Denise Duffy & Associates, Inc.
PLANNING AND ENVIRONMENTAL CONSULTING

2012 Grassland Monitoring Report
Palo Corona Regional Park

September 2012

Prepared for:

Monterey Peninsula Regional Parks District
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Introduction

Denise Duffy and Associates, Inc. (DD&A) was contracted by the Monterey Peninsula Regional Park District (District) to complete grassland monitoring surveys at the Palo Corona Regional Park (Park), located just south of the Carmel River in Monterey County, California (Figure 1). The emphasis of the surveys was to collect vegetation data within established monitoring plots in order to evaluate the progress of the biological goals and objectives outlined in the *Grassland Management Plan for the Palo Corona Regional Park* (Management Plan; McGraw, 2007) and the *Grassland Management Plan for Palo Corona Regional Park: Updated Grassland Monitoring Program* (Updated Plan; McGraw, 2010).

Background

The Palo Corona Regional Park is a 4,300 acre area protected to preserve its exceptional biodiversity values, which include a diverse mosaic of ecological communities and regionally significant populations of several rare and endangered species. Of particular concern are the Park's estimated 1,400 acres of coastal prairie grassland – a unique and diverse community that supports a high proportion of endemic plants and provides habitat for several rare and endangered animals (McGraw, 2010).

In 2007, the District, with funding and planning assistance from The Big Sur Land Trust and The Nature Conservancy (henceforth referred to collectively as the Managing Partners), adopted the Management Plan, which identified management strategies and techniques designed to maintain or enhance the distribution, native plant community structure and species composition, and special-status species populations of the grassland associations within the Park (McGraw, 2010). The Management Plan also included an adaptive management program that included quantitative monitoring of plant community composition and structure to evaluate the effectiveness of grazing prescriptions at enhancing native species diversity and abundance.

The monitoring protocols outlined in the Management Plan were implemented in 2008 by Dr. Hall Cushman of Sonoma State University, who produced a monitoring report entitled *Assessing the Influence of Cattle Grazing on Vegetation at Palo Corona Regional Park* (Cushman, 2008). However, the Managing Partners identified issues associated with the long-term use of the study to monitor grazing effects and effectiveness. These issues included funding concerns and changes to the grazing regime outlined in the Management Plan. Therefore, in 2010, the Updated Plan was prepared to address these issues and provide revised monitoring protocols. Specifically, the revised monitoring will be used to evaluate grazing effects across the site, rather than according to the specific grazing prescriptions. The following report documents the implementation of the revised monitoring protocols outlined in the Updated Plan, reports and discusses the results in the context of the stated monitoring objectives and adaptive management triggers, and provides recommendations for future management and monitoring of the Park's Grasslands.

Monitoring Goals and Objectives

Two monitoring protocols are outlined in the Updated Plan:

1. Quantitative monitoring of plant community composition and structure and
2. Aerial extent mapping of the grasslands.

The District contracted with DD&A to complete the quantitative monitoring only.

Title: **Location Map**

File: Location Map.mxd

Date: 09-20-12

Scale: 1 in=2.85 mi

Project: 2012-02 PCRP Grass

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Figure 1

The stated monitoring objectives of the updated plan are to evaluate the status of the following plant community structure and composition variables in order to track grassland condition:

1. Abundance and richness of native grassland plants,
2. Frequency and abundance of invasive exotic plants, and
3. Abundance of woody vegetation encroaching from adjacent scrubland and woodland.

Abundance refers to the relative cover of a given species or functional group such as natives or exotics within a sampling area. Frequency refers to how often a species or functional group is identified as present.

The variables identified to be monitored in the Updated Plan are as follows:

- Plant Community Composition (plant cover),
- Plant Height and Litter Depth,
- Species Richness (species list),
- Woody Plants, and
- Biomass.

Methods

The methods used to collect the data for this report followed the Updated Plan except for the following variances:

- The District established 30 paired monitoring plots within grassland areas of the Park. One of these plots could not be located by the District in 2012 (plot 4-5). As a result, DD&A sampled only 29 paired plots[1], for a total of 58 plots (Figure 2).
- The term 'mean abundance' and 'abundance' are used in the updated plan to refer to the calculation of percent cover by species or functional group by combining the total number of point interceptions collected in the field. To more clearly and accurately describe the data, the terms absolute and relative cover are being used in this document. Mean abundance will still be used when text from the updated plan is inserted into this report. This is done in an effort to be as literal as possible in linking the monitoring data and results to the goals, objectives, and adaptive management triggers as possible.
- Individual stem counts of woody plant data were not collected as outlined in the Updated Plan because it was infeasible due to cover density. In addition, it was determined that stem counts did not provide meaningful information relevant to woody plant encroachment as it said nothing about cover and therefore nothing about its relative effect of total plant cover. Monitoring objectives and variables relevant to woody plants were analyzed using the point intercept data. This method provides a more accurate and complete measure of the potential effects of grazing on the presence or absence of woody plant within the plots and the potential encroachment of scrubland replacing grassland.

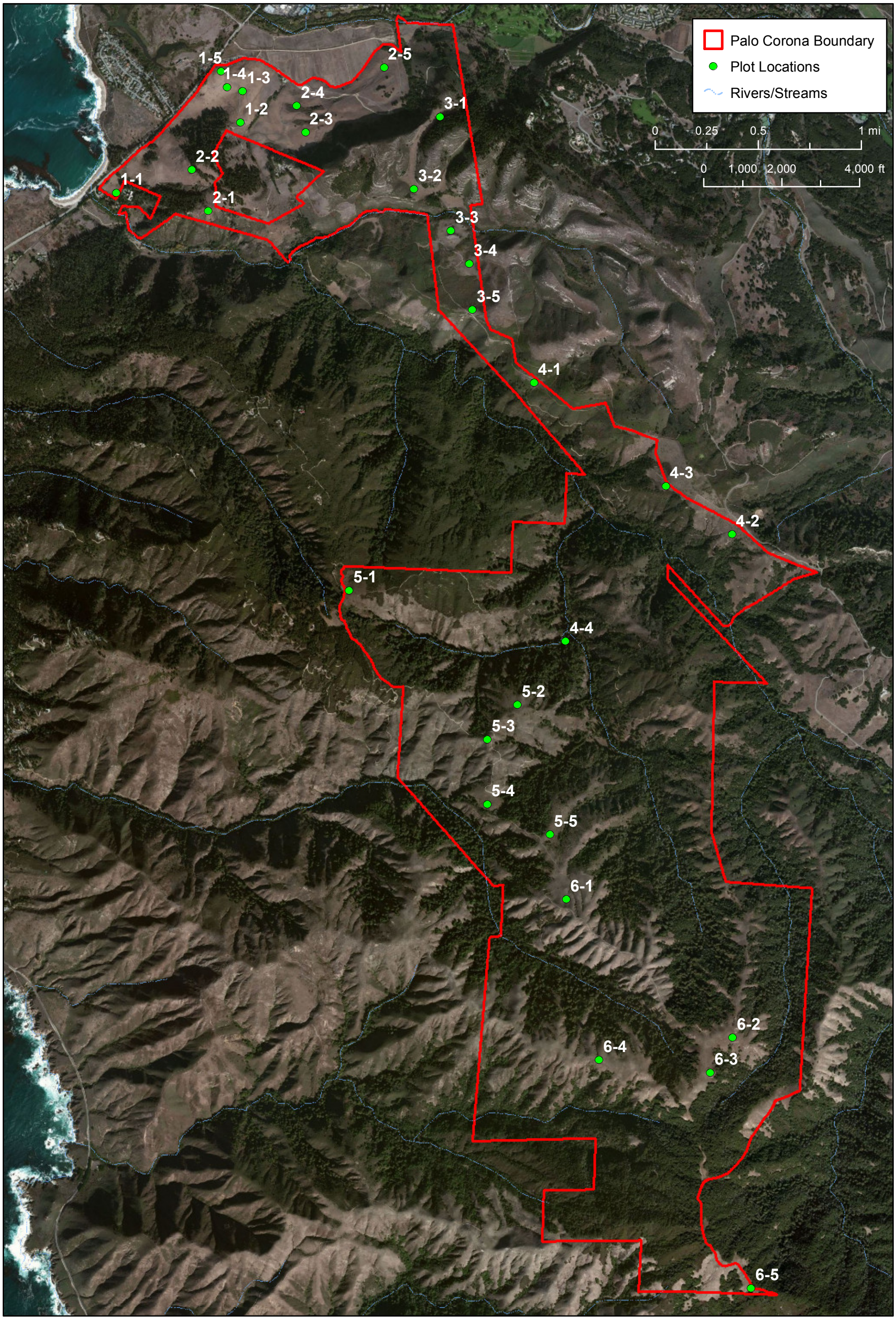
Field Surveys

Field surveys were conducted on 11 days from May 1-18, 2012. Surveys were conducted by DD&A Senior Environmental Scientist/Project Manager, Josh Harwayne, and DD&A Assistant Environmental Scientist, Jami Davis, with the assistance of local Biologist, David Keegan. Each paired plot was sampled, and all data was taken on the same day, except for plots 1-5 and 4-4, where litter depth data was collected two days later than all other data. The following outlines the type of data collected for each plot and the methodology for collection.

Point-Intercept Transects (plant cover)

Each plot included five established transects spaced 1.25 m apart and marked by rebar. A rope was placed between the rebar which was pre-marked every 0.25 m, beginning and ending one meter in from each end (Figure 3). A sampling frame was set over the transect and a dowel was pushed down into the vegetation (Photo 1). The first individual plant intercepted by the dowel was recorded for each intercept point. Data collected for each live plant intercept point includes; height, origin (native or exotic), growth form (grass, forb, or woody plant[2]), and life cycle (annual or perennial[3]) for the individual plant. If dead vegetation was the first thing touch the dowel, "thatch" was recorded. If no vegetation was touched, "bare ground" was recorded. For each plot, 125 data points (five transects, 25 points per transect) were collected. The data were recorded on data sheets, using a six-letter code for each species that included the first three letters each of the genus and species (e.g. *Bromus diandrus* = BRODIA). In some plots,

[1] Please note that "paired plot" refers to the control and fenced plots adjacent to each other (e.g. Paired Plot 1-2 = Plot 1-2 Control and Fenced collectively), while "plot" refers to an individual 8x8 meter plot (e.g. Plot 1-1 Control or Plot 1-1 Fenced).
[2] Woody plants include shrub, tree, woody vines (blackberry [*Rubus ursinus*]), and fern species.
[3] Please note that biennial species were considered perennial for this analysis.



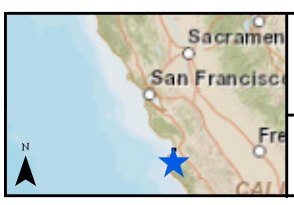
	Title: Plot Locations File: Plot Location Map.mxd	Date: 6-12-12 Scale: 1 inch = 2,201 feet Project: 2012-02 PC Grassland	Monterey | San Jose **Denise Duffy and Associates, Inc.** Environmental Consultants Resource Planners 947 Cass Street, Suite 5 Monterey, CA 93940 (831) 373-4341	Figure 2

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Figure 3. Transect Setup Within Each Plot

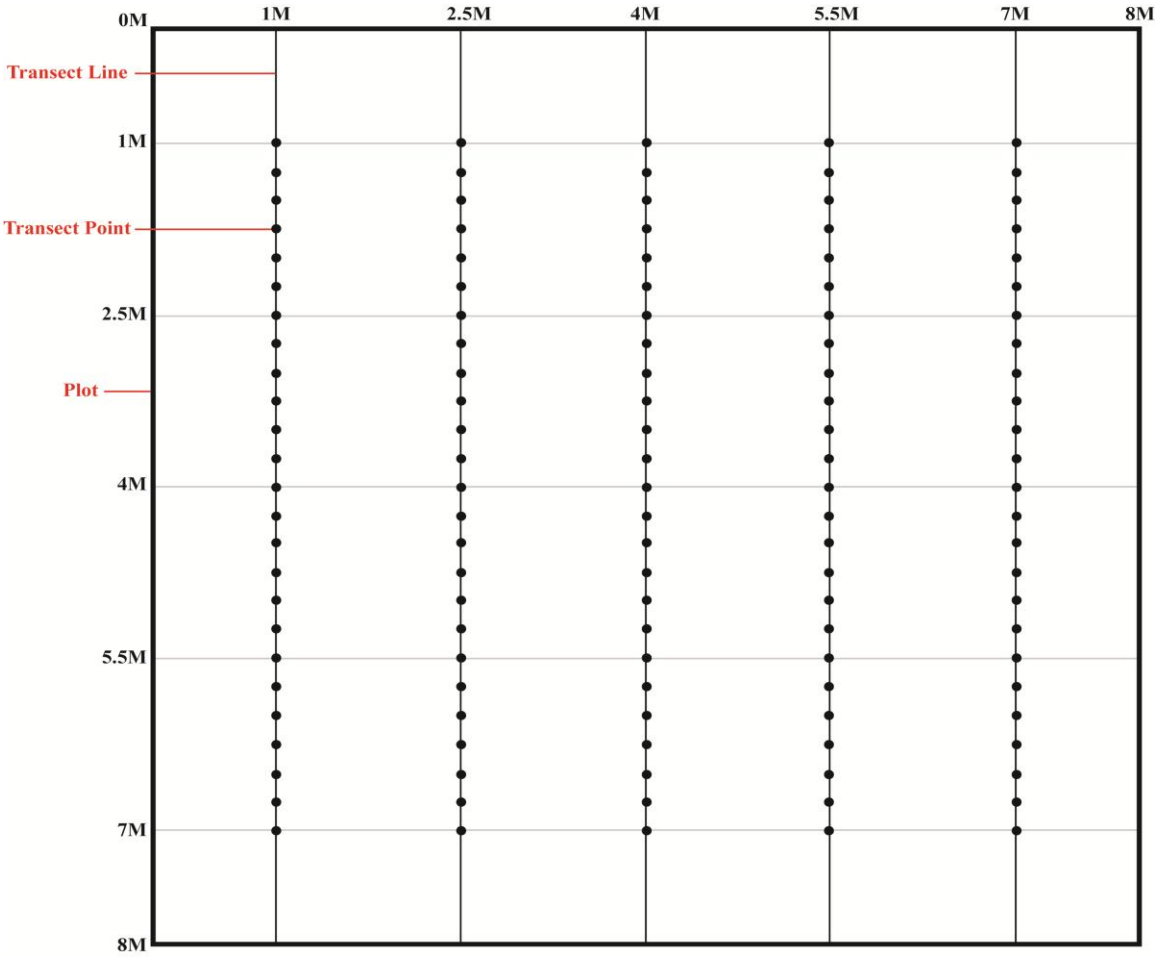


Photo 1. Sampling Frame

however, it was not possible to collect data due to the nature of the plants in the plot (e.g. it was too hazardous to enter and collect data in plots that were covered almost completely with milk thistle [*Silybum marianum*]). In these instances, an estimate of the percent cover of the most dominant species within the plot was recorded. This method was used for the following plots: 2-3 Fenced, 2-4 Fenced, 2-4 Control, and 2-5 Fenced.

Most species were identified in the field using *An Illustrated Field Key to the Flowering Plants of Monterey County and Ferns, Fern Allies, and Conifers* (Matthews, 2006). However, some species could not be identified in the field; therefore, samples were taken from within the plot (not from the transects) and keyed in the office. Of the individual plants found during the study, only two were not able to be identified further than genus (*Cryptantha* sp. and *Festuca* sp.), and one was not able to be identified further than family (Unknown Composite – *Asteraceae* family) because it was not blooming during the time of the survey.

Mean Recorded Plant Height

Height was recorded for each intercept data point. The height measurement was taken by recording the height at which the recorded species or thatch touched the dowel.

Litter Depth

Liter and thatch are used interchangeably. Litter depth measurements were taken at four random locations within each plot. The locations were identified using random numbers (from a computer generated table) as X and Y coordinates within the plot, using each of the four corners of the plot as starting points. Measurements were taken by placing a sharpened wooden dowel down into the thatch and measuring the depth of liter in mm. However, in some plots it was not possible to collect thatch depth due to the nature of the plants in the plot. Litter depth was not collected in the following plots: 2-3 Fenced, 2-4 Fenced, 2-4 Control, and 2-5 Fenced. In addition, one litter depth point is missing from Plot 6-1 Fenced.

Species Richness

A species list was generated for each plot by recording all species found within the plot, whether on or off the transects. Plants included on the species list were assigned an origin, growth form, and life cycle. Similar to the plants found on the transects, most species were identified in the field; however, this was not possible for some species and samples were taken to be keyed in the office.

Woody Plants

Data was collected via the point-intercept methodology for woody plants.

Biomass

Biomass samples were collected at two randomly selected points within each plot. The random points were generated and located in the same manner as described above for the Litter Depth samples, except only two opposite corners were used as starting points, instead of all four. Additionally, if the sample location was directly on a transect, the location was adjusted slightly to be outside of the transect, so as not to alter future transect studies. In addition, in some plots it was not possible to collect biomass data due to the nature of the plants in the plot (e.g. it was too hazardous to enter and collect samples from plots that were almost completely covered with milk thistle). Biomass data was not collected in the following plots: 2-3 Fenced, 2-4 Fenced, 2-4 Control, and 2-5 Fenced.

Samples were taken by cutting all vegetation down to the ground within a 13.5 inch diameter circle, which was measured using a pre-measured cardboard disc. The samples from each of the plots were then combined and air dried. Once dry, the samples were weighed.

Data Analysis

Following the field surveys, all data collected were entered into Excel spreadsheets for analysis. The following outlines the analyses conducted.

Plant Community Composition (Percent Cover)

The term 'mean abundance' and 'abundance' are used in the updated plan to refer to the calculation of percent cover by species or functional group by combining the total number of point interceptions collected in the field for control and fenced plots. To more clearly and accurately describe the data the terms absolute and relative percent cover are being used in this document. Thatch and bare ground were included in the queries for absolute cover. These were not included in queries for relative cover. Queries were run to determine the following results:

- Absolute Percent Cover by Growth Form,
- Absolute Percent Cover of Grass Species,
- Absolute Percent Cover of Forb Species,
- Absolute Percent Cover of Woody Plant Species,
- Absolute Percent Cover by Origin and Life Cycle, and
- Overall Absolute Percent Cover.

Mean Recorded Height

A mean of all height measurements was calculated for the fenced and control plots.

Mean Litter Depth

A mean of all litter depth measurements was calculated for the fenced and control plots.

Species Richness

The number of species in each plot was counted and separated out for origin, growth form, and life cycle. Queries were run to determine the following results:

- Mean Species Richness by Origin and Life Cycle
- Mean Species Richness by Origin
- Mean Species Richness by Growth Form

Woody Plants

Absolute percent woody plant cover was calculated from the plant community composition data.

Above-Ground Plant Biomass

The weight of each sample was converted from grams (g) to g/m^2 using the following formula:

1 sample = 143.14 in^2 = 0.1m^2

2 samples/plot = 0.2m^2

Combined sample weight (g) x 0.2m^2 = g/m^2

The recorded weights were summed to determine the above-ground plant biomass for the fenced and control plots.

Adaptive Management Analysis

The Updated Plan outlines three triggers for adaptive management responses:

1. Mean abundance and/or richness of native grassland herbs is 20% lower in control plots,
2. Invasive exotic plant cover exceeds 5% in any one plot, and
3. Woody plant cover exceeds thresholds set for each grassland association in any one plot (i.e., 30% for moist perennial grassland, 20% for subshrub grassland, and 10% for ridge grasslands).

As such, data analysis was conducted to determine if the thresholds for the triggers have been reached. Queries were run to determine the following results:

- Relative Percent Herbaceous Species Cover by Origin and Life Cycle,
- Mean Herbaceous Species Richness by Origin,
- Absolute Percent Cover of Invasive Exotic Plants (within each plot),
- Relative Percent Cover of Invasive Exotic Plants,
- Absolute Percent Cover of Woody Plants by Grassland Types, and
- Relative Percent Cover of Woody Plants,

Please note that a list of invasive plant species for adaptive management consideration was generated by referencing the 2007 Grazing Plan and the California Invasive Plant Inventory (California Invasive Plant Council [Cal-IPC], 2006). The 2007 Grazing Plan lists a handful of species for adaptive management consideration; these are Jubata grass, French broom, poison hemlock, Harding grass, invasive thistles, invasive mustards, and invasive forbs. An analysis was conducted for these species, as well as for other exotic plants encountered within the plots that were rated as "High" or "Moderate" on the Cal-IPC list. A "High" rating is defined by Cal-IPC as species that "have severe ecological impacts on physical processes, plant and animal communities, and vegetation structure; their reproductive biology and other attributes are conducive to moderate to high rates of dispersal and establishment." A "Moderate" rating is defined as species that "have substantial and apparent – but generally not severe – ecological impacts on physical processes, plant and animal communities, and vegetation structure; their reproductive biology and other attributes are conducive to moderate to high rates of dispersal, though establishment is generally dependent upon ecological disturbance." In addition, three species that were rated "Limited" by Cal-IPC were included in the analysis based on their local abundance and potential to present a high impact to the local habitat. Appendix A presents a list of exotic species encountered within the plots and their Cal-IPC rating.

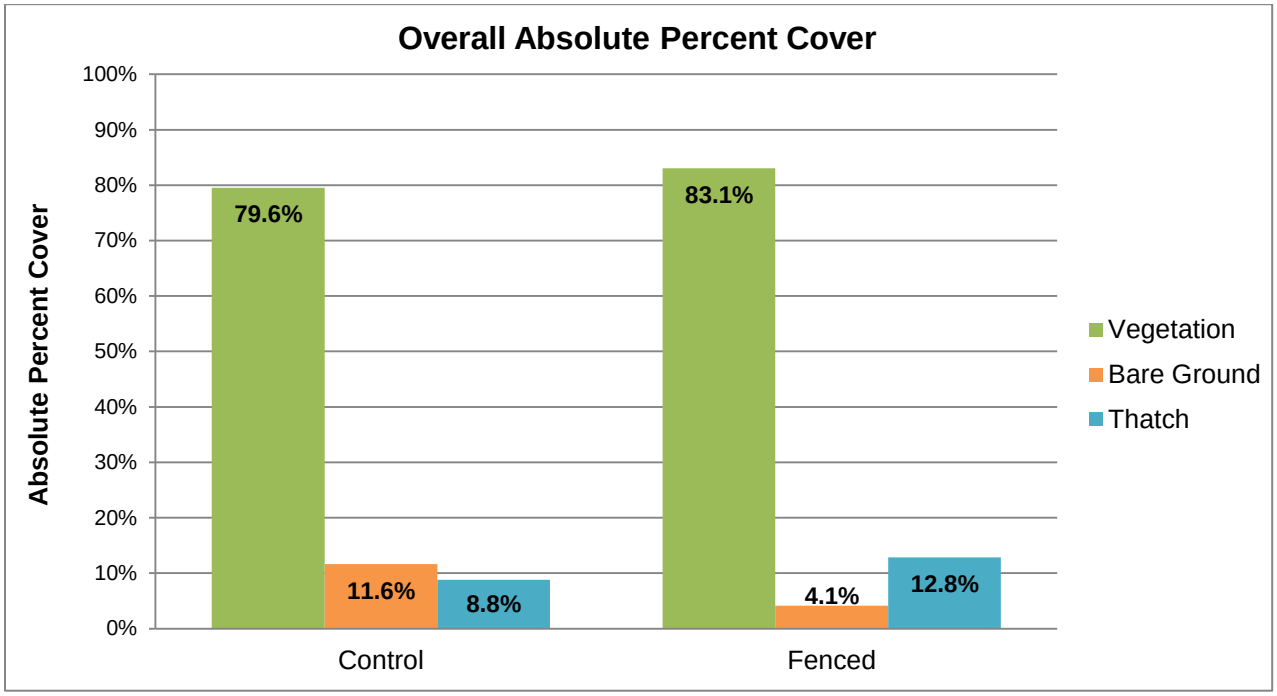
Results

All results compare the fenced and control plots. A complete list of plant species identified within the plots is included in Appendix B.

Plant Community Composition:

Absolute vegetative cover was very similar, but slightly higher (4%[4]) in the fenced areas compared to the control areas (Chart 1). Bare ground was almost three times higher in the control plots (183%), while thatch was 45% higher in the fenced plots.

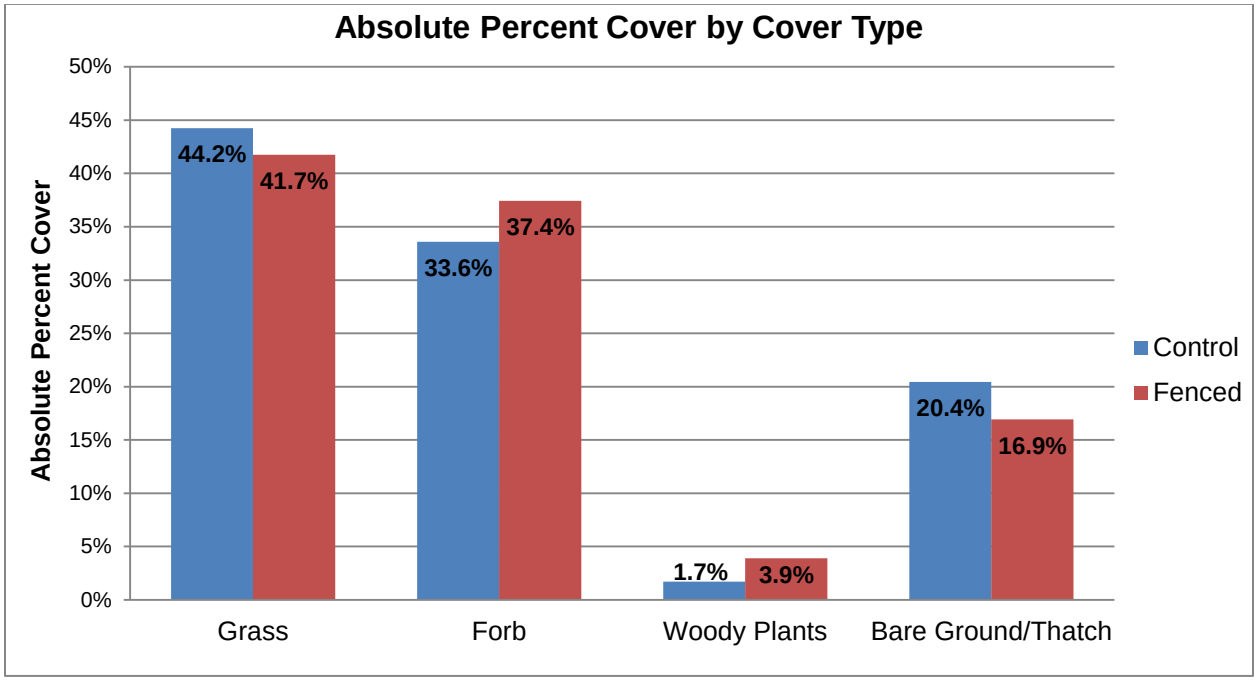
Chart 1. Overall Absolute Percent Cover



[4] Percent difference is calculated using the following formula: $$d_r = \frac{|x-y|}{\left(\frac{|x|+|y|}{2}\right)}.$$

Cover of woody plants was more than double (129%) in the fenced areas compared to the control areas, but contributed only a fraction of the cover for both (Chart 2). The fenced areas had about 11% greater cover of forbs and 6% less cover of grass than the control areas.

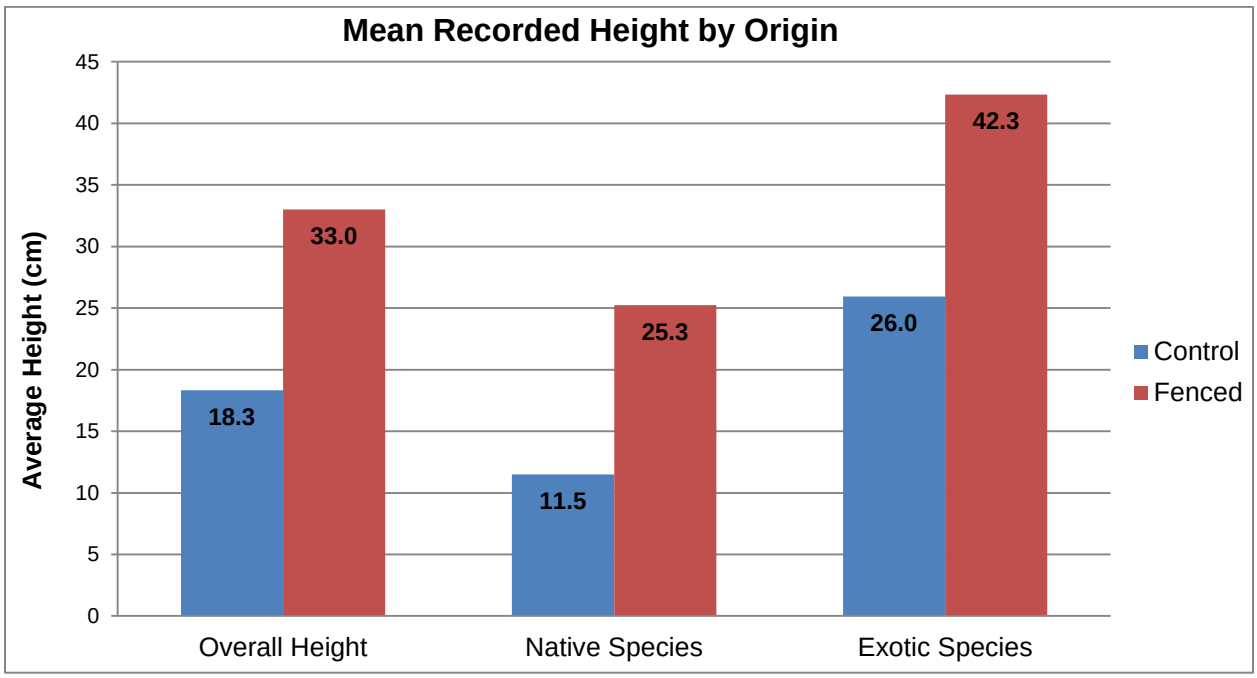
Chart 2. Absolute Percent Cover by Cover Type



Mean Recorded Height

Overall mean recorded height was nearly two times greater (80%) in the fenced areas compared to the control areas (Chart 3). This was consistent for both native and exotic species.

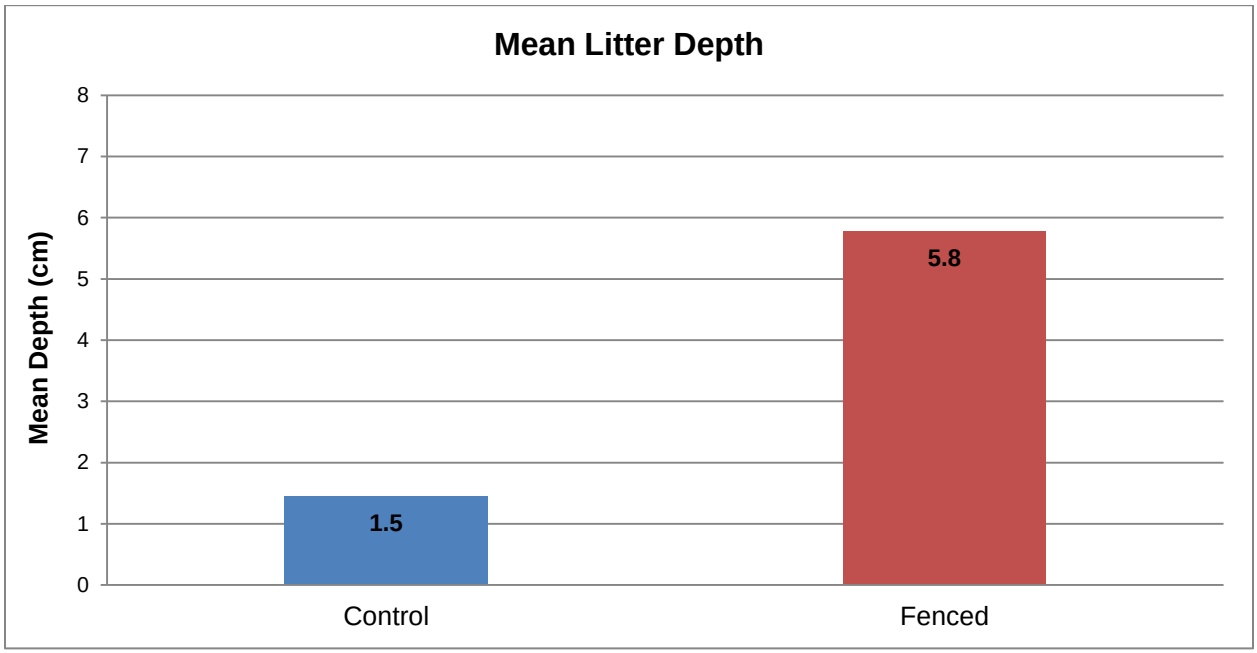
Chart 3. Mean Recorded Height



Mean Litter Depth

Mean litter depth was almost four times greater (287%) in the fenced areas compared to the control areas.

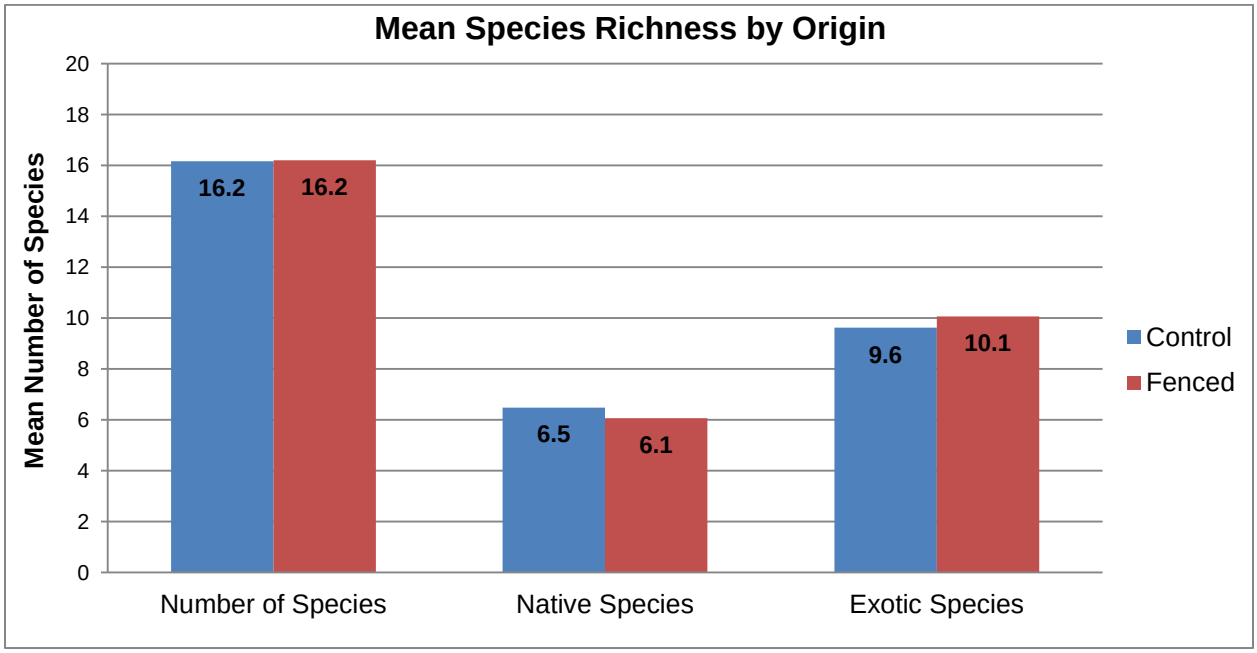
Chart 4. Mean Litter Depth



Species Richness

Overall mean species richness was the same between the control and fenced plots (Chart 5). However, there was 7% greater native species richness and 5% less exotic species richness in the control plots compared to the fenced plots.

Chart 5. Mean Species Richness by Origin



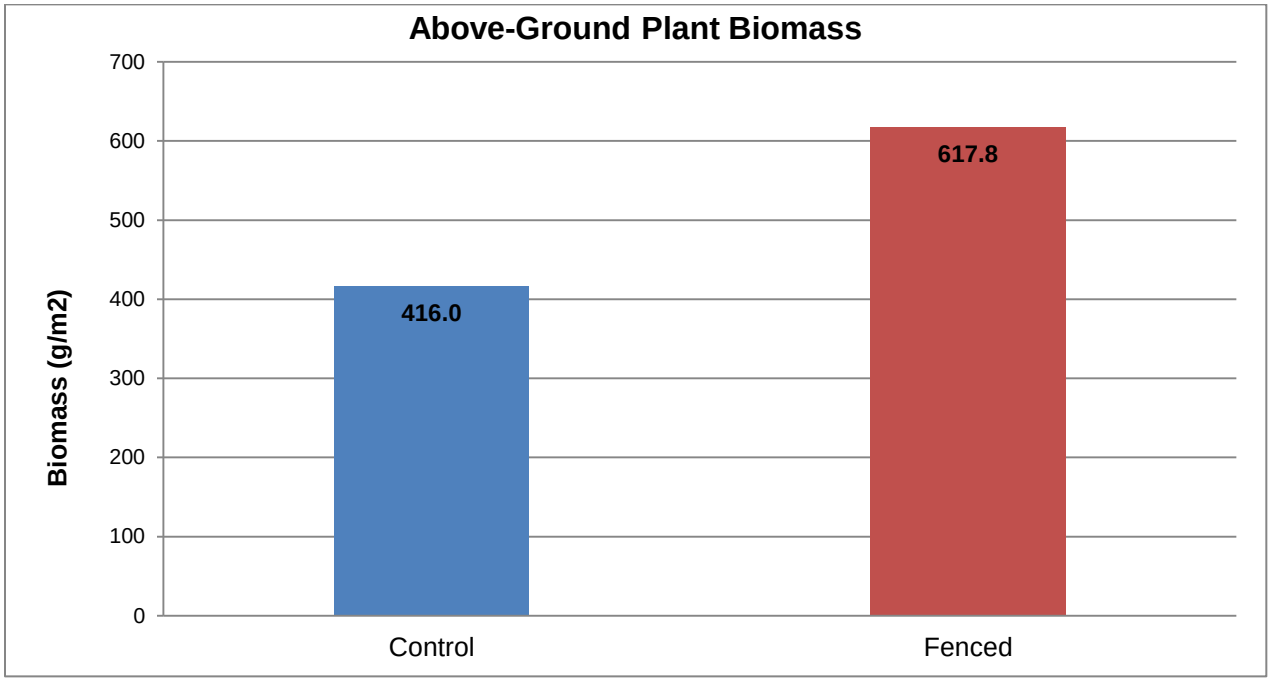
Woody Plants

Please refer to Chart 2 above which shows 129% greater absolute percent cover of woody plant in the fenced plots compared to the control plots.

Above-Ground Plant Biomass

Above–ground biomass was 49% greater in the fenced areas compared to the control areas (Chart 6).

Chart 6. Above-Ground Plant Biomass



Adaptive Management

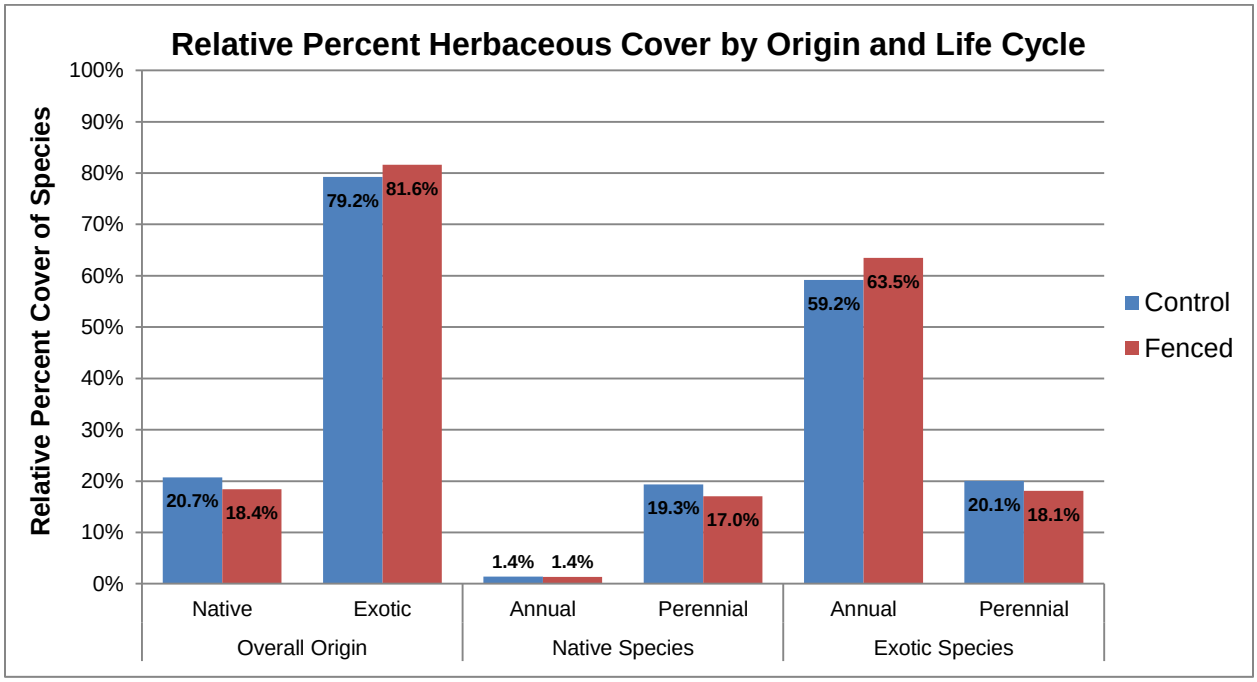
The stated triggers for the implementation of adaptive management responses in the Updated Plan are:

1. Mean abundance and/or richness of native grassland herbs is 20% lower in control plots,
2. Invasive exotic plant cover exceeds 5% in any one plot, and
3. Woody plant cover exceeds thresholds set for each grassland association in any one plot (i.e., 30% for moist perennial grassland, 20% for subshrub grassland, and 10% for ridge grasslands).

Mean Abundance

As described above in the Methods Section, mean abundance is a representation of percent cover. Herbs are defined as herbaceous species, which includes forbs and grasses. Ferns and woody vines such as blackberry are considered woody species for the purposes of this report. The relative cover of native herbaceous species is approximately 13% greater in the control plots (Chart 7). No adaptive management is required.

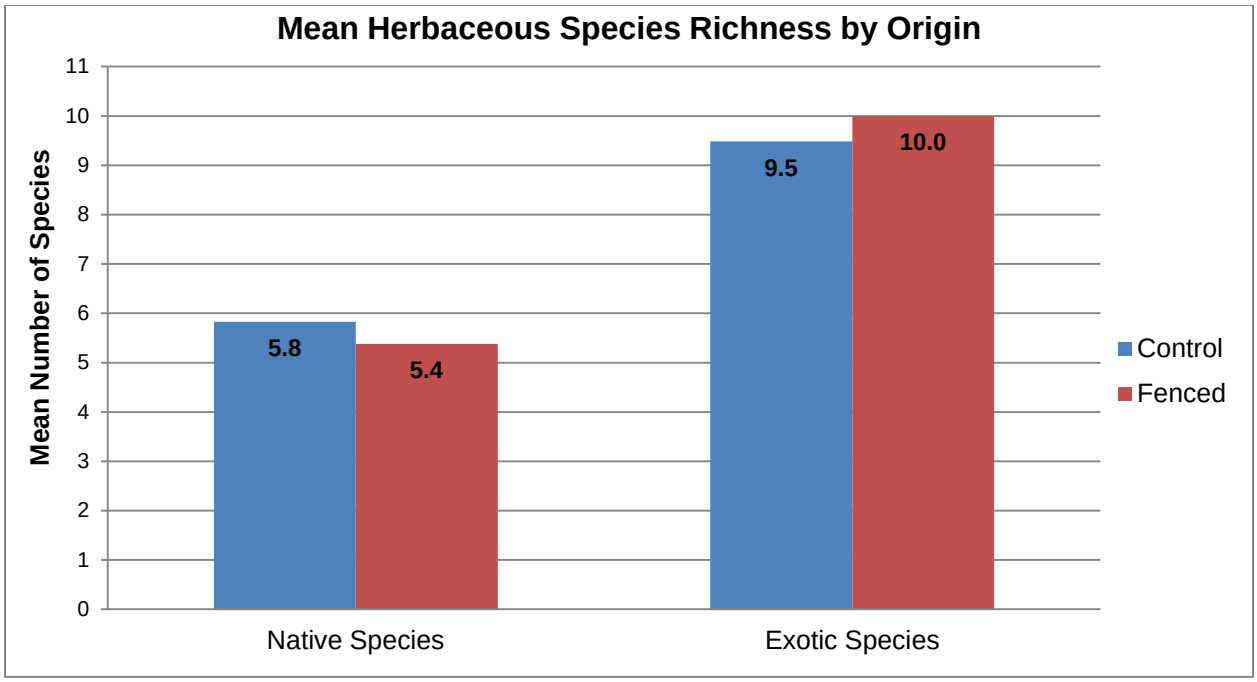
Chart 7. Relative Percent Herbaceous Cover by Origin and Life Cycle



Mean Richness

Mean species richness of native herbaceous species is approximately 7% greater in the control plots (Chart 8). No adaptive management is required.

Chart 8. Mean Herbaceous Species Richness by Origin



Invasive Exotic Plant Cover

The vast majority of plots contain invasive exotic plant cover far greater than the 5% threshold set for adaptive management (Chart 9). However, this threshold is neither achievable nor appropriate for the purposes of adaptive management in the context of grazing management. The stated purpose of adaptive management is to use a study design that allows analysis of change due to management and therefore evaluation of management effectiveness. It is not possible to identify if the percent cover of exotic invasive plant species within a plot is a function of grazing management without knowing what the baseline condition was prior to the management and performing a relative comparison between grazed and ungrazed plots. As a result, no evaluation of management effectiveness can be performed using the stated threshold because there is no relative measure of comparison. A much more effective trigger, which is consistent with the adaptive management program's purpose and the goals and objectives outlined in the updated plan, is as follows:

- Invasive exotic plant cover is 5% higher in Control (grazed) plots compared to Fenced (ungrazed).

This suggested threshold would evaluate the relative difference in cover between grazed and ungrazed plots. The percent difference calculated would be an effect linked to management, independent of baseline conditions, and therefore could be used to evaluate management effectiveness. If this trigger were to be reached it would indicate that the grazing management was resulting in a significant increase in invasive exotic plant cover compared to no management. If this were the case, it would be appropriate and important to modify the management through an adaptive management approach. While invasive exotic plant cover did exceed the thresholds set in the Updated Plan in many plots, invasive exotic plant

cover was higher, not lower, in the fenced plots compared to the control plots (Chart 10). As a result, it did not exceed the suggested threshold. No adaptive management is recommended.

Chart 9. Absolute Percent Cover of Invasive Exotic Species

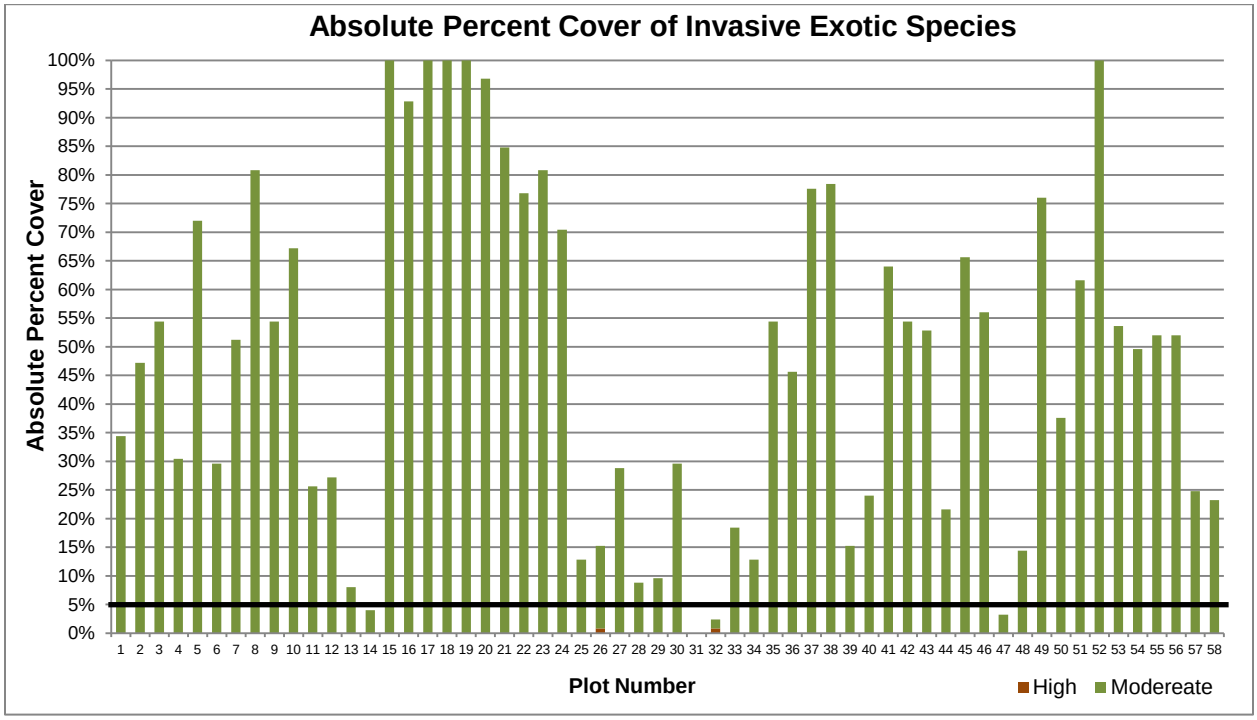
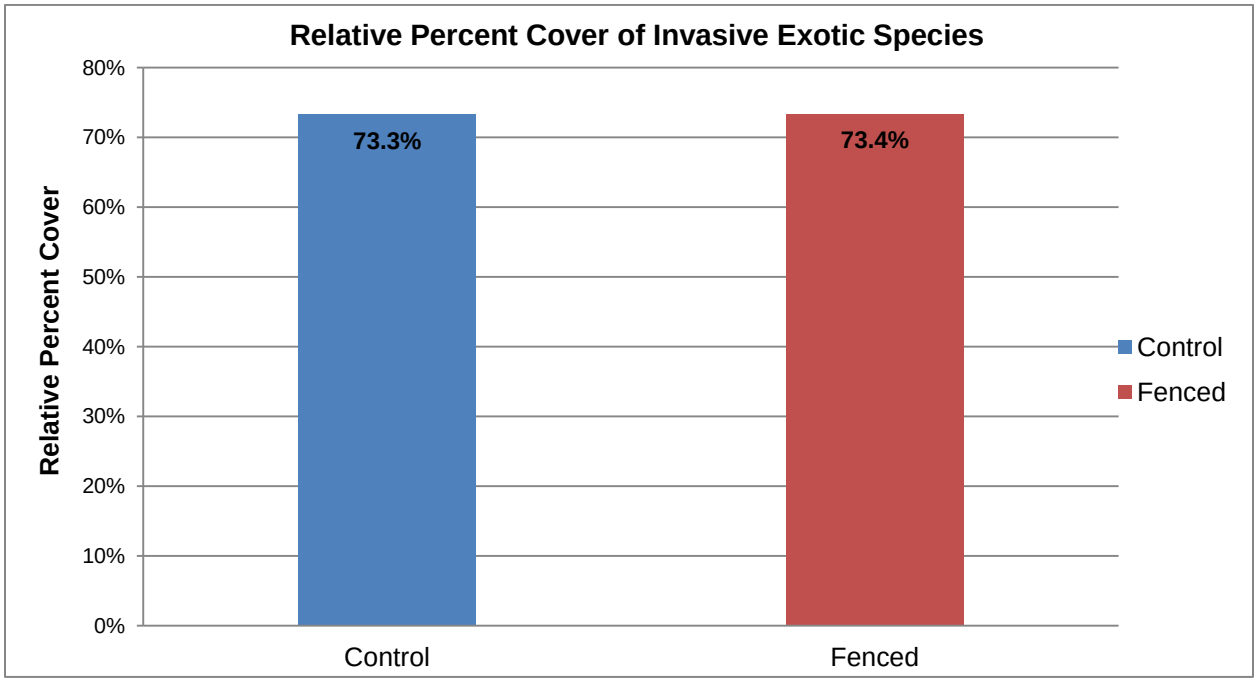


Chart 10. Relative Percent Cover of Invasive Exotic Species



Woody Plant Cover

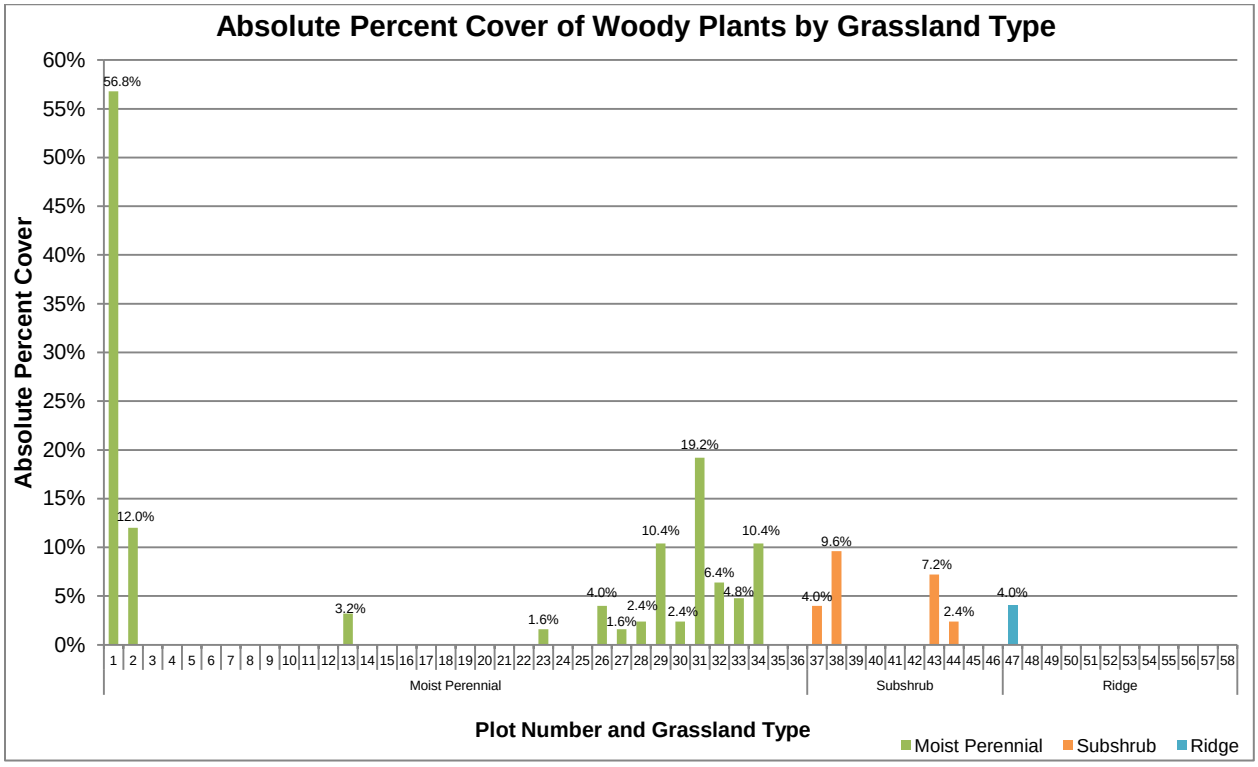
The adaptive management threshold stated in the Updated Plan is not effective for woody plant cover for the same reasons stated above for invasive exotic species. It may be desirable that woody plant cover fall below some predetermined percentile within the Park grasslands; however, thresholds for vegetation cover that trigger adaptive management but are not determined via evaluating the effects of grazed relative to ungrazed plots, are more appropriately included in a vegetation management plan rather than a grazing management plan. For example, if woody plant cover were to surpass the coverage threshold within a grazed plot, it would be unknown if the coverage were due to grazing management without comparing the coverage to an ungrazed plot. In addition, it cannot be determined if a given woody plant coverage within a given plot was affected by grazing management without knowing what the baseline condition was.

A much more effective trigger, which is consistent with the adaptive management program's purpose and the goals and objectives outlined in the Updated Plan, is as follows:

- Woody plant cover is 5% higher in Control (grazed) plots compared to Fenced (ungrazed).

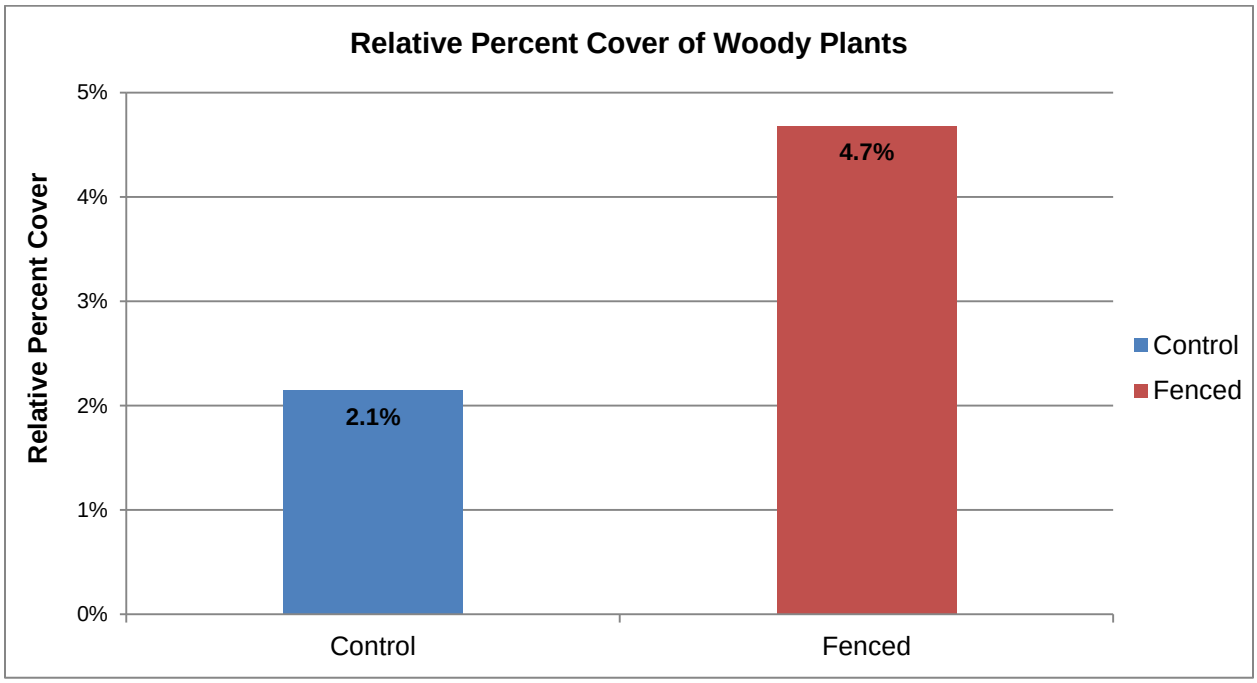
Woody plant cover exceeded the stated threshold for one plot, Plot 1-1 (Chart 11), but did not exceed the suggested threshold, as it was 93% lower in the control plots (Chart 12)[5]. No adaptive management is required.

Chart 11. Absolute Percent Cover of Woody Plants by Grassland Type



[5] Woody plant cover in this plot was almost exclusively California blackberry.

Chart 12 Relative Percent Cover of Woody Plants



Discussion

The results of the monitoring data collected indicate that current grazing management appears to have a significant effect on native grassland structure and composition.

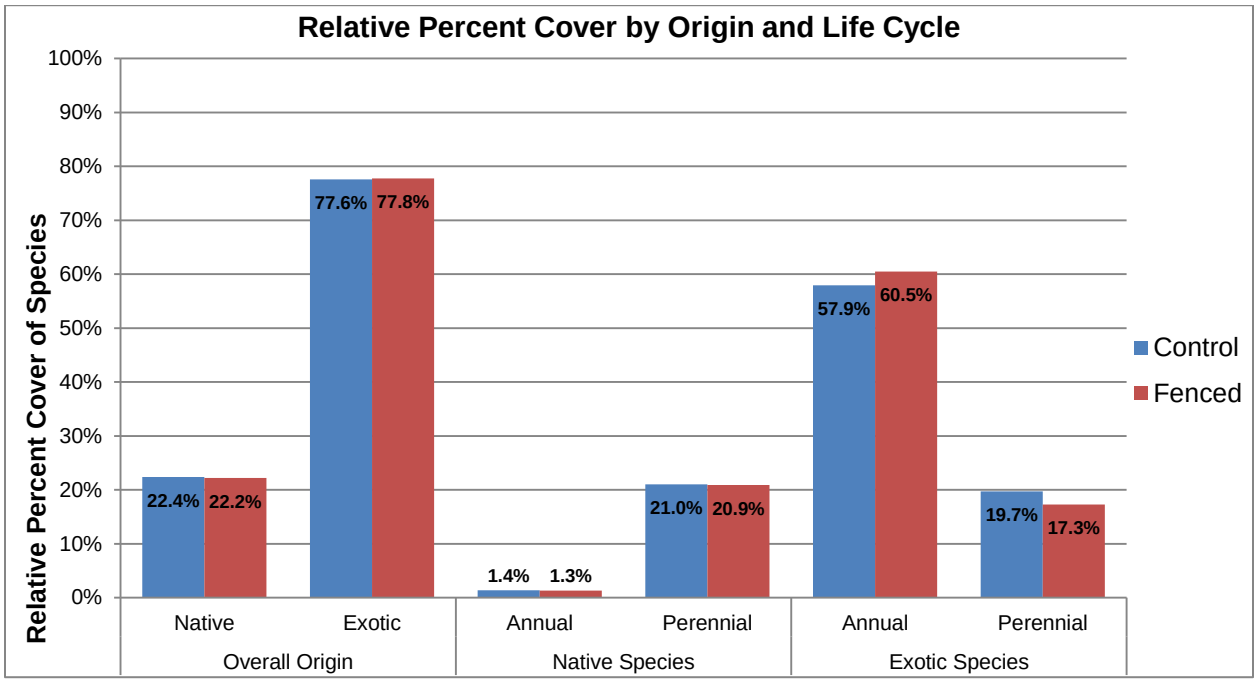
Structure

Biomass, plant height, and litter depth totals are all significantly lower in the control plots, while bare ground is higher. Cover of woody plants in the fenced plots is more than double that recorded in the control areas. Grazing appears to limit the ability of woody plants to colonize and thrive. Additionally, grazing is reducing the density and buildup of plant materials, resulting in a much shorter canopy with more bare ground. These outcomes are consistent with the goals and objectives of the Management Plan and may affect a number of special-status plant and wildlife species that are postulated to benefit from a reduction in competition, amount of litter, vegetation height, plant densities, and shrub encroachment. Please see Appendix C of the Management Plan for more information on potential effects of grazing on the flora and fauna of the Park.

Composition

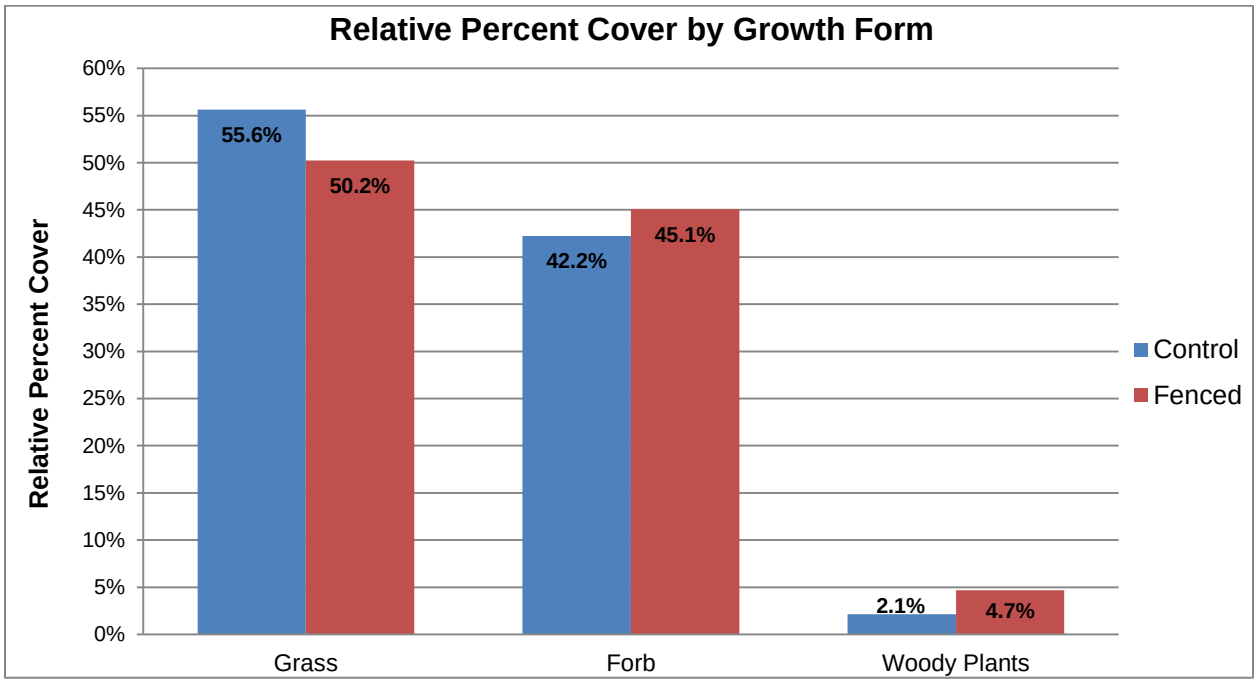
The results of the monitoring data collected indicate that the current grazing management has an effect on some aspects of species composition within the plots. Overall absolute vegetation cover between the grazed and ungrazed plots is similar (Chart 1), and relative cover between the two treatments is also similar when broken down by origin and life cycle (Chart 13).

Chart 13. Relative Percent Cover by Origin and Life Cycle



However, there are some important differences between the treatments. The control plots have greater percent relative cover of grasses, while the fenced plots have a greater relative cover of forbs and woody plants (Chart 14). This would suggest that grazing promotes grass species over forbs and woody species. This effect of grazing is consistent with the goals and objectives of the Management Plan.

Chart 14. Relative Percent Cover by Growth Form



In addition, for both forbs and grasses, relative cover of natives is greater in the control plots and exotic cover is greater in the fenced plots (Charts 15 and 16). This would suggest that grazing promotes native over exotic herbaceous species composition. This is consistent with the goals and objectives of the Management Plan.

Chart 15. Relative Percent Grass Cover by Origin and Life Cycle

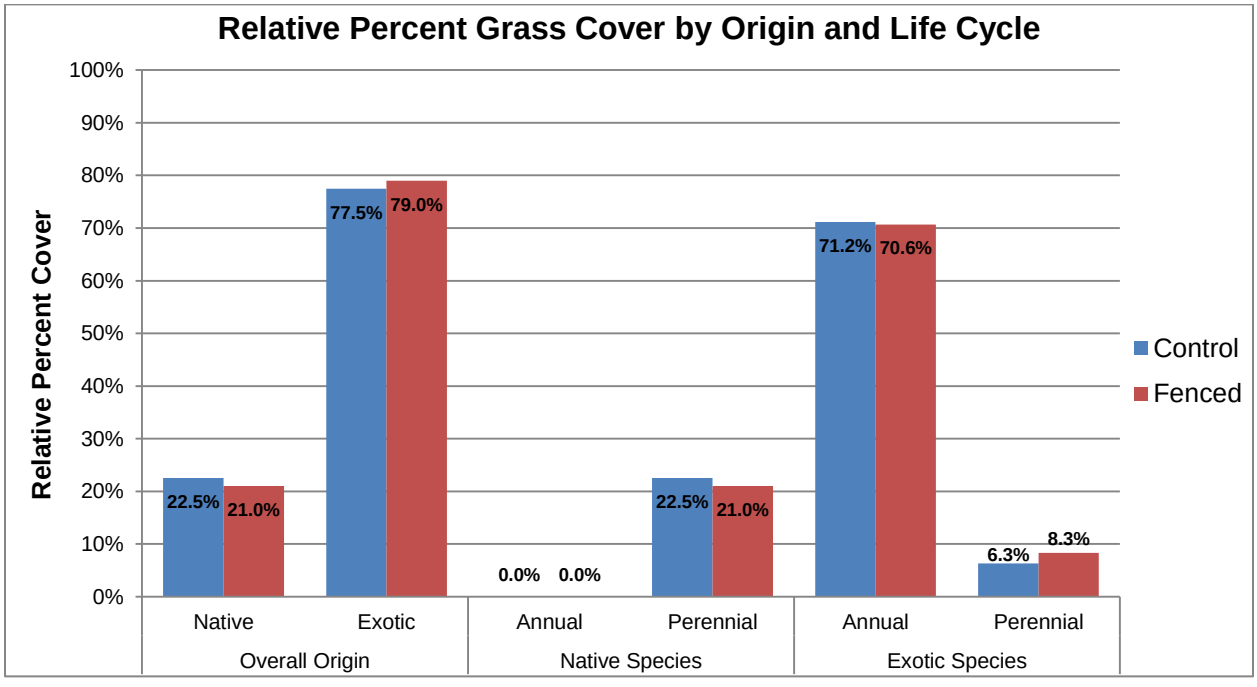
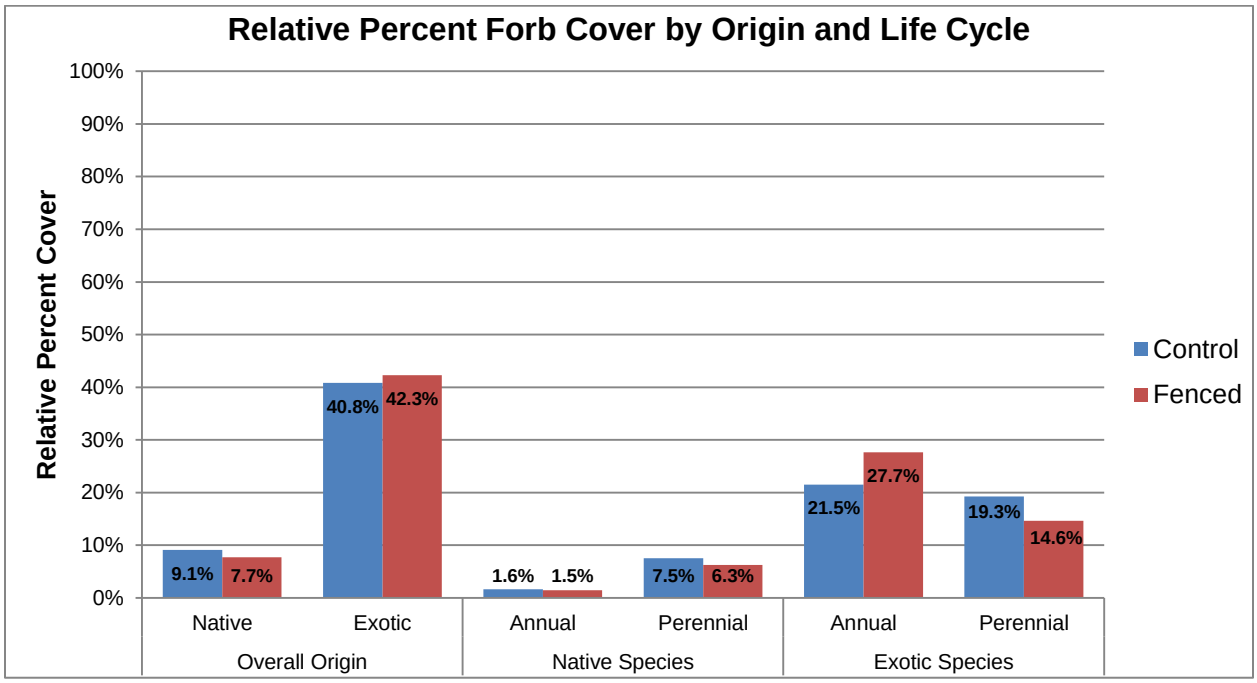


Chart 16. Relative Percent Forb Cover by Origin and Life Cycle



Native annual grass species were not present in the point intercept data and exotic annual grass cover was very similar for both treatments. However, grazed plots have 12% more native perennial grass cover and 2% less exotic perennial grass cover than ungrazed plots (Chart 15). As native perennial grass species are the prime constituent element of coastal prairie grasslands, the relative percent coverage of this functional group is likely one of the most important indices to look at in determining if the effects of grazing are improving the coastal prairie grassland habitat within the Park.

The ratio (a/b) of relative native (a) to exotic (b) perennial grass cover is 3.43 for the control plots and 2.43 for the fenced plots. The relative percent difference of these ratios is 34%. This is an important result in that the ratio of native to exotic perennial grass cover is greater in the control (grazed) areas verses the fenced (ungrazed) plots and may be an effect of grazing management. This outcome would suggest current grazing management promotes native perennial grass species over exotic perennial grass species.

The same trend was identified for forb cover when broken out between native and exotic cover; the cover of native forbs was greater in the grazed plots and the cover of exotic forbs was greater in the ungrazed plots (Chart 16). However, when the relative percent difference is calculated from the native to exotic ratio for perennial forbs alone, the opposite is shown; 10% in favor of exotic over native cover. This outcome is likely a result of the presences of English plantain (*Plantago lanceolata)* within the landscape. This perennial exotic forb is low-growing and thrives in grazed areas. It may be that this species does not do as well when thatch is allowed to develop or under a dense canopy of non-native grasses, both of which are more likely within the fenced plots. In addition, if present, this species may be less likely to be identified via the point intercept methods in tall dense vegetation like that found in many of the ungrazed plots because the dowel will hit the dense canopy first without reaching the ground level. English plantain is often found in high value coastal prairie habitat that is characterized by relatively high cover of native grasses. Unlike some other more invasive exotic perennial plants, such as milk thistle or poison hemlock (*Conium maculatum*), English plantain may persist in high value coastal prairie habitat as one of a number of constituent species without rapidly increasing in density or abundance to exclude some or all of the native cover. In addition, individuals of this species are small, but occur in large numbers in and

amongst other native grass and forb species, making its removal difficult at best and potentially negatively impacting the habitat as a whole.

It is recommended that the moderate potential increase of this exotic species within grazed areas may just be the result of data bias for the reasons described above. To the extent it is real and not just skewed data, it should be viewed as a minimal side effect of a management policy that likely yields significant overall benefit to this sensitive habitat. This is especially true given the fact that both overall and exotic forb cover are both lower in the grazed areas compared to the ungrazed, as identified above.

Conclusion

Current grazing management affects structure and composition of the coastal prairie grassland habitat within the Park. Grazing appears to facilitate the following trends:

- Less buildup of thatch resulting in less biomass and more bare ground,
- Reduced canopy height and woody plant cover,
- Less exotic cover and more native cover,
- Less forb cover and more grass cover, and
- Higher native to exotic perennial grass cover ratio.

These effects are consistent with the goals and objectives of the Management Plan, suggesting the current grazing management effort within the Park is successful. In analyzing the data, the only result that appeared to be in contrast with the major trends is the exotic to native forb ratio. It appears that grazing promotes growth of the exotic English plantain such that the ratio of exotic to native forbs is higher in grazed plots. As describe above, this result should not be of significant concern and does not jeopardize the demonstrated success of current grazing management within the Park.

Recommendations

It is recommended that grazing continue within the Park as it appears to be having a beneficial effect on native grasslands.

It should be noted that the collection of data for this report was not timed or coordinated with specific grazing activities. Some plots were recently grazed when data was taken while other plots may not have been grazed prior to data collection. It may be that certain species or functional groups are underrepresented under certain conditions. Forbs, for example, may not be picked up if recently grazed because all of their leaves are gone, while the same is not true for perennial grass tufts. This potentially could result in data skewed towards perennial grass verses forbs. It is understood that there is only a short window in which the data can be taken such that the greatest potential for identifying plant species is achieved. However, it is recommended that grazing and data collection be coordinated to the greatest extent feasible in the future, in order to make the data as consistent as possible across the Park. Having made this recommendation, it is likely that the long duration of the study and the large data set reduces the potential effects described above.

As described above in the Adaptive Management Section of this report, it is recommended that new thresholds be adopted, as provided.

There are a number of fenced plots in the moist perennial grasslands that are completely taken over by milk thistle and other invasive species. These plots cannot be easily entered and data can't be taken consistent with the prescribed methods. These plots have been very valuable in the course of the study in that they dramatically show the effects of grazing and weed eradication efforts in these specific areas (i.e., significantly reduced presence of noxious invasive forbs). However, it's likely that the continued usefulness of these plots for this study in the future is low. As this point the plots are a seed source for these non-native plants. It is recommended that these plots be evaluated in terms of their potential to provide alternative data or that they be used for alternative land use treatments. There is the potential to use these plots to look at the effects of weed reduction efforts such as mowing and/or spraying.

Appendix A.

List of Exotic Invasive Species Encountered Within Plots

Invasive Exotic Species Encountered Within Plots

Family	Species	Species Code	Origin	Functional Group	Life History	Common Name	Cal IPC Rating
Fabaceae	Genista monspessulana	GENMON	Exotic	Shrub	Perennial	French broom	High
Poaceae	Avena barbata	AVEBAR	Exotic	Grass	Annual	Oat grass	Moderate
Brassicaceae	Brassica nigra	BRANIG	Exotic	Forb	Annual	Black mustard	Moderate
Poaceae	Bromus diadrus	BRODIA	Exotic	Grass	Annual	Ripgut brome	Moderate
Asteraceae	Carduus pycnocephalus	CARPYC	Exotic	Forb	Annual	Italian thistle	Moderate
Asteraceae	Cirsium vulgare	CIRVUL	Exotic	Forb	Biennial	Bull thistle	Moderate
Apiaceae	Conium maculatum	CONMAC	Exotic	Forb	Biennial	Poison hemlock	Moderate
Poaceae	Cynosurus echinatus	CYNECH	Exotic	Grass	Annual	Dogtail grass	Moderate
Brassicaceae	Hirschfeldia incana	HIRINC	Exotic	Forb	Perennial	Summer mustard	Moderate
Poaceae	Holcus lanatus	HOLLAN	Exotic	Grass	Perennial	Velvet grass	Moderate
Poaceae	Hordeum murinum ssp. leporinum	HORMUR	Exotic	Grass	Annual	Barnyard foxtail	Moderate
Asteraceae	Hypochaeris radicata	HYPRAD	Exotic	Forb	Perennial	Hairy cat's-ear	Moderate
Poaceae	Lolium multiflorum	LOLMUL	Exotic	Grass	Annual	Italian ryegrass	Moderate
Poaceae	Phalarais aquatica	PHAAQA	Exotic	Grass	Perennial	Harding grass	Moderate
Polygonaceae	Rumex acetosella	RUMACE	Exotic	Forb	Perennial	Sheep sorrel	Moderate
Fabaceae	Trifolium hirtum	TRIHIR	Exotic	Forb	Annual	Rose clover	Moderate
Poaceae	Vulpia myuros ssp. myuros	VULMYU	Exotic	Grass	Annual	Rattail fescue	Moderate
Poaceae	Briza maxima	BRIMAX	Exotic	Grass	Annual	Rattlesnake grass	Limited
Poaceae	Bromus hordeaceus	BROHOR	Exotic	Grass	Annual	Soft chess	Limited*
Scrophulariaceae	Digitalis purpurea	DIGPUR	Exotic	Forb	Biennial	Foxglove	Limited
Geraniaceae	Erodium cicutarium	EROCIC	Exotic	Forb	Annual	Red-stemmed filaree	Limited*
Geraniaceae	Geranium dissectum	GERDIS	Exotic	Forb	Annual	Cutleaved geranium	Limited
Asteraceae	Hypochaeris glabra	HYPGLA	Exotic	Forb	Annual	Smooth cat's-ear	Limited
Fabaceae	Medicago polymorpha	MEDPOL	Exotic	Forb	Annual	Bur clover	Limited
Asteraceae	Picris echioides	PICECH	Exotic	Forb	Annual	Bristly ox-tongue	Limited
Plantaginaceae	Plantago lanceolata	PLALAN	Exotic	Forb	Perennial	English plantain	Limited
Asteraceae	Silybum marianum	SILMAR	Exotic	Forb	Annual	Milk thistle	Limited*
Poaceae	Aira caryophyllea	AIRCAR	Exotic	Grass	Annual	Silvery hair grass	Not Rated
Primulaceae	Anagallis arvensis	ANAARV	Exotic	Forb	Annual	Scarlet pimpernell	Not Rated
Poaceae	Briza minor	BRIMIN	Exotic	Grass	Annual	Small quaking/ rattlesnake grass	Not Rated
Poaceae	Bromus catharticus	BROCAT	Exotic	Grass	Annual	Rescue grass	Not Rated
Poaceae	Bromus madritensis	BROMAD	Exotic	Grass	Annual	Spanish brome	Not Rated
Caryophyllaceae	Cerastium glomeratum	CERGLO	Exotic	Forb	Annual	Mouse-eared chickweed	Not Rated
Geraniaceae	Erodium moschatum	EROMOS	Exotic	Forb	Annual	White-stemmed filaree	Not Rated
Geraniaceae	Geranium molle	GERMOL	Exotic	Forb	Annual	Dovesfoot	Not Rated
Asteraceae	Lactuca serriola	LACSER	Exotic	Forb	Annual	Prickly lettuce	Not Rated
Fabaceae	Lotus corniculatus	LOTCOR	Exotic	Forb	Perennial	Bird's-foot trefoil	Not Rated

Family	Species	Species Code	Origin	Functional Group	Life History	Common Name	Cal IPC Rating
Malvaceae	Malva parviflora	MALPAR	Exotic	Forb	Annual	Cheeseweed	Not Rated
Polygonaceae	Rumex conglomeratus	RUMCON	Exotic	Forb	Perennial	Clustered dock	Not Rated
Caryophyllaceae	Silene gallica	SILGAL	Exotic	Forb	Annual	Catchfly	Not Rated
Asteraceae	Sonchus asper	SONASP	Exotic	Forb	Annual	Prickly sow thistle	Not Rated
Asteraceae	Sonchus oleraceus	SONOLE	Exotic	Forb	Annual	Common sow thistle	Not Rated
Caryophyllaceae	Stellaria media	STEMED	Exotic	Forb	Annual	Common chickweed	Not Rated
Fabaceae	Trifolium campestre	TRICAM	Exotic	Forb	Annual	Hop clover	Not Rated
Fabaceae	Trifolium subterraneum	TRISUB	Exotic	Forb	Annual	Subterranean clover	Not Rated
Fabaceae	Vicia sativa	VICSAT	Exotic	Forb	Annual	Common vetch	Not Rated
Fabaceae	Vicia sativa ssp. nigra	VICSATn	Exotic	Forb	Annual	Smaller common vetch	Not Rated

*Species included in analysis due to local abundance and potential to present a high impact

Appendix B.

List of Species Encountered Within Plots

2012 Palo Corona Grassland Monitoring Species List

Family	Species	Species Code	Origin	Functional Group	Life History	Common Names
Rosaceae	Acaena pinnatifida var. californica	ACAPIN	Native	Forb	Perrenial	California acaena
Asteraceae	Achillea millefolium	ACHMIL	Native	Forb	Perrenial	Common yarrow
Poaceae	Agrostis pallens	AGRPAL	Native	Grass	Perrenial	Leafy bent-grass
Poaceae	Aira caryophyllea	AIRCAR	Exotic	Grass	Annual	Silvery hair grass
Boraginaceae	Amsinckia menziesii var. intermedia	AMSMEN	Native	Forb	Annual	Rancher's fireweed/common fiddleneck
Primulaceae	Anagallis arvensis	ANAARV	Exotic	Forb	Annual	Scarlet pimpernell
Asteraceae	Artemisia californica	ARTCAL	Native	Shrub	Perrenial	California sagebrush
Poaceae	Avena barbata	AVEBAR	Exotic	Grass	Annual	Oat grass
Asteraceae	Baccharis pilularis	BACPIL	Native	Shrub	Perrenial	Coyote bush
Brassicaceae	Brassica nigra	BRANIG	Exotic	Forb	Annual	Black mustard
Poaceae	Briza maxima	BRIMAX	Exotic	Grass	Annual	Rattlesnake grass
Poaceae	Briza minor	BRIMIN	Exotic	Grass	Annual	Small quaking/rattlesnake grass
Poaceae	Bromus carinatus	BROCAR	Native	Grass	Perrenial	California brome
Poaceae	Bromus catharticus	BROCAT	Exotic	Grass	Annual	Rescue grass
Poaceae	Bromus diadrus	BRODIA	Exotic	Grass	Annual	Ripgut brome
Poaceae	Bromus hordeaceus	BROHOR	Exotic	Grass	Annual	Soft chess
Poaceae	Bromus madritensis	BROMAD	Exotic	Grass	Annual	Spanish brome
Portulacaceae	Calandrinia ciliata	CALCIL	Native	Forb	Annual	Red maids
Onagracaceae	Camissonia ovata	CAMOVA	Native	Forb	Annual	Sun cups
Asteraceae	Carduus pycnocephalus	CARPYC	Exotic	Forb	Annual	Italian thistle
Cyparaceae	Carex tumulicola	CARTUM	Native	Forb	Perrenial	Foothill sedge
Scrophulariaceae	Castilleja affinis	CASAFF	Native	Forb	Perrenial	Indian paintbrush
Caryophyllaceae	Cerastium glomeratum	CERGLO	Exotic	Forb	Annual	Mouse-eared chickweed
Liliaceae	Chlorogalum pomeridianum	CHLPOM	Native	Forb	Perrenial	Soap plant
Asteraceae	Cirsium occidentale var. occidentale	CIRCOCCo	Native	Forb	Biennial	Cobweb thistle
Asteraceae	Cirsium vulgare	CIRVUL	Exotic	Forb	Biennial	Bull thistle
Onagracaceae	Clarkia lewisii	CLALEW	Native	Forb	Annual	Lewis' clarkia
Portulacaceae	Claytonia perfoliata	CLAPER	Native	Forb	Annual	Miner's lettuce
Apiaceae	Conium maculatum	CONMAC	Exotic	Forb	Biennial	Poison hemlock
Asteraceae	Corethrogyne filaginifolia	CORFIL	Native	Shrub	Perrenial	(=Lessingia filaginifolia) Beach aster
Boraginaceae	Cryptantha sp.	Cryptantha sp.	Native	Forb	Annual	Popcorn flower
Poaceae	Cynosurus echinatus	CYNECH	Exotic	Grass	Annual	Dogtail grass
Poaceae	Danthonia californica	DANCAL	Native	Grass	Perrenial	Danthonia
Poaceae	Deschampsia elongata	DESELO	Native	Grass	Perrenial	Slender hair-grass
Liliaceae	Dichelostemma capitatum	DICCAP	Native	Forb	Perrenial	Blue dicks
Scrophulariaceae	Digitalis purpurea	DIGPUR	Exotic	Forb	Biennial	Foxglove
Poaceae	Distichlis spicata	DISSPI	Native	Grass	Perrenial	Salt grass
Poaceae	Elymus glaucus	ELYGLA	Native	Grass	Perrenial	Western ryegrass
Polygonaceae	Eriogonum latifolium	ERILAT	Native	Shrub	Perrenial	Coast buckwheat
Polygonaceae	Eriogonum nudum	ERINUD	Native	Shrub	Perrenial	Naked buckwheat

2012 Palo Corona Grassland Monitoring Species List

Family	Species	Species Code	Origin	Functional Group	Life History	Notes/Common Names
Geraniaceae	Erodium cicutarium	EROCIC	Exotic	Forb	Annual	Red-stemmed filaree
Geraniaceae	Erodium moschatum	EROMOS	Exotic	Forb	Annual	White-stemmed filaree
Papaveraceae	Eschscholzia californica	ESCCAL	Native	Forb	Annual	California poppy
Poaceae	Festuca sp.	Festuca sp.	Native	Grass	Perrenial	Idaho fescue or Red fescue
Rosaceae	Fragaria vesca	FRAVES	Native	Forb	Perrenial	Wood strawberry
Rubiaceae	Galium trifidum var. pacificum	GALTRI	Native	Forb	Perrenial	Galium/bedstraw
Fabaceae	Genista monspessulana	GENMON	Exotic	Shrub	Perrenial	French broom
Geraniaceae	Geranium dissectum	GERDIS	Exotic	Forb	Annual	Cutleaved geranium
Geraniaceae	Geranium molle	GERMOL	Exotic	Forb	Annual	Dovesfoot
Asteraceae	Gnaphalium californicum	GNACAL	Native	Forb	Annual	California cudweed
Asteraceae	Grindelia stricta	GRISTR	Native	Forb	Perrenial	Gum plant
Asteraceae	Hazardia squarrosa	HARSQU	Native	Shrub	Perrenial	Sawtooth goldenbush
Brassicaceae	Hirschfeldia incana	HIRINC	Exotic	Forb	Perrenial	Summer mustard
Poaceae	Holcus lanatus	HOLLAN	Exotic	Grass	Perrenial	Velvet grass
Poaceae	Hordeum brachyantherun	HORBRA	Native	Grass	Perrenial	Meadow barley
Poaceae	Hordeum murinum ssp. leporinum	HORMUR	Exotic	Grass	Annual	Barnyard foxtail
Asteraceae	Hypochaeris glabra	HYPGLA	Exotic	Forb	Annual	Smooth cat's-ear
Astereceae	Hypochaeris radicata	HYPRAD	Exotic	Forb	Perrenial	Hairy cat's-ear
Juncaceae	Juncus effusus	JUNEFF	Native	Forb	Perrenial	Common rush
Juncaceae	Juncus occidentalis	JUNOCC	Native	Forb	Perrenial	Western rush
Juncaceae	Juncus patens	JUNPAT	Native	Forb	Perrenial	Spreading rush
Juncaceae	Juncus phaeocephalus	JUNPHA	Native	Forb	Perrenial	Brown-headed rush
Poaceae	Koeleria macrantha	KOEMAC	Native	Grass	Perrenial	June Grass/Koeler's grass
Asteraceae	Lactuca serriola	LACSER	Exotic	Forb	Annual	Prickly lettuce
Linaceae	Linum bienne	LINBIE	Native	Forb	Perrenial	Western blue flax
Poaceae	Lolium multiflorum	LOLMUL	Exotic	Grass	Annual	Italian ryegrass
Apiaceae	Lomatium parvifolium	LOMPAR	Native	Forb	Perrenial	Coast parsnip
Fabaceae	Lotus corniculatus	LOTCOR	Exotic	Forb	Perrenial	Bird's-foot trefoil
Fabaceae	Lotus humistratus	LOTHUM	Native	Forb	Annual	Short-podded lotus
Fabaceae	Lotus micranthus	LOTMIC	Native	Forb	Annual	Small-flowered lotus
Fabaceae	Lotus scoparius	LOTSCO	Native	Shrub	Perrenial	Deerweed
Fabaceae	Lupinus arboreus	LUPARB	Native	Shrub	Perrenial	Tree lupine/yellow bush-lupine
Fabaceae	Lupinus nanus	LUPNAN	Native	Forb	Annual	Sky lupine
Fabaceae	Lupinus variicolor	LUPVAR	Native	Shrub	Perrenial	Lindley's varied lupine
Juncaceae	Luzula comosa	LUZCOM	Native	Grass	Perrenial	Common wood rush
Asteraceae	Madia elegans	MADELE	Native	Forb	Annual	
Asteraceae	Madia radiata	MADRAD	Native	Forb	Annual	Golden madia
Malvaceae	Malva parviflora	MALPAR	Exotic	Forb	Annual	Cheeseweed
Cucurbitaceae	Marah fabaceus	MARFAB	Native	Forb	Perrenial	Wild cucumber/manroot
Fabaceae	Medicago polymorpha	MEDPOL	Exotic	Forb	Annual	Bur clover

2012 Palo Corona Grassland Monitoring Species List

Family	Species	Species Code	Origin	Functional Group	Life History	Notes/Common Names
Poaceae	Nassella pulchra	NASPUL	Native	Grass	Perrenial	Purple needle-grass
Oxalidaceae	Oxalis albicans ssp. pilosa	OXAALB	Native	Forb	Perrenial	Hairy wood-sorrel
Poaceae	Phalaris arundinacea	PHAARU	Native	Grass	Perrenial	Reed canary grass
Poaceae	Phalarais aquatica	PHAAQA	Exotic	Grass	Perrenial	Hharding grass
Asteraceae	Picris echioides	PICECH	Exotic	Forb	Annual	Bristly ox-tongue
Pinus	Pinus radiata	PINRAD	Native	Tree	Perrenial	Monterey pine
Plantaginaceae	Plantago lanceolata	PLALAN	Exotic	Forb	Perrenial	English plantain
Dennstaediaceae	Pteridium aquilinum	PTEAQU	Native	Fern	Perrenial	Bracken fern
Ranunculaceae	Ranunculus californicus	RANCAL	Native	Forb	Perrenial	California buttercup
Rosaceae	Rubus ursinus	RUBURS	Native	Forb	Perrenial	California blackberry
Polygonaceae	Rumex acetosella	RUMACE	Exotic	Forb	Perrenial	Sheep sorrel
Polygonaceae	Rumex conglomeratus	RUMCON	Exotic	Forb	Perrenial	Clustered dock
Apiaceae	Sanicula arctopoides	SANARC	Native	Forb	Perrenial	Footsteps of spring
Apiaceae	Sanicula crassicaulis	SANCRA	Native	Forb	Perrenial	Pacific sanicle
Lamiaceae	Satureja douglasii	SATDOU	Native	Forb	Perrenial	Yerba buena
Scrophulariaceae	Scrophularia californica	SCRCAL	Native	Forb	Perrenial	Bee plant
Malvaceae	Sidalcea malviflora	SIDMAL	Native	Forb	Perrenial	Checkerbloom
Caryophyllaceae	Silene gallica	SILGAL	Exotic	Forb	Annual	Catchfly
Asteraceae	Silybum marianum	SILMAR	Exotic	Forb	Annual	Milk thistle
Iridaceae	Sisyrinchium bellum	SISBEL	Native	Forb	Perrenial	Blue-eyed grass
Asteraceae	Sonchus asper	SONASP	Exotic	Forb	Annual	Prickly sow thistle
Asteraceae	Sonchus oleraceus	SONOLE	Exotic	Forb	Annual	Common sow thistle
Lamiaceae	Stachys bullata	STABUL	Native	Forb	Perrenial	Wood mint
Caryophyllaceae	Stellaria media	STEMED	Exotic	Forb	Annual	Common chickweed
Fabaceae	Trifolium campestre	TRICAM	Exotic	Forb	Annual	Hop clover
Fabaceae	Trifolium hirtum	TRIHIR	Exotic	Forb	Annual	Rose clover
Fabaceae	Trifolium microcephalum	TRIMIC	Native	Forb	Annual	Maiden's clover
Fabaceae	Trifolium subterraneum	TRISUB	Exotic	Forb	Annual	Subterrannean clover
Fabaceae	Trifolium wildenovii	TRIWIL	Native	Forb	Annual	Tomcat clover
Liliaceae	Triteleia ixiodes	TRIIXI	Native	Forb	Perrenial	Golden brodiaea/pretty face
Verbenaceae	Verbena lasiostachys	VERLAS	Native	Forb	Perrenial	Verbena/western vervain
Fabaceae	Vicia sativa	VICSAT	Exotic	Forb	Annual	Common vetch
Fabaceae	Vicia sativa ssp. nigra	VICSATn	Exotic	Forb	Annual	Smaller common vetch
Violaceae	Viola pedunculata ssp. pedunculata	VIOPED	Native	Forb	Annual	Johnny jump-up
Poaceae	Vulpia myuros ssp. myuros	VULMYU	Exotic	Grass	Annual	Rattail fescue
Lilliaceae	Zigadenus fremontii	ZIGFRE	Native	Forb	Perrenial	Star lily
Asteraceae	Unknown Composite	Unk. Comp				