ponds for California Tiger Salamander and facilitate connectivity among ponds by eradicating or controlling (<5% cover) French broom around ponds and preventing accidental collapse of burrows.*						■	
5.6 *Reduce the potential for spread of amphibian disease among ponds.*							■
5.7 *Increase the cover and species richness of native wetland plants in and around the 24 springs.*	■						

legged frog and California tiger salamander, and then Wire Corrals pond, which supports wetland vegetation and may support native amphibians. Echo Ridge and Van Winkleys ponds represent lower priorities, as they do not support special status amphibians and they may not be able to support wetland plants, owing to their hydrology and/or occurrence in the densely shaded hardwood forest (Hemingway and Doak 2006).

5.2 POND SEDIMENTATION

Pond habitat can be degraded by sedimentation, which reduces the depth and area of water.

Description: Dredging should be used to remove accumulated sediment, if pond monitoring indicates sediment levels are excessive and are limiting water depth and area (Section 8.2).

Objectives: Accumulated sediment within ponds should be removed to maintain the area and depth of water within ponds that is required to support special status amphibian populations, and prevent pond succession to meadow.

Rationale: Over time, sedimentation from creeks and eroding banks will reduce pond size and depth, thus degrading habitat for aquatic species and converting ponds to meadows.

Application: Dredging should be conducted in response to pond monitoring results that indicate declines in pond area or depth due to sediment build up. The following methods are recommended to avoid negative impacts to the pond species.

1. Dredging should be conducted between late August and the first hard rain (i.e. 1"), when amphibians are least susceptible to habitat alterations and least likely to be trampled.
2. A biologist with appropriate state and federal permits should enter the pond ahead of equipment in attempt to encourage adult amphibians to vacate the treatment area.
3. Efforts should be used to maintain as much vegetation within and along the banks of the pond, unless pond monitoring indicates that vegetation removal is also needed to maintain pond habitat.
4. Only 50% of a pond should be dredged each year, to avoid impacting entire populations.
5. Ponds should be dredged on a rotation, with no more than two ponds dredged in a single year.

5.3 VEGETATION MANAGEMENT

Description: Vegetation management might be needed to maintain a mosaic of pond conditions in the absence of cattle grazing.

Objectives: Vegetation management is recommended to:

- Create and maintain a mosaic of conditions within a pond to enhance diversity
- Facilitate populations of special status amphibians that require varying pond conditions during their different life stages.

Rationale: In the absence of cattle grazing and trampling, the cover of aquatic plants is predicted to increase. While this will likely benefit species such as tricolored blackbird, which requires large areas of dense emergent vegetation, such vegetation could degrade habitat for other species that require deep water and open sunlit conditions, such as California red-legged frog. Maintaining a mosaic of conditions is thought to enhance overall diversity as well as facilitate special status species populations. As with other amphibians, California red-legged frogs require deep water to escape predators, and shallow, warm water conditions for juvenile growth and metamorphosis. While they require aquatic vegetation for egg mass attachment, too much vegetation can reduce water depth and temperature. As a result, a diversity of conditions is thought to promote successful population growth (Hemingway and Doak 2006).

Application: If pond monitoring results indicate that habitat is being degraded for special status amphibians, vegetation management should be implemented using the following techniques designed to minimize inadvertent negative impacts:

1. Conduct work between late August and the first hard rain
2. A biologist with appropriate state and federal permits should enter the pond ahead of equipment to encourage adult amphibians to vacate the treatment area
3. Remove vegetation through hand cutting or pulling, rather than with herbicides or large equipment
4. Remove all invasive exotic plants
5. Remove native plants as needed to maintain a mosaic of habitat conditions, including open shallow water, open deep water, vegetated shallow water, and vegetated deep water.
6. Maintain relatively large contiguous patches of emergent vegetation for tricolor blackbirds and other species adapted to dense vegetation.

5.4 EXOTIC PLANT MANAGEMENT

Description: Exotic plant management is recommended to remove French broom around and between Dead Pig, Salamander, and Roadrunner ponds (Figure 2-4).

Objectives: French broom should be removed to create and maintain open herbaceous-dominated habitat required by California tiger salamander and to promote population persistence through recolonization following extirpations within individual ponds.

Rationale: California tiger salamanders prefer upland habitat dominated by herbaceous plants, including grasslands. These habitats support a greater abundance of ground squirrels and pocket gophers, the burrows of which California tiger salamanders use an estimated 11 months of each year. French broom around and between Salamander, Dead Pig, and Roadrunner ponds degrades upland habitat and likely deters migration among habitats. Such migration is essential for recolonization of ponds where the species might have been or could become extirpated, thus maintaining the metapopulation at PCRP. Driving roads adjacent to ponds can collapse burrows used by native amphibians (Hemingway and Doak 2006).

Application: As described in Section 4.2.1.2, French broom should be controlled around and between the three ponds through the following techniques, which should be conducted between

late August and the first hard rain, except as noted, in order to minimize potential for direct impacts on special status species.

1. Within 50 feet of the ponds, use weed wrenches to pull French broom, and then use flaming in the winter (January-February) to kill emerging seedlings.
2. In monocultures between ponds, mow and/or apply herbicide (e.g. roundup) to kill plants in monocultures.
3. Remove plants within intact plant communities through pulling (weed wrench).

Ranchers, land managers, and researchers should avoid driving on roads adjacent to ponds, including the road on the north bank of Salamander pond, in order to minimize accidental collapse of burrows used by amphibians including California tiger salamander (Hemingway and Doak 2006).

5.5 AMPHIBIAN DISEASE SPREAD

Description: Park visitor access to ponds is restricted and park staff and contractors follow best management practices to prevent the spread of disease among ponds.

Objectives: These measures are needed to prevent the human-mediated spread of diseases that could threaten amphibian populations within the pond.

Rationale: Persistence of native animal populations may be threatened by emergent wildlife disease, including chytrid fungus and ranaviruses which can reduce the demographic performance of individuals. These diseases have been observed in a subset of the ponds examined at PCRP (Table 2-3). Humans can inadvertently and unknowingly vector disease between ponds (Hemingway and Doak 2006).

Application: Ranchers, park staff, and researchers should follow best management practices designed to prevent the spread of disease among ponds (Hemingway and Chabre 2006; Appendix F). In addition to fencing the ponds, efforts should be made to locate trails so as to reduce public contact with pond habitat and species. Signs could be posted at park entrances and near ponds to explain why pond access is prohibited and encourage public compliance with the regulation.

5.6 SPRING FENCES

Description: The 24 springs should be fenced to prevent cattle encroachment. As needed, alternative water systems should be created by piping water to troughs located at least 25' away from the stream, at which the livestock can drink without doing damage to the spring site or the runoff path of the spring. As with all new fencing, fences should be constructed so as to reduce impacts on native species, including by using smooth strands on the top and bottom and elevating the bottom strand 18".

Objectives: Fencing springs to prevent cattle access will accomplish the following:

- Increase cover of aquatic and wetland plants which provide habitat for amphibians
- Prevent mortality to amphibians caused by cattle trampling

- Reduce spring erosion due to cattle trampling and removal of vegetation
- Increase water quality by preventing cattle defecation.

Rationale: The 24 known springs within PCRP provide habitat for wetland plants, breeding habitat for amphibians including Pacific tree frogs, and a source of free water for terrestrial species including birds and mammals. Cattle negatively impact springs, by removing wetland vegetation, causing erosion, and reducing water available to native animals.

Application: An assessment of the park springs should be conducted to determine their condition and prioritize fencing. Priority should be given to springs that support or have the potential to support wetland vegetation if not grazed, and are located in areas of anticipated cattle use. For example, many springs in the center and southern portion of the park are located in deep canyons that cattle are not predicted to access during early season grazing. Such springs could be monitored to determine cattle impacts and then fenced as necessary.

CHAPTER 6: RIPARIAN AND RIVERINE MANAGEMENT STRATEGIES AND TECHNIQUES

Management of the riparian and riverine areas within the PCRP should focus on reducing threats in order to enhance the areal extent, community structure, and species composition, and habitat conditions for special status species. Specific objectives are to:

1. Increase the areal extent of riparian vegetation.
2. Eliminate or reduce stream bank erosion and stream sedimentation, which degrade habitat for aquatic species, including steelhead trout.
3. Eradicate or control (<5% cover) invasive exotic plant species occurring within riparian and riverine systems, including poison hemlock, bull thistle, and Cape ivy.

6.1 RIPARIAN UNIT MANAGEMENT

Description: Cattle grazing and mowing should be discontinued within two management units supporting small patches of moist perennial grassland that are adjacent to riparian areas, in order to facilitate expansion of the riparian woodland.

Objectives: Increasing the width and density of riparian vegetation along streams will:

- Provide habitat to native birds including tricolored blackbirds, as well as other native animals adapted to moist conditions along streams.
- Improve habitat conditions for steelhead trout and other aquatic species.

Rationale: Vegetation along streams is critical to maintaining aquatic habitat by providing food inputs, stabilizing soil, and providing shade, which regulates water temperature. Riparian vegetation also provides important breeding and migration habitat for birds, as well as important habitat for other animal species adapted to the relatively mesic conditions. The width of the riparian corridor influences bird diversity and nesting success for many species. Increasing the area of riparian vegetation could provide nesting habitat for yellow warblers and tricolored blackbirds, which have been observed at PCRP.

Application: Cattle grazing and mowing should be discontinued within the River and Well Units (Figures 2-3, 4-1). In the absence of grazing and mowing, riparian species are predicted to naturally colonize the moist grassland that was previously maintained by grazing and mowing. Active revegetation can be used to promote riparian woodland species establishment if natural tree recruitment is slow due to competition from exotic plants.

6.2 RIPARIAN AREA FENCING

Description: Fence streams located in management units in which grazing is prescribed after March: Lower San Jose Creek (Monastery and South Front Units) and Barn Creek (Bull, Middle, North Front, Barn, and Harding Units).

Table 6-1: Management strategies and techniques designed to attain the goals and objectives in the riparian and riverine systems. ■ Denotes a technique that has high likelihood of promoting the objective, while ◘ denotes a strategy that is likely to support success toward the objective. Details provided in text.

Biological Objective	Discontinue grazing in 2 Units	Fence Riparian Areas	Early Season Grazing in Stream Units	Riding to Limit Stream Access	Eradicate Cape Ivy	Control Exotic Forbs
6.1 *Increase the areal extent of riparian vegetation.*	■	■	■	■	◘	◘
6.2 *Eliminate or reduce stream bank erosion and stream sedimentation which degrade habitat for aquatic species, including steelhead.*	■	■	■	■		
6.3 *Eradicate or control (<5% cover) invasive exotic plant species occurring within riparian and riverine systems, including poison hemlock, bull thistle, and Cape ivy.*				■	■	■

Objectives: Increase the width and density of riparian vegetation along streams, in order to:

- Provide habitat to native birds including tricolored blackbirds, as well as other native animals adapted to moist conditions along streams.
- Improve stream habitat conditions for steelhead trout and other aquatic species.

Rationale: Cattle access to streams removes riparian vegetation and erodes stream banks, increasing water temperature fluctuations, destroying in-stream habitat (e.g. pools), and increasing sedimentation, which eliminates gravel beds required for success of steelhead redds (nests). When cattle are grazed during the late spring, summer, and early fall, they will access riparian areas to seek refuge from hot temperatures, obtain water, and forage on new growth.

Application: Fences should be erected to exclude cattle access to Lower San Jose Creek in the Monastery and South Front Units, and Barn Creek, which is in several units on the northern coastal terrace. Fences should be located 100' away from the stream corridors on either side. Alternative water should be provided via pipes to troughs. If alternative water cannot be provided, a small (10' wide) access point could be created at a stable location along the stream bank, with fencing installed to prevent movement up or down-stream. Such an access point will be needed to provide access between the Monastery and South Front Units (Figure 4-1).

6.3 CATTLE STREAM ACCESS

Description: Cattle should be grazed during the early season, to reduce access to streams, and riding used to reduce impacts of cattle during stream crossing.

Objectives: Reduce cattle access to streams in order to:

- Increase riparian vegetation density and width.
- Provide habitat to native birds including tricolored blackbirds, as well as other native animals adapted to moist conditions along streams.
- Improve stream habitat conditions for steelhead trout and other aquatic species.

Rationale: Cattle access to streams removes riparian vegetation and erodes stream banks, increasing water temperature fluctuations, destroying in-stream habitat (e.g. pools), and increasing sedimentation which eliminates gravel beds required for success of steelhead redds (nests). During the early season, cattle preferentially forage on warm slopes and avoid cool canyons in which streams flow, such that provided they have alternative water in the grasslands atop the ridges, they are not predicted to access the streams for water or forage. In order to move between management units, cattle will need to walk along Seneca Creek and across San Jose Creek, which are steelhead steams.

Application: In the following management units with streams supporting steelhead trout, cattle use should be limited to early season (November-March) and water troughs should be located at least 100 feet from the stream corridor: West San Jose, East San Jose, and Seneca (Figure 2-5). Riders should monitor cattle use locations and herd cattle away from canyons as needed. Riders should also move cattle across San Jose Creek and along Seneca Creek so as to limit their time in or near the stream.

6.4 EXOTIC PLANT MANAGEMENT

Description: Implement measures described in Section 4.2.1.1 to eradicate Cape ivy, and control poison hemlock, thistles, and other invasive species within the riparian woodlands.

Objectives: To reduce the negative impacts and prevent the spread of invasive exotic plants within the riparian areas of the PCRP.

Rationale: Invasive exotic plant species degrade riparian and riverine habitat, particularly in northern portion of the park where poison hemlock, bull thistle, and Cape ivy occur. Discontinuing cattle grazing will likely allow these species to increase in abundance, particularly that of poison hemlock which has formed a nearly impenetrable stand along River Pond which was fenced to exclude cattle. Dominant trees of the riparian woodland, including sycamore, black cottonwood and willow, may eventually create low light conditions that preclude establishment of these ruderal species. However, in the short term, the exotics may create dense stands that inhibit riparian woodland plant establishment.

Application: Section 4.2.1.1 describes eradication methods for Cape ivy and Section 4.2.1.2 describes techniques to control poison hemlock and thistles.

CHAPTER 7: FACILITIES MANAGEMENT STRATEGIES AND TECHNIQUES

Successful use of cattle grazing as a management tool to facilitate the biological goals and objectives within PCRP will require implementation of strategies designed to minimize the negative impacts of a cattle operation on the conservation targets, native ecosystems, and visitors within the park.

7.1 FENCE SYSTEMS

Perimeter fences are needed to prevent cattle trespass onto adjacent properties, while fences separating the management units are needed to effectively implement the grazing strategy and minimize impacts to conservation targets and other components of the park ecosystem. New interior fences need to be installed to implement the grazing strategy developed for this plan. In addition, existing perimeter and interior fences require repair to prevent breaches.

7.1.1 Install new Interior Fencing

In order to implement the grazing strategy developed in this plan, the following new interior fence segments must be installed to create the new management unit configuration.

1. Install an estimated 800 foot long fence segment across the southwest corner of the Middle Unit to create the 6-acre Harding Unit, which will be separately managed to control Harding grass.
2. Install an estimated 1,400 foot fence to separate the current Front pasture into North and South Units, allowing differential management of the moist perennial grasslands it contains.
3. Install an estimated 2,000 foot fence to create the Seneca Unit from the northern portion of the existing Corona pasture and the eastern edge of the Panoche pasture

Additional fence segments may be needed to create the designed management units, if for example, a brush barrier that currently constitutes a management unit boundary proves ineffective.

To enhance effectiveness and durability, fences should be installed following the Natural Resources Conservation Service's Conservation Practice Specifications for fences (Appendix E).

To facilitate wildlife movement, new fences as well as repaired fences segments (below) should be constructed per the following:

1. The lowest wire strand should be 18" off the ground to allow wildlife to duck the fence.
2. The bottom and top wire should be smooth, rather than barbed.

7.1.2 Repair Existing Fences

Portions of the perimeter and interior fences are in disrepair, particularly in the central and southern portions of the park which have not been grazed recently. Breech points should be identified and repaired along with other problem areas (i.e. dilapidated fence segments) within

the perimeter and interior fences. Repaired fence segments should be created following the NRCS specifications and wildlife protection mechanisms described above.

7.1.3 Install Gates and Fence Crossings

Secure gates are needed to allow vehicle movement into the park and between management units, while containing livestock. Gates should be locked at all times and used only by authorized personnel.

To allow park visitors to pass through fences, appropriate fence crossings should be installed at locations where trails identified in the trails plan cross perimeter and interior fences. The nature of the fence crossing will likely depend on the trail use (e.g. pedestrian or multiuse), as identified in the trails plan.

7.1.4 Additional Cattle Exclosures

Additional fencing will likely need to be installed to exclude cattle from areas where their use would degrade public enjoyment of the park facilities, such as picnic areas and campgrounds. These areas will be identified in a park facility and management plan to be developed at a later date. Alternative grassland management techniques, including mowing and weed whipping might be needed to maintain vegetation within these areas.

7.2 ROAD MAINTENANCE

At present, PCRP contains an estimated 46.6 miles of roads, including main roads and secondary roads. With the exception of an approximately 0.5 mile paved road which accesses the private inholding (Fish residence), all of the roads are unpaved. Many roads were not constructed using current standards designed to reduce erosion and as a result, require frequent and costly maintenance to maintain drivability.

Use and maintenance of some of the roads degrades habitat for special status species. For example, road grading within the subshrub grasslands and other areas that support seaside buckwheat results in the spoils being deposited on host plants of the Smith's blue butterfly. Road spoils eventually make it to the creeks, including Seneca Creek and San Jose Creek, where the resulting sedimentation degrades habitat for steelhead.

Some of the current roads will be maintained for use by park staff and contractors, including the cattle operator, for management. Roads will also provide trails for park visitors as well as movement by cattle. Some of existing roads might also be maintained for their value as fuel breaks to aid fire management.

To address road maintenance, a roads and hydrology plan should be created. The plan should be coordinated with the fire management plan, trails plan, and this grassland and grazing plan, to ensure that the various uses of the current road system are considered in designating locations where roads will be retained. Where feasible, roads near ponds should be rerouted to occur at least 100 feet away from ponds.

7.3 TROUGHS

7.3.1 Trough Location

Functional and well-distributed cattle troughs will be essential to successful implementation of the grazing strategy. Cattle preferentially forage within close proximity to water. While areas within 800 feet of water are anticipated to receive 100% use, areas beyond 2 miles are expected to receive no use (Guenther et al. 2001). In steep terrain, cattle use may be limited to areas within 1 mile of water (Smith et al. 1986), and cattle use on slopes above 60% is typically light (Guenther et al. 2001). Some variability in use is desirable, as it creates heterogeneous habitat conditions. However, if the unused portion of a management unit is large, the benefits of cattle grazing at increasing native plant diversity and abundance, and reducing shrub encroachment and thus maintaining grasslands, will be limited. Given this, well dispersed water sources are desirable.

Water is plentiful and fairly well-dispersed in the northern management units, where current troughs are likely sufficient to allow desirable use under the proposed grazing strategy. In the central and southern portions of the park, water availability is limited. Perhaps more significantly, many troughs are located down canyon slopes, away from the grasslands which are concentrated on the ridges. Lack of sufficient water within these grasslands was one factor considered in limiting grazing in this portion of the park to early season (November-March), when cattle water demands are lower.

As part of implementation monitoring, use patterns will be examined within each of the management units to determine whether use away from water is sufficient to attain the RDM objectives for grazing management (e.g. 1200-1800 lbs), or alternatively, if areas near water are receiving excessive use and/or if large areas far from water are receiving insufficient use (Section 8.2).

7.3.2 Trough Design and Maintenance

Troughs are used by native animals include amphibians that can use them for breeding ponds, and terrestrial species, which use them as a source of free water. The following trough design and maintenance strategies will minimize potential inadvertent negative effects on native animal species.

1. Troughs should have float valves to minimize water collected from springs.
2. Troughs should be cleaned, as needed, during the summer and early fall to avoid impacts to breeding amphibians that would occur during the breeding season (March- August).
3. Troughs should have ramps, emergent rock piles, or other mechanisms that allow animals to escape and avoid drowning.

7.4 SALT AND SUPPLEMENTS

Range cattle are provided salt and mineral supplements to enhance their health and facilitate foraging. As with troughs, the location of salt and mineral supplements within the park can

influence grassland use and thus effectiveness of cattle as a management tool. Unlike troughs, which can be difficult to establish owing to source water limitations, salt licks and vitamin supplement stations can be readily erected. Salt and supplement feeders should be placed per the following guidelines:

1. In areas of relatively high exotic plant abundance that might not otherwise receive use due to distance from water or other factors.
2. On flat areas and moderate slopes (<20º), avoiding steep slopes
3. Away from water sources, including streams, ponds, troughs, and springs (>100 yards).
4. Away from known special status plant species occurrences and Smith Blue butterfly habitat (>100 yards).

Based on results of RDM monitoring, salt and mineral supplement feeders can be located to encourage use, or away from areas of excessive use.

7.5 SUPPLEMENTAL FEED

As part of historic cattle operations, cattle have been provided supplemental feed within the grasslands during periods of low forage availability. Such supplemental feeding can have negative effects on grassland species, as it concentrates cattle use in small areas (i.e. where feed is placed) and can introduce non-native plant seed. Perhaps more importantly, maintaining cattle within a management unit when forage is insufficient results in undesirable high intensity use (i.e. overgrazing).

Supplemental feed such as hay should not be provided within the grassland management units, and instead, should be limited to the corrals and facilities.

7.6 WILDLIFE PROTECTION

The following additional recommendations are designed to protect native species within the park. Animals perceived as a nuisance or threat to livestock, such as ground squirrels, coyotes, or mountain lions, should not be killed (shot, poisoned) or otherwise harmed or harassed. Dead cattle should be left in place for use by scavengers such as California condors, where doing so will not threaten livestock, wildlife, or public health or impair public enjoyment of the park.

7.7 PUBLIC INFORMATION

Public information materials are recommended to inform visitors about the rationale for using cattle grazing as a management tool and provide guidelines for their safety around cattle. The informational content could be similar to that developed by the East Bay Regional Parks District, where livestock are grazed in 20 grassland parks that also provide recreation opportunities for cyclists, equestrians, and pedestrians.

The information should be provided via a variety of media, including:

1. The Monterey Peninsula Regional Park District website
2. The park brochure provided at park entrance(s)
3. One or more interpretive signs posted at areas of high visitor use where cattle grazing will be frequently observed, such as the northern coastal terraces.

CHAPTER 8: ADAPTIVE MANAGEMENT AND MONITORING PROGRAM

This chapter outlines the coordinated program that integrates management and monitoring to facilitate progress toward the biological goals and objectives through a process known as adaptive management.

8.1 ADAPTIVE MANAGEMENT PROGRAM COMPONENTS AND PROCESSES

Adaptive management is the process by which management activities are implemented and monitored using a study design that allows analysis of changes due to management and therefore evaluation of management effectiveness (Lee 1999). Following a cycle of activities (Figure 8-1), adaptive management includes six main steps: 1) develop a model of the system, 2) develop objectives that describe the desired conditions, 3) design and implement management to meet the objectives, 4) monitor the system, 5) analyze data to determine whether the objectives were reached, and 6) change management based on new insights gained if objectives are not met. Greater details about adaptive management, including step by step guidance for the development of adaptive management plans are provided in the literature (Walters and Holling 1990, Nyberg 1998, Lee 1999, Elzinga et al. 2001).

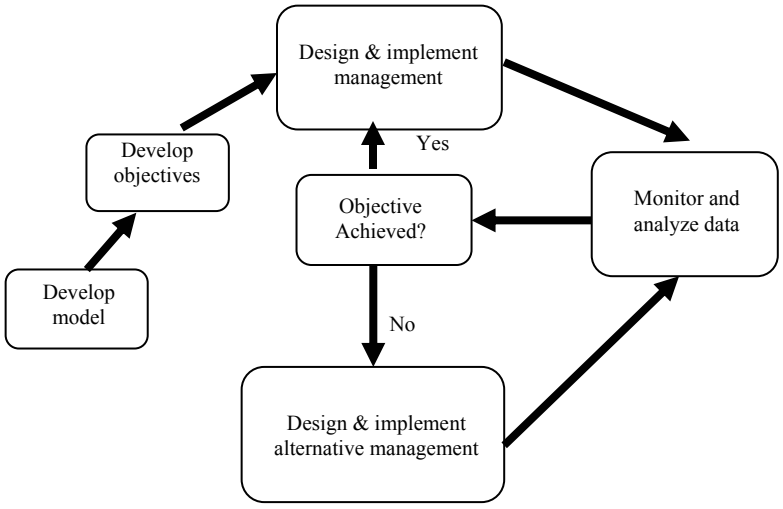

Figure 8-1: Adaptive management cycle from (Elzinga et al. 2001).

This plan recommends adaptive management techniques to address the uncertainty inherent in management, adapt to changed conditions within the PCRP, to integrate new information, and to increase understanding of the ecology of the system that is needed to inform conservation of biodiversity within the park.

8.1.1 Address Uncertainty in Management

Though management strategies in this plan were developed based on available scientific research, many specific techniques have not been examined within the target systems. Unique aspects of the park site, communities, and implementation techniques could interact to result in unpredicted management effects. Implementation of management as an experiment allows determination of management effects on the target systems. Should management succeed,

monitoring can document long-term success. Should a given strategy fail, or have unintended consequences, monitoring results can be used to refine the model for the system that will increase the likelihood of future management success.

8.1.2 Adapt to Changed Conditions

Adaptive management is also needed to adapt to changes in the grasslands and aquatic systems that occur during plan implementation. Changes that might require alteration to the management strategies include:

- unusual weather (e.g. an extended drought) or climate change;
- changes in the composition of the grassland, such as the invasion of a new exotic plant or spread of an existing exotic species;
- widespread fire that alters grassland community composition and productivity;
- heightened conservation concern for a special status species population (e.g. decline in Smith's blue butterfly populations due to disease outbreak).

In addition, management techniques that might have been effective in one place or time may not be effective in another, requiring continued vigilance to achieve the conservation goals.

8.1.3 Integrate New Information

Ongoing scientific research will continue to provide information about the ecology of the conservation targets within the PCRP that can be used to inform management. Researchers are currently examining:

- the effects of various grassland management techniques, including fire and grazing on native plant diversity and abundance in grasslands
- the factors influencing successful control of exotic plants, such as French broom
- the management of special status species populations, such as the California red-legged frog and California tiger salamander
- the effects of grazing on Smith's blue butterfly (Cushman 2006).

Park managers working to implement this plan should integrate new information to update the management strategies and techniques. Occasionally a biological objective that might prove inappropriate for attaining the biological goal might also require adaptation based on new information.

The plan should be updated as new information becomes available, or at a minimum, once every five years.

8.1.4 Proactive and Remedial Management

This plan recommends proactive management. That is, rather than waiting for conditions to decline, management should be implemented to address the stresses that have already degraded grassland and aquatic habitats including exotic plants, fire exclusion, and inappropriate grazing practices (Section 2.11). It is anticipated that such proactive management will facilitate success toward the biological goals and objectives, as well as increase understanding of the ecology of the systems and species. However, due to foreseen circumstances, including fire (wildfire or management burn), prolonged drought, or the invasion and spread of exotic plants, and perhaps

currently unforeseen circumstances, biological effectiveness monitoring might reveal that the one or more of the biological objectives are not being met. In such an event, efforts should be taken to determine the reasons for lack of success and develop management strategies to remedy the situation. The effects of remedial management should be evaluated to determine whether the target conditions have been achieved and, if not, inform future strategies and techniques in the ongoing adaptive management cycle.

8.2 MONITORING

As part of the adaptive management program, three main types of monitoring are recommended:

1. **Implementation monitoring** to evaluate whether the management techniques are being implemented as prescribed in the plan.
2. **Biological effectiveness monitoring** to evaluate progress toward the biological goals and objectives for the conservation targets.
3. **Individual project monitoring** to evaluate the effectiveness of specific management projects and increase knowledge about the systems.

Monitoring protocols to evaluate the effects of specific management projects should be developed on a project-by-project basis, using an adaptive management approach (Figure 8-1).

The following sections describe recommended protocols for implementation and biological effectiveness monitoring.

8.2.1 Implementation Monitoring

Implementation monitoring is recommended to evaluate whether the management plan components are being implemented as prescribed, and identify deviations from the plan strategies. This monitoring component is essential to the success of biological effectiveness monitoring, which relates changes or differences in the observed communities to the management strategies that are implemented. If the strategies are not implemented as described, then such deviations need to be considered when evaluating the effectiveness of management at attaining the biological goals and objectives.

Implementation monitoring is presently prescribed solely for grazing management. Implementation of other plan components could also be monitored, as needed, to document management. For example, implementation monitoring could be developed for exotic plant management and vegetation management to address encroachment by trees and shrubs to help ensure that they are conducted following the recommended strategies.

Implementation of the grazing strategy should be monitored in terms of its two main components:

1. Seasonality of Use
2. Intensity of Use

8.2.1.1 Seasonality of Use Monitoring

Two methods are recommended to track implementation of the season of use prescriptions for the management units within PCRP (Table 4-2):

1. Maintenance of a grazing log by the grazing operator
2. Inspections by park staff

8.2.1.1.1 Grazing Log

To substantiate adherence to the season of use prescriptions, the grazing operator should create each year a log that documents the number of animal units in each of the management units at each time during the lease year. This information will ideally be tabulated, either in calendar format or a spreadsheet, rather than a narrative, to facilitate ready evaluation of cattle use.

8.2.1.1.2 Inspections by Park Staff

Staff of the MPRPD or their contractors should develop and implement a schedule of site visits designed to determine the location and estimated quantity of animal units within the management units. Observations should be recorded by park staff in a log or calendar. The schedule will include key cattle movement periods, such as turn out in the late fall, cessation of early season grazing at the end of March, and implementation of summer grazing in the subset of management units (Section 4.1). The operator should be asked to correct any deviations for the season of use prescription as well as address errant or trespassing cattle.

8.2.1.2 Intensity of Use (RDM) Monitoring

Intensity of use is determined for this plan based on the amount of residual dry matter (RDM) that remains within the grassland in late fall, prior to onset of the new season's rains (Section 4.1). In developing the grazing prescriptions, each management unit was assigned a range of acceptable RDM levels based on the intensity level hypothesized to facilitate the goals and objectives for the grasslands within the park (Table 4-4). Monitoring RDM is used to evaluate whether the intensity of use within each management unit was within the prescribed range.

Monitoring Objective

The objective of RDM Monitoring is to evaluate success of the cattle operator at attaining desired intensity of use within each management unit. This is done by mapping the grassland habitat according to predefined RDM classes, using the resultant map to calculate RDM across the management unit, and assessing the extent to which use reflected the RDM objectives.

Monitoring Study Design

This monitoring study consists of two components:

1. Areal mapping of RDM classes throughout the grasslands in each grazed management unit.
2. Detailed examination of RDM at RDM reference monitoring sites.

Areal Mapping of RDM

At the end of the grazing year (late October), the amount of RDM should be visually estimated and mapped according to seven predefined RDM classes:

1. >4,000 lbs/acre
2. 3,000-4,000 lbs/acre
3. 2,000-3,000 lbs/acre
4. 1,200-2,000 lbs/acre
5. 800-1,200 lbs/acre
6. <800 lbs/acre (no fire)
7. <800 lbs/acre (due to fire)

Variation in soils, topography, plant species composition, and cattle use, among other factors, create variation in RDM within a management unit. Breaks in classes are delimited based on observed discontinuities in RDM. Most management units feature 2-3 classes (Guenther 2006).

Geographic information system (GIS)-based analyses can be used to calculate the acreage within each management unit that was classified as having the target RDM level. Management units in which less than 90% of the area did not attain the intensity of use objective, either because use was too high (RDM below target) or too low (RDM exceeds target) will be identified. The original RDM areal map will be used to identify specific areas (i.e. map polygons) which might have contributed to failure to meet the established objective.

RDM Reference Monitoring Sites

As described in greater detail in the *Palo Corona Ranch Year 2005 Monitoring Report* (Guenther 2006), 22 RDM reference monitoring sites were located throughout the PCRP (Figure 8-2). To facilitate accuracy of the RDM areal mapping and substantiate the monitoring results, RDM is estimated at each RDM reference monitoring site using visual indicators and clipping and weighing, as needed (Guenther 2006). Digital imagery is used to photodocument the site.

Intensity Monitoring Implementation

Frequency

Residual dry matter monitoring should be conducted each year in order to ensure effective implementation of the grazing prescriptions. Interannual variability in weather, particularly precipitation, can greatly influence grassland productivity. The cattle operator will need to make adjustments to the stocking rate to attain the intensity objectives. Monitoring intensity each year will facilitate understanding of the factors that influence success toward the biological goals and objectives.

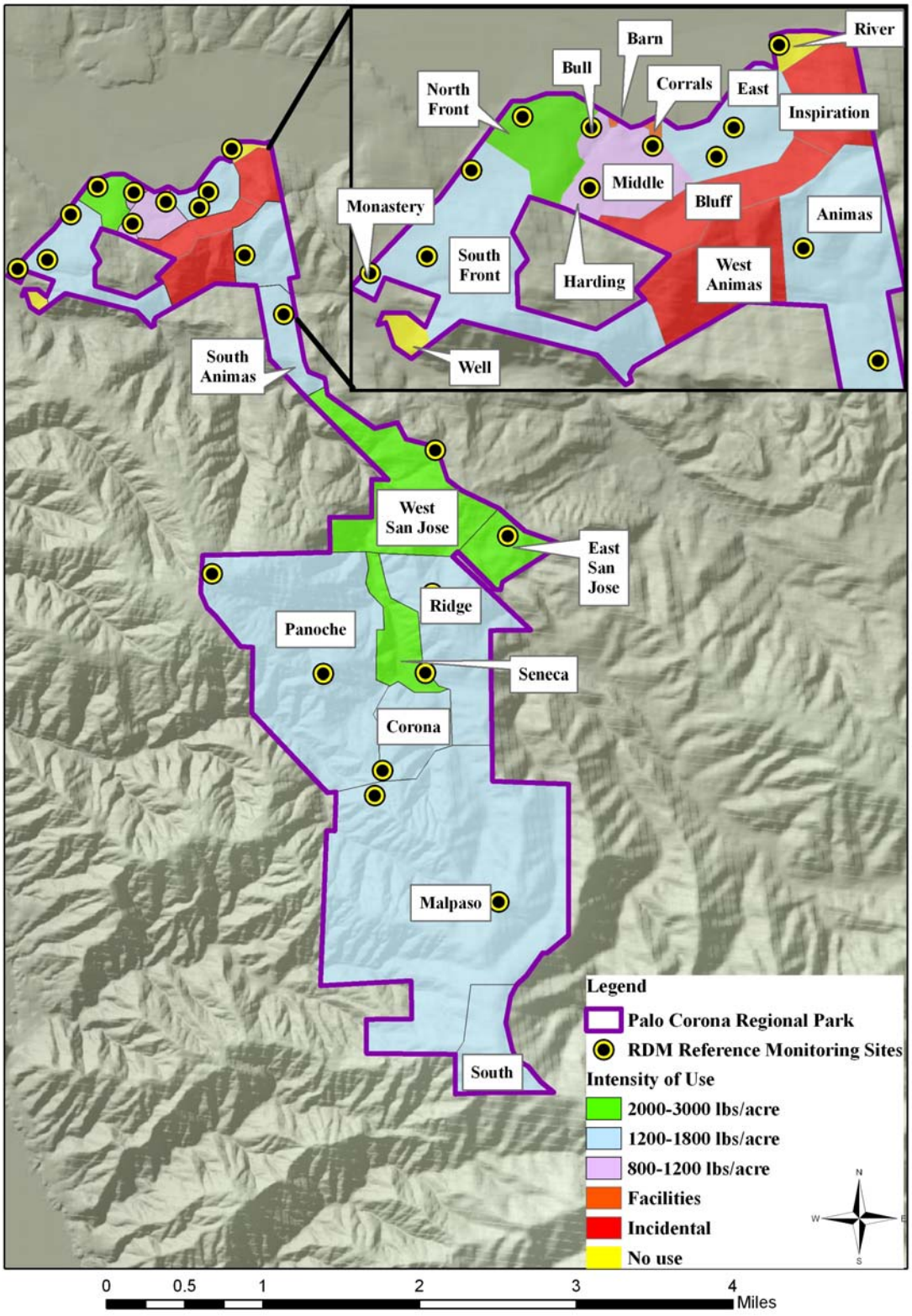

Figure 8-2: Location of residual dry matter (RDM) reference monitoring sites within the management units of Palo Corona Regional Park (Guenther 2006). Map prepared by Jodi McGraw with GIS data provided by Guenther (2006).

Seasonality

Residual dry matter monitoring should be conducted in mid-October, at the end of the grazing year, before green up with the first hard rains which typically occur in November.

Personnel

Because RDM monitoring involves visual estimation of RDM, it should be conducted by a certified range management professional or other individual with extensive experience calculating and estimating RDM in coastal grasslands. The RDM monitor must also be able to incorporate the areal map in GIS and conduct simple GIS-based analyses to calculate the area within each management unit in which the RDM goals were attained.

8.2.2 Biological Effectiveness Monitoring

Biological effectiveness monitoring is designed to determine the effectiveness of management toward attaining the biological objectives within the grasslands and ponds. The recommended monitoring involves the systematic observation and recording of conditions in and around the target systems in order to:

- Accurately detect the status of the indicators and identify real and biologically meaningful trends in their values
- Increase understanding of the ecology of the target systems
- Maximize monitoring efficacy while minimizing the resources required

Three main biological effectiveness monitoring studies are recommended:

1. Areal extent mapping of the grasslands to monitor persistence of the grassland associations
2. Quantitative monitoring of plant community composition and structure to evaluate effectiveness of the grazing prescriptions at enhancing native species diversity and abundance
3. Amphibian monitoring to examine trends in abundance and evaluate effects of pond management

8.2.2.1 Areal Extent Monitoring

Areal extent monitoring can be used to track the occurrence of grassland associations within the PCRP, and thus progress toward objectives focused on maintaining or enhancing their areal extent within the PCRP (Section 3.1).

Monitoring Objective

The objective of areal extent monitoring is to identify and track the location and areal coverage of grassland communities within the PCRP, and thus success toward the biological goal of maintaining or increasing the area of grasslands within the park. Maintaining a spatially explicit database for the distribution of grasslands will facilitate the implementation of ongoing grassland

management as well as quantitative monitoring (below), and provides insight into the factors affecting the distribution and persistence of the associations.

Monitoring Study Design

General Methods

The areal extent of grassland associations within the PCRP will be determined by mapping polygons delimiting grassland patches through analysis of aerial imagery and field assessment. Due to their dominance by herbaceous cover, grasslands have a distinct "signature" that can be easily discerned from the other PCRP communities which are dominated by woody plants. Transitions between grassland and adjacent communities are often abrupt, though ecotones can occur particularly between coastal scrub and grassland. Overall, 10 foot accuracy is anticipated.

Monitoring can be based upon the existing grassland map (Overtree 2006), which identified the location of grasslands and assigned them to one of the four main types. In order to use the existing GIS coverage as a baseline, it would need to be converted to a geodatabase in which adjacent patches of vegetation have shared edges. This work could focus exclusively on the grassland associations.

During future monitoring, a copy of the current geodatabase could be overlaid onto new aerial imagery and the polygons revised to reflect current extent of the grassland patches, as evidenced by changes in the grassland signature. A simple intersection analysis using the current and future grassland coverages can be used to calculate the change in the areal extent of the communities by association type.

In the future, it might be possible to use multi- or hyperspectral analysis of aerial images to perform the same task with the aid of computer algorithms, which analyze and classify the pixels according to various spectra. This could potentially increase the speed and accuracy with which grassland polygons are delimited. It might also allow discernment of the grassland types, which could feature different signatures owing to their different species composition.

Frequency

Areal mapping should occur approximately every 10 years. Areal mapping is designed to detect changes in occurrence of grasslands that might result from succession to shrubland or woodland, due to unmanaged encroachment of shrubs and trees from adjacent communities, or alternatively, conversion of shrubland or woodland to grassland as a result of fire or other disturbance. These processes are likely to occur over relatively long time-scales. To reduce costs associated with requisitioning aerial imagery for the park, the monitoring should be implemented as new aerial imagery for the region becomes available.

Seasonality

There is no special seasonality to areal mapping based on GIS; however, ability to readily distinguish grasslands or perhaps different grassland associations could be influenced by the season in which the aerial imagery is produced.

Personnel

Areal extent mapping should be completed by personnel trained in GIS and aerial image analysis, able to identify the grasslands in aerial images, either manually or using spectral analysis, and capable of differentiating the grassland types based on species composition, as part of ground truthing that might be conducted.

Analyses

Geographic information system can be used to calculate total patch area, the number of patches, and mean patch size for the grasslands as a whole, and by grassland type. Intersection analysis will be used to identify areas of type conversion. Attempts should be made to correct or account for errors associated with the polygons, including those caused by image rectification, and classification error. Areas where shifts are identified should be reexamined, using ground truthing as needed, to determine whether changes have indeed occurred, or whether the shift might be attributable to errors in the analysis.

Thresholds and Evaluation

A five percent reduction in the areal extent of all grassland or any one grassland type during an estimated 10 year interval should be evaluated as a basis for remedial action, the nature of which would depend on the known or hypothesized cause(s) of grassland habitat loss. As a threshold, five percent is designed to accommodate error associated with the analyses and some localized shifts in vegetation cover before remedial action is taken to reverse grassland conversion.

8.2.2.2 Quantitative Monitoring of Grassland Composition and Structure

Success of management toward many of the objectives within the plan goals related to maintaining or enhancing the structure and species composition of the grasslands can be monitored through the following quantitative monitoring study.

Monitoring Objectives

Quantitative monitoring within the grassland associations is designed to accomplish the following objectives:

1. Monitor the abundance and richness of native grassland plants
2. Monitor the frequency and abundance of invasive exotic plants
3. Monitor the abundance of woody vegetation encroaching from adjacent shrubland and woodlands.

In addition, by conducting the monitoring as a large-scale ecological experiment with control plots, long-term quantitative monitoring will allow the following:

1. Testing hypotheses for the effects of grazing on various aspects of grassland community structure and species composition.
2. Increase understanding of the ecology of the system and species.

General Methods

Sampling Design

Within areas currently mapped as supporting grassland (Overtree 2001), paired 8m x 8m sample sites will be located using a stratified random design, in which the strata are the 6 grassland association by grazing prescription combinations (Table 4-2). Within each of the 6 strata, 5 plots will be located at a randomly chosen site (i.e. using GIS). Five of the plots will be randomly assigned to the grazing treatment, while the other five will be designated a no-grazing control plot, around which a fence will be erected. To facilitate data collection, five, 6m long parallel permanent transects will be established 1.5m apart, beginning 1m in from the plot perimeter to avoid edge effects.

Plot Monumentation

To increase the accuracy of the repeated measurements, the four corners of each plot and the two ends of each transect will be permanently monumented using 50cm long pieces of metal conduit (approx. ½" diameter). The markers should be placed 40cm into the ground. In areas where vandalism is not a concern, the tops of the markers can be painted to facilitate detection. A resource grade GPS will be use to obtain the coordinates of the north corner stake, so that the plot can be relocated if the corner stakes are removed.

Measurements

During data collection, a transect tape will be used to delimit the boundaries of each plot. Separate transect tapes used to conduct measurements along transects as described below.

Plant Community Composition: Point intercept sampling will be used to calculate absolute cover of plants within each plot. At each 0.25m interval along each transect, a pin will be dangled and plants intercepting the pin will be recorded. The total number of interceptions or hits from all five transects will be combined to calculate percent cover by species and diversity for each plot.

Plant Height and Litter Depth: At 1m intervals along each transect (total points= 35), plant height will be measured by gently dropping a 23 cm diameter (19 g) plastic disk until it rests on the vegetation, then measuring distance from the disk to the soil surface. Litter will be measured by pushing a pin through the litter until it hits the soil surface, and then measuring the highest horizontal dead plant material (Hayes and Holl 2003).

Species Richness: Following completion of the transect sampling, a search of the plot will be used to identify plant species which were not measured in plant community composition sampling.

Woody Plants: The number of shrubs and trees within each plot will be counted by species and by life stage: seedling (first year), juvenile (>1 year but not reproductive) and adult (reproductive).

Residual Dry Matter (RDM): At the end of the season (late October), all aboveground plant biomass within two randomly located 0.96 ft^2 circular quadrat (13.25" diameter) will be clipped, dried to constant weight, and weighed.

Implementation

To provide accurate information that can be compared through time, sampling will be implemented following these considerations.

Seasonality: Field surveys will occur during the middle of spring (approx. mid-April to mid-May), when annual herbs are in flower. Most perennial herbs not yet in flower can be identified based on vegetative morphology and/or the presence of previous year's inflorescences.

Personnel: Sampling will be completed by individuals trained to identify the plant species within the grassland associations based on vegetative and reproductive morphology, and to carefully implement standardized monitoring protocols.

Frequency: Sampling will ideally be conducted each year. An interval of two or three years could be used to provide results at reduced cost, however a longer duration of monitoring would be required in order to detect ecologically meaningful differences amidst the background variation in many of the variables that will be due to interannual variability in climate and grazing.

Analyses

Descriptive Statistics: Descriptive statistics will be used to calculate the following within the grazed and ungrazed plots in each of the six strata:

- Mean native plant cover and mean exotic plant cover by guild (i.e. annual herb, perennial herb, annual grass, perennial grass, subshrub, shrub, and tree)
- Total grassland richness within each grassland strata and across all strata
- Mean cover of invasive plants
- Mean cover of woody plants (shrubs and trees)
- Mean vegetation height
- Mean residual dry matter

Inferential Statistics: Repeated measures Analysis of Variance (ANOVA) will be used to evaluate the role of grazing (or cessation of grazing) in influencing plant community structure and species composition and changes through time in the six grazing strata. Regression analyses

can be used at single intervals to evaluate relationships between the measured variables, such as residual dry matter and the plant community composition variables, in order to test hypotheses regarding their relationships (e.g. lower RDM facilitates native annual forbs).

Evaluating Thresholds for Remedial Action

Remedial action should be triggered if monitoring results within grazed plots in one or more of the grazing strata reveal the following:

- Mean abundance and/or richness of native grasslands herbs decline by 20%.
- Invasive exotic plant cover exceeds 5% in any one plot.
- Woody plant cover exceeds thresholds set for each grassland associations in any one plot (i.e. 30% for moist perennial grassland, 20% for subshrub grassland, and 10% for ridge grasslands).

These thresholds are designed to accommodate some temporal shifts in plant community composition and statistical error before remedial action is initiated. The nature of the remedial management should be determined based on the condition, but can include additional vegetation management techniques, such as manual treatment or fire, or alternative grazing strategies.

If inferential statistical analyses reveal that the grazing prescriptions fail to attain one or more of their stated objectives, or that cessation of grazing in one or more of the grazing strata improves plant community structure and species composition, or otherwise enhances progress toward one or more of the biological objectives of this plan, then management should similarly be re-evaluated to specifically reconsider the role of ongoing grazing.

8.2.2.3 Pond and Amphibian Monitoring

The ponds within the PCRP should be monitored in order to:

1. Evaluate effectiveness of management, including cessation of grazing
2. Determine the need for remedial actions, including dredging to address sedimentation, or exotic animal eradication.

Based on the management strategies recommended within this plan and the recommendations for future monitoring described in the two-year amphibian monitoring study at PCRP (Hemingway and Doak 2006), monitoring will consist of a coordinated study designed to examine the following:

1. Pond habitat conditions
2. Larval amphibian population abundance
3. Amphibian. breeding

Monitoring Objectives

Pond and amphibian monitoring is designed to:

1. Determine the status and trends in the abundance of larval amphibians
2. Determine the breeding status and estimated populations within the ponds
3. Measure pond habitat conditions that might affect amphibian abundance and breeding
4. Evaluate the effects of grazing cessation on the aquatic and wetland communities

5. Determine the need for remedial management designed to maintain a mosaic of habitat conditions that will promote diversity and maintain amphibian populations.

General Methods

Pond Conditions

At each of the 10 ponds, the following will be measured:

1. pond maximum and mean depth
2. wetted area of the pond
3. sediment depth
4. cover of aquatic vegetation, by species
5. cover of wetland vegetation , by species
6. cover of invasive exotic plants, by species

Vegetation cover will be estimated visually with the following cover classes: <1%, 1-5%, 6-10%, 11-25%, 26-50%, 51-75%, 76-90%, and >90%. In addition, for each pond, four permanent photoplot locations should be established to facilitate examination of changes in pond conditions.

Larval Amphibians

Following the methods describe in Hemingway and Doak (2006), the relative abundance of larval amphibian populations within the ponds at PCRP will be evaluated using dip-net surveys. At each pond, the abundance and species composition of larva amphibians should be determined through 15 dip net samples.

Amphibian Breeding

The identity and estimated abundance of amphibian breeding within each pond will be monitored using Audio Strip Transects (AST) and Visual Encounter Surveys (VES).

Audio Strip Transects: In AST, observers listen for 10 minutes at every 10 m along the bank of each pond and note the identity of each frog species heard calling, and estimate abundance according to one of three classes:

- Single individual calling
- X discernable individuals calling
- A chorus of individuals with too many calls to discern the number of individuals.

Visual Encounter Surveys: In VES, flashlights are used to search ponds from the banks and detect amphibians. At each 10m along the bank, the pond will be searched to determine the abundance of each species observed.

Implementation

To provide accurate information that can be compared through time, sampling should be implemented following these considerations.

Seasonality

Pond condition and larval amphibian sampling will occur in spring (approx. mid-April to mid-May), while breeding surveys will occur between January and April. Both AST and VST will be conducted between January and April, to survey for pacific tree frogs and California red-legged frogs. AST can be used to check for the presence of breeding bullfrogs between June and September, as needed to supplemental larval surveys

Personnel

Pond condition sampling will be conducted by individuals who can identify plant species that occur within the PCRP ponds. Larval amphibian sampling will be completed by one or more individuals trained to identify the amphibian species, at least one of whom will have permits from both the California Department of Fish and Game and the US Fish and Wildlife Service which allow them to conduct such surveys which involve handling of larva. Breeding frog surveys will be conducted by individuals trained to detect frog vocalizations and identify species visually.

Frequency

Sampling will ideally be conducted each year, at least initially in order to establish a baseline and evaluate potential changes in pond conditions and amphibian populations that could result from cessation of grazing, exotic plant removal, or other pond management activities.

Duration

Larval amphibian sampling will be conducted for three years, in order to obtain a total of five years of abundance data, which can be used to increase understanding of the interannual variability in larval populations, and evaluate initial effects of pond management. Following the five year period, monitoring results can be used to determine the status of the populations (i.e. stable, unstable) and evaluate whether monitoring should continue. Pond condition sampling should be conducted in perpetuity.

Analyses

Pond Conditions: Pond condition data will be examined descriptively to determine changes in pond area, depth, vegetation cover, and sediment load.

Larval Abundance: The abundance of larva for each species will be estimated for each pond based on the mean abundance from the dip net samples multiplied by the wetted area of the pond. Trends in abundance will be evaluated for each species. Observed declines should be examined to determine potential causes, in terms of pond habitat conditions, annual weather, diseases, predators, and the occurrence of any non-native aquatic species detected.

Breeding Amphibians: Data should be used to determine whether there are any shifts in the distribution and abundance of breeding frogs in the ponds, and if such changes are detected, use pond condition data or aspects of known management to determine potential causes.

Evaluating Thresholds for Remedial Action

Remedial action should be triggered if monitoring results indicate one or more of the following:

1. Reduction in area or depth of the wetted pond attributed to plant water uptake and/or sedimentation (as opposed to rainfall).
2. Occurrence of invasive exotic plants
3. Occurrence of non-native animal species
4. Extirpation of a breeding population of California red-legged frog or California tiger salamander (i.e. loss of occurrence at one or more ponds).

The nature of the remedial action should be determined based on the condition and the known or hypothesized causes.

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APPENDIX A:

ANALYSIS OF SOILS AND COMMUNITIES

Introduction

Developing management strategies for California's grasslands is facilitated by an understanding of the factors that influence their distribution and species composition. Of particular interest is the role of edaphic factors, such as soils and subsurface geology, in influencing their occurrence. It is important to know the extent to which the patchy occurrence of grasslands is influenced by soil conditions, as opposed to solely resulting from disturbance.

This appendix contains results of a GIS-based analysis to evaluate the occurrence of the plant communities with respect to soils. The goal was to determine whether the available data could be used to answer two interrelated questions:

1. Do any of the soil types preferentially support the grassland community or any of its four associations?
2. Do the grassland associations and grassland community type overall preferentially occur any of the soil types?

Methods

To evaluate the co-occurrence of the plant communities and soils of Palo Corona Regional Park, overlay analysis was used to calculate the acreage of each community type located on each soil type. The plant community map used contained fairly fine-scale variation in plant community composition. Polygons ranged from 89 square feet to 20 acres in size (Overtree 2006). The soil layer was prepared by the US Department of Agriculture Soil Conservation Service (now the Natural Resources Conservation Service) for Monterey County in 1978. The soil polygons ranged from 218 square feet to than 545 acres in size. Using ArcGIS 9.1, the intersect analysis function was used to create polygons delimiting each combination of soil and vegetation type. The areas of the polygons for each unique combination of soil and vegetation type were then summed to calculate total area. The percent of each soil type supporting each vegetation type, and the percent of each vegetation type that occurs on each soil type, were then calculated.

Results

1. Do any of the soil types preferentially support the grassland community?

All of the 15 soil types occurring within at least 10 acres of PCRP supported at least some grassland, with the percent of area of each soil type supporting grassland range from 1% to 99% (Table A-1). Five of the mapped soil types supported grasslands on at least 70% of their acreage (Table A-1). These include soils ranging in texture from clay loam to loamy sand. Located in the center and north of the park, these soils support moist perennial grassland. This suggests at least some potential for the role of soil type in influencing grassland occurrence.

Among the other seven terrestrial communities, the Linne/Shedd silty clay preferentially supports coastal scrub (69%), as does the Santa Lucia/Reliz shaly clay loam (63%). The Junipero sandy loam primarily supports hardwood forest (93%), while the Gamboa/Sur complex of gravelly loam soils predominantly supports redwood forest (67%). However, many other soils

support a mosaic of vegetation types including grassland. This could result from the fact that factors other than soil type influence vegetation (e.g. disturbance history, microclimate) as well as the coarse-scale nature of the soil maps used in the analysis.

2. *Does the grassland community type preferentially occur any of the soil types?*

Of the 1,433 acres of grassland evaluated in this analysis, 706 acres (49%) occur on the Sheridan coarse sandy loam. This soil type is mapped as occurring over 33% of the park acreage, suggesting the soil is only marginally more likely to support grassland than expected by chance alone.

3. *Do any of the soil types preferentially support any of the grassland associations?*

Focusing just on the grasslands, several soil types support only one type of grassland association (Table A-2). Santa Lucia shaly clay loam supports only exotic-dominated patches of moist perennial grassland, Gazos silt loam, Elder very fine sandy loam, and San Andreas fine sandy loam only support moist perennial grassland. Meanwhile, the Arnold loamy sand supports only the subshrub grassland.

4. *Do any of the grassland associations preferentially occur any of the soil types?*

The ridge grasslands occur largely on the Sheridan coarse sandy loam (82%). The subshrub grassland occurs primarily on the Cieneba gravelly sandy loam (42%) and Sheridan coarse sandy loam (39%)—two coarser textured soils. The moist perennial grasslands occur on a range of soil types, with the native dominated association occurring the most on the Santa Ynez fine sandy loam (44%) and the exotic dominated association occurring largely on the Santa Lucia shaly clay loam (42%). In general, the moist perennial grasslands occur on finer-textured soils than the ridge and subshrub grasslands.

Summary

Landscape level analysis revealed some patterns between the occurrence of grassland vegetation. However, in general, results suggest that the grasslands occur throughout a range of soil types, which also support other plant communities, including shrublands and woodlands. These results do not indicate a large role for soil type in influencing the distribution and species composition of the grasslands. Instead, the occurrence of grasslands may be predicted by other factors including other aspects of soils (other than their type), topography (e.g. ridges), and disturbance history, including prior land use such as grazing and vegetation management to maintain grasslands. Variation in soil texture between the north and the south likely combines with climate to result in differences in plant species composition between these areas.

Table A-1: Soils types and complexes supporting plant communities within Palo Corona Regional Park, showing the percent of the soil type supporting a given vegetation type (percent soil) and the percent of each vegetation type that is supported by each soil type (percent veg).

Soil Type		Grassland			Coastal Scub			Chaparral			Oak Woodland			Hardwood Forest			Pine Forest			Redwood			All Vegetation	
			Percent			Percent			Percent			Percent			Percent			Percent			Percent				
Name	Texture	Acres	Soil	Veg	Acres	Soil	Veg	Acres	Soil	Veg	Acres	Soil	Veg	Acres	Soil	Veg	Acres	Soil	Veg	Acres	Soil	Veg	Acres	% of PCRP
Linne/Shedd	Silty Clay	6	31	0	13	69	2		0	0		0	0		0	0			0		0	0	19	0
Santa Lucia	Shaly Clay Loam	47	73	3	13	20	2	0	0	0	4	6	4	0	0	0	0	0	0	0	0	0	64	1
Santa Lucia, Reliz Complex	Shaly clay loam	16	9	1	110	63	19		0	0	33	19	31		0	0	15		22		0	0	174	4
Gazos	Silt Loam	54	29	4	71	39	12	22	12	6	9	5	8	0	0	0	27	15	40	1	1	0	184	4
Lockwood	Shaly Loam	9	98	1	0	1	0		0	0	0	1	0		0	0			0		0	0	10	0
Elder	Very Fine Sandy Loam	31	79	2	7	18	1		0	0		0	0		0	0	1		1	0	1	0	39	1
Santa Ynez	Fine Sandy Loam	191	89	13	9	4	2	0	0	0	12	6	11	0	0	0	2	1	3	0	0	0	214	5
Gorgonio	Sandy Loam	9	36	1	1	3	0	1	4	0	0	1	0		0	0	0		1	14	55	2	25	1
Junipero	Sandy Loam	1	1	0		0	0		0	0		0	0	121	93	19			0	9	7	1	131	3
Gamboa, Sur, Junipero Complex	Gravelly loam	32	5	2	42	7	7		0	0	34	6	32	93	15	15			0	415	67	46	616	15
Sheridan	Coarse Sandy Loam	706	52	49	76	6	13	83	6	22	6	0	6	173	13	28	0	0	0	325	24	36	1369	33
Cieneba	Gravelly Sandy Loam	237	35	17	94	14	16	223	33	59		0	0	55	8	9	19		28	55	8	6	682	17
Arnold/San Andreas	Loamy Sand	46	99	3		0	0		0	0		0	0		0	0			0	0	1	0	47	1
Junipero/Sur	Stoney loamy sand	25	5	2	127	27	22	49	11	13	5	1	5	172	37	28	1		2	84	18	9	462	11
Rock Outcrop, Xerorthent	Rock outcrop	23	35	2	26	40	4	3	4	1	3	5	3	8	13	1	2		3	1	1	0	65	2
		1433		**100**	**588**		**100**	**380**		**100**	**107**		**100**	**622**		**100**	**67**		**100**	**903**		**100**	**4100**	**100**

Table A-2: Soils types and complexes supporting native and exotic-dominated grassland assemblages within Palo Corona Regional Park, showing the percent of the soil type supporting a given vegetation type (percent soil) and the percent of each vegetation type that is located on a given soiltype (% veg).

		Exotic Grasslands			Moist Perennial			Ridges			Alluvial Canyon			Subshrub			All Grasslands	
			Percent			Percent			Percent			Percent			Percent			%
Name	Texture	Acres	Soil	Veg	Acres	Soil	Veg	Acres	Soil	Veg	Acres	Soil	Veg	Acres	Soil	Veg	Acres	of Veg Type
Linne/Shedd	Silty Clay Loam		0		6	100	2		0			0			0		6	0
Santa Lucia	Shaly Clay Loam	47	100	42		0			0			0			0		47	3
Santa Lucia/Reliz	Shaly clay loam	8	49	7	8	51	2		0			0			0		16	1
Gazos	Silt Loam	0	0	0	50	100	15	0	0	0	0	0	0	0	0	0	50	4
Elder	Very Fine Sandy Loam		0		11	100	3		0			0			0		11	1
San Andreas	Fine Sandy Loam		0		2	100	1		0			0			0		2	0
Santa Ynez	Fine Sandy Loam	43	22	38	149	78	44	0	0	0	0	0	0	0	0	0	192	14
Gorgonio	Sandy Loam	6	77	5		0			0			0		2	23	1	8	1
Junipero	Sandy Loam		0			0		1	100	0		0			0		1	0
Sheridan	Coarse Sandy Loam	7	1	6	72	10	21	483	68	82	9	1	86	137	19	39	709	50
Gamboa,Sur, Junipero	Gravelly loam		0		3	9	1	14	45	2		0		15	46	4	32	2
Cieneba	Gravelly Sandy Loam		0		10	4	3	77	33	13	1	1	14	148	62	42	237	17
Arnold, San Andreas	Loamy Sand		0											46	100	13	46	3
Junipero,Sur	Stoney loamy sand	1	5	1	7	28	2	14	57	2		0		2	10	1	25	2
Rock Outcrop, Xerorthent	Rock outcrop		0		19	87	6		0			0		3	13	1	22	2
	Total	**112**		**100**	**338**		**100**	**590**		**100**	**10**		**100**	**353**		**100**	**1404**	**100**

APPENDIX B:

DESCRIPTIONS OF THE PONDS OF PALO CORONA REGIONAL PARK

Introduction

This appendix provides brief descriptions of the 10 ponds within Palo Corona Regional Park Information about their size, condition, species composition, and occurrence of amphibian disease, contained in these descriptions was synthesized a two-year study of the amphibians of PCRP (Hemingway and Doak 2006), and a management plan for the site (Overtree 2001). Much of the information is summarized in Table 2-3. Figure 2-4 provides a map of the ponds.

Palo Corona Regional Park Ponds

Entrance Pond: Located in the north front area, this approximately 5,400 ft^2 perennial depression pond has a maximum depth of approximately 8 feet. Fenced in 2001 to exclude cattle, the pond currently features rushes (*Juncus* spp. and *Scirpus* spp.) within the water and along its banks. The pond is surrounded by moist perennial grasslands and supports Pacific tree frogs (*Pseudacris* regilla) and California red-legged frog (*Rana aurora draytonii)*. Chytrid fungus has been observed on frogs in this pond (Hemingway and Doak 2006).

Boundary Pond: Located on Barn Creek at the property boundary with the Fish Ranch, Boundary Pond is an estimated 5,400 ft^2 seasonal in-stream pond with a maximum depth of approximately 3 feet. In 2006, the pond featured only sparse rushes growing along its banks and fenceline that bisects the pond. Installation of a fence in 2006 could increase the diversity and abundance of aquatic and wetland plants. The pond is located within grasslands with patches of coyote brush. The pond supports populations of California newt (*Taricha terrosa*), Pacific tree frog, and California red-legged frog, and has no known occurrence of chytrid fungus.

Animas Pond: Located on Animas Creek within the Animas Unit, this estimated 13,000 ft^2 perennial in-stream pond has a maximum depth of approximately 5 feet. The pond is covered by relatively dense aquatic vegetation including native rushes, duckweed (*Lemmna* sp.), water cress (*Rorippa nasturtium-aquaticum*), and water parsely (*Oenanthe sarmentosa*), as well as the exotic yellowflag iris (*Iris pseudacorus).* Nestled within a mosaic of upland vegetation including grassland, coastal scrub, and oak woodland, the fenced pond is accessed by cattle moving from Animas to S. Animas Unit. The pond currently supports California red-legged frog and Pacific tree frog, and may support California newts. Chytrid fungs has been observed in the pond (Hemingway and Doak 2006). Animas pond is a popular destination amongst hikers currently accessing PCRP.

Roadrunner Pond: Located in the southeast corner of the South Animas Unit along the main access road, this approximately 2,150 ft^2 seasonal catchment basin has an unknown maximum depth. The unfenced pond lacks aquatic vegetation as well as plant cover on 20% of its banks, with the remaining portion of the banks occupied by coyote brush (50%) and rushes and grasses (30%). Nestled in a mosaic of grassland and coastal scrub, Roadrunner pond supports populations California tiger salamander, California red-legged frog, California newt, and Pacific tree frog.

Dead Pig Pond: Located in the northern portion of the West San Jose Unit, just west of the main park access road, this seasonal catchment basin pond is approximately 11,000 ft^2 and has a

maximum depth of approximately 7 feet. Though unfenced, the dense trees and shrubs of the upland vegetation oak woodland and invaded coastal scrub surrounding the pond may limit cattle access. Sparse submerged aquatic vegetation and rushes grow within the pond, which features dense French broom (*Genista monspessulana;* 70%*)* and willows (30%) along its banks. California red-legged frog, California newt, and Pacific tree frog occupy this pond, within which chytrid fungus has been observed (Hemingway and Doak 2006).

Salamander Pond: Located in the central portion of West San Jose Unit, on its eastern border of the PCRP adjacent to land owned by the Fish Ranch Trust, this perennial catchment basin pond is approximately 27,000 ft^2 and has a maximum depth of approximately 7 feet. The pond features submerged aquatic plants (25%) as well as emergent rushes (20%), with its banks occupied by tall rushes (*Scirpus*) and grasses (70%) and French broom (30%). The upland habitat surrounding the pond consists of coastal scrub invaded by French broom, with small patches of grassland that are successional to coastal scrub. Populations of California red-legged frog, California Newt, and Pacific tree frog occupy the pond, in which chytrid fungus has been observed. Of the six PCRP ponds sampled in 2006, Salamander pond featured the greatest relative abundance of amphibians (Hemingway and Doak 2006). The upland habitat surrounding the pond was mowed in fall 2006 to remove French broom and create access to the pond via a secondary road.

River Pond: Located in the River Unit on the northern border of the PCRP adjacent to the Carmel River, this 3,500 ft^2 pond was created in 1977 by damming a spring. Fenced to exclude cattle, River Pond supports very dense emergent plants including rushes and cattail (*Typha* sp.), with willows in and on the banks of the pond. The pond is bordered by annual grasslands to the east, oak woodland and grasslands to the south, agricultural fields to the west, and riparian woodland dominated by black cottonwood to the north. It supports populations of California red-legged frog and Pacific tree frog. Dense aquatic vegetation precluded seine surveys for larva and thus detection of California newts, which may also occur in the pond, though California tiger salamander does not currently occupy the pond. The grasslands within the River Unit were mowed in 2006 to prevent encroachment by coyote bush.

Wire Corrals: Located on the northern border of the Malpaso Unit in the central portion of the PCRP, this seasonal catchment basin pond is approximately 1,100 ft^2 and has a maximum depth of approximately 7 feet. Owing to the steepness of the slopes, it has only a small, shallow area. Located within the ridge grasslands, this unfenced pond supports approximately 10% cover of submerged aquatic plants, and limited floating plants aquatic species. Its banks are entirely covered by herbaceous plants including rushes (*Juncus* spp.) and grasses, which intergrade with shrubs including poison oak (*Toxicodendron diversilobum*) and coyote bush farther upslope. The pond was not surveyed as part of the recent amphibian study at PCRP (Hemingway and Doak 2006). It is thought to support suitable habitat for California red-legged frog; however, it small size and occurrence over 1.75 miles south of the nearest known populations suggest it is unlikely to support persisting populations or provide important habitat for this species. The pond is neither deep nor open enough to support California Tiger Salamander (V. Hemingway, pers. comm. 2007).

Van Winkley's Pond: Located in the southeastern portion of the Malpaso Unit in the south of the park, this 850 ft^2 pond created by an in-stream dam has a maximum depth of approximately 1.5 feet. The unfenced pond lacks aquatic and wetland vegetation, likely because the relatively steep banks are lined by hardwood forest species (California bay and tan oak) which create low light conditions. Though not surveyed during the 2005-2006 amphibian study, Van Winkley's pond is deemed unsuitable for amphibians owing to the shallow, cold water and lack of aquatic and wetland vegetation (V. Hemingway, pers. comm. 2007).

Echo Ridge Pond: Located in the southeastern portion of the Malpaso Unit in the south of the park near the boundary with the Mittledork Preserve owned by the Big Sur Land Trust, this 540 ft^2 pond created by a spring dam has a maximum depth of approximately 0.3 feet. Located at an ecotone between of ridge grassland and hardwood forest, it's banks support dense rushes and grasses, as well as coyote bush. Perhaps best characterized as a seep due to its small size, this pond was not surveyed as part of the recent amphibian study and it is deemed to shallow to support eggs and tadpoles of California red-legged frog and California Tiger salamander, though Pacific tree frogs have been observed calling there.

APPENDIX C:

DESCRIPTION OF THE STREAMS OF PALO CORONA REGIONAL PARK

Introduction

This appendix describes the thirteen named streams that are found within Palo Corona Regional Park based on a synthesis of available information about their length, location, dominant vegetation, and known animal species. This information is summarized in Table 2-4. Figure 2-4 provides a map of the streams.

Palo Corona Regional Park Streams

North

In the north, the Carmel River flows along the northern border of the PCRP, while the coastal terraces are drained by two small ephemeral streams.

The **Carmel River** flows an estimated 27 miles from the interior slopes of the Santa Lucia Mountains, through the Carmel Valley to the Ocean less than one mile northwest of the PCRP. Though the park boundaries do not include the river channel, it does contain riparian vegetation dominated by black cottonwood (*Populus balsamifera ssp. trichocarpa)* along an estimated 1,470 feet on the south river bank. The Carmel River supports steelhead trout *(Oncorhynchus mykiss irideus*) and California red-legged frog.

Barn Creek drains the north slope of the frontal cliffs, where it enters the park from the private inholding and flows approximately 0.5 mile to the northern border of the park just west of the barn. It is not known whether it flows through a culvert or drainage ditch in the agricultural fields between the park and the Carmel River, or whether it flows underground. Within the park, Barn Creek supports 6 acres of riparian vegetation dominated by arroyo willow (*Salix lasiolepis*), which is adjacent to exotic-dominated grasslands on the east side of the creek, and native remnant grassland on the west side of the creek. Livestock are not excluded from Barn Creek which instead has an interior fence down its center, such that cattle can access a portion of the seasonally wet stream from four management units: Bull, Middle, Harding, and North Front.

Monastery Creek drains the northwest slope of the frontal cliffs, where if flows west through the park, along the boundary with the Carmelite Monastery, and then through a culvert under Highway 1, then to the ocean near Monastery Beach. It supports 2.75 acres of riparian vegetation dominated by arroyo willow on the stream reaches adjacent to and south of the Carmelite Monastery. On the south side of the stream, the riparian vegetation intergrades with exotic grassland, while the north side of the creek is adjacent to moist native perennial grassland. It is not fenced to exclude livestock, which can instead access the riparian area from two units: South Front and Monastery.

Center

The center and south-central portion of the park is drained primarily by the San Jose Creek and its major tributaries, which, moving upstream from the ocean, are Animas, Seneca, and Van Winkley.

Animas Creek originates 1.3 miles east of the PCRP, in adjacent private land (Fish Ranch Trust). After entering the PCRP, Animas Creek flows east approximately 1 mile, within and adjacent to the park boundary with the adjacent private land (Whisler Family Trust), to its confluence with San Jose Creek which is in the southern part of the PCRP South Front Unit. Within the park, Animas Creek drains a steep, narrow, canyon, which is covered by coastal scrub. An estimated 2.8 acres of riparian vegetation dominated by arroyo willow lines Animas Creek within this canyon.

Where the main road crosses Animas Creek approximately one-fifth of a mile downstream of where it enters PCRP, the creek was dammed to create Animas Pond (Appendix B). Upstream Animas Creek supports an additional 6 acres of riparian vegetation dominated by arroyo willow. Grassland vegetation consisting of moist perennial native grassland covers an estimated 70 acres (24%) on the eastern portion of the watershed within the PCRP (Table 2-1).

There are existing barbed-wire fences around Animas Pond and the adjacent riparian vegetation. There is no fence within the steep canyon stream reach downstream of the pond. Upstream of the confluence with San Jose Creek, there is a fence approximately 700 feet long, though it is unclear whether it is on the north or south side of the creek, or whether it alternates banks.

Seneca Creek originates within the PCRP, where it flows north 2.75 miles from its headwaters in the center of the Malpaso Unit north of Palo Corona Peak, to its confluence with San Jose Creek. Seneca Creek is lined by Redwood Forest, with patches of hardwood forest, coastal scrub, and maritime chaparral occurring high up the canyon slopes. *Seneca Creek* has a variety of habitats including riffles, pools, and runs, and a sandy and coarse gravel substrate (Hemingway and Doak 2006).

Seneca Creek has two east-flowing tributaries that drain the steep slopes on the western portion of the PCRP: **Chavote Creek** a 0.45 mile long tributary, and **Panoche Creek**, a nearly one mile long stream. Both streams are small and steep and lined by redwood forest, which extends up the north-facing canyon slopes. The watersheds feature native remnant grasslands on the higher slopes and ridgetops.

In total, grasslands cover 455 acres (31%) of the Seneca Watershed within the PCRP. There are no fences excluding cattle from Seneca Creek or its tributaries. The main access road crosses San Jose Creek near its confluence with Seneca Creek, and then traverses the western bank of Seneca Creek for approximately 1.4 miles to the Chavote homestead, before turning up the Chavote Creek drainage.

Van Winkley Creek originates within the PCRP, where it flows north 1.2 miles from its headwaters in the center of the Malpaso Unit east of Seneca Creek, to its confluence with San Jose Creek in the adjacent Santa Lucia Conservancy land. The upper 0.75 mile reach is intermittent. Van Winkley Creek is lined by Redwood Forest, with hardwood forest occurring on the upper slopes. Coastal scrub and native remnant grassland occur on the ridgetops, with grassland cover 53 acres (18%) of the watershed. The small stream is generally high gradient does not appear to have many pools (Hemingway and Doak 2006). There are no fences

preventing livestock access to Van Winkley Creek, though use is likely limited by the steepness of the canyon, occurrence of dense evergreen forest, and distance from grasslands.

Palo Corona Regional Park's largest stream, the mainstem of **San Jose Creek,** originates approximately four miles southeast of the PCRP in land owned by the Santa Lucia Conservancy. Within the PCRP, San Jose Creek flows an estimated two-thirds of a mile through a canyon lined primarily with redwood forest, but with a 5.5 acre patch of riparian vegetation. It includes a variety of habitats, including pools, riffles, and runs with sand, gravel, and large angular rocks as substrate. San Jose Creek was dammed It was dammed in the 1950s, but the dam blew out in 1998 and the stream banks have since been revegetated. The main road fords the creek within this reach, before traversing Seneca Creek canyon, as described above. California red-legged frogs have been observed near the ford (Hemingway and Doak 2006).

After leaving PCRP, San Jose Creek flows northwest for three miles on private land through a very steep, narrow, redwood forest-lined canyon. San Jose Creek re-enters the PCRP in the Well Unit, where it flows 700 feet through a 20 acre patch of riparian vegetation. From there, the stream flows a quarter of a mile to the ocean

The PCRP also contains all or a portion of twelve, short unnamed tributaries to San Jose Creek that comprise a total of 1.6 miles. These short stream reaches primarily drain the steep, south-facing slope of the San Jose watershed, which supports a mosaic of coastal scrub, oak woodland, and native grasslands.

In total, grasslands cover an estimated 135 acres (20%) of the San Jose Watershed. There are no fences preventing livestock access to San Jose Creek and its tributaries, and cattle have historically congregated in the summer in the reach where the main road fords the stream.

South

The southern portion of the PCRP contains coastal streams that flow west, directly to the ocean.

Malpaso Creek originates within PCRP in the center of the Malpaso Unit north of Palo Corona Peak. It flows 1.75 miles within the park to Garrapata State Park, in which it flows 2.5 miles before entering the ocean. Within PCRP, Malpaso Creek is lined by redwood forest, which extends up the north-facing canyon slopes, especially in the numerous finger-like drainages on the steep slope. The rounded ridgetops feature native perennial grassland, which extend well down the south-facing slope. Two small patches of Sycamore-dominated riparian woodland totaling 1.5 acres are found within adjacent drainages on the south slope of the canyon above Malpaso Creek. Grasslands cover an estimated 364 acres (60%) of the Malpaso Watershed within the PCRP. There are no fences to exclude livestock from the creek

The maintstem of **Soberanes Creek** originates within PCRP in the center of the Malpaso Unit north of Palo Corona Peak. It flows west 1 mile before entering Garrapata State Park, within which it flows 2.5 miles to the ocean. Within PCRP, a narrow strip of redwood forest lines Soberanes Creek, with hardwood forest covering the north-facing canyon slope and the drainages within the south-facing slope. On the south-facing slopes, hardwood forest intergrades with

coastal scrub on the middle elevation slopes, with native grasslands occurring on the higher slopes and rounded ridgetop.

PCRP also contains the headwaters of an unnamed tributary to Soberanes Creek, which drains the western slope of Palo Corona peak. It flows for 450 feet within PCRP, before entering private land that is part of the Doud Ranch, from which it flows into Garrapata State Park where it joins the mainstem. Within PCRP, this stream reach flows through hardwood forest, with patches of maritime chaparral on the south-facing slope and native grasslands on the gentle north-facing slope and ridge. Grasslands cover 89 acres (20%) of the Soberanes watershed within PCRP. There are no fences restricting livestock access to the streams.

The headwaters of two creeks that drain the south slope of Palo Corona Peak also occur within PCRP. An unnamed tributary to **Doud Creek** flows 220 feet through a small patch of hardwood forest nestled within native grasslands in PCRP before entering the adjacent Joshua Creek Ecological Reserve and then the private Doud Ranch, for a total of 3.5 miles before entering the ocean. **Granite Creek** flows 200 feet through maritime chaparral before entering the private Doud Ranch as it flows 3.25 miles to the ocean. Both stream reaches are likely intermittent, and neither stream is fenced to exclude cattle.

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APPENDIX D:

DESCRIPTION AND GRAZING IMPACT ASSESSMENT FOR THE SPECIAL STATUS SPECIES OF THE GRASSLANDS AND AQUATIC SYSTEMS

Introduction

The grasslands and aquatic systems of Palo Corona Regional Park (PCRP) support several special status plant and animal species have been identified as conservation targets (Table 2-5, and 2-6). This section synthesizes information available about these species to facilitate development of the management strategies This assessment relied primarily on existing information, including that available within the primary literature as well as other syntheses designed to facilitate conservation, such as US Fish and Wildlife Service recovery plans, Point Reyes Bird Observatory Bird conservation plans, and species accounts for endangered species created by the California Department of Fish and Game.

Following the description of each species, this section provides an assessment of the known and hypothesized, direct and indirect effects of cattle grazing on each of the conservation targets. It also assesses the role of seasonality and intensity of grazing in influencing these effects. These assessments were conducted through review of available literature describing the effects of cattle grazing on the targets or ecologically similar systems species. Because there have been few studies examining the effects of grazing on the targets, the assessment of cattle grazing impacts was primarily developed through consideration of the aspects of the anticipated cattle use and the ecological aspects of the target, such as a species' life history or a community's composition, in order to generate hypotheses for cattle impacts. More research is needed to accurately predict the impacts of cattle grazing, or the removal of cattle from the system, on the conservation targets.

To facilitate development of grazing prescriptions, grazing impact tables were compiled for each of the four grassland associations and for the aquatic systems as a whole. Each table identifies the hypothetical net impact of grazing on various targets within the association, including the special status species, as well as guilds of plants (e.g. native bunchgrasses, invasive forbs). The impacts are assessed based on the season of use, which is broken up into four use periods, and four main grazing intensities, which correspond to the percent utilization and amount of residual dry matter remaining at the end of the grazing season. These grazing impact tables are provided at the end of this appendix.

D. 1 GRASSLAND PLANTS

Marsh Microseris (*Microseris paludosa*)
Status: CNPS IB (Rare, threatened, or endangered in CA and elsewhere)

Marsh microseris is a perennial herb in the sunflower family (Asteraceae) that is endemic to central and northern coastal California where it occurs in seasonally moist grasslands including coastal terrace prairies. Within Palo Corona, it is known from the moist perennial grasslands of the Front Management Units (G. Hayes, unpublished data).

Effects of Grazing: As with other perennial herbs, cattle may negatively impact marsh microersis directly through herbivory which reduces growth and fecundity (i.e. seed production). The effects of herbivory might be limited due to the growth form of marsh microseris, which has a basal rosette of leaves that might be less likely to be grazed. Cattle could have the greatest

negative impact if grazed during the late-season when the species is in flower (April-June). Cattle grazing could facilitate establishment of seedlings by reducing litter and competition, thus creating safe sites for seed germination and seedling survival.

Hutchinson's larkspur (*Delphinium hutchensoniae)*
Status: CNPS IB (Rare, threatened, or endangered in CA and elsewhere)

Hutchinson's larkspur is a perennial herb in the buttercup family (Ranunculaceae) that is endemic to Monterey County where it occurs in grasslands, chaparral, and forests. Within Palo Corona, it is known from three locations: hardwood forest and subshrub grasslands within the Panoche Unit, and coastal scrub in the West San Jose Unit (Overtree 2006).

Effects of Grazing: Like other larkspurs, Hutchinson's larkspur is likely to contain alkaloids poisonous to cattle, which are present when the plant is in leaf and increase through seed set. Cattle will still eat larkspurs, and thus toxicity does not protect them from herbivory, which could reduce plant performance (i.e. survivorship and fecundity), particularly during late and dormant season grazing when cattle would consume flowers and fruits.

Moderate to heavy grazing during the early season might indirectly facilitate Hutchinson's larkspur by reducing competition with dense annual grasses, and by creating open areas which facilitate establishment. It is not known whether such beneficial effects would outweigh the direct negative effects of herbivory and trampling, to which it might be especially susceptible owing to its tall stature (2-3 feet).

San Francisco popcorn flower (*Plagiobothrys reticululatus var. rossianorum)*
Status: California Endangered, CNPS IB (Rare, threatened, or endangered in CA and elsewhere)

San Francisco popcorn flower is an annual herb in the forget-me-not family (Boraginaceae) that is endemic to the Santa Cruz and Monterey Counties where it occurs in moist places including coastal terrace prairie grasslands. Within Palo Corona, it is known to occur in one location within the moist perennial grasslands of the North Front Unit (Overtree 2006).

Effects of Grazing: Based on its preferential occurrence in low grassland canopy areas including roads and heavily grazed areas, San Francisco popcorn flower populations are hypothesized to be facilitated by grazing. As with other native annual forbs, grazing may facilitate establishment of this species by preventing the build up of dense leaf litter on the soil surface (Hayes and Holl 2003). In the highly productive (e.g. 4,000 lbs/acre) moist perennial grasslands where San Francisco popcorn flower occurs in the PCRP, a heavy stocking rate may be required to adequately remove the biomass.

Grazing may also facilitate populations of San Francisco popcorn flower by reducing competition from the dominant native perennial grasses and forbs, as well as exotic grasses which are patchily abundant in its preferred habitat (Hayes and Holl 2003). Early season grazing

(November – March) will likely maximize this beneficial effect, by reducing competition during the growth period, though year-round grazing might be required to adequately reduce biomass (Hayes 2005).

Large-flower linanthus (*Linanthus grandiflorus)*
Status: CNPS 4 (Limited Distribution)

Large-flower linanthus is an annual herb in the phlox family (Polemoniaceae) that is endemic to central and northern coastal California, where it occurs in open grassy areas on sandy soils. Within Palo Corona, it is known to occur in two locations within the subshrub grasslands in the Panoche Unit on Arnold loamy sand and Cieneba gravelly sandy loam (Overtree 2006, USDA 1978).

Effects of Grazing: By removing biomass and precluding build up of dense leaf litter, grazing may facilitate establishment of this species. As it occurs within the lower productivity grasslands, it is unclear whether litter build up in the absence of grazing would preclude establishment of this species.

Grazing may also facilitate populations of large-flower linanthus by reducing competition, particularly that of exotic annual grasses which are patchily abundant. Early season grazing (November – March) will likely maximize this beneficial effect, by reducing competition during the growth period, and avoiding grazing during the flowering period (March to May), which could reduce fecundity.

Lewis's clarkia (*Clarkia lewisii)*
Status: CNPS 4 (Limited Distribution)

Lewis's clarkia is an annual herb in the evening primrose family (Onagraceae) that is endemic to Monterey and San Benito Counties, where it occurs in open grassy areas on sandy soils. Within Palo Corona Regional Park, it is known to occur in two locations within the subshrub grasslands in the Panoche Unit on Arnold loamy sand and Cieneba gravelly sandy loam (Overtree 2006, USDA 1978).

Effects of Grazing: By removing biomass and precluding build up of dense leaf litter, grazing may facilitate establishment of this species. As it occurs within the lower productivity grasslands, it is unclear whether litter build up in the absence of grazing would limit establishment of this species.

Grazing may also facilitate populations of Lewis's clarkia by reducing competition, particularly that of exotic annual grasses which are patchily abundant. Early season grazing (November – March) will likely maximize this beneficial effect, by reducing competition during the growth period, and avoiding grazing during the flowering period (April- June), which could reduce fecundity.

Pinnacles buckwheat (*Eriogonum nortonii)*
Status: CNPS 1B (Rare, threatened, or endangered in CA and elsewhere)

Pinnacles buckwheat is an annual herb in the buckwheat family (Polygonaceae) that is endemic to Coast Range Mountains within Monterey and San Benito Counties, where it occurs primarily in open rocky areas within grasslands and chaparral. Within Palo Corona, it is known to occur in one location within the Panoche Unit along Chamise Ridge Road in the chamise-dominated chaparral (Overtree 2006).

Effects of Grazing: Pinnacles buckwheat is unlikely to be affected by grazing, as cattle do not frequent areas of dense shrub cover. In the sandy ridge grasslands, cattle could enhance establishment by removing biomass and precluding build up of dense leaf litter, though the impacts of this effect could be limited as litter accumulation might not be an issue in the droughtier soils.

Grazing may facilitate populations of Pinnacles buckwheat by reducing competition, particularly that of exotic annual grasses which are patchily abundant in the central and southern grasslands within the park. Early season grazing (November – March) will likely maximize this beneficial effect, by reducing competition during the growth period, and avoiding grazing during the flowering period which could reduce fecundity.

Douglas's spineflower (*Chorizanthe douglasii)*
Status: CNPS 4 (Limited Distribution)

Douglas's spineflower is an annual herb in the buckwheat family (Polygonaceae) that is endemic to the central Coast Range Mountains, where it occurs primarily on coarse soils within chaparral and woodlands. Within Palo Corona, it is known to occur in one location within the Panoche Unit in the chamise-dominated chaparral (Overtree 2006).

Effects of Grazing: Douglas's spineflower is unlikely to be affected by grazing, as cattle do not frequent the shrub-dominated areas where it primarily occurs. In the southern and central grasslands which intergrade with chaparral, cattle could enhance establishment by removing biomass and precluding build up of dense leaf litter, which has been found to inhibit establishment of a congener (McGraw 2004). As it occurs within the lower productivity sandy soil grasslands, it is unclear whether establishment is limited by litter build up in the absence of grazing.

Grazing may facilitate populations of Douglas's spineflower by reducing competition, particularly that of exotic annual grasses which are patchily abundant in the central and southern grasslands within the park. Early season grazing (November – March) will likely maximize this beneficial effect, by reducing competition during the growth period, and avoiding grazing during the flowering period (March – June) which could reduce fecundity. The prostrate growth form of the spineflower, which has a basal rosette of leaves, likely limits cattle herbivory during the

early season (November-March), when cattle will preferentially forage on the taller annual grasses.

Cattle trampling could facilitate Douglas's spineflower by creating open soil conditions which provide safe sites for spineflower establishment (McGraw 2004); though trampling during the growing season (November-June) could reduce Douglas's spineflower performance.

D. 2 GRASSLAND ANIMALS

Smith's blue butterfly (*Euphilotes enoptes smithi*)
Status: Federal Threatened species

Smith's blue butterfly is a small butterfly found on inland and coastal dunes, serpentine grasslands, and cliffside chaparral communities between the Salinas River in northern Monterey County, and San Carpoforo Creek in northern San Luis Obispo County. It occupies areas supporting two buckwheat species, coast buckwheat (*Eriogonum latifolium*) and seacliff buckwheat (*Eriogonum parvifolium*), on which it relies for food and breeding habitat (Arnold 1983). Previous studies have suggested butterfly abundance is correlated with buckwheat abundance (Arnold 2002).

In Palo Corona Regional Park, Smith's blue butterflies are found associated with seacliff buckwheat, which occurs within the coastal scrub, the subshrub grassland, and where buckwheat occur within the moist perennial grasslands, such as the steep, rocky hillslopes above Animas Creek (Overtree 2006; Figure 2-5).

Smith's blue butterflies complete their one year life cycle in close association with the coastal buckwheat species. Between June and September, the adults emerge and live for approximately one week feeding on the nectar in the buckwheat flowers. They mate and lay their eggs within the flowers of the buckwheat, and the larvae that emerge approximately one week later feed on the petals and seeds. After maturing through four larval stages (instars) over a three to four week period, the larva becomes a chrysalis, which pupates in the leaf litter below the plant, from where the adult emerges in summer the following year (Arnold 1983).

Effects of Grazing: There have been no known studies examining the effects of grazing on Smith's blue butterfly. Based on the species' life history and ecology, cattle grazing during the adult activity and reproduction period (June and September) is hypothesized to negatively impact the butterflies. During this season, cattle would feed on the buckwheat plants, including their inflorescences, thus reducing the nectar source for adults, and potentially causing direct mortality to eggs and larva in the flowers. Cattle could also negatively impact Smith's blue butterfly by trampling seacliff buckwheat and reducing their survivorship and growth.

Cattle grazing could have an indirect positive effect on Smith's blue butterfly by facilitating the establishment, growth, and reproduction of seacliff buckwheat. In the subshrub grasslands, seacliff buckwheat grows amidst a moderately dense cover of herbaceous plants, including exotic grasses and forbs. Early in the year (November to March), cattle grazed in these

grasslands would preferentially forage on the new herbaceous plant growth. In doing so, cattle would reduce the abundance and growth of herbaceous plants, with which seacliff buckwheat likely competes for scarce soil resources.

The Nature Conservancy, Big Sur Land Trust, and Monterey Peninsula Regional Parks District are collaborating with Sonoma State University researchers to examine the effects of cattle grazing on Smith's blue butterflies (Cushman 2006). In the experimental study, cattle will be grazed in the Panoche Unit, which supports the highest density of seacliff buckwheat, and exclosures will be used to compare the performance of seacliff buckwheat and Smith's blue butterfly in grazed and ungrazed areas. Results of this research will be used to refine the grazing strategy for the Panoche Unit, which currently calls for conservative intensity, early season grazing designed to facilitate seacliff buckwheat while avoiding direct impacts to Smith's blue butterfly.

Western burrowing owl (*Athene cunicularia hypugaea)*
Status: California Species of Special Concern (listing petition in review)

Western burrowing owls are small, earless, highly terrestrial owls of prairie and grassland habitats that modify and inhabit burrows created by small mammals including ground squirrels. They feed on a variety of items including insects, rodents, amphibians, reptiles, and small birds. Their predators include coyotes, foxes, skunks, raccoons, snakes, hawks, eagles, and larger owls. The burrowing owl is declining across much of California, presumably due to habitat loss, ground squirrel control efforts, and intensive agriculture (Dechant et al. 1999).

In the PCRP, burrowing owls have been observed within the northern portion of the park near the barn (Overtree 2006). It is not known whether they are breeding within the park.

Effects of Grazing: Cattle grazing in California grasslands is largely credited with facilitating populations of burrowing owl, though the mechanisms behind this effect are unknown. Cattle are hypothesized to have direct negative effects on burrowing owl populations by trampling burrows. This effect is hypothesized to be most acute during the nesting season, between March and August, and would be proportional to stocking rates. Cattle could have direct positive effects by providing dung which owls use to line their burrows (Dechant et al. 1999).

Cattle are also likely to have an indirect positive effect on burrowing owls by reducing the density of grassland vegetation, creating and maintaining open habitat preferred by burrowing owls. Cattle grazing can also indirectly facilitate borrowing owl populations by increasing populations of ground squirrels, which often create the burrows used by the owls in California. However, the effects of grazing on ground squirrel populations are equivocal as recent research reported ground squirrel populations were not affected by grazing (Fehmi et al. 2005). These indirect positive effects are hypothesized to outweigh the negative impacts of trampling and be maximized through moderate to high intensity early season grazing. For late-season and year round grazing, these benefits are slightly mitigated by the negative effects of trampling during the breeding season.

Grasshopper sparrow (*Ammodramus savannarum)*
Status: California Species of Special Concern

Grasshopper sparrow is a summer resident and rarely year-round resident of California grasslands, where it prefers moderately tall, dense vegetation with large forbs, subshrubs, or shrubs that provide singing perches that they use to maintain their territories of 1-4 acres in size. Though individual home ranges are small, grasshopper sparrows are 'area sensitive', preferring large grassland areas to small ones, with an estimated 75 acres required to support a breeding population (Dechant et al. 1998a).

Dense grass and forb cover may be required to provide concealment for grasshopper sparrow nests, which are made of grasses and forbs and occur in slight depressions within the ground at the base of overhanging herbaceous cover. Grasshopper sparrows breed between March and early August, and may raise 2-3 broods per year. They feed primarily on grasshoppers (Orthopterans) (grasshoppers), but also eat other invertebrates as well as seeds, for which they search on the ground and in litter within dense grasslands (Dechant et al. 1998a).

Within PCPR, grasshopper sparrows have been observed in the central and southern grasslands, near the wire corrals (Overtree 2006). It is not known whether they breed within the park.

Effects of Grazing: Cattle could have a direct negative effect on grasshopper sparrows by trampling their ground nests, which are present between March and August, such that late-season, dormant season, and year-round grazing could impact breeding. The magnitude of this effect is expected to be roughly proportional to the intensity of grazing.

The indirect effects of grazing on grasshopper sparrows via habitat modifications vary throughout the species range and cannot be generalized. In tall grass systems, or where shrubs encroach into grasslands in the absence of disturbance, grazing has been found to facilitate grasshopper sparrows by reducing vegetation height to moderate levels, and by preventing shrub encroachment which has been shown to result in the extirpation of grasshopper sparrows (Dechant et al. 1998). In areas of moderate grass height, grazing has been shown to degrade habitat for grasshopper sparrows by removing the dense herbaceous cover and, in some cases, subshrubs and shrubs used for perching (Dechant et al. 1998).

Given this, it is hypothesized that cattle grazing within the PCRP would benefit grasshopper sparrows to the extent that it prevents grassland conversion to shrubland or woodland, but that within the grasslands, intense or prolonged grazing would degrade habitat conditions by reducing herb height and cover and removing perching sites. This effect would be proportional to intensity and greater for grazing during the breeding season.

Golden eagle (*Aquila chrysaetos)*
Status: California Species of Special Concern, Fully Protected Species

Golden eagles occur throughout much of California, where they use open areas including grasslands, deserts, and savannahs for hunting and nest in tall trees, including oaks, pines, and sycamores, as well as other tall structures such as cliffs and electricity transmission towers (Hunt et al. 1995 *in* De Long 2004). They feed on small mammals, including ground squirrels, jack rabbits, and mule deer fawns; birds including yellow-billed magpies, and reptiles (Carnie 1954). Golden eagles occupy year round territories ranging between 8 and 25 square miles, with one study finding that territory size was negatively correlated with preferred prey availability (Collopy and Edwards 1989 *in* De Long 2004).

Golden eagles have been observed throughout the grasslands in the central and northern portion of PCRP, including San Jose Ridge, Animas Meadow, Inspiration Point, and the northern terraces (Overtree 2006). It is not known whether they are breed within the park, though appropriate habitat exists.

Effects of Grazing: There have been no known studies examining the effects of cattle grazing on golden eagles. However, one study in central California suggested that golden eagles were preferentially found in grazed grasslands because their preferred prey, California ground squirrels, prefers shorter grass habitat and occurred at higher abundance in grazed grasslands (Hunt et al. 1995 in De Long 2004). However, a recent study within California grasslands did not find increased abundance of ground squirrels in grazed versus ungrazed grasslands (Fehmi et al. 2005); suggesting grazing might not always promote ground squirrel populations and thus golden eagles generally.

Northern harrier (*Circus cyaneus)*
Status: California Species of Special Concern

The northern harrier is a year-round resident of California that occurs in a variety of open habitats, including grasslands, especially those near wetlands, within flat or hummocky terrain. Within these areas, northern harriers preferentially occur in areas of dense and tall grass, with abundant residual vegetation, which they use for nesting, cover, and feeding. Their breeding home ranges have been found to be between 650 and 2000 acres, with one study finding that habitat patches less than 250 acres in size were unlikely to support northern harriers (Descant et al. 1998b).

Northern harriers feed mostly on voles and other small mammals, but also take birds, frogs, small reptiles, crustaceans, insects, and, rarely fish. Northern harrier populations have been shown to vary with the abundance of voles (*Microtus* spp.), which is their most common prey. They roost on the ground, and use tall grass areas for cover. Northern harriers breed between April and September, with a peak in June and July. Their nests are most commonly seen in shrubby vegetation at the edge of a marsh, but they also nest in grasslands or fields several miles from water (Descant et al. 1998b).

Effects of Grazing: Several studies throughout North American have examined the distribution and abundance of northern harriers with respect to land use, including grazing, with most finding that northern harriers do not use areas that are grazed annually, even if only moderately. Instead, northern harriers are most commonly found in taller, denser vegetation with residual matter that accumulates in the absence of grazing, mowing, and/or fire for with 2-5 years (Descant et al. 1998b).

Periodic grazing, mowing, or fire might be needed to maintain northern harrier habitat in areas where grasslands are successional to shrublands. Infrequent grazing, mowing, or fire (e.g. every 3-5 years) might also facilitate populations of *Microtus* and other small mammals on which northern harriers prey. As northern harriers nest on the ground, grazing cattle during the late season and dormant season could cause nest to be trampled, though it is unknown how frequently this would occur (Descant et al. 1998b).

Given this, cattle grazing is hypothesized to facilitate northern harriers by maintaining grassland habitat and promoting populations of their prey. However, grazing that reduces grassland vegetation height is thought to degrade habitat for northern harriers, with this effect being proportional to intensity and greater for grazing during the breeding season.

White-tailed kite (*Circus cyaneus)*
Status: California Species of Special Concern, Federal Protected Species

The white-tailed kite is a year-round resident of California that occurs in open habitat conditions including grasslands and oak woodlands along the coastal and in the low valleys. It feeds primarily on diurnal mammals, including voles (*Microtus* spp.), but also amphibians, reptiles, small birds, and insects. It preferentially forages in grasslands, where it hunts from a centrally located perch. It roosts and nests in dense stands of deciduous trees, such as in riparian woodlands.

In Palo Corona Regional Park, white-tailed kite have been observed in the grasslands from the wire corrals in the south, to the barn in the north.

Effects of Grazing: Researchers in Humboldt County found that white-tailed kites occurred at six times the frequency in ungrazed portions of grasslands within a wildlife area, than the grazed portions. They attributed their results to the likely higher occurrence of voles within the taller-structured grasslands (HSU Wildlife 2004).

Given this, grazing that reduces the abundance of voles is hypothesized to negatively effect white-tailed kites. In the productive moist perennial grasslands, grazing during the early season (November to March) would is hypothesized to still result in tall structure created by the perennial grasses.

merlin (*Falco columbarius)*
Status: California Species of Special Concern

The merlin is an uncommon winter migrant to the western half of California, where it inhabits open grasslands, savannahs, woodlands, particularly those near the coast, lakes, and wetlands. Merlins can be found in California September and May, after which they fly to Alaska and Canada to breed. Merlins feed primarily on small birds, but also reptiles and insects, which they hunt by flying fast and low over the ground (i.e. 1 m).

In the PCRP, merlins have been observed on in the moist perennial grasslands of the northern coastal terraces and San Jose Ridge, and the ridge grasslands of the main ridge (Overtree 2006, J. McGraw, pers. obs. 2006).

Effects of Grazing: A synthesis of prior research examining merlins concluded that grazing to create a mosaic of habitat conditions, which includes some low structure, would promote merlins by providing a diversity of prey (Konrad 2004). Intensive year-long grazing which creates homogenous low structure was deemed negative for merlins. However, studies in mid-west tall- and mixed grass prairies have concluded that some grazing to create light to moderate herb cover promotes merlins (Konrad 2004).

Given this, grazing in the PCRP that creates and maintains moderate herb cover is hypothesized to facilitate merlins. In the high productivity moist perennial grasslands, variable grazing intensity and seasonal of use will create desirable grassland habitat heterogeneity. In the lower-productivity ridge grasslands, conservative intensity grazing during the early season (November to March) is hypothesized to create moderate structure while avoiding potential direct negative impacts of cattle that would result from longer duration grazing.

California condor (*Gymnogyps californianus)*
Status: Federal endangered species, California endangered species

The California condor is a highly endangered resident of California, where it is found in the Coast Ranges from Santa Clara Co. south to Los Angeles Co., the Transverse Ranges, Tehachapi Mts., and southern Sierra Nevada. California condors are scavengers that prefer large, dead mammals including deer, cattle, and sheep, but will also feed on the carcasses of ground squirrels and other smaller mammals. They forage over wide areas of open areas and roost on cliffs and in large trees and snags. In order to enable their return to flight, food must be in open areas (Polite 2005).

There are no known observations of the California condor within the PCRP. However, California condors have been reintroduced into the Ventana Wilderness to the south, and recently have been observed breeding in Monterey County (Ventana Wilderness Society 2006). Given the location of the PCRP adjacent to other large protected areas, California condors may use the park for foraging and perhaps one day breeding.

Effects of Grazing: No studies have examined the effects of cattle grazing on California condors. Based on the species' life history and ecology, it is hypothesized that cattle grazing facilitates California condors by creating and maintaining open areas, including grasslands, which it requires for foraging. Cattle that die also provide food for condors. The presence of cattle could alter California condor behavior, by disrupting foraging (i.e. cattle could deter condors from landing near a carcass) or influence nesting sites. More research is needed to understand the effects of cattle on California condors.

Given this, grazing in the PCRP that maintains open grasslands is hypothesized to facilitate condors. If dead cattle can be left in place, this could provide a food source for condors as well as other scavengers.

California Horned lark (*Eremophila alpestris actia)*
Status: California Species of Special Concern

The California horned lark is a common and abundant year-round resident of California that occurs in open habitats including grasslands along the coast. They prefer grasslands with low, sparse vegetation, in which they feed by walking along the ground in search of spiders, insects, and snails during the breeding season (March-July) and also seeds and other plant material outside the breeding season. Solitary breeding pairs build grass-lined nests in shallow cups in the ground. In the fall and winter, California horned larks form dense flocks.

In the PCRP, California horned larks have been observed in the center and southern grasslands, particularly the ridge grasslands located on the main ridge and Malpaso Ridge. In 2000, chicks were observed on the main ridge, indicating that the species was breeding within the park (Overtree 2006)

Effects of Grazing: A synthesis of prior research examining horned larks (all 21 subspecies) recommended grazing, burning, and mowing to maintain open grassland habitat characterized by low shrub cover, and sparse and short herbaceous plant cover that is the preferred habitat for horned larks (Dinkins et al 2000). Across numerous studies examining horned lark habitat use with respect to grazing, the species was consistently found to favor grazed areas. The short stature may favor abundance of their prey and facilitate foraging (Dinkins et al. 2000).

Given this, grazing that creates and maintains sparse, short herbaceous vegetation is hypothesized to facilitate California horned larks. In the lower-productivity ridge grasslands were it has been observed, grazing during the early season (November to March) is hypothesized to create appropriate conditions while avoiding potential direct negative impacts of cattle on the ground nesting birds. In high productivity (i.e. high rainfall) years, a longer season of use might be required to create the low structure habitat conditions.

Loggerhead shrike (*Lanius ludovicianus)*
Status: California Species of Special Concern, Federal Species of Concern

The loggerhead shrike is a common resident and winter visitor in lowland areas throughout California, where it occupies open habitats such as grasslands. It occurs primarily in areas with scattered perches such as shrubs, trees, and fence posts, from which it forages primarily for large insects, though it also takes small mammals, birds, reptiles, and amphibians. Between March and May, loggerhead shrikes build solitary, well-concealed nests within shrubs or trees with dense foliage.

In the PCRP, loggerhead shrikes inhabit the grasslands and maritime chaparral, and have been near the corrals in the north of the park (Overtree 2006)

Effects of Grazing: A synthesis of prior research examining loggerhead shrikes found that grazing has a positive effect in tall-grass areas, by reducing grass height and facilitating foraging behavior, but that in shorter vegetation structure, grazing had negative effects by reducing abundance of prey. Through herbivory and trampling (e.g. rubbing), cattle can negatively impact loggerhead shrikes by removing the shrubs and trees used for perches (Deschant 2002).

Given this, grazing that creates and maintains sparse, moderate herbaceous vegetation is hypothesized to facilitate loggerhead shrikes. In the lower-productivity ridge grasslands were it has been observed, conservative grazing during the early season (November to March) is hypothesized to maintain appropriate moderate herbaceous cover while minimizing cattle impacts to shrubs. Meanwhile, moderate intensity, longer duration grazing is hypothesized to maintain moderate grass height in the higher productivity moist perennial grasslands.

California horned lizard (*Phrynosoma coronatum frontale)*
Status: California Species of Special Concern, Federal Species of Special Concern

California horned lizard (*Phrynosoma coronatum frontale*) is a California endemic subspecies of the coast horned lizard (*P. coronatum*), which occurs in variety of open habitats, and is preferentially found in areas with a gravelly-sandy substrate and scattered shrubs, including California buckwheat in coastal scrub (Morey 2005)

California horned lizards hibernate during the winter under the soil surface or rocks or logs. They have been observed as active between April and October. Between May and June, California horned lizards lay eggs in loose soil, with hatchlings have been observed between July and August (Morey 2005).

California horned lizards are ant specialists, but may take small beetles, wasps, grasshoppers, flies, and caterpillars, especially when abundant. Research on the San Diego horned lizard (*P. c. blanevillei*) showed that 94% of the diet was comprised of native ants, and that the species does not eat the introduced Argentine ants (*Iridomyrmex humilis*). As these ants displace native ants, factors which facilitate the invasion of Argentine ants into horned lizard habitat are thought to threaten populations (Suarez et al. 2000). Moreover, this study showed that a diversity of ant

species are required by horned lizards throughout their development, with smaller individuals feeding on smaller ants.

Within PCRP, California horned lizards have been observed in the ridge grasslands located in the central and southern portion of the park.

Effects of Grazing: There have been no known studies examining the effects of livestock grazing on horned lizards. Understanding of the species ecology may be used to hypothesize the direct and indirect effects of cattle grazing on the species.

Cattle might negatively impact horned lizards directly, through trampling of individuals hibernating during the winter, and in nests during the spring and early summer. Cattle might also indirectly negatively affect California horned lizards by altering prey abundance and diversity. Research has shown that grazing can reduce the abundance and diversity of ant species, in part by compacting soil which prevents nesting of some ants, but also by reducing overall heterogeneity of vegetation structure and thus plant species composition (Bestlemeyer and Wiens 2001, Boulton et al. 2005).

Cattle grazing might indirectly positive effect California horned lizard populations within the invaded coastal scrub habitat by reducing the cover of exotic annual grasses, which could degrade lizard habitat. This beneficial effect would most likely result from early season grazing, which could at the same time cause mortality to hibernating lizards, making it difficult to predict the net effect of cattle grazing.

D. 3 AQUATIC ANIMALS

The ponds, springs, riparian, and riverine systems within PCRP support four special status species: steelhead trout, California tiger salamander, California red-legged frog, and tricolored blackbird.

Steelhead trout (*Oncoryhnchus mykiss irideus)*
Status: Federal threatened species

Members of the family Salmonidae, steelhead trout (or "steelhead") are the anadramous form of rainbow trout. Streams in the region of Palo Corona Regional Park support the South-Central California Coast Evolutionary Significant Unit of steelhead-- a population that is reproductively isolated enough from other populations to merit protection.

Steelhead spawn from December through April in small streams where cool, well-oxygenated water is available year round. Sites with gravel substrate and good water flow are selected for breeding by females, which lay their eggs in nests called redds, where they are then fertilized by males. Young steelhead live one to two years or more in streams before they swim to the ocean, where they live and grow for one to two years before returning to freshwater (often its natal stream) to spawn. Spawning migration typically occurs during the winter rains which was out sand bars between streams and the ocean that create coastal lagoons.

Effects of Grazing: Cattle activity in streams can degrade habitat for steelhead through a variety of mechanisms, including: causing erosion and sedimentation, which degrades spawning habitat, directly trampling redds, and by removing riparian vegetation that regulates stream temperatures (and thus oxygen availability) and provides important inputs to the stream food web. These impacts are likely proportional to the duration and intensity of cattle activity within a stream. Cattle access to streams is likely greatest during between May and September, when temperatures and water demands are high. During the early season (November to March) cattle prefer to remain on upper slopes and ridgetops away from the cool temperatures and shade of the canyons. Thus limiting grazing to the early season is hypothesized to result in limited negative effects on steelhead and riparian and riverine systems in general.

Tricolored blackbird (*Agelaius tricolor*)
Status: California Species of Special Concern, Federal Species of Concern

Tricolored blackbird is a passerine that has been observed in the western U.S. and Canada. The greatest populations are within California, where the species occurs most frequently from the western foothills of the Sierra Nevada to the coast, including in the Coast Ranges Mountains, but is most prominent in the Central Valley. Owing to dramatic declines in populations observed during the past 80 years, the tricolored blackbird is recognized as a California Department of Fish and Game Species of Special Concern and US Fish and Wildlife Service Species of Concern, while the Audubon Society has placed it on their watch list (Hamilton 2004).

Tricolored blackbirds typically occur in large flocks found in riparian areas and wetlands. Between April and late-July, tricolored blackbirds breed in colonies often within emergent wetland vegetation. Nests are created over or near fresh water cattails, tule, willows, blackberries, and thistles, where they are well-concealed to reduce predation by coyotes and raccoons (Hamilton 2004, Granholm 2005). Tricolored blackbirds are not susceptible to cowbird nest parasitism because they do not initiate incubation until they lay their first egg (Hamilton 2004).

Tricolored blackbirds are omnivores, feeding largely on insects and spiders during the spring and summer, and seeds and grains during the fall and winter. They forage up to 4 miles away from the nesting sites. Though not migratory, tricolored blackbird flocks are nomadic during the fall and winter as they search for food (Hamilton 2004, Granholm 2005).

Within PCRP, tricolored blackbirds have been observed in the grassland habitat, though it is unknown whether they are breeding in the park.

Effects of Grazing: Though no known studies have examined the effects of cattle grazing on tricolored blackbirds, aspects of the species ecology can be evaluated in terms of known effects of cattle in riparian areas to hypothesize the effects of grazing on this rare bird. These effects likely apply to other riparian birds as well.

By reducing the cover of emergent and riparian vegetation used by nesting tricolored blackbirds, cattle grazing likely reduces their populations. As described above, the negative effect of cattle on instream and riparian plants is likely greater as a result of late and dormant season grazing, than it is for early season grazing when cattle are hypothesized to graze primarily in upland areas and access water less frequently. Grazing in the grasslands adjacent to streams and ponds occupied by tricolored blackbirds may also reduce the abundance of grains (i.e. grass seeds) which they rely upon during feed fall and winter.

California red-legged frog (*Rana aurora draytonii*)
Status: Federal Threatened Species

California red-legged frog is endemic to California and Baja California. As a result of habitat loss and degradation, California red-legged frogs have been extirpated from an estimated 70% of their range. Presently, the majority of occurrences are found within rivers and coastal drainages in the central California (USFWS 2002).

California red-legged frogs require dense, shrubby or emergent riparian vegetation closely associated still or slow moving water that it at least 2.3 feet deep. Deep-water pools with dense stands of overhanging willows (*Salix* spp.) and an intermixed fringe of cattails (*Typha latifolia*) often support high density populations. California red-legged frogs might require vegetated riparian corridors for shelter during the winter (USFWS 2002).

California red-legged frogs feed largely along the shoreline and on the surface of the water. Larvae are thought to eat algae, while adults most commonly eat invertebrates, though small vertebrates including pacific tree frogs (*Pseudacris regilla*) might be taken by larger adults.

While adult California red-legged frogs are primarily nocturnal, juveniles are active day and night. Though frogs in interior sites may hibernate, those in coastal drainages are not thought to hibernate. During summer and dry weather, California red-legged frogs aestivate in small mammal burrows and under moist leaf litter. They have been found up to 100 feet from water in adjacent dense riparian vegetation, which is thought to be an important component of their terrestrial habitat (USFWS 2002).

California red-legged frogs breed between November and March, with the timing thought to ensure that water is cool enough for embryonic survival and that water is present in sufficient quantity for larvae to grow and metamorphose. Egg masses are typically attached to emergent vegetation at or near the surface of the water. Eggs hatch within 6-14 days and larvae metamorphose between July and September (Jennings et al. 1993).

California red-legged frogs are negatively affected by exotic animals including bullfrogs (*Rana catesbeiana*), mosquito fish (*Gambusia affinis*), and a variety of predatory fish including blue gill (*Lepomis machrochirus*). Indeed, predatory fish and bullfrogs are often implicated for the absence of California red-legged frogs in a variety of streams and ponds. Chitrid fungus, a fungus only recently found to infect vertebrates, has been found in declining amphibian populations, and may also be a threat to California red-legged frogs (USFWS 2002).

Surveys of streams and ponds within the PCRP revealed the occurrence of California red-legged frogs within 7 ponds (Table 2-3b). In four of these ponds, chytrid fungus was detected (Hemingway and Doak 2006). California red-legged frogs also occur in the Carmel River and may also inhabit other stream reaches not surveyed.

Effects of Grazing: Grazing is hypothesized to negatively impact California red-legged frogs by removing emergent vegetation, which is a crucial component of their habitat. Cattle can also degrade habitat for California red-legged frogs by trampling pond and stream banks and causing erosion that creates wider, shallower, warmer water which limit adults escaping from predators. Finally, cattle can reduce water quality, through defecation and reduce water quantity, through drinking, which reduces habitat available to California red-legged frogs, and increases temperatures, particularly during the summer drought.

These effects of cattle grazing are likely proportional to the frequency of use of the aquatic habitat, which is a function of the stocking rate and the seasonality of grazing. As noted previously, cattle access aquatic areas more frequently during the late and dormant seasons, when their water demands are higher and when streams provide green vegetation which is less abundant in adjacent uplands. Pond and stream access is thought to be greatly reduced during early season grazing, when cattle water needs are lower, and so they are hypothesized to spend most of their time in the warmer, upland areas feeding on green, new growth.

California red-legged frogs may benefit from cattle grazing that partially aquatic vegetation and maintains open water conditions which they require for escape of predators. If ponds become shallow in the absence of grazing, emergent vegetation can be manually removed to maintain open water, which the species requires (Hemingway and Doak 2006).

California tiger salamander (*Ambystoma californiense*)
Status: Federal Threatened Species, California listing pending

California tiger salamander is endemic to California where it occurs in grasslands and vernal pool habitats. Adults spend about 11 months primarily underground in burrows created by ground squirrels and gophers that are located within approximately 300 feet of breeding ponds. Adults are thought to feed earthworms, snails, insects, fish, and occasionally small mammals (Kucera 2005).

California tiger salamanders breed in seasonal wetlands, including ponds and vernal pools, to which they migrate during the rainy season between November and May. Eggs are laid on submerged and emergent vegetation as well as submerged debris in shallow water. Juveniles feed on littoral, benthic, and planktonic arthropods. During late spring or early summer, larva transform and disperse from the breeding sites after spending a few hours or days near the pond margin (Jennings and Hayes 1994).

California tiger salamanders are negatively affected by exotic animals including bullfrogs (*Rana catesbeiana*) and predatory fish, which are thought to preclude their use of perennial streams. California tiger salamanders may hybridize with eastern tiger salamanders introduced into

aquatic systems through their use as fishing bate, thus reducing the performance of the native salamanders (Riley et al. 2003). Chitrid fungus, a fungus may also be a threat to California tiger salamander.

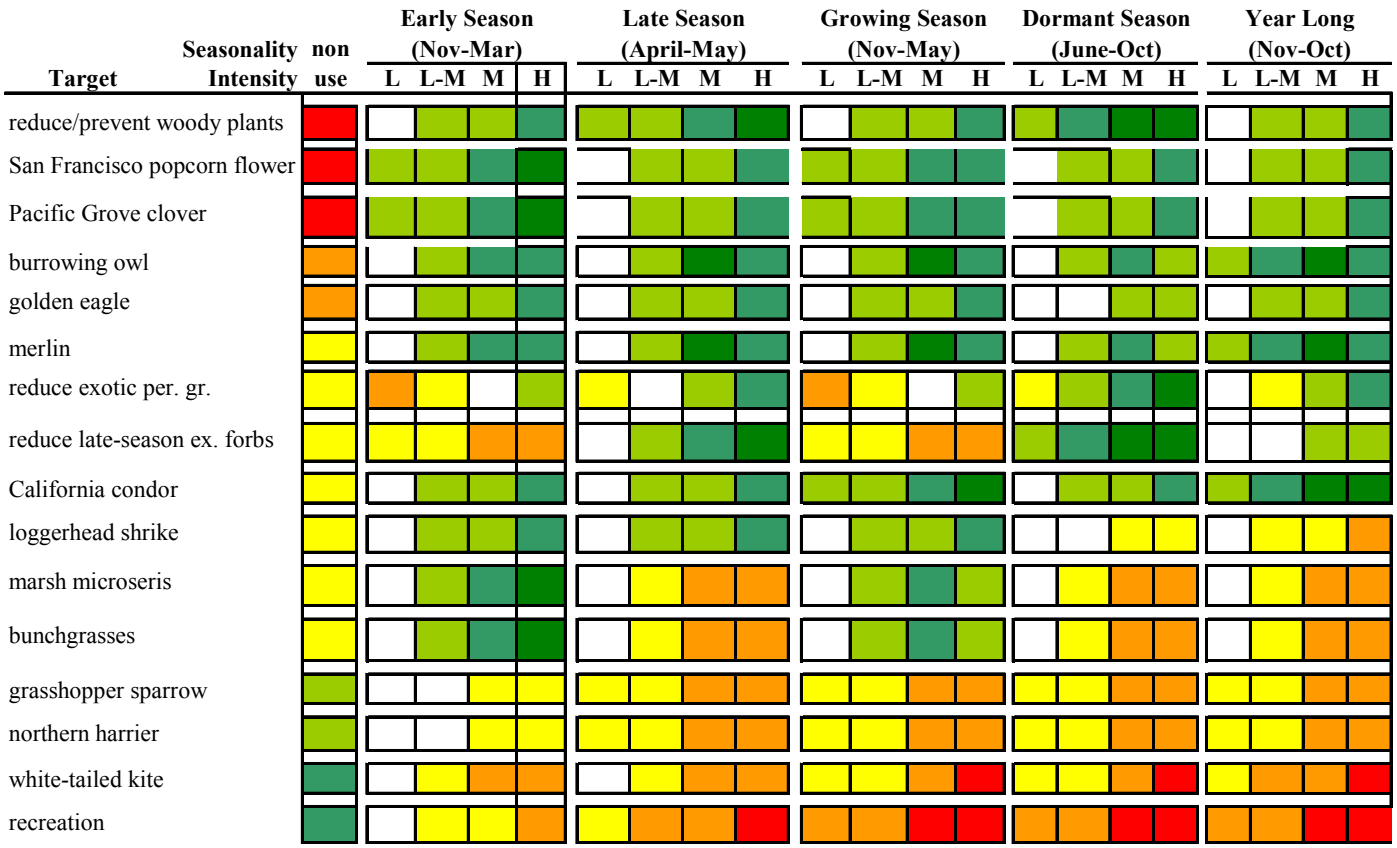
Surveys of ponds within the PCRP revealed the occurrence of California tiger salamander within a single pond—roadrunner pond (Table 2-3b). Chytrid fungus was not detected in this pond (Hemingway and Doak 2006).

Effects of Grazing: Grazing is hypothesized to negatively impact California tiger salamanders breeding habitat by removing emergent vegetation, to which they attach eggs and which provides the basis for the pond food webs. Cattle can also degrade habitat for California tiger salamanders by trampling causing erosion that fills ponds, creating shallower, warmer water that might not provide the necessary habitat for larva. Finally, cattle can reduce water quality, through defecation, and reducing water quantity, through drinking, which reduces habitat and increases temperatures, particularly during the summer drought.

These negative effects of cattle grazing are likely proportional to the frequency of use of the ponds, which is a function of the stocking rate and the seasonality of grazing. As noted previously, cattle access aquatic habitat more frequently during the late and dormant seasons, when their water demands are higher and when streams provide green vegetation which is less abundant in adjacent uplands. Pond and stream access is thought to be greatly reduced during early season grazing, when cattle water needs are lower, and so they are hypothesized to spend most of their time in the warmer, upland areas feeding on green, new growth.

Cattle grazing may benefit California tiger salamanders through two main mechanisms. By reducing shrub encroachment, cattle grazing can help maintain open grassland habitat which is preferred by adult California tiger salamanders. Cattle grazing could also help maintain habitat for ground squirrels, which create burrow systems used by California tiger salamanders. As noted previously, a recent study within California grasslands did not find increased abundance of ground squirrels in grazed versus ungrazed grasslands (Fehmi et al. 2005) suggesting grazing might not always promote ground squirrel populations generally.

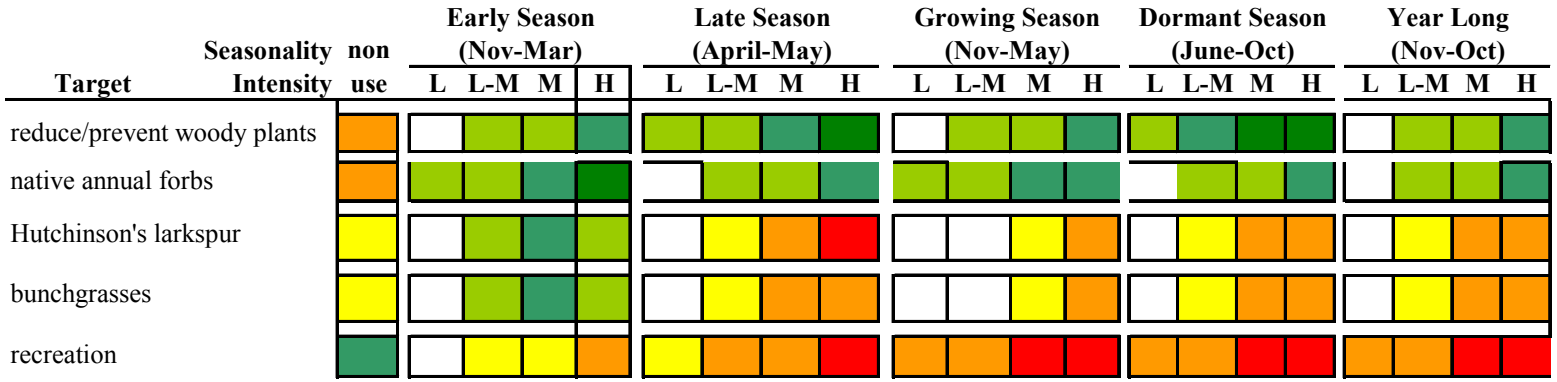
Table D-1: Anticipated grazing impacts on targets (species, management objectives) within the moist perennial grassland association based on the season of use and intensity of grazing. Details provided in text.



Kety to Impacts
High Positive
Moderate Positive
Low Positive
None
Low Negative
Moderate Negative
High Negative
Unknown

Key to Intensity		Utilization	RDM
Light	L	25%	2,500-3,000 lbs
Conservative	L-M	50%	1800-2500 lbs
Moderate	M	51-75%	1200 -1800 lbs
Heavy	H	75%	<1200 lbs

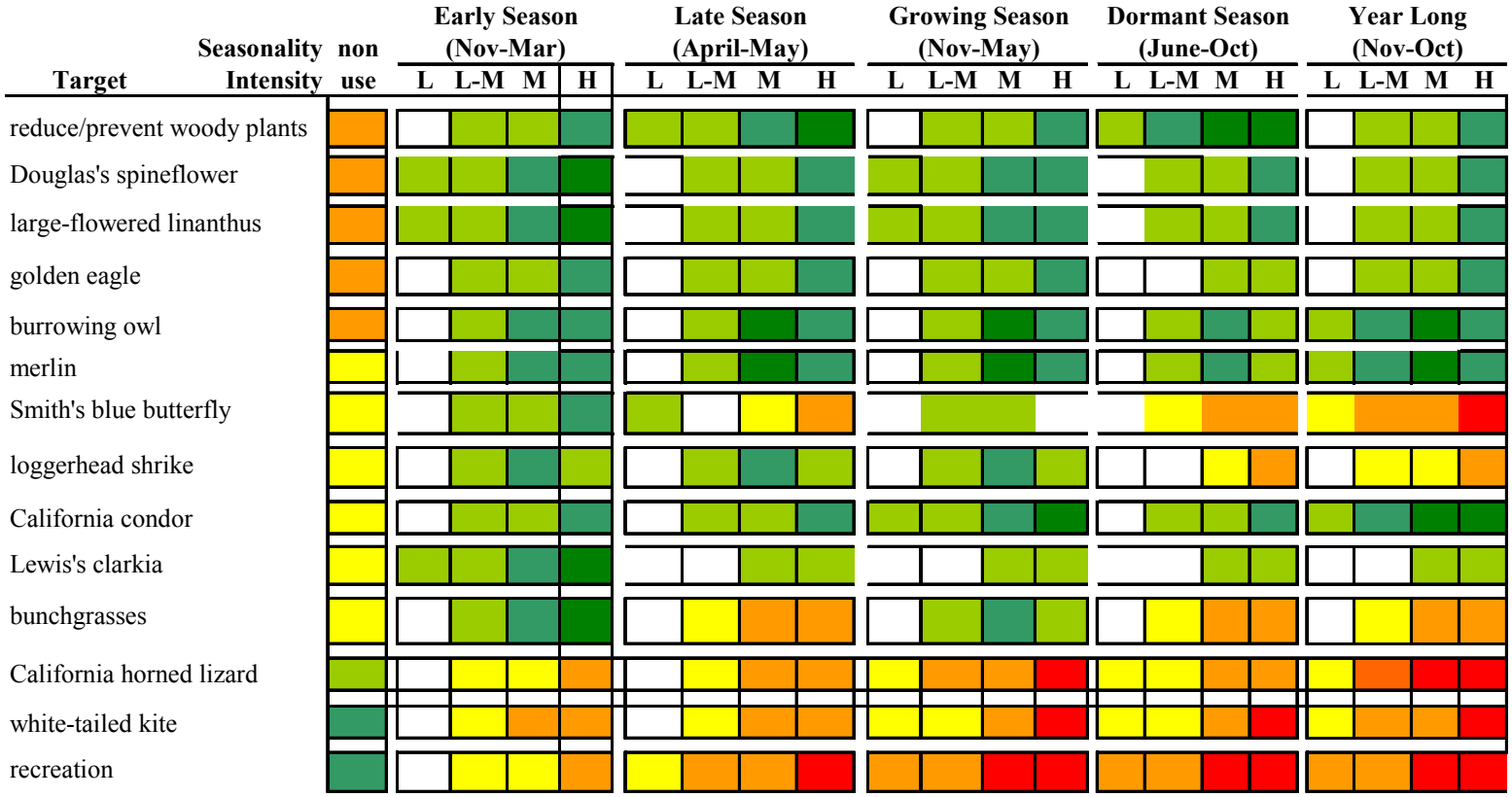
Table D-2: Anticipated grazing impacts on targets (species, management objectives) within the alluvial canyon grasslands based on the season of use and intensity of grazing. Details provided in text.



Kety to Impacts	
High Positive	
Moderate Positive	
Low Positive	
None	
Low Negative	
Moderate Negative	
High Negative	
Unknown	

Key to Intensity		Utilization	RDM
Light	L	25%	2,500-3,000 lbs
Conservative	L-M	50%	1800-2500 lbs
Moderate	M	51-75%	1200 -1800 lbs
Heavy	H	75%	<1200 lbs

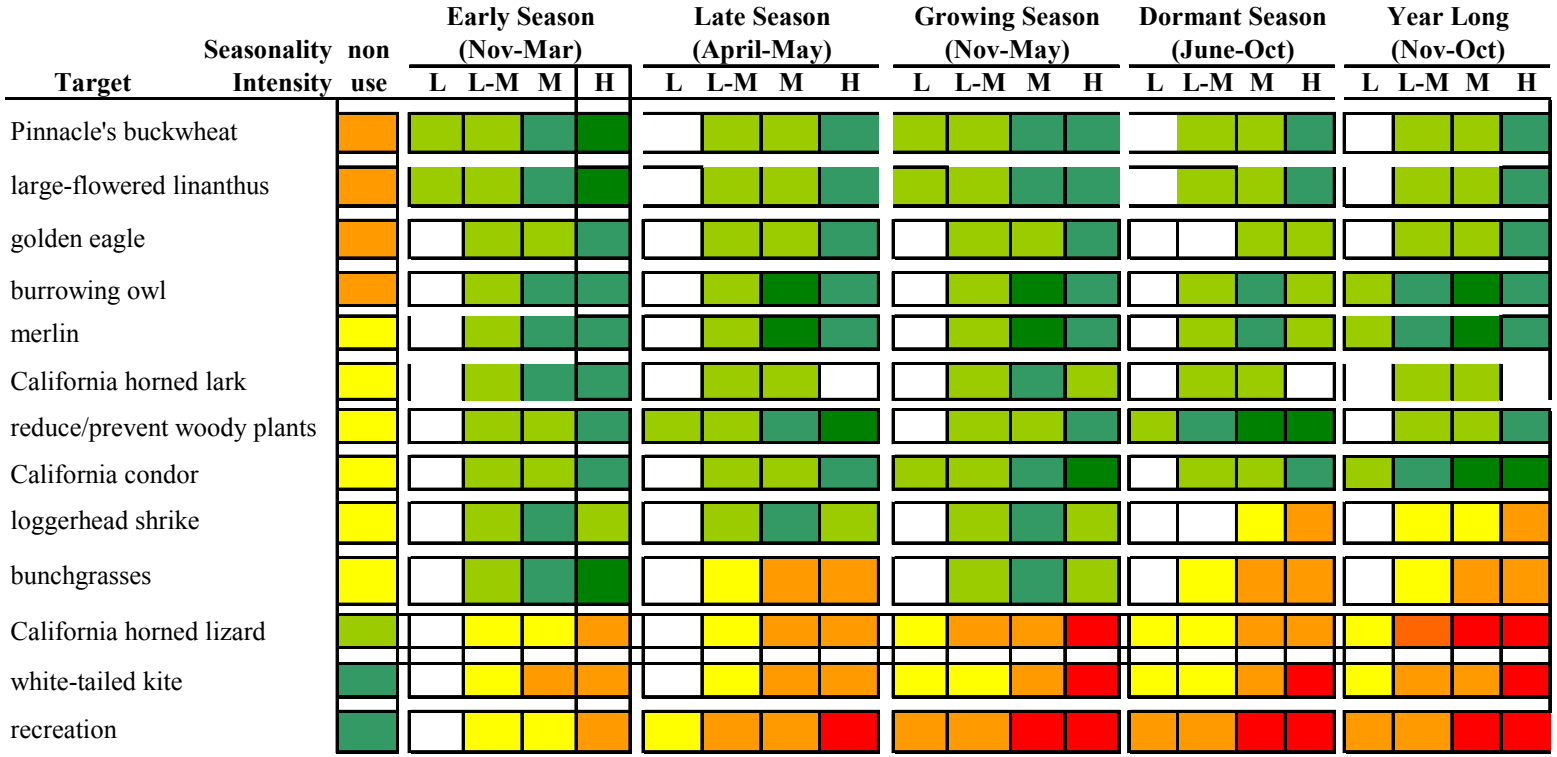
Table D-3: Anticipated grazing impacts on targets (species, management objectives) within the subshrub grassland association based on the season of use and intensity of grazing. Details provided in text.



Kety to Impacts
High Positive
Moderate Positive
Low Positive
None
Low Negative
Moderate Negative
High Negative
Unknown

Key to Intensity		Utilization	RDM
Light	L	25%	1,500-2,000 lbs
Conservative	L-M	50%	1.000-1500 lbs
Moderate	M	51-75%	500 -1,000 lbs
Heavy	H	75%	<500 lbs

Table D-4: Anticipated grazing impacts on targets (species, management objectives) within the ridge grassland association based on the season of use and intensity of grazing. Details provided in text.



Kety to Impacts
High Positive
Moderate Positive
Low Positive
None
Low Negative
Moderate Negative
High Negative
Unknown

Key to Intensity		Utilization	RDM
Light	L	25%	1,500-2,000 lbs
Conservative	L-M	50%	1.000-1500 lbs
Moderate	M	51-75%	500 -1,000 lbs
Heavy	H	75%	<500 lbs

Table D-5: Anticipated grazing impacts on conservation targets within the aquatic systems--ponds, springs, riverine, and riparian--based on the season of use and intensity of grazing in the surrounding moist perennial grasslands.

Target	Seasonality / Intensity	non use	Early Season (Nov-Mar) L	L-M	M	H	Late Season (April-May) L	L-M	M	H	Growing Season (Nov-May) L	L-M	M	H	Dormant Season (June-Oct) L	L-M	M	H	Year Long (Nov-Oct) L	L-M	M	H
California tiger salamander																						
California red-legged frog																						
steelhead trout																						
riparian woodland																						
aquatic and wetlland plants																						
tri-colored blackbirds																						

Kety to Impacts
High Positive
Moderate Positive
Low Positive
None
Low Negative
Moderate Negative
High Negative
Unknown

Key to Intensity		Utilization	RDM
Light	L	25%	2,500-3,000 lbs
Conservative	L-M	50%	1800-2500 lbs
Moderate	M	51-75%	1200 -1800 lbs
Heavy	H	75%	<1200 lbs

APPENDIX E:

NATURAL RESOURCES CONSERVATION DISTRICT CALIFORNIA CONSERVATION PRACTICE SPECIFICATIONS FOR FENCES

(NRCS, CA 2000)

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE SPECIFICATION

382A - FENCE

I. SCOPE

The work shall consist of furnishing materials and installing either barbed, smooth, or woven wire, or combinations thereof at the location as shown on the drawings or as staked in the field.

II. TYPES OF FENCES

A. 4 wire barbed and/or smooth--min. height 42 inches. (Figure 1)

B. 3 wire barbed and/or smooth-min. height 40 inches. (Figure 2)

C. Woven wire and barbed wire--min. height 40 inches. (Figure 3)

D. 4 wire barbed and/or smooth--min. height 42 inches. Bottom wire a minimum of 15 inches above ground.

III. MATERIALS

The materials used must be constructed to equal or exceed, in strength and durability in accordance with the following specifications:

A. Wire

Barbed wire, woven wire and wire netting fencing shall conform to the requirements of Federal Specification RR-F-221f, and further specified:

Type I - Barbed wire, style 2 - zinc coated. Barbed wire shall be 13 gage or wire of greater diameter (lesser gage), or 15 1/2 gage high tensile double strand. The minimum breaking strength for single 13 gage wire is 590 lbs, and for double 15 1/2 gage wire is 850 lbs, the wire shall have barbs at a spacing of 4-inch interval. The zinc-coating shall be at least 0.50 ounces per square foot of wire surface.

Type II - woven wire, style 4 - Farm fence. Woven wire shall be a minimum of 26 - inch high with 14 1/2 gage with stay wires spaced at an interval of 12 - inches or less. All woven wire shall be of new galvanized material, with a zinc-coating of 0.40 ounces per square feet of wire surface.

Woven wire fences shall be topped by at least two lines of double strand barbed wires. When splicing is necessary, the "Western Union" splice shall be used (Figure 6). The splice is made by overlapping the ends of each wire and wrapping each wire five times around the other wire. The use of a fence splicing tool will facilitate this operation and result in a neat job. (Figure 6). High compression splices (Figure 6) should be used when High tensile wire is used.

B. Staples

Staples shall be of nine gauge polished (bright) hard wire and should be 1 1/2 inches long for soft woods and 1 1/4 inches long for hardwood posts. The staples shall be driven diagonally with the wood grain to avoid splitting. Space should be left between the staple and the linepost to permit movement of the wire. Tie wires of galvanized 12 gauge may be substituted for staples.

C. Posts

Line Posts

Wood Type. Untreated posts from such species as juniper, cedar, oak, osage orange, black locust, and redwood or pine posts treated with a creosote coal-tar solution, or pentachloropherol, with not less than six pounds retention per cubic foot, in accordance with Federal Specification TT-W-571c, are acceptable.

Steel. Standard "Tee" or "U" section steel posts weighing not less than 1.29 pounds per foot of length, exclusive of anchor plate, may

be used in lieu of wood line posts. Length shall be the same as for wooden posts.
Steel posts shall be rolled from high carbon steel and shall have a protective coating. The coating may be either galvanizing by the hot dip process or painting in accordance with Commercial Standard 184 with one of more coats of high graded, weather resistant steel paint or enamel applied and baked. Steel posts shall be studded, embossed or punched for the attachment of wire to the posts. Wire shall be attached to the posts by wrapping with 16 gauge galvanized wire or by use of manufacturer's specially designed clips.
Size. Post length must be at least 5 feet 6 inches to construct a 42-inch high fence and be set solidly in the ground a minimum depth of two feet in deep soils or 18 inches in rocky shallow soil. Ninety-five percent of top diameters of wooden posts (two inches minimum above the top wire) must be three inches or larger. In shallow or rocky soil where penetration cannot be obtained with ordinary hand tools, straddlejacks may be used.
Spacing. On 4 wire and woven wire standard fences, maximum post interval shall not exceed 20 feet if no stays are used between post, or 30 feet if stays are used between posts at intervals not greater than 10 feet.
On 3 wire standard fences, maximum interval between posts shall not exceed 16 1/2 feet with or without stays.

D. Corner, Gate and Brace Posts (Figure 4,5,7)

Brace Posts

Wood. Same species as for line posts.
Size. Length shall be 6 feet 6 inches minimum to provide for the construction of at least a 42-inch high fence and permit setting at least 36 inches in the ground, top diameter commercial size six inches or larger.
Steel. Steel corner or brace posts with a three-inch new (or equivalent weight of 7.58 pounds per linear foot) pipe or larger, with brace member welded to the posts. Posts to be set in concrete. (Figure 7)
If soil conditions prevent proper brace or line post installations, trees may be used.
Rock cribs may be used in shallow rocky areas. (refer to BLM 2400--Range)
Bracing. Required at all corners, gates and at all definite angles in the line fence. In straight sections brace units (pull posts) shall be spaced at intervals not to exceed 1,320 feet. Horizontal braces can be a six-inch diameter top line post of the above species with minimum length of 6.0 feet notched into the top one-half of the brace post and post being braced, or two inch new or used pipe or angle iron (2" x 2" x 1/4") installed not less than three feet above ground line and no higher than the top wire. A tension member composed of two complete loops of number 12 1/2 gauge double strand barbed or smooth wire, shall extend from a point approximately six inches below the top of the brace post to ground level of the post being braced. The brace wire shall be twisted to secure the brace and provide needed rigidity. (Figure 4).
A diagonal fence strainer is equal in strength and holding force to a horizontal strainer (fig.1). On a high-tensile, smooth-wire fence, one or two diagonal strainer(s) can be used for a corner in place of two horizontal braces (fig. 2). In the design and installation of a diagonal brace or strainer, several principles should be kept in mind. (Figure 5).

1. Make the diagonal (horizontal as well) brace as long as possible.

2. Be sure that the end of the diagonal brace in contact with the ground is free to move forward and is not blocked by a stack or post.

3. The diagonal brace can bear against the corner post in any location from the middle of the post to the top. However, probably the best place to have the diagonal brave contact the corner post is at the top.

4. When installing a diagonal strainer, the corner post should be set first, then the diagonal brace installed, then the bottom holding wire brace

installed, and then the wires attached and tensioned. If this procedure is followed, the lower wire brace will not have to be twisted to tighten.

5. The diameter of the corner post should be as large as possible.

6. If one diagonal strainer will not hold the fence tension, a second diagonal strainer should be installed with each strainer taking half the tension of the fence (fig.3).

7 When using the diagonal strainer as a line brace, care must be exercised not to over-tension the brace wires. The vertical post can be jacked out of the ground.

IV. INSTALLATION

The installation of the fence shall conform to the figures and to the drawings. All posts shall be placed to the required depth and shall be firmly embedded so that there is less than 1 inch of horizontal movement at the top of post when a horizontal force of 80 lbs is applied. The completed job shall be workmanlike and present a good appearance. The installer and other persons will conduct all work in accordance with proper safety procedures.

V. BASIS OF ACCEPTANCE

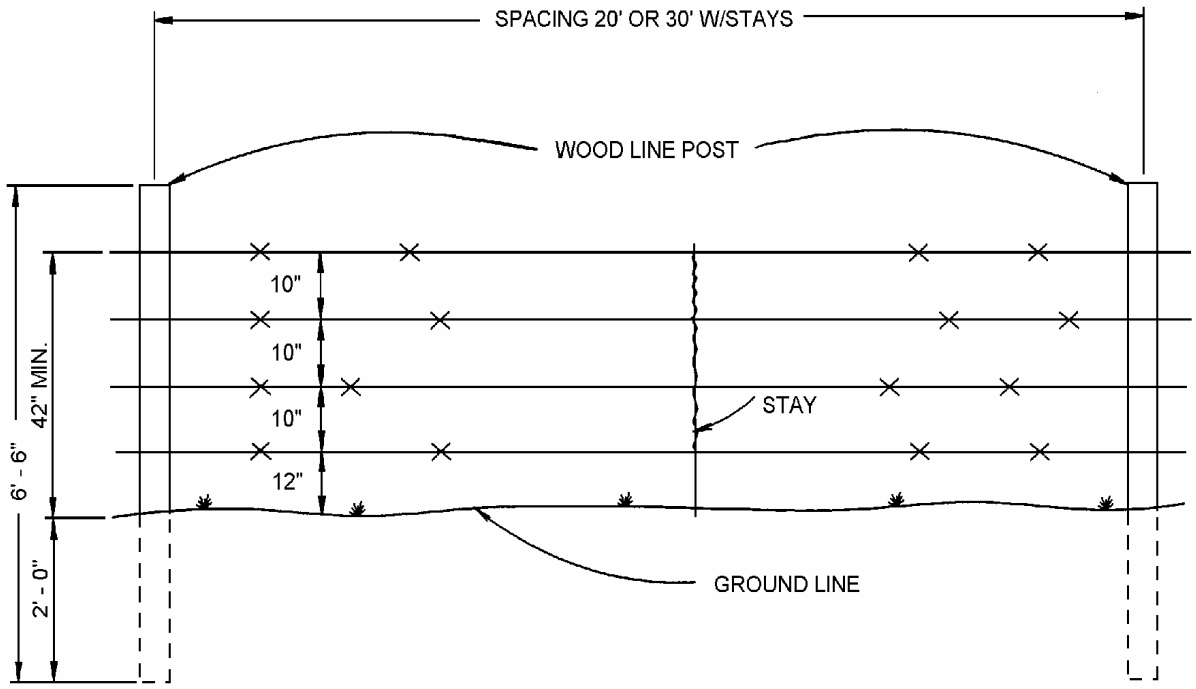
After the fence has been installed, a site inspection will be made to determine if the materials and placement adhered to the specification.

VI. MAINTENANCE

A properly maintained fence is an asset to your property. This practice will require you to perform periodic maintenance. Some items to be observed and corrected are:

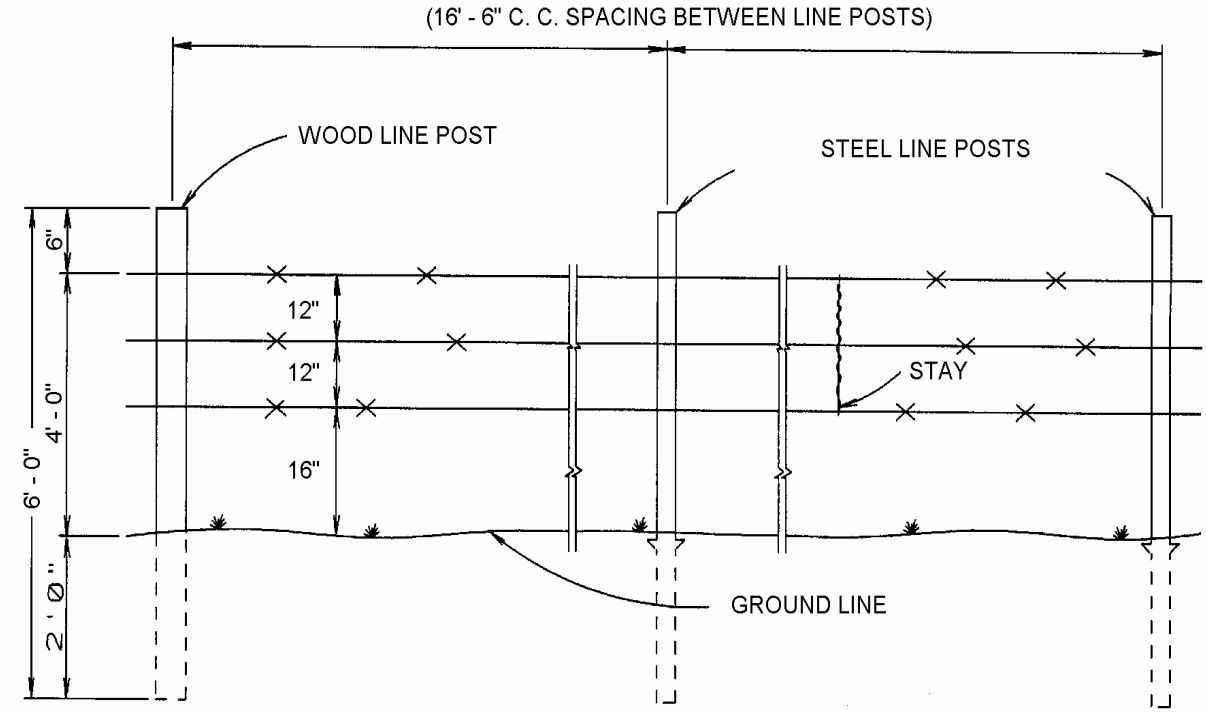
* tension of wire, broken wires.

* post alignment, post stability.



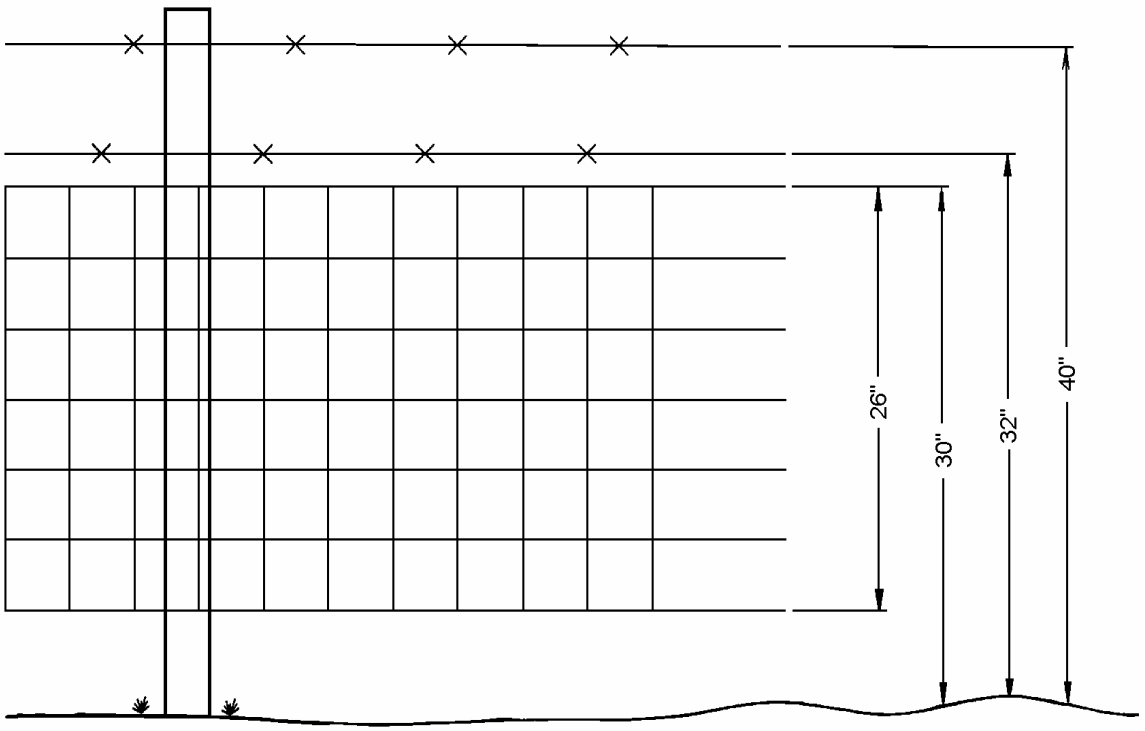
STANDARD 4 WIRE FENCE

FIGURE 1.



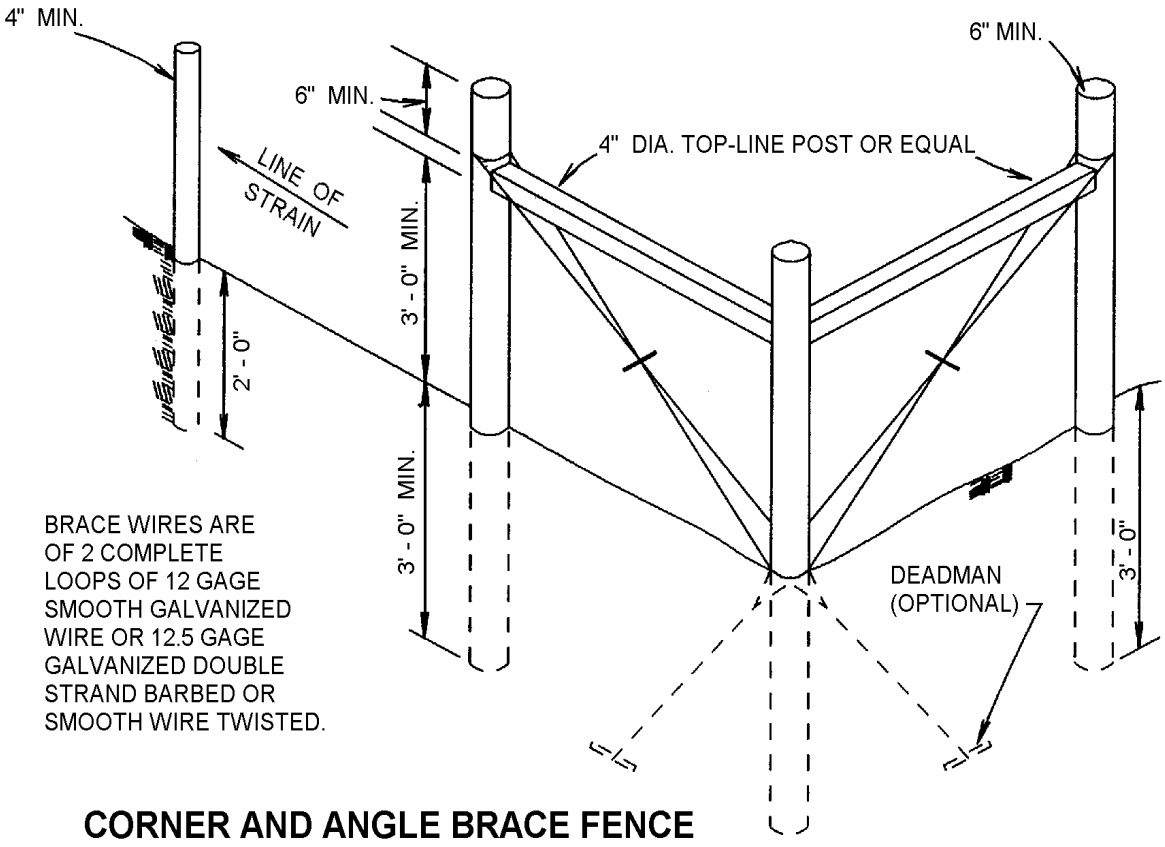
STANDARD 3 WIRE FENCE

FIGURE 2.

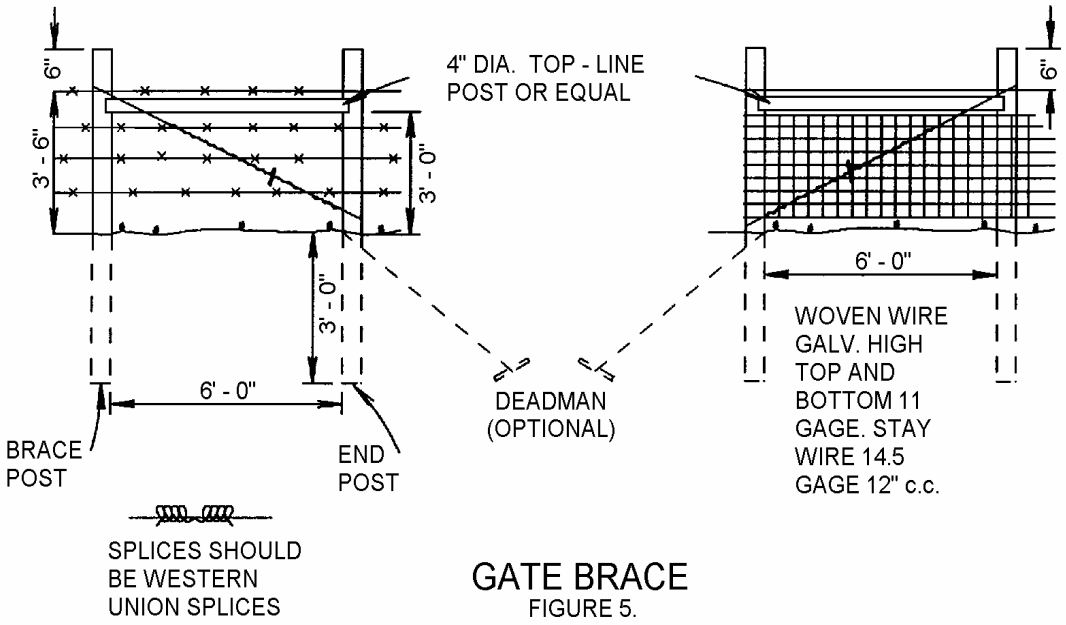


WOVEN WIRE WITH 2 STRANDS BARBED WIRE

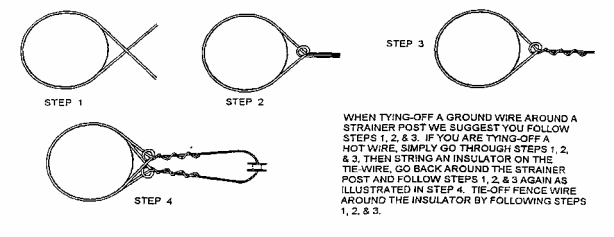
FIGURE 3.

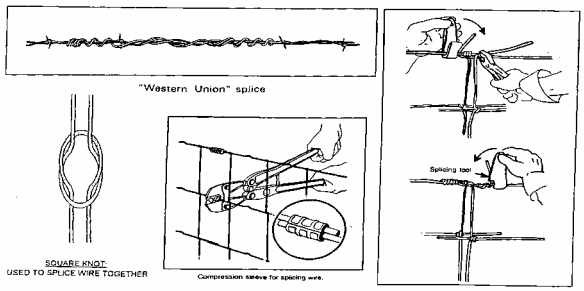


CORNER AND ANGLE BRACE FENCE
FIGURE 4.



GATE BRACE
FIGURE 5.


STEP 1
STEP 2
STEP 3
STEP 4
WHEN TYING-OFF A GROUND WIRE AROUND A STRAINER POST WE SUGGEST YOU FOLLOW STEPS 1, 2, & 3. IF YOU ARE TYING-OFF A HOT WIRE, SIMPLY GO THROUGH STEPS 1, 2, & 3, THEN STRING AN INSULATOR ON THE TIE-WIRE, GO BACK AROUND THE STRAINER POST AND FOLLOW STEPS 1, 2, & 3 AGAIN AS ILLUSTRATED IN STEP 4. TIE-OFF FENCE WIRE AROUND THE INSULATOR BY FOLLOWING STEPS 1, 2, & 3.


"Western Union" splice
SQUARE KNOT
USED TO SPLICE WIRE TOGETHER
Compression sleeve for spacing wire.
Splicing tool
FIGURE 6.
KNOTS

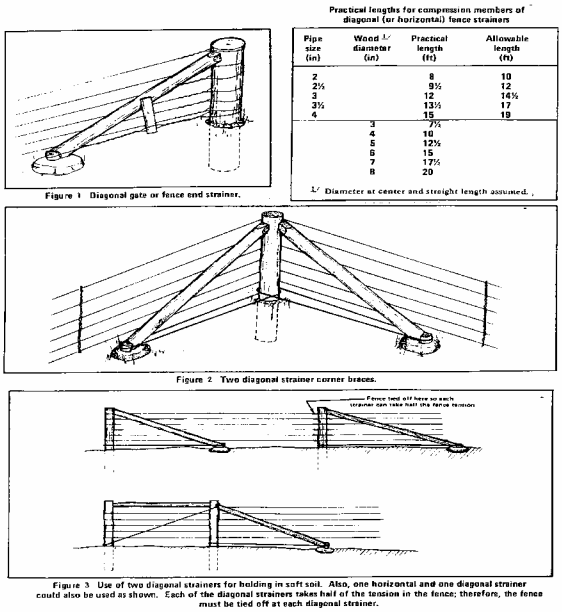

Practical lengths for compression members of diagonal (or horizontal) fence strainers
Pipe size (in) | Wood 1/ diameter (in) | Practical length (ft) | Allowable length (ft)
2 | | 8 | 10
2½ | | 9½ | 12
3 | | 12 | 14½
3½ | | 13½ | 17
4 | | 15 | 19
3	7½
4	10
5	12½
6	15
7	17½
8	20
1/ Diameter at center and straight length assumed.
Figure 1 Diagonal gate or fence end strainer.
Figure 2 Two diagonal strainer corner braces.
Figure 3 Use of two diagonal strainers for holding in soft soil. Also, one horizontal and one diagonal strainer could also be used as shown. Each of the diagonal strainers takes half of the tension in the fence; therefore, the fence must be tied off at each diagonal strainer.

FIGURE 7.

APPENDIX F:

DON'T BE A VECTOR:
FIELD METHODS TO AVOID SPREADING AMPHIBIAN DISEASES
(HEMINGWAY AND CHABRE 2006)

Appendix A: Decontamination Procedures

Don't Be A Vector:
Field Methods to Avoid Spreading Amphibian Diseases

Valentine Hemingway and Cammy Chabre
August 2006

Just as emerging infectious disease has become a prime concern for human health, new pathogens have become a concern for wildlife populations, including amphibians. Amphibians in our region have a variety of threats to contend with, from loss of habitat to poor water quality to introduced predators to a variety of diseases. Many researchers are beginning to find that synergisms between these threats pose unexpected consequences for amphibians. Until we understand what these threats mean to the amphibians in our region, we advise erring on the side of caution.

We have put together a list of recommendations that are easy to incorporate to your fieldwork routine. These recommendations are based on recent research and recommendations made by the USFWS. The main amphibian diseases that are of concern are chytrid and ranaviruses. By following these guidelines you will decrease the possibility of becoming a vector of these diseases. The goal is not to cease transmission of infection here, as this would be an impossibility for us at this time. Instead, the idea is not to increase the rate of transmission both between sites and at sites by our activities.

Recommendations

Between Sites

Option 1: Dedicated Equipment for Each Site

One strategy is to use dedicated equipment for each site. This includes waders, nets, boots, and any other equipment that may contact the site. Few will have the luxury of this option.

Option 2: Decontaminate Between Sites

When using the same equipment for different sites, decontaminate between sites. Also, if you do not wear waders and your skin and clothing come into contact with the water, mud, or other materials from the site, you should decontaminate clothing and skin between sites.

A. Use a **stiff bristle brush** to scrub off any organic debris, mud or dirt from your equipment while at the site. Use fresh, clean water for this scrubbing.

B. **Spray down**, soak, or wipe your equipment (nets, boots, waders, float tubes, boats, measuring devices, traps, syringes, etc.) with decontamination solution of choice. Dr. David Green of the USGS National Wildlife Health Center strongly recommends the use of household bleach as it is broad-spectrum, breaks down quickly, and it definitely kills both chytrid and ranavirus when used properly. If your skin or clothing has come in contact with

water or mud from the site, spray this also to kill pathogens you may be carrying. After the appropriate amount of time for the particular decontamination solution you are using (see below), **rinse the equipment with clean water** to avoid adding toxins to your next site. Applying the solution and rinsing should be done into a container to dispose of the effluent later or in a location where the effluent will not enter the water body, at least 100 feet/35 meters away from the water. We recommend garden sprayers as a convenient way to store, move, and apply fresh water and solution. Standing in a large Rubbermaid container while spraying will allow for the collection of the effluent and its safe disposal later.

C. Should you not be able to decontaminate equipment or clothing between sites, place those items in **waterproof bags or containers** to avoid potential contamination of the next site.

Decontamination of Vehicles:

If you are driving **vehicles** into the water bodies, drive 100 feet/35 meters away from the water body and spray the vehicle, especially the tires and undercarriage, with decontamination solution. If it is impossible to do this between each water body, at a minimum do it between catchments.

Dry Down Equipment Between Sites Not Recommended:

Drying down equipment between sites is another recommendation effective against chytrid, but this does not appear to be effective for all strains of ranavirus. Ranavirus can survive up to 90 days out of water. Thus, we recommend using one of the above procedures for decontamination between sites.

At Sites

Option 1: Bag Hands

When hand-catching animals, use a bag around your hand to catch the individual and hold it for processing. Some water in the bag can help dilute any peptides they may release that could be harmful to them. Individuals can be measured and weighed (if the bag does not contain water and other materials) and pittagged while in the bag. The bag can be used to hold amphibians to swab for chytrid. An added benefit to using these bags is they can be decontaminated later and reused. After trying a variety of bags, we recommend using "Kyjen UnScented Cornstarch Pooch Pickup Bags," available at Petsmart in Santa Cruz and online. They are thin enough to get a good hold while catching and have handles that can be tied to hold the amphibian until you are ready to process it. You can also write the site where the amphibian was caught on the bag for later release.

Option 2: Use Gloves

Use nitex, latex, or vinyl gloves to catch and process each animal singly. Gloves should be changed between animals by pulling them off, making them inside out, and disposed of properly after use (i.e. soaked in decontamination solution or autoclaved and disposed.)

water or mud from the site, spray this also to kill pathogens you may be carrying. After the appropriate amount of time for the particular decontamination solution you are using (see below), **rinse the equipment with clean water** to avoid adding toxins to your next site. Applying the solution and rinsing should be done into a container to dispose of the effluent later or in a location where the effluent will not enter the water body, at least 100 feet/35 meters away from the water. We recommend garden sprayers as a convenient way to store, move, and apply fresh water and solution. Standing in a large Rubbermaid container while spraying will allow for the collection of the effluent and its safe disposal later.

C. Should you not be able to decontaminate equipment or clothing between sites, place those items in **waterproof bags or containers** to avoid potential contamination of the next site.

Decontamination of Vehicles:

If you are driving **vehicles** into the water bodies, drive 100 feet/35 meters away from the water body and spray the vehicle, especially the tires and undercarriage, with decontamination solution. If it is impossible to do this between each water body, at a minimum do it between catchments.

Dry Down Equipment Between Sites Not Recommended:

Drying down equipment between sites is another recommendation effective against chytrid, but this does not appear to be effective for all strains of ranavirus. Ranavirus can survive up to 90 days out of water. Thus, we recommend using one of the above procedures for decontamination between sites.

At Sites

Option 1: Bag Hands

When hand-catching animals, use a bag around your hand to catch the individual and hold it for processing. Some water in the bag can help dilute any peptides they may release that could be harmful to them. Individuals can be measured and weighed (if the bag does not contain water and other materials) and pittagged while in the bag. The bag can be used to hold amphibians to swab for chytrid. An added benefit to using these bags is they can be decontaminated later and reused. After trying a variety of bags, we recommend using "Kyjen UnScented Cornstarch Pooch Pickup Bags," available at Petsmart in Santa Cruz and online. They are thin enough to get a good hold while catching and have handles that can be tied to hold the amphibian until you are ready to process it. You can also write the site where the amphibian was caught on the bag for later release.

Option 2: Use Gloves

Use nitex, latex, or vinyl gloves to catch and process each animal singly. Gloves should be changed between animals by pulling them off, making them inside out, and disposed of properly after use (i.e. soaked in decontamination solution or autoclaved and disposed.)

c. Enclosures and tanks
d. Dr. David Green of the USGS National Wildlife Health Center strongly recommends the use of household bleach as it is broad-spectrum, breaks down quickly, and it definitely kills both chytrid and ranavirus when used properly.
*Not tested against ranavirus

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