

**Annual report for the East Bay Regional Park District  
Grassland Monitoring Project  
2009 Field Season (Year 8)**

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## **Summary**

### *Introduction*

In its eighth year, the Grassland Monitoring Project continues to develop and implement improved quantitative monitoring methods to determine the response of Park District grassland communities to management. The focus of the project is on the Valley grassland community in four Park District units: Morgan Territory, Pleasanton Ridge, Sunol-Ohlone, and Vasco Caves. Valley grassland is the East Bay's and the District's most extensive grassland vegetation type and has high bird conservation value.

Following the collection of baseline data, the project has intensified its focus on native plant and grassland bird diversity in the Valley grassland and the effects of livestock grazing on this diversity. We have begun to elucidate the effects of grazing compared to no grazing on native plants and birds, which will be expanded as we gather further years of data.

Although many of the general relationships among plants, animals, and environment are known for the Valley grassland, information from previous research and experience is not sufficient to predict the effects of management reliably. Better descriptions of the spatial and temporal variation in grassland communities combined with an understanding of the relationships between vegetation structure and animal abundance will help guide reliable and informed management decisions.

### *Vegetation monitoring overview*

Annual rainfall amount and pattern wield enormous control over Valley grassland vegetation; species composition, diversity, dominance relationships, and production all vary significantly with annual rainfall. The first several years of the project saw average or above-average rainfall. The last three years 2007-2009, however, were drought years, and, consequently, the project now has much-needed data on the response of the Valley Grassland community to drought.

Consistent with previous years, species cover distribution in 2009 was highly skewed to a few dominant species. Of the 100 species observed in 2009, the three most abundant species, wild oats (*Avena fatua*), broadleaf filaree (*Erodium botrys*), and annual ryegrass (*Lolium multiflorum*), all non-native species, made up almost 40% of the total relative cover. Total species richness for 2009 was 100 species. Fifty percent of the species were native, and 50% were non-native. Of the 50 native species, 60% were annual forbs, 28% were perennial forbs, and 10% were perennial grasses.

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Rainfall appears to be the primary driver of native species richness and native cover, with high rainfall years producing greater cover and richness than low rainfall years. Livestock grazing may exert some influence on diversity metrics, however, even at the landscape level.

California's Valley grassland typically has low cover of native species. Consistent with this generalization, absolute native cover at the study sites has been low, fluctuating between 3 – 7% depending on year. Averaged over all sites, native cover appears to track rainfall amount and pattern: 2005 was a wet year, and native cover was notably high; in contrast, 2007's very dry weather was the likely cause of the lowest native cover observed during the project's run. Although 2008 and 2009 were also drought years, native cover was greater in both years than 2007's low.

When categorized by grazing status, annual native cover fluctuates differently within each park from 2005 to 2009. Morgan Territory's grazed plots declined in native cover in 2007 and 2008 compared to 2006 and had less native cover than its ungrazed plots in both 2007 and 2008; Morgan Territory's ungrazed plots increased slightly in native cover over the same period. However, this trend was reversed in 2009: grazed plots increased in native cover, overtaking ungrazed plots, which declined in native cover. Trends at Vasco Caves were complicated by a 2006 wildfire that burnt some of the ungrazed plots. In 2009, on Vasco Caves' grazed plots, there was a return to a more moderate level of native cover; ungrazed plots at Vasco Caves also experienced a decline in native cover in 2009. At Sunol, both grazed and ungrazed plots decreased in native cover from 2005 to 2007 but increased in 2008. Ungrazed plots at Sunol decreased once again in native cover in 2009, but grazed plots experienced a dramatic increase. Grazed plots had much greater native cover than ungrazed plots in all years at Sunol. Comparing parks over the last four years, there was no consistent trend in native cover and grazing status.

Native species richness (the number of native species in a location) is an important metric in the Valley grassland. In Valley grassland, non-native species typically make up more than 90% of the cover. Species richness, in contrast, is more evenly distributed between native and non-native species. Like native cover, native species richness generally appears to track annual weather patterns and not management regimes. Average native species richness on all cattle-grazed plots in 2009 was greater than on ungrazed plots or on sheep-grazed plots. In the non-drought years of 2003 to 2006, grazed plots generally exhibited higher native richness than ungrazed plots, and at the landscape level, grazing appeared to maintain higher native species richness. However, in the last three years of drought, this relationship became more complicated. The drought/grazing interaction is complex, with weather, site, and grazing factors playing roles. Even in the three drought years, grazed plots had greater native species richness than ungrazed sites in almost all comparisons.

As noted in previous reports, the bunchgrass Purple needlegrass (*Nassella pulchra*) has exhibited a steady decline over the course of the project; purple needlegrass is the most abundant native species in our study plots. This decline in Purple needlegrass has occurred in all parks and on grazed and ungrazed plots leading us to surmise that the decline was related to regional environmental factors rather than management activities. In 2008, this decline slowed somewhat; however, in 2009, annual average cover of Purple needlegrass dropped once again. This decrease in Purple needlegrass cover occurred at all parks sampled in 2009 except for Pleasanton Ridge. Fluctuations in Purple needlegrass cover appear to be driven primarily by regional environmental factors with livestock grazing exerting little influence. The installation of additional grazed and ungrazed plots at Vasco Caves should help confirm or refute this hypothesis over the next few years.

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Purple false-brome (*Brachypodium distachyon*), a non-native grass, may be spreading on EBRPD properties. Since 2003, it has been observed on over 50% of the study plots; of the four parks sampled in 2009, only at Vasco Caves were there no purple false-brome observations. Unfortunately, no information about management control of this grass has been found.

In 2009, we found one species rated as “high” in the California Invasive Plant Council’s Invasive Plant Inventory (Cal-IPC 2006): Medusahead (*Taeniatherum caput-medusae*). Implementing a control program may inhibit the spread of medusahead. Because we did not survey the invasive-species-rich Brushy Peak, Chabot Ridge, and Sycamore Valley in 2008 and 2009, the number of invasive species observed in the last two years is lower than in earlier years of this study.

### *Avian monitoring overview*

The monitoring project has completed a baseline inventory of common grassland birds on park district Valley grassland and continues to focus on the effect of livestock grazing on grassland bird diversity and abundance. Point count surveys are conducted on the same grassland monitoring plots as the vegetation plots within areas that are livestock grazed and ungrazed.

On plot avian detection rates remain fairly constant and show no obvious temporal trends over the years of the study, 2004-2009. Plot detection rates are counted as the total number of individual birds on plot (within 100m of center) added cumulatively over three surveys per breeding season. In spite of the differences in climate, 2007-2008 had below average rainfall, there is no obvious trend showing climatic effects on median avian plot detection rates over all the parks and years.

Sunol-Ohlone continues to have the highest overall park avian species richness while Vasco Caves remains the lowest. This trend is also reflected in the cumulative park avian species richness within the 2004-2009 Breeding Bird Status table.

A continuing focus of the grassland bird monitoring project is to look at the grassland-specialist species that are commonly found on plot. Our grassland bird guild, Grasshopper Sparrow, Horned Lark, Savannah Sparrow, and Western Meadowlark, were chosen for their status as species of conservation and management concern and well known preference for breeding within park district grassland habitat. Comparing all the parks over 2004-2009, this grassland bird guild has a patchy distribution with low numbers of detection. None of the parks has a consistent yearly presence of all four of the guild species. For the guild, median plot detection rates are heavily weighted by the number of zeros, or plots with no birds detected. Vasco Caves is the only park where individuals from the guild are consistently found on a majority of the plots.

Our dataset does not show significant population trends for any of the guild species, because the four species are at very low numbers throughout all the parks. Our most ubiquitous grassland species, the Western Meadowlark, has a downward trend throughout the study with the 2nd lowest number of observations in 2009. Savannah Sparrows also showed a downward trend, dropping to zero detections in 2008 but reappearing with small numbers on plot in 2009. Horned Larks, our second most abundant guild species, are remaining more or less consistent in their number of total detections per year. Grasshopper Sparrows are also remaining consistent with their low numbers of total detection rates per year. Overall the grassland bird guild remains a low density community, present in some areas and consistently absent from other locations within these parks. Future analyses looking at landscape scale factors like grassland patch size,

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alongwith land-use history, current management, and other grassland habitat characteristics may help to explain the grassland bird distribution within the park district.

### *Previous work*

Previous reports have detailed 1) grassland insect abundance and diversity (2008 report); 2) small mammal relationships with soil, vegetation and livestock grazing (2007 report); 3) mid-project review (2006 report); and 4) considerations for the development of a grassland vegetation monitoring program (2005 report).

To date, the project has resulted in one doctoral dissertation (2007), two master's theses (2004, 2008), an undergraduate senior thesis (2008), three scientific journal articles (2007, 2008, 2009), and a conference proceedings article (2008) (see Appendix A for details). An article on the habitat associations of grassland birds will be submitted for publication in early 2011, and work is progressing on an article evaluating the spatial and temporal variability of the East Bay grasslands.

The rich EBRPD dataset has also proven essential to the development of new ecological models and hypotheses about the Valley grassland. Four book chapters have been informed by these models and hypotheses, including chapters in two important recent reviews of California grasslands: *Terrestrial vegetation of California*, 3<sup>rd</sup> edition and *California grasslands: ecology and management* (Bartolome et al. 2007, Huntsinger et al. 2007, Jackson and Bartolome 2007).

We have made 44 presentations about Project findings and methodology at public agency meetings and scientific conferences, including in 2009, a presentation at the California Society for Ecological Restoration and California Native Grasslands Association Joint Conference (see Appendix B for further details).

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## 1.0 Introduction

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## 2.0 Study location

In 2009, fifty-one vegetation plots were sampled in four parks: Morgan Territory, Pleasanton Ridge, Sunol-Ohlone, and Vasco Caves. Recent additions to the study include three plots in Vasco Caves, added in 2008 to improve our ability to discern grazing effects on native plants, in particular the important native bunchgrass Purple needlegrass (*Nassella pulchra*). The three new Vasco Cave plots contain substantial cover of Purple needlegrass; two of the plots are not grazed, and the third is grazed.

This year, three plots on Valpe Ridge and High Valley in Sunol/Ohlone were sampled for the first time. The plots are fenced to exclude livestock grazing and will provide valuable data on the effects of grazing as compared to grazing removal on the high diversity and cover of native forbs found at Valpe Ridge and High Valley.

## 3.0 Field survey methods

A plot is a location where plant species composition is measured in the spring. We use a permanent plot system in which percent cover and spatial patterning of plant species are measured along the same four line-point transects in each plot over multiple years. Permanent sampling plots were established in selected Park District properties starting in 2002 and 2003, with additional plots sited in subsequent years.

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Bird activity is measured using point count surveys conducted with the same central point as the vegetation plots. Other vertebrate wildlife activity is sampled through counts of animal sign along the vegetation transects. Environmental and management variables including physical site characteristics, soil properties, weather, and livestock grazing are also determined for each plot.

### 3.1 Plot locations

Sample plots were randomly located within a stratified design. The strata depended upon the specific park but were generally based on pre-existing management areas. For example, plots at Pleasanton Ridge were randomly chosen from areas already subjected to sheep grazing or cattle grazing. A majority of plots are located a minimum of 300 meters from shrub or forest habitat (greater than 30% canopy cover of shrubs or trees) so as to limit the study to grassland wildlife species.

### 3.2 Plot design and vegetation sampling (species cover and plant height)

Each plot comprises four 17-m vegetation transects radiating in the 4 cardinal directions from a central, permanently marked centroid (Bonham 1988). This radial design allows integration of a standard bird and mammal monitoring protocol with the vegetation monitoring. From a vertical line dropped perpendicular to the transect line, first-hit plant species and height are recorded every 10 cm for the first 4.5 m and every 50 cm from 5 to 17 m, for a total of 70 points per transect and 280 total per plot. In addition, 2 photos are taken of each transect: 1 from the centroid out to the end of the transect and another from the end of the transect in to the centroid (8 photos per plot).

### 3.3 Bird surveys

Variable circular plot point count surveys (Ralph et al. 1995) are conducted to measure and compare avian species composition, breeding status, richness, and diversity across parks and management regimes (treatments). Three visits are made at least ten days apart during the spring breeding season, March 31 - June 15. The center of the 100 m radius plots is the same centroid used for vegetation sampling. Distance from the center of the plot is noted for each individual in 10-meter intervals up to 100 meters and then at greater than 100 meters. Individuals flying over the plot are also recorded. Special note is made of any breeding activity observed (e.g., active nest, carrying nesting material). Counts are not conducted in conditions of excessive wind, fog, or rain.

### 3.4 Other vertebrate wildlife surveys

During both the vegetation sampling and bird surveys, careful note is taken of any presence or sign of other vertebrate wildlife.

Vegetation sampling includes the documentation of all signs of non-avian vertebrates along the four transects. Attempts are made to identify to species and quantify the various scat, runways, trails, and holes within one meter on either side of each transect. Any sightings of vertebrates during vegetation sampling are noted within the 17-meter radius plots and in the park

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at large. The point count surveys include the documentation of non-avian vertebrates, with notation of location within the 100 meter radius plot and in the park.

### 3.5 Environmental variables

Using a Global Positioning System unit, we determined the coordinates for each plot's centroid. These location data were overlaid on a USGS 10-meter Digital Elevation Modal (DEM) obtained from the USGS Bay Area Regional Database. The DEM generated the following topographical variables: percent slope, elevation, and aspect. We converted aspect into a linear proxy, heatload (McCune and Grace 2002, pp. 22, 24).

Weather data are downloaded on an annual basis from the NOAA weather station in Livermore. Data obtained are 1) monthly precipitation for the July to June "rain-years" over the life of the Project and 2) monthly precipitation averaged over the 30-year period, 1971-2000, for comparison with individual rain-years.

Soil samples were collected in 2002, 2003, and 2006 (full Valley grassland plot dataset). One 10 cm deep soil sample was taken adjacent to each of the four transects of a plot, and transect soil measurements were averaged for overall plot values. The UC Davis DANR Lab conducted the soil analyses. Soil properties evaluated include cation exchange capacity (CEC), and percent sand, silt, and clay. Soil chemistry measurements include nitrogen (NH<sub>4</sub> and NO<sub>3</sub>), carbon, phosphorus, and pH.

Results of soil analyses are briefly discussed in the 2006 annual report and more fully in Gea-Izquierdo et al. (2007).

### **4.0 Interannual vegetation changes using new interannual subset**

In reports prior to 2008, for year to year comparisons, we used the Valley grassland "interannual subset" of parks and plots, which consisted of data for 40 plots in 6 parks from 2003 onwards (see Appendix C for a list of the former interannual subset plots), but did not include data from the nine plots in Sunol/Ohlone (added in 2005) nor the ten new plots added in 2005 and 2006 to Morgan Territory and Vasco Caves. Starting in 2008, we created a new interannual subset of plots to compare interannual variation for a more complete group of plots. Because of site/time dependency, it is important to follow the same plots over time. Consequently, we excluded data from 2002-2004 because these years did not include a substantial number of the plots. Brushy Peak, Chabot Ridge, and Sycamore Valley were no longer included in the interannual subset because these parks were not sampled after 2007.

The new interannual comparison dataset comprises all data from 2005 through the present year at four parks, Morgan Territory, Pleasanton Ridge, Sunol/Ohlone, and Vasco Caves, with the exception of the three new plots added at Vasco Caves in 2008 and the three new plots added at Sunol/Ohlone in 2009, for a total of 45 plots (Table 4.1). The three Vasco Caves plots were deliberately located in areas of high native cover and so skew year-to-year comparisons; these plots are used in the Purple needlegrass analyses, however. The three Sunol/Ohlone plots have not been included in the 2009 analyses to allow for a year of transitioning from grazed to ungrazed status.

Note that three plots in Pleasanton Ridge previously grazed by cattle were left ungrazed in 2009 (PR4-6). This change in management status should be kept in mind when evaluating

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interannual changes on these three plots. In the following analyses, we treated the 2009 data from these plots as grazed because we assumed that a single year of grazing removal was not likely to have resulted in significant changes on the plots.

**Table 4.1:** New “interannual subset” of 45 plots

Morgan Territory		Grazing status	Pleasanton Ridge	Grazing status	Sunol/Ohlone	Grazing status
2005	2006-2009		2005-2009		2005-2009	
MT1	MT1	Ungrazed	PR4	*Cattle grazed	SU1	Cattle grazed
MT2	MT2	Ungrazed	PR5	*Cattle grazed	SU2	Cattle grazed
MT3	MT3	Ungrazed	PR6	*Cattle grazed	SU3	Cattle grazed
MT4	MT4	Cattle grazed	PR7	Sheep grazed	SU4	Cattle grazed
MT5	MT5	Cattle grazed	PR8	Sheep grazed	SU5	Cattle grazed
MT6	MT6	Cattle grazed	PR9	Sheep grazed	SU6	Cattle grazed
MT7	MT7	Cattle grazed	*Pleasanton Ridge cattle grazed plots not grazed in 2009		SU7	Ungrazed
MT8	MT8	Cattle grazed			SU8	Ungrazed
MT9	MT9	Ungrazed			SU9	Ungrazed
MT10	MT10	Ungrazed				
	MT11	Ungrazed				
	MT12	Ungrazed				
	MT13	Ungrazed				
	MT14	Cattle grazed				
	MT15	Cattle grazed				
	MT16	Cattle grazed				

Vasco Caves	Grazing status	Vasco Caves	Grazing status
2005		2006-2009	
VC1	Sheep grazed	VC1	Sheep grazed
VC2	Sheep grazed	VC2	Sheep grazed
VC3	Sheep grazed	VC3	Sheep grazed
VC4	Ungrazed	VC4	Ungrazed
VC5	Ungrazed	VC5	Ungrazed
VC6	Ungrazed	VC6	Ungrazed
VC7	Sheep grazed	VC7	Sheep grazed
VC8	Sheep grazed	VC8	Sheep grazed
VC9	Sheep grazed	VC9	Sheep grazed
VC10	Ungrazed	VC10	Ungrazed
VC11	Cattle grazed	VC11	Sheep grazed
VC12	Cattle grazed	VC12	Sheep grazed
VC13	Cattle grazed	VC13	Sheep grazed
VC14	Cattle grazed	VC14	Sheep grazed

4.1 Native cover by management type

Variation in Valley grassland species composition and dominance relationships is driven primarily by a complex combination of abiotic factors: annual rainfall and temperature patterns, soil chemistry and texture, and topographic characteristics such as elevation, aspect, and slope. At any given location, each year’s rainfall pattern and temperature in winter and spring largely determines which plants germinate, grow, and reproduce that year. Management activities have fairly limited influence on long-term and landscape-level changes in the grassland (Bartolome et al. 2007).

California’s Valley grassland typically has low cover of native species (Bartolome et al. 2007). Consistent with this generalization, absolute native cover at the study sites has been low, fluctuating between 3 – 7% depending on year (Table 4.2). Averaged over all sites, native cover appears to track rainfall amount and pattern: 2005 was a wet year, and native cover was notably high; in contrast, 2007’s very dry weather was the likely cause of the lowest native cover observed during the project’s run. Although 2008 and 2009 were also drought years, native cover was greater in both years than 2007’s low.

**Table 4.2:** Percent absolute cover of native plant species, 2005-2009 (new interannual subset)

Percent native cover				
2005	2006	2007	2008	2009
6.9	4.2	2.8	4.3	5.2

2007 was the first significant drought year (64% of normal rainfall) to occur during the course of the project. In the 2007 annual report, we noted that there appeared to be an interaction between grazing and annual rainfall pattern. From 2003 to 2006, grazed and ungrazed plots showed the same general native cover trajectory, likely in response to annual weather patterns; overlaying the general, weather-related trajectory, there was also an apparent management-related response: grazed plots consistently had higher native cover than ungrazed plots. In 2007, however, this management-related response changed: native cover increased from 2006 levels on ungrazed plots but declined on grazed plots (Table 4.3), and, in several instances, ungrazed plots had higher levels of native cover than grazed plots for the first time during the course of the project.

2008 was also a drought year (73% of normal rainfall), but the drought/grazing interaction did not appear as strong as in the previous year. Both grazed and ungrazed plots increased in native cover compared to 2007. Ungrazed plots increased to a greater extent than cattle-grazed plots, however, and, in fact, reached their greatest level of native cover over the five-year period (Table 4.3). Intriguingly, sheep-grazed plots also showed a much larger increase in native cover than cattle-grazed plots and sported their greatest native cover over the five-year period. For the sheep-grazed plots, this trend was driven by a significant increase in Purple needlegrass (*Nassella pulchra*) cover at Vasco Caves. Pleasanton Ridge is the only other park with sheep-grazed plots, and those plots had almost no native cover in 2008.

2009 was the third consecutive drought year (74% of normal rainfall). Compared to 2008, absolute native cover on cattle-grazed plots doubled in 2009, approaching native cover levels seen in 2005, a year notable for abundant native forbs. Concurrently, sheep-grazed and

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ungrazed plots both showed a decline in native cover, sheep-grazed plots decreasing most sharply. This decrease in native cover on sheep-grazed plots can be attributed to the decline of Purple needlegrass (*Nassella pulchra*) cover at Vasco Caves (see Section 5.0). Pleasanton Ridge, the only other park with sheep grazing, increased in native cover on sheep-grazed plots in 2009.

Over the past five years, fluctuation in native cover has been about twice as large on cattle-grazed and sheep-grazed plots as it has been on ungrazed plots. The coefficient of variation for native cover, 2005-2009, is 39% for cattle-grazed plots, 45% for sheep-grazed plots, and 22% for ungrazed plots.

**Table 4.3:** Percent absolute cover of native species, 2005-2009, comparing combined cattle-grazed, sheep-grazed, and ungrazed plots (new interannual subset)

Grazing status	Percent absolute native cover				
	2005	2006	2007	2008	2009
*cattle grazed	11.6	7.3	4.7	5.0	10.0
sheep grazed	3.7	3.0	1.2	4.9	2.5
ungrazed	2.1	1.6	2.1	2.9	2.1

\*PR4-6 not grazed in 2009 but grouped with cattle grazed plots

Table 4.4 shows the annual changes in native cover within each park from 2005 to 2009, categorized by grazing status. As has been noted in previous annual reports, parks often exhibit significant differences not only in native cover levels but in trend as well. Morgan Territory's grazed plots have declined in native cover since 2006 and had less native cover than its ungrazed plots in both 2007 and 2008; Morgan Territory's ungrazed plots increased slightly in native cover over the same period. However, this trend was reversed in 2009: grazed plots increased in native cover, overtaking ungrazed plots, which declined in native cover.

Vasco Caves' grazed plots increased substantially in native cover in 2008 compared to 2007, while its ungrazed plots decreased slightly in 2008. The decrease in 2007 followed by the increase in 2008 of native cover on Vasco Caves' grazed plots may have been an artifact of the fire that occurred in June 2006 and which burned three of the grazed plots. This hypothesis is supported by the return to a more moderate level of native cover on Vasco Caves' grazed plots in 2009, though ungrazed, unburned plots at Vasco Caves also experienced a decline in native cover in 2009.

At Sunol, both grazed and ungrazed plots decreased in native cover from 2005 to 2007 but increased in 2008. Ungrazed plots at Sunol again decreased in native cover in 2009, but grazed plots experienced a dramatic increase. Grazed plots had much greater native cover than ungrazed plots in all years at Sunol.

**Table 4.4:** Average native percent relative cover for management type within park, 2005-2009 (new interannual subset)

site	plot	grazing status	native percent relative cover					
			2005	2006	2007	2008	2009	
MT (2005)	1-3, 9-10	ungrazed	1.5					
MT (2005)	4-8	cattle	8.4					
MT	1-3, 9-13	ungrazed		1.4	1.6	2.1	1.3	
MT	4-8, 14-16	cattle		3.6	1.0	1.1	2.4	
PR	4-6	cattle	8.2	5.8	3.8	4.6	10.1*	
PR	7-9	sheep	1.0	0.9	0.4	0.4	1.1	
SU	7-9	ungrazed	0.5	0.2	0.1	1.5	0.9	
SU	1-6	cattle	24.6	16.9	12.3	13.7	24.3	
VC (2005)	1-3, 7-9	sheep	6.5					
VC (2005)	11-14	cattle	4.0					
VC	4-6, 10	ungrazed	4.5	4.0	7.8	7.3	6.1	
VC	1-3, 7-9, 11-14	sheep		4.3	1.9	7.4	3.4	

\*PR4-6 not grazed in 2009

4.2 Native species richness by management type

Native species richness (the number of native species in a location) is an important native species metric in the Valley grassland. As noted in the previous sub-section, native cover is generally low in Valley grassland: non-native species typically make up more than 90% of the cover. Species richness, in contrast, is more evenly distributed between native and non-native species. Like native cover, however, native species richness appears to track annual weather patterns (Table 4.5). In wet years like 2005, native species richness was greater than in drought years like 2007.

**Table 4.5:** Average annual native species richness, 2005-2009 (new interannual subset)

Average annual native species richness				
2005	2006	2007	2008	2009
4.0	3.5	2.3	2.8	3.2

In 2009, average native species richness on all cattle-grazed plots (5.8) was greater than on ungrazed plots (1.1) or on sheep-grazed plots (2.2). The difference between cattle-grazed and ungrazed plots was highly statistically significant (p-value=0.002; 2-tailed t-test with unequal variance). The difference between sheep-grazed plots and ungrazed plots was not statistically significant (p-value=0.26; 2-tailed t-test with unequal variance).

In the non-drought years of 2003 to 2006, grazed plots generally exhibited higher native richness than ungrazed plots, and at the landscape level, grazing appeared to maintain higher

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native species richness (see Section 6.3 of 2006 Report). However, in the last three years of drought, this relationship became more complicated. The drought/grazing interaction is complex, with weather, site, and grazing factors playing roles.

Even in the three drought years, grazed plots had greater native species richness than ungrazed sites in all but 2 instances: Vasco Caves in 2007 and Morgan Territory in 2008 (Table 4.6). However, in drought years, trajectories were sometimes different between grazed and ungrazed plots. Interestingly, Morgan Territory and Sunol/Ohlone plots exhibited similar patterns, while Vasco Caves differed from the other two parks.

In the two former parks, native species richness in both grazed and ungrazed plots fell in the first and most severe drought year, 2007 (64% of normal rainfall). 2008, the second year of drought (73% of normal rainfall) saw an increase in ungrazed species richness but a small continued decrease in grazed species richness. In 2009, the third consecutive year of drought (74% of normal rainfall), species richness fell on ungrazed plots but rose on grazed plots, in the case of Sunol to higher levels than in any other year (Table 4.6).

In contrast, at Vasco Caves, ungrazed plots' native species richness actually rose in 2007; grazed plots' species richness fell. The following year, both grazed and ungrazed plots increased, only to decrease in tandem again in 2009 (Table 4.6).

As noted, these drought/grazing interactions are complex, with weather, site factors (e.g., soil, topography), and grazing status potentially playing interacting roles in determining native species richness in any given year. The functional group identity of the dominant native species may also play a part, as the native vegetation at Morgan Territory and Sunol/Ohlone is dominated by forbs, while at Vasco Caves, Purple needlegrass, a bunchgrass, is the native dominant.

Type of grazing animal could also have had an effect: Sunol/Ohlone and Morgan Territory are cattle-grazed and Vasco Caves is sheep-grazed. In Pleasanton Ridge, which is both sheep- and cattle-grazed, cattle-grazed plots followed trajectories similar to Sunol/Ohlone and Morgan Territory's cattle-grazed plots, while sheep-grazed plots followed trajectories similar to Vasco Caves' sheep-grazed plots (Table 4.6). Note, however, that Pleasanton Ridge cattle-grazed plots were not grazed in 2009.

**Table 4.6:** 2005-2009 average native species richness by grazing status within park (new interannual subset); unknown species not included in analysis

site	plots	grazing status	average native species richness					
			2005	2006	2007	2008	2009	
MT (2005)	1-3, 9-10	ungrazed	2.4					
MT (2005)	4-8	cattle	5.8					
MT	1-3, 9-13	ungrazed		1.5	1.3	1.8	1.4	
MT	4-8, 14-16	cattle		5.3	2.0	1.8	2.3	
PR	4-6	cattle	4.7	3.7	3.3	2.3	4.7*	
PR	7-9	sheep	1.0	1.0	0.3	1.0	1.0	
SU	7-9	ungrazed	0.7	0.7	0.3	1.0	0.7	
SU	1-6	cattle	9.7	8.5	7.7	7.5	11	
VC (2005)	1-3, 7-9	sheep	3.2					
VC (2005)	11-14	cattle	1.8					
VC	4-6, 10	ungrazed	3.3	1.0	1.5	2.3	1.0	
VC	1-3, 7-9, 11-14	sheep		3.1	1.4	3.1	2.6	

\*PR4-6 not grazed in 2009

### 4.3 Management implications

Rainfall appears to be the primary driver of native species richness and native cover, with high rainfall years producing greater cover and richness than low rainfall years. Livestock grazing may exert some influence on these diversity metrics, however, even at the landscape level. In years with average or above-average rainfall, grazed plots have higher levels of native cover and richness than ungrazed plots, at some sites and at the landscape-scale. In drought years, livestock grazing may be associated with a reduction in native cover and species richness, but the data suggest that this effect is transient.

In 2009, the 3<sup>rd</sup> year of drought, native cover and species richness generally made a strong recovery, with cattle-grazed plots achieving the 2<sup>nd</sup> highest level of cover observed from 2005-2009. Ungrazed plots also returned to pre-drought levels of native cover, although cattle-grazed plots had much higher cover levels (Table 4.3). Sheep-grazed plots fluctuated in native cover and species richness to such an extent over the 3 drought years that no clear conclusion is possible. Fully teasing apart the effects of grazing and drought will require further investigation.

It will be instructive to observe the effects of a high rainfall year following the drought years to see whether native abundance relationships and trends revert back to their non-drought year patterns.

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4.4 Species composition (interannual subset)

Consistent with previous years, species cover distribution in 2009 was highly skewed to a few dominant species (Tables 4.7 and 4.8). Of the 100 species observed in 2009, the three most abundant species, wild oats (*Avena fatua*), broadleaf filaree (*Erodium botrys*), and annual ryegrass (*Lolium multiflorum*), made up 39% of the total relative cover. The 13 species with an individual relative cover of  $\geq 1\%$  made up 88% of the total relative cover as a group, and the bottom 50% of the species had  $\leq 0.07\%$  cover individually and, combined, made up only 1.3% of the total relative cover.

Total species richness for 2009 was 100 species. Fifty percent of the species (50 of 100) were native, and 50% were non-native (50 of 100). Of the 50 native species, 60% (30 of 50) were annual forbs, 28% (14 of 50) were perennial forbs, and 10% (5 of 50) were perennial grasses; there was also 1 native forb species of unidentifiable life-history.

**Table 4.7:** 2008 and 2009 absolute cover values (interannual subset); total of 12,600 point hits for each year

	<b>2008 % absolute cover</b>	<b>2009 % absolute cover</b>
Native species	4.3	5.2
Non-native species	77.9	79.8
Unidentifiable species	1.1	0.4
Non-plant material (litter, soil, rock, moss)	16.7	14.6
Purple needlegrass ( <i>Nassella pulchra</i> ) (most abundant <b>native</b> species)	1.3	0.9
Johnny jump-up ( <i>Viola pedunculata</i> ) (2 <sup>nd</sup> most abundant <b>native</b> species)	0.4	0.6
Wild oats ( <i>Avena fatua</i> ) (most abundant species overall)	12.4	12.9
Broadleaf filaree ( <i>Erodium botrys</i> ) (2 <sup>nd</sup> most abundant species in 2009, 3 <sup>rd</sup> in 2008)	11.7	10.9
Annual ryegrass ( <i>Lolium multiflorum</i> ) (3 <sup>rd</sup> most abundant species in 2009, 2 <sup>nd</sup> in 2008)	12.1	9.3

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**Table 4.8:** Rank for all species, plus litter and soil, with  $\geq 1\%$  absolute cover (all plots)

2008				2009		
Rank	Species	Origin	% absolute cover	Species	Origin	% absolute cover
1	<i>Avena fatua</i>	exotic	12.4	<i>Avena fatua</i>	exotic	12.9
2	<i>Lolium multiflorum</i>	exotic	12.1	<i>Erodium botrys</i>	exotic	10.9
3	<i>Erodium botrys</i>	exotic	11.7	<i>Lolium multiflorum</i>	exotic	9.3
4	litter		10.5	litter		8.6
5	<i>Bromus diandrus</i>	exotic	8.8	<i>Bromus madritensis</i> ssp. <i>madritensis</i>	exotic	7.5
6	<i>Bromus hordeaceus</i>	exotic	7.2	<i>Bromus hordeaceus</i>	exotic	7.1
7	soil		6.0	<i>Bromus diandrus</i>	exotic	6.8
8	<i>Bromus madritensis</i> ssp. <i>madritensis</i>	exotic	4.8	<i>Trifolium hirtum</i>	exotic	6.0
9	<i>Avena</i> sp.	exotic	3.9	soil		5.9
10	<i>Brachypodium distachyon</i>	exotic	3.2	<i>Avena</i> sp.	exotic	4.1
11	<i>Avena barbata</i>	exotic	3.2	<i>Brachypodium distachyon</i>	exotic	3.0
12	<i>Erodium cicutarium</i>	exotic	1.4	<i>Avena barbata</i>	exotic	2.8
13	<i>Nassella pulchra</i>	native	1.3	<i>Erodium cicutarium</i>	exotic	1.7
14	<i>Vulpia bromoides</i>	exotic	1.3	<i>Hordeum marinum</i> ssp. <i>gussoneanum</i>	exotic	1.2
15	<i>Hordeum marinum</i> ssp. <i>gussoneanum</i>	exotic	1.1	<i>Vulpia bromoides</i>	exotic	1.0
16	unknown grass	unk.	1.0			
<b>Total % cover:</b>			90.0	<b>Total % cover:</b>		88.9

## 5.0 Purple needlegrass dynamics

The bunchgrass Purple needlegrass (*Nassella pulchra*) is the most abundant native species in our study plots. Over the course of the Project, Purple needlegrass has been found on transects in 5 out of the 7 Valley grassland parks (Table 5.1). Purple needlegrass's main presence is at Chabot Ridge and Vasco Caves, parks which had grazed and ungrazed comparison plots. Unfortunately, in both locations, circumstances have made evaluating differences between grazed and ungrazed plots difficult. In 2007, ungrazed plots at Chabot Ridge started being grazed, and they have been subject to mowing and nearby oak planting for several years. Chabot Ridge was not sampled in 2008 or 2009. At Vasco Caves, there was only one ungrazed Purple needlegrass plot, and the grazed plot with the highest Purple needlegrass cover burnt in the June 2006 wildfire, likely reducing cover, at least in the first year after the fire. These confounding factors make it difficult to draw strong conclusions about the effect of grazing on Purple needlegrass.

To address the lack of paired grazed/ungrazed plots in areas of high Purple needlegrass cover, we added three new plots to Vasco Caves in 2008. Plots were randomly located in areas with high Purple needlegrass cover. Two of the plots are not grazed, the other is grazed.

As noted in previous reports, Purple needlegrass has exhibited a steady decline over the course of the project (Table 5.1). The decline occurred in all parks and on grazed and ungrazed plots leading us to surmise that the decline was related to regional environmental factors rather than management activities. In 2008, this trend slowed somewhat, with plots maintaining cover levels similar to those of previous years, and even increasing, particularly at Vasco Caves plots. The increase occurred in multiple parks and on both grazed and ungrazed plots, lending credence to the hypothesis that the fluctuations in Purple needlegrass cover are driven by regional environmental phenomena, e.g., rainfall amount and pattern, rather than management activities.

However, in 2009, annual average cover of Purple needlegrass dropped once again. This decrease in Purple needlegrass cover occurred at all parks sampled in 2009 except for Pleasanton Ridge (Table 5.1). At Pleasanton Ridge, Purple needlegrass increased on 3 of the 4 Purple needlegrass plots, in contrast to the general decline on both grazed and ungrazed plots at Morgan Territory, Sunol, and Vasco Caves, and in contrast to the two previous years at Pleasanton Ridge in which Purple needlegrass was not hit in any plots. Interestingly, two of the Pleasanton Ridge plots were not grazed in 2009 for the first time since the beginning of this study; one of these plots displayed the park's largest increase in Purple needlegrass cover, while the other plot contained no Purple needlegrass for the third year in a row. The other two Pleasanton Ridge plots containing Purple needlegrass were sheep-grazed as normal. These disparate trends again suggest that grazing plays only a limited role in Purple needlegrass dynamics.

### 5.1 Management implications

Fluctuations in Purple needlegrass cover appear to be driven primarily by regional environmental factors with livestock grazing exerting little influence. The installation of additional grazed and ungrazed plots at Vasco Caves should help confirm or refute this hypothesis over the next few years.

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**Table 5.1:** Purple needlegrass (*Nassella pulchra*) % absolute cover and grazing status, 2003-2009; VC10 sheep-grazed 2003-2004, ungrazed 2005-2009; PR4-6 not grazed in 2009

Plot ID	percent absolute cover							grazing status
	2003	2004	2005	2006	2007	2008	2009	
MT6	0.7	0.4	3.6	0.4	0.4	0	0.4	cattle
MT7			0.7	0	0	0	0.0	cattle
MT8			1.1	0	0	0.4	0.0	cattle
MT10			0	0	0	0.4	0.0	ungrazed
MT11				1.8	0.4	1.8	0.4	ungrazed
MT14				0	0	0.4	0.0	cattle
PR5	9.3*	8.2*	9.3*	1.1*	0*	0*	4.3 <sup>+</sup>	cattle* / ungrazed <sup>+</sup>
PR6	1.1*	0*	0.4*	0*	0*	0*	0 <sup>+</sup>	cattle* / ungrazed <sup>+</sup>
PR7	0	0	0	0.7	0	0	0.4	sheep
PR8	2.9	1.8	1.4	0.4	0	0	1.4	sheep
SU2			0.4	0.4	0	0	0	cattle
SU3			0	0	0	0.4	0	cattle
SU6			7.1	3.6	4.3	4.6	3.9	cattle
SU9			0.7	0	0	0	0	ungrazed
SU10							0.7	ungrazed
VC2	21.8	18.9	15	11.1	5	22.1	8.2	sheep (6/2006 fire)
VC3	2.5	3.6	1.4	2.1	1.8	6.1	2.9	sheep
VC8	3.2	6.8	2.9	0.7	1.8	2.9	2.1	sheep (6/2006 fire)
VC9	0	0.7	0	0.4	0.7	0.4	0.4	sheep (6/2006 fire)
VC10	11.4*	6.8*	12.1 <sup>+</sup>	10.4 <sup>+</sup>	18.9 <sup>+</sup>	20.7 <sup>+</sup>	18.2 <sup>+</sup>	sheep* / ungrazed <sup>+</sup>
VC15						17.9	4.3	ungrazed
VC16						12.5	8.2	ungrazed
VC17						9.3	7.9	sheep
<b>Annual average cover on NAPU plots</b>	7.7	6.5	4.2	3.3	2.5	4.5	2.8	

**6.0 Native annual and perennial forbs and grazing status (all plots)**

In their large-scale study of California’s coastal prairie grassland type, Hayes and Holl (2003) found higher native annual forb species richness and cover on cattle-grazed sites than they found on ungrazed sites. They hypothesized that reduced litter depth and increased bare soil on grazed sites favored the growth and germination of annual forbs. Hayes and Holl’s findings were supported by EBRPD’s Valley Grassland data from 2006: native annual forb cover and richness on cattle-grazed plots were significantly greater than on ungrazed plots. In the drought years of 2007 and 2008, native annual forb cover and richness on cattle-grazed plots continued to be significantly greater than on ungrazed plots, although the differences between grazed and ungrazed plots tended to be smaller. A third consecutive year of drought occurred in 2009.

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We analyzed both native annual and native perennial forb species richness and cover for the 2009 season. Please note that although the cattle-grazed plots at Pleasanton Ridge were not grazed during the 2009 season, we chose to analyze these plots as cattle-grazed because their vegetation composition was more characteristic of grazed than ungrazed grassland.

In 2009, 51% (26 of 51) of the plots had native annual forbs present, slightly less than in 2008. Of these 26 plots, 46% were cattle-grazed, 31% ungrazed, and 23% sheep-grazed. Native perennial forbs were found on 49% (25 of 51) of the plots in 2009. Cattle-grazed and ungrazed plots both accounted for 44% of these 25 plots, and sheep grazed plots accounted for 12% of the plots with native perennial forbs present.

In 2009, average relative cover of both native annual and perennial forbs continued to be greater on cattle-grazed plots than on ungrazed plots (Table 6.0). Cattle-grazed plots had an average relative cover of native annual forbs of 6.05% and ungrazed plots 1.24%; this difference was statistically significant (p-value=0.02; 2-tailed t-tests with unequal variance). Relative to 2008, annual forb cover rose on both cattle-grazed plots (2008: 2.48%) and ungrazed plots (2008: 0.79%). Average relative cover of native perennial forbs was 4.21% on cattle-grazed plots and 0.92% on ungrazed plots; this difference was just short of being statistically significant (p-value=0.11). Compared to 2008, perennial forb cover also rose on both cattle-grazed plots (2008: 3.0%) and ungrazed plots (2008: 0.80%).

Average species richness of both native annual and perennial forbs was greater on cattle-grazed than ungrazed plots in 2009 (Table 6.0). Native annual forbs had an average species richness of 3.88 on cattle-grazed plots and 0.85 on ungrazed plots, a highly statistically significant difference (p-value= 0.005; 2-tailed t-test with unequal variance). Native perennial forbs had an average species richness of 1.53 on cattle-grazed plots and 0.70 on ungrazed plots, a statistically significant difference (p-value= 0.05; 2-tailed t-test with unequal variance). Compared to native species richness in 2008, cattle-grazed and ungrazed annual forbs (2008: 1.9 and 0.5 respectively) and cattle-grazed perennial forbs (2008: 1.3) increased while ungrazed perennial forbs fell slightly (2008: 0.8).

**Table 6.0:** 2009 cover and species richness for native forbs

	% average relative cover		Average species richness	
	annuals	perennials	annuals	perennials
Cattle-grazed	6.05	4.21	3.88	1.53
Ungrazed	1.24	0.92	0.85	0.70

Average percent relative cover of native annual forbs increased on all cattle-grazed plots from 2008 to 2009, but there was no clear trend observed on ungrazed or sheep-grazed plots (Table 6.1). At Morgan Territory, relative cover of native annual forbs on cattle-grazed plots (1.98%) was, once again, greater than on ungrazed plots (0.22%), though this was not quite a statistically significant difference (p-value=0.15); native annual forb cover on ungrazed plots had overtaken cover on grazed plots between 2007 and 2008 at this park. Cattle-grazed plots at Sunol-Ohlone continued to have a much higher relative cover of native annual forbs than ungrazed plots, this difference being statistically significant (p-value=0.03). Cattle-grazed plots had a higher relative cover of annual forbs than sheep-grazed plots at Pleasanton Ridge, though this difference was not statistically significant (p-value=0.41). Sheep-grazed plots at Vasco

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Caves continued to have a greater relative cover of native annual forbs than ungrazed plots, though the difference between the management types decreased from 2008 to 2009, losing statistical significance.

**Table 6.1:** 2008 and 2009 average native annual forb percent relative cover by management type within park (all plots; plots in same color are paired plots within the same park) and 2009 p-values from 2-tailed t-tests with unequal variances comparing native cover

Park	Grazing status	Average % relative cover, 2008	Average % relative cover, 2009	p-values from t-tests for 2009
Morgan Territory	ungrazed	0.94	0.22	0.15
Morgan Territory	cattle	0.65	1.98	
Pleasanton Ridge	cattle*	3.27	4.44	0.41
Pleasanton Ridge	sheep	0.00	0.00	
Sunol-Ohlone	ungrazed	1.28	3.23	0.03
Sunol-Ohlone	cattle	4.46	12.48	
Vasco Caves	ungrazed	0.25	0.42	0.41
Vasco Caves	sheep	1.21	1.03	

\*Pleasanton Ridge cattle grazed plots were not grazed in 2009

As occurred with average percent relative cover of native annual forbs, average relative cover of native perennial forbs increased on all cattle-grazed plot between 2008 and 2009, while sheep-grazed and ungrazed plots displayed no clear trend across parks (Table 6.2). However, in contrast to the cover results for native annual forbs, native perennial forb cover remained greater on ungrazed plots than cattle-grazed plots at Morgan Territory in 2009, though both management types had low percent covers and the difference was not statistically significant. Cattle-grazed plots at Sunol-Ohlone had a much greater relative cover of native perennial forbs than ungrazed plots, this difference being statistically significant (p-value=0.09). Cover of native perennial forbs on cattle-grazed plots at Pleasanton Ridge was greater than cover on sheep-grazed plots but was not statistically significant (p-value=0.23). At Vasco Caves, average native perennial forb cover decreased on both ungrazed and sheep-grazed plots, ungrazed plot cover of native perennial forbs overtaking cover on sheep-grazed plots; however the difference was not statistically significant (p-value=0.48).

Average species richness of native annual forbs also increased on all cattle-grazed plots between 2008 and 2009, but sheep-grazed and ungrazed plots showed no obvious trend (Table 6.3). Average native annual forb richness on the grazed plots at Morgan Territory (cattle) and Vasco Caves (sheep) were just short of being statistically significantly greater than their ungrazed counterparts (p-values=0.14 and 0.17, respectively). At Sunol-Ohlone, there was a highly statistically significant difference between native annual forb species richness on cattle-grazed plots (7.50) and ungrazed plots (2.00), with a p-value of 0.004. There was a three-fold increase in average species richness of native annual forbs on cattle-grazed plots at Pleasanton Ridge from 2008 (1.00) to 2009 (3.00); sheep-grazed plot native annual forb species richness remained at 0, but the difference between cattle-grazed and sheep-grazed plots was still not statistically significant (p-value=0.36).

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**Table 6.2:** 2008 and 2009 average native perennial forb percent relative cover by management type within park (all plots; plots in same color are paired plots within the same park) and 2009 p-values from 2-tailed t-tests with unequal variances comparing native cover

Park	Grazing status	Average % relative cover, 2008	Average % relative cover, 2009	p-values from t-tests for 2009
Morgan Territory	ungrazed	0.44	0.56	0.56
Morgan Territory	cattle	0.24	0.32	
Pleasanton Ridge	*cattle	0.57	1.11	0.23
Pleasanton Ridge	sheep	0.00	0.00	
Sunol-Ohlone	ungrazed	0.26	1.71	0.09
Sunol-Ohlone	cattle	8.04	10.81	
Vasco Caves	ungrazed	0.83	0.49	0.48
Vasco Caves	sheep	1.58	0.26	

\*Pleasanton Ridge cattle grazed plots were not grazed in 2009

**Table 6.3:** 2008 and 2009 average native annual forb percent species richness by management type within park (all plots; plots in same color are paired plots within the same park) and 2009 p-values from 2-tailed t-tests with unequal variances comparing native species richness

Park	Grazing status	Average species richness, 2008	Average species richness, 2009	p-values from t-tests for 2009
Morgan Territory	ungrazed	0.38	0.38	0.14
Morgan Territory	cattle	0.88	1.50	
Pleasanton Ridge	cattle*	1.00	3.00	0.36
Pleasanton Ridge	sheep	0.00	0.00	
Sunol-Ohlone	ungrazed	0.67	2.00	0.004
Sunol-Ohlone	cattle	3.83	7.50	
Vasco Caves	ungrazed	0.50	0.33	0.17
Vasco Caves	sheep	1.36	1.27	

\*Pleasanton Ridge cattle grazed plots were not grazed in 2009

Generally, average species richness was low for native perennial forbs. Average native perennial forb richness displayed a statistically significant difference between paired management types only at Sunol-Ohlone (p-value=0.001), cattle-grazed plots (3.17) having a greater average richness than ungrazed plots (0.83) (Table 6.4). Both grazed and ungrazed plots at Sunol-Ohlone showed an increase in average perennial forb richness between 2008 and 2009. Native perennial species richness on ungrazed plots at Morgan Territory remained slightly greater than that on cattle-grazed plots. Likewise, perennial species richness continued to be a little greater on ungrazed plots than sheep-grazed plots at Vasco Caves. Cattle-grazed plots at Pleasanton Ridge increased slightly in perennial forb species richness in 2009 while perennial forbs continued to be absent from sheep-grazed plots, but this difference was not statistically significant (p-value=0.23).

**Table 6.4:** 2008 and 2009 average native perennial forb percent species richness by management type within park (all plots; plots in same color are paired plots within the same park) and 2009 p-values from 2-tailed t-tests with unequal variances comparing native species richness

Park	Grazing status	Average species richness, 2008	Average species richness, 2009	p-values from t-tests for 2009
Morgan Territory	ungrazed	0.75	0.63	0.74
Morgan Territory	cattle	0.50	0.50	
Pleasanton Ridge	cattle*	0.67	1.00	0.23
Pleasanton Ridge	sheep	0.00	0.00	
Sunol-Ohlone	ungrazed	0.33	0.83	<b>0.001</b>
Sunol-Ohlone	cattle	2.67	3.17	
Vasco Caves	ungrazed	1.33	0.67	0.62
Vasco Caves	sheep	0.73	0.45	

\*Pleasanton Ridge cattle grazed plots were not grazed in 2009

### 6.1 Management Implications

In spite of 2009 being the third consecutive drought year for California, cattle grazing consistently favored native annual forbs. Compared to 2008, annual forbs on cattle-grazed plots displayed an increase in both average species richness and cover in 2009. The benefits of cattle grazing versus no grazing seem to be less significant for perennial forbs, but cattle grazing sustains a greater cover and richness of both native annual and perennial forbs at the landscape level. This is noteworthy because forbs constitute the majority of the native species richness found on Park District grasslands.

The effect of sheep grazing on native forb abundance is less clear. Sheep-grazed plots at Vasco Caves had no native forbs from 2006 to 2009; however, there are no ungrazed control plots with which to compare these results. At Vasco Caves, sheep-grazed plots had more annual but fewer perennial forbs than ungrazed plots. Interestingly, in contrast to most of the other sites, forb richness and cover at Vasco Caves decreased between 2008 and 2009 on both sheep-grazed and ungrazed plots, suggesting a site rather than a management cause.

### 7.0 Purple false-brome watch (all plots)

Purple false-brome (*Brachypodium distachyon*), a non-native grass, may be spreading on EBRPD properties. Since 2003, it has been observed on over 50% of the study plots; of the four parks sampled in 2009, only at Vasco Caves were there no purple false-brome observations. Although purple false-brome cover has not shown significant increases over the past three drought years and has decreased slightly on some plots, the species does appear to be spreading each year (Table 7.1). It was hit on two further Morgan Territory plots in 2009 and was hit or observed in two of the three newly established Sunol/Ohlone plots.

The ecological impacts of purple false-brome are unknown, although the California Invasive Plant Council's (Cal-IPC) Plant Assessment Form for this species notes that purple

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false-brome can “form dense stands in some locations, particularly in oak woodlands” which could “reduce diversity and prevent native species from establishing” (<http://portal.cal-ipc.org/files/PAFs/Brachypodium%20distachyon.pdf>, accessed June 2007). Cal-IPC’s Invasive Plant Inventory (Cal-IPC 2006) assigns purple false-brome an invasive plant score of “moderate,” that is: a species that has “substantial and apparent—but generally not severe—ecological impacts.” In addition, DiTomaso and Healy (2007) note that purple false-brome makes poor forage because of its fibrous stems, sparse foliage, and long awns, which can also injure animals. Unfortunately, no information about control of this grass was found.

**Table 7.1:** Purple false-brome hits, 2003-2009; ND=no detections; OBS=observed on plot but not hit

Plot	2003 hits	Plot	2004 hits	Plot	2005 hits	Plot	2006 hits	Plot	2007 hits	Plot	2008 hits	Plot	2009 hits
						MT1	5	MT1	1	MT1	4	MT1	5
								MT2	2	MT2	2		ND
										MT3	5	MT3	1
								MT4	1		ND		ND
								MT6	OBS	MT6	OBS	MT6	OBS
										MT7	OBS	MT7	OBS
Plots not in project						MT8	1	MT8	8	MT8	3	MT8	4
Plots not in project					5	MT9	14	MT9	14	MT9	25	MT9	37
Plots not in project								MT10	2	MT10	OBS	MT10	OBS
Plots not in project						MT11	62	MT11	38	MT11	38	MT11	14
Plots not in project												MT12	1
Plots not in project						MT13	62	MT13	57	MT13	52	MT13	79
Plots not in project						MT14	56	MT14	46	MT14	43	MT14	26
Plots not in project						MT15	OBS	MT15	1	MT15	2	MT15	2
Plots not in project								MT16	OBS		ND	MT16	1
PR6	1		ND		ND		ND		ND		ND		ND
PR7	91	PR7	34	PR7	35	PR7	76	PR7	46	PR7	45	PR7	48
PR9	23	PR9	72	PR9	55	PR9	62	PR9	57	PR9	35	PR9	34
						VC5	OBS		ND		ND		ND
Plots not in project						SU1	7	SU1	9	SU1	11	SU1	2
Plots not in project						SU2	1	SU2	4	SU2	3	SU2	4
Plots not in project						SU3	6		ND		ND		ND
Plots not in project						SU4	44	SU4	63	SU4	67	SU4	63
Plots not in project						SU5	5		ND		ND	SU5	1
Plots not in project						SU6	65	SU6	107	SU6	75	SU6	78
Plots not in project											SU8	OBS	ND
Plots not in project						SU9	2	SU9	5	SU9	OBS	SU9	2
Plots not in project												SU10	97
Plots not in project												SU11	OBS

**8.0 Invasive species listed by the California Invasive Plant Council (all plots)**

In 2009, we found two species rated as “high” in the California Invasive Plant Council’s Invasive Plant Inventory (Cal-IPC 2006): Red brome (*Bromus madritensis* ssp. *rubens*) and Medusahead (*Taeniatherum caput-medusae*). Because we did not survey the invasive-species-rich Brushy Peak, Chabot Ridge, and Sycamore Valley in 2008 and 2009, the number of invasive species we observed in the last two years was lower than in earlier years of this study.

Cal-IPC describes species with an invasive plant score of “high” as follows: “These species have severe ecological impacts on ecosystems, plant and animal communities, and vegetational structure.

Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal and establishment. These species are usually widely distributed ecologically, both among and within ecosystems” (Cal-IPC 2003a, p.4).

Table 8.1 lists the 2009 location and percent relative cover for Medusahead. The only site where Medusahead was hit on transect in 2009 was at Morgan Territory plot MT2, but relative cover on this plot was < 1%. Between 2007 and 2008, cover of the invasive annual grass Medusahead doubled at Sunol plot SU5 (2008: 5.5% relative cover) in High Valley though remaining at a fairly low level. However, Medusahead was not hit on transect at SU5 in the 2009 drought year, though it was present on plot. In addition, Medusahead was found on plot though not hit on transect at Pleasanton Ridge plots PR4 and PR5.

Implementing a control program may inhibit the spread of medusahead. Recent publications describing Medusahead control include Kyser et al. (2007) for herbicide, DiTomaso et al. (2007) for sheep-grazing, and Kyser et al. (2008) for prescribed burning.

Red brome is not listed because its high Cal-IPC rating is due to the species’ deleterious effects in the Mohave Desert; in the California annual grassland, Red brome is unlikely to have severe ecological impacts (Cal-IPC 2003b).

**Table 8.1:** Location and % relative cover for invasive species found in 2009 (all plots) rated as “high” in the California Invasive Plant Council’s Invasive Plant Inventory (Cal-IPC 2006)

Plot	Grazing status	Species	Scientific name	% relative cover
Morgan Territory plot MT2	ungrazed	Medusahead	<i>Taeniatherum caput-medusae</i>	0.9

**9.0 2008/2009 precipitation data from the Livermore weather station**

We present data from the Livermore NOAA weather station to show the general weather trend in the region for the rain years 2002/03 to 2008/09.

Rainfall during the initial years of the study was mostly close to average or above average with no bad drought years. 2006/07 finally provided a drought year, with much less rain and a different pattern of rainfall timing over the growing season; 2007/08 and 2008/09 were also drought years though less dry overall than the 2006/07.

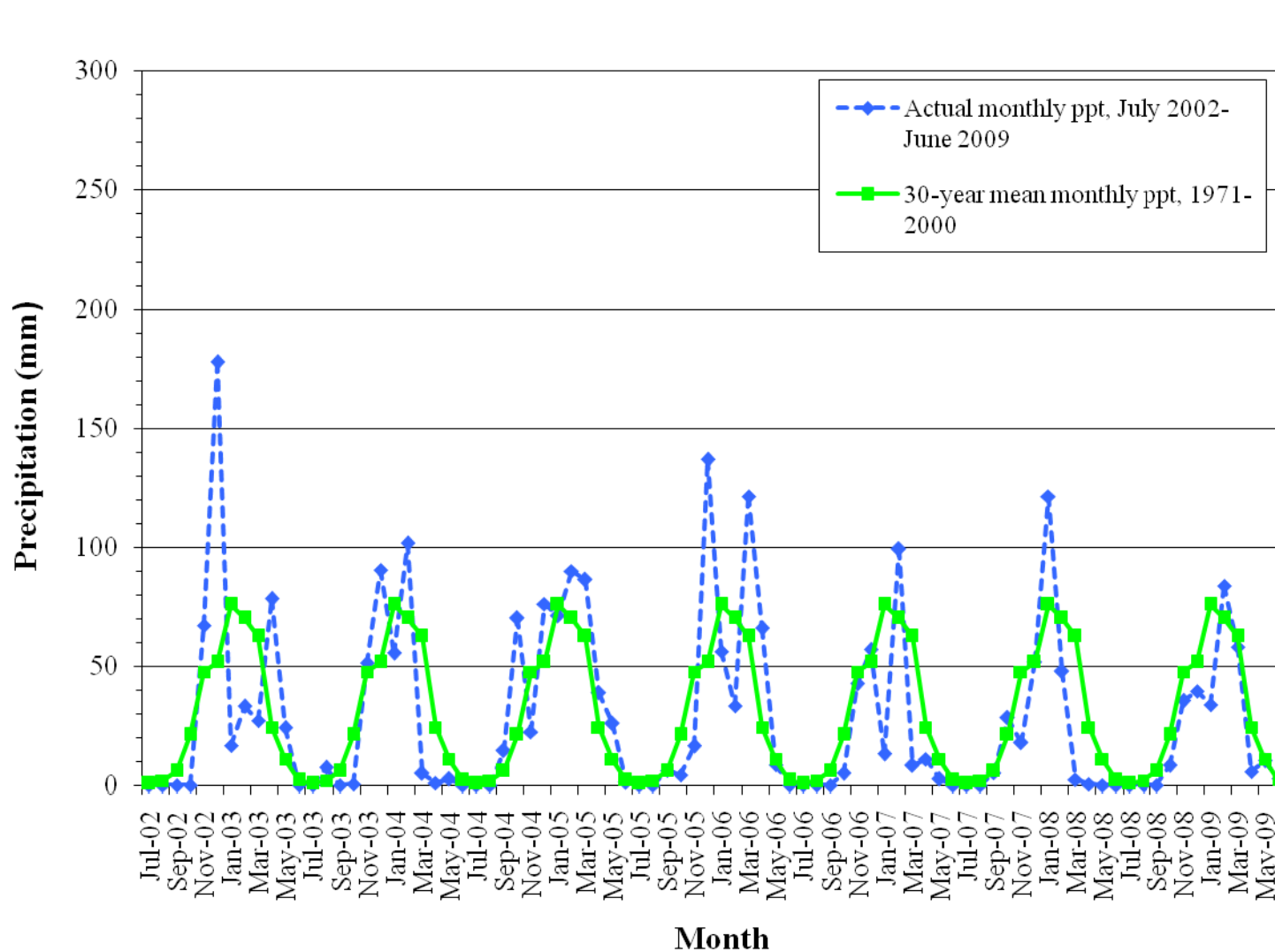
In Livermore, total precipitation in the 2008/09 rain-year was 279 mm, 74% of the 30-year mean, about the same as the previous rain-year (Table 9.1).

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**Table 9.1:** 30-year mean annual rainfall and annual rainfall, 2002/03-2008/09, (in mm) for the Livermore NOAA weather station

	<b>Annual rainfall (mm)</b>	<b>% of 30-year mean</b>
30-year (1971 - 2000) mean	376	
<b>Rain year</b>		
July 2002 - June 2003	425	113 %
July 2003 - June 2004	316	84 %
July 2004 - June 2005	498	132 %
July 2005 - June 2006	450	120%
July 2006 - June 2007	240	64%
July 2007 - June 2008	276	73%
July 2008 - June 2009	279	74%

Rainfall timing has a strong effect on Valley grassland species composition. In 2008/09, fall and winter were consistently drier than average, with an especially droughty January. February delivered a modestly greater-than-average rainfall, followed by an average March, a dry April, and an average May and June (Figure 9.1). This drought pattern differed from the previous two drought years' patterns: while there were no winter months with large rainfall spikes, spring was closer to average rainfall than the very dry previous years.



**Figure 9.1:** Actual monthly precipitation (in mm), July 2004 - June 2009, and 30-year mean (1971-2000) monthly precipitation (in mm) for Livermore NOAA weather station

## 10.0 Avian sampling 2009

### 10.1 2009 Valley Grassland focus

Field work in 2009 followed the same plan and methodology as previous years, consisting of 42 Valley Grassland point count plots, 16 ungrazed and 32 grazed. Chabot Ridge and Brushy Peak are removed from the survey because of the lack of a grazed and ungrazed comparison at both parks as well as the consistent absence of grassland birds at Chabot-Fairmont Ridge (see 2007 report for a more detailed explanation). Bird surveys continue at Sycamore Valley due to the presence of grassland bird species and the grazed and ungrazed plot comparison within the park. As part of the targeted Purple Needlegrass (*Nassella pulchra*) grazing comparison plots, one ungrazed plot was added to the point count survey at Vasco Caves.

### 10.2 Avian data collection methods

Avian data collection involves 10-minute, 100-meter variable circular plot point count surveys following USFWS protocol (Ralph et al. 1995). Between March 31 and June 15, three surveys were conducted in each park between 2004 and 2009. Three point count visits per plot in a breeding season are necessary to maximize the number of detections in what appears to be a low-density grassland bird community.

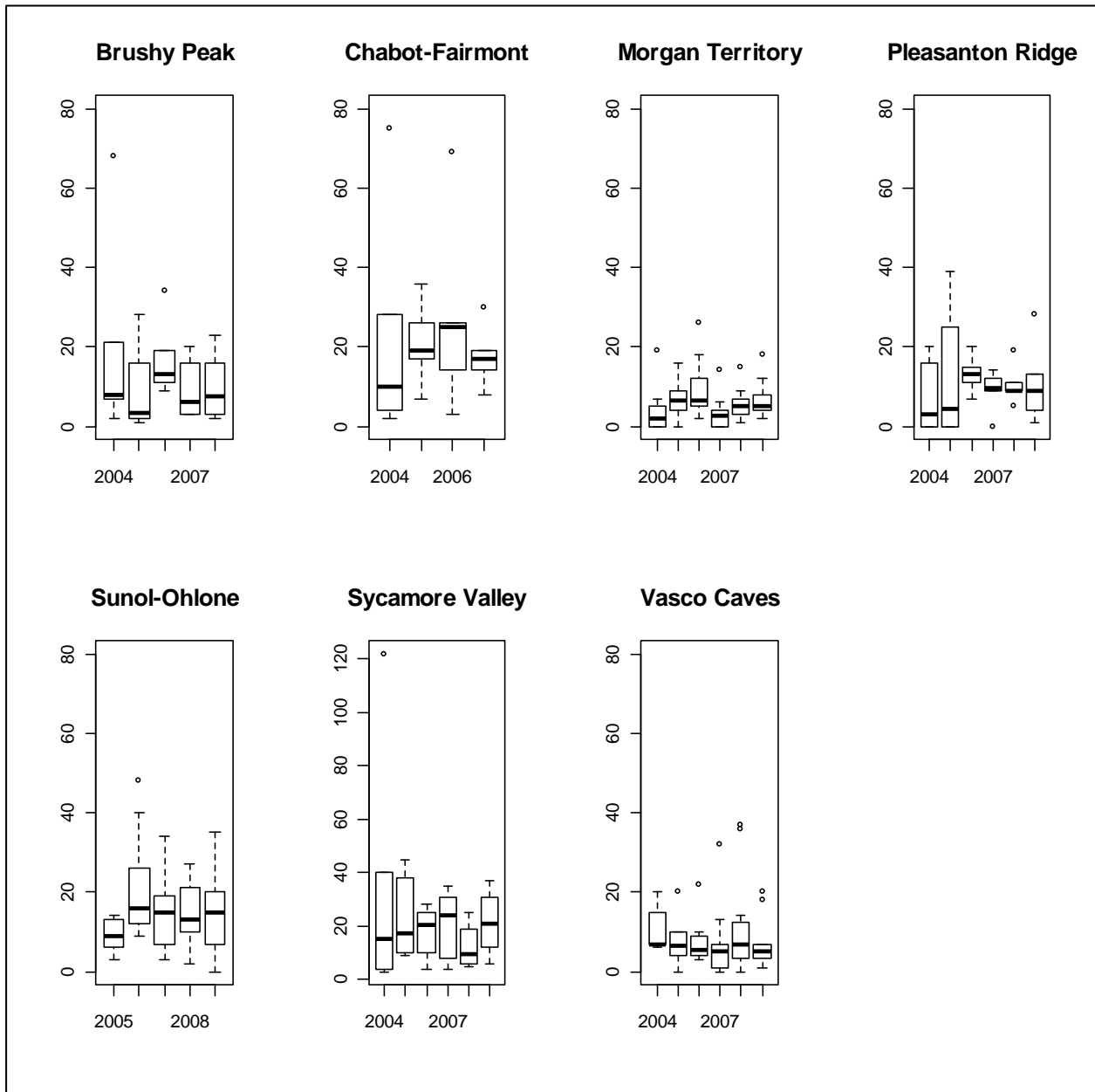
### 10.3 2004-2009 Avian dataset overview

Summaries within this report use a restricted avian dataset that only includes bird observations on plot within 100 meters of the plot center. The Breeding Bird Status table (Table 11.1, p. 33) is the only summary that uses the entire dataset of bird observations; incorporating all point count survey detections, including individuals detected outside of the timed count, as well as any observations of bird activity during other visits to the park.

On plot avian detection rates remain fairly constant and show no significant temporal trend over the years of the study, 2004-2009 (Figure 10.1). Plot detection rates are counted as the total number of individual birds on plot (within 100m of center) added cumulatively over three surveys per breeding season. Figure 10.1 uses Tukey boxplots to show by park the spread of annual plot detection numbers. These boxplots illustrate that median plot detection numbers stay more consistent at Morgan Territory and Vasco Caves. Outlier or extreme values of park plot detection rates are caused by sporadic occurrences of large flocks on plot (e.g. California Quail, American Pipits, Cedar Waxwings). In spite of the differences in climate, 2007-2009 had below average rainfall, there is no obvious trend showing climatic effects on median plot avian detection rates over all the parks and years.

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**Figure 10.1:** 2004-2009 annual park avian detection rates shown with a Tukey boxplot, dark lines are the median of summed plot detections per year per park, whiskers are the minimum and maximum plot values unless that value is 1.5 times the innerquartile range when it is represented with an outlier dot; Brushy Peak not surveyed 2009, Chabot-Fairmont Ridge not surveyed 2008-2009, Sunol-Ohlone not surveyed 2004; data restricted to detections of individuals on plot ( $\leq 100\text{m}$ ); note y-axis scale in Sycamore Valley different to accommodate outlier

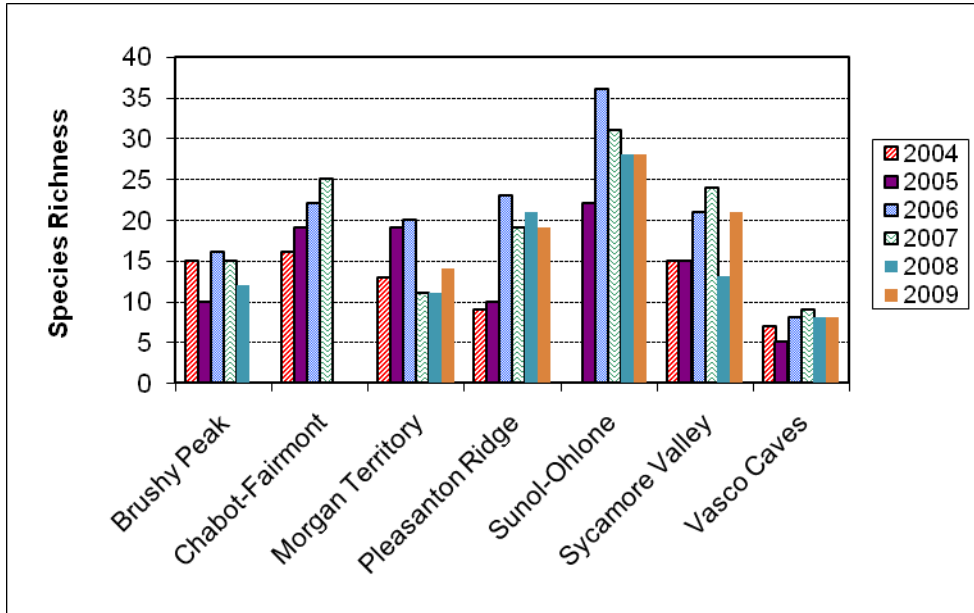


Using the restricted dataset (detections  $\leq 100\text{m}$ ), Sunol-Ohlone continues to have the highest overall park avian species richness while Vasco Caves remains the lowest (Figure 10.2).

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This trend is also reflected in the cumulative park avian species richness within the 2004-2009 Breeding Bird Status table (Table 11.1). This complete dataset of bird observations, using data as well as notes from all park visits, shows that species richness is highest for Sunol-Ohlone and lowest for Vasco Caves. Vasco Caves, in contrast, has the highest number of confirmed breeders. A species is considered a confirmed breeder when it has been observed in an activity that clearly represents reproductive activity (e.g. active nest or adult with juveniles).

**Figure 10.2:** 2004-2009 park avian species richness interannual comparison; data restricted to detections  $\leq 100\text{m}$



### 11.0 Grassland bird focal species overview

Focal grassland species of conservation and management concern, as determined by the California Partners in Flight Grassland Bird Conservation Plan (CPIF 2000), observed in the project study area are: Burrowing Owl (*Athene cunicularia*), Ferruginous Hawk (*Buteo regalis*), Grasshopper Sparrow (*Ammodramus savannarum*), Northern Harrier (*Circus cyaneus*), Savannah Sparrow (*Passerculus sandwichensis*), Western Meadowlark (*Sturnella neglecta*), and White-tailed Kite (*Elanus leucurus*). The Mountain Plover (*Charadrius montanus*) is the only CPIF primary focal species not found on our plots from 2002-2009; although it is a wintering species much less likely to be encountered during our intensive breeding season point count survey.

Secondary species, defined by the CPIF as birds nesting and/or primarily foraging in grasslands, observed in areas covered by this project are: Blue Grosbeak (*Guiraca caerulea*), Horned Lark (*Eremophila alpestris*), Mallard (*Anas platyrhynchos*), Prairie Falcon (*Falco mexicanus*), Ring-necked Pheasant (*Phasianus colchicus*), Song Sparrow (*Melospiza melodia*), Swainson's Hawk (*Buteo swainsoni*), and Tricolored Blackbird (*Agelaius tricolor*).

### 11.1 Grassland bird guild overview

Bird species with direct associations to a particular vegetation or habitat type are good indicators of ecosystem health (Carignan and Villard 2002). We chose four of the focal CPIF species to represent our grassland bird guild for their association with and dependence on grassland habitat within our sites: Grasshopper Sparrow, Horned Lark, Savannah Sparrow, and Western Meadowlark.

Comparing all the parks over 2004-2009, the grassland bird guild has a patchy distribution with low numbers of detection (Figures 11.1 and 11.2). None of the parks has a consistent yearly presence of all four of the guild species. For the guild, median plot detection rates (black lines within the boxplots) are heavily weighted by the number of zeros. In other words, across all of the parks the majority of plots have no guild species detected on plot. Guild plot detection rates are counted as the total number of guild species individuals on plot (within 100m of center) added cumulatively over three surveys per breeding season. Figure 11.1 uses Tukey boxplots to show by park the spread of annual guild plot detection numbers. The boxplots illustrate the close to zero grassland bird detection rate for Chabot-Fairmont Ridge. Vasco Caves is the only park where individuals from the guild are consistently found on a majority of the plots. Figure 11.1 shows that Vasco Caves had detections of at least one guild species on every plot in 2009.

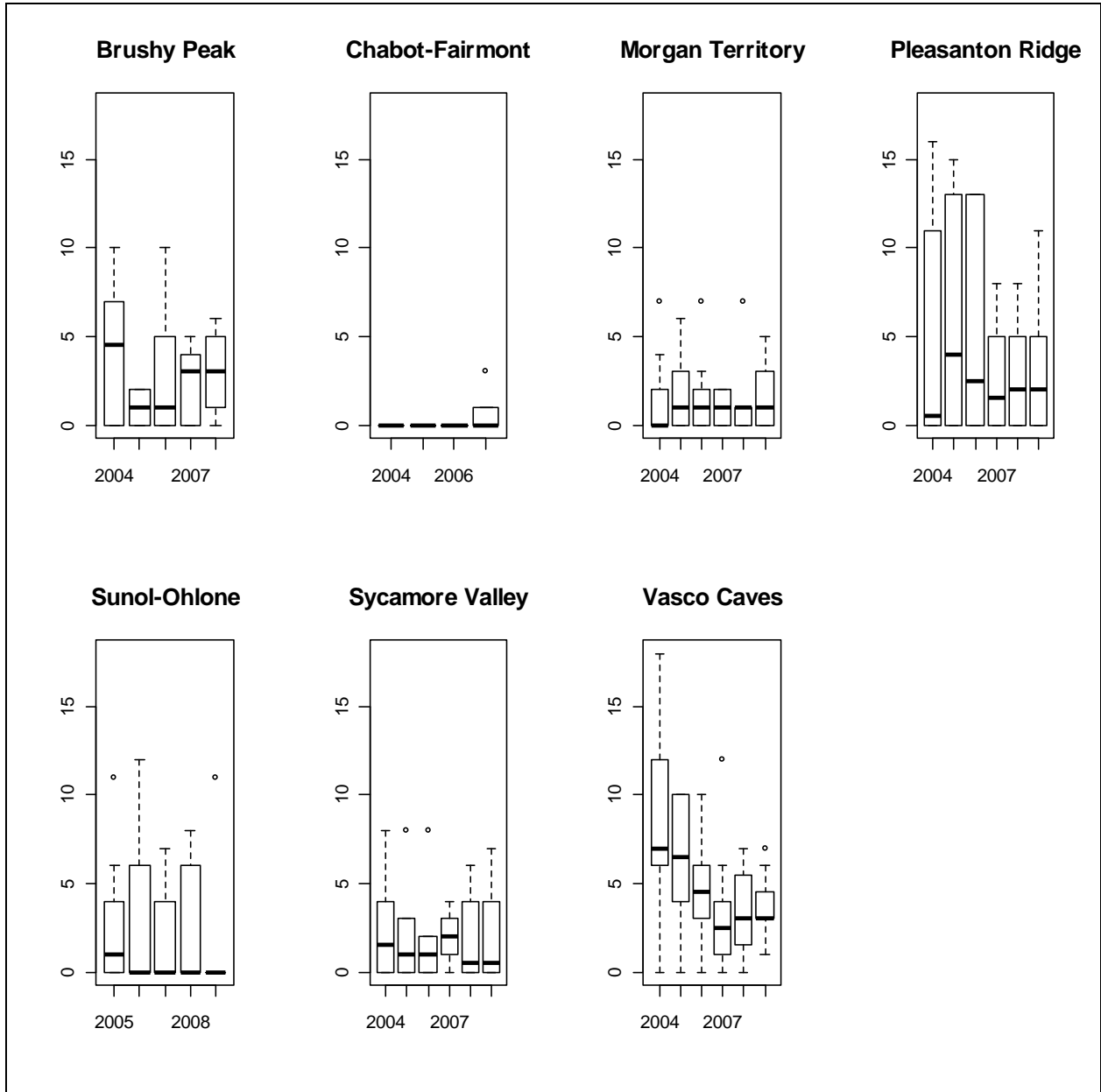
Savannah Sparrows reappeared on plot in three parks (4 total detections) in 2009 after dropping to zero detections in 2008 (Figure 11.2). Some variability in species detection can be attributed to observer bias but in this case the observers remained the same over 2008-2009. Our most ubiquitous grassland species, the Western Meadowlark, has a downward trend throughout the study with the 2nd lowest number of observations in 2009 (38 total detections). Horned Larks, our second most abundant guild species, are remaining more or less consistent in their number of total detections per year. Grasshopper Sparrows are also remaining consistent with their total detection rates per year.

In 2009, grassland bird detections remain consistently low over all the parks. There is a possible effect of the drought years in the total detection numbers of Horned Larks and Grasshopper Sparrows. Detection numbers appear to drop for these two species in 2007-2008 from a peak in 2006 which may reflect the reproductive effect of lower precipitation in certain areas of the parks. Lower precipitation in these grasslands may have an effect on the amount of vegetation produced which may also influence the abundance of insects, the principle food source for these birds during the breeding season.

Overall the grassland bird guild remains a low density community, present in some areas and consistently absent from other locations within these parks. Future analyses looking at land-use history, current management, native species abundance or other abiotic factors may help to answer some of the reasons behind this patchy grassland bird distribution.

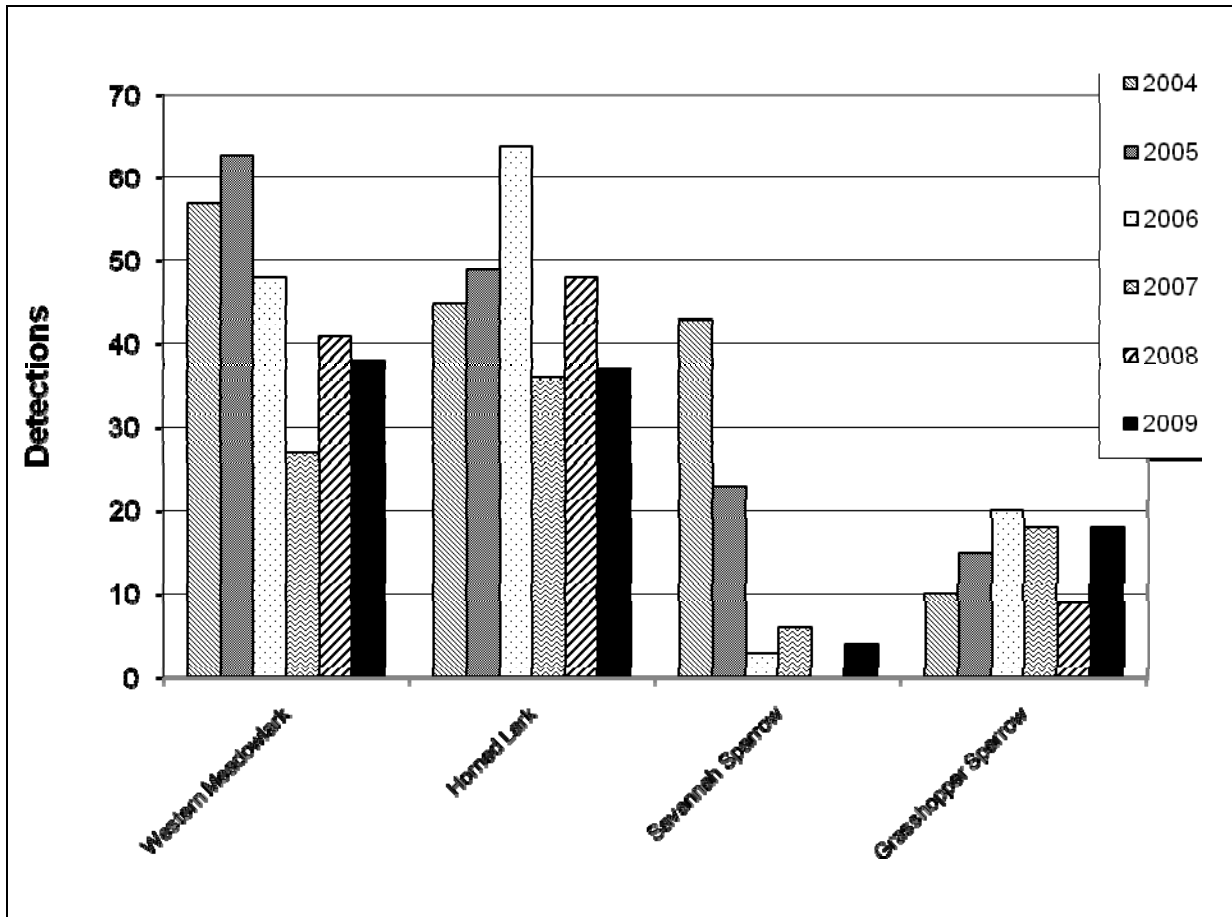
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**Figure 11.1:** 2004-2009 annual park grassland bird guild detection rates shown with a Tukey boxplot, dark lines are the median of summed plot detections of the grassland guild species per year per park, whiskers are the minimum and maximum plot values unless that value is 1.5 times the innerquartile range when it is represented with an outlier dot; Brushy Peak not surveyed 2009, Chabot-Fairmont Ridge not surveyed 2008-2009, Sunol-Ohlone not surveyed 2004; data restricted to detections of individuals on plot ( $\leq 100m$ )



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**Figure 11.2:** 2004-2009 total detections of grassland bird guild species, species are ranked by total detections over all parks; only includes parks that are currently being surveyed; data restricted to detections  $\leq 100m$



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**Table 11.1:** Valley grassland Breeding Bird Status 2004-2009

*Breeding bird status:*

- no evidence of breeding: bird encountered but no territorial or breeding behavior noted.
- 1) possible breeder: bird encountered singing or acting territorial only once during the breeding season (in suitable habitat).
- 2) Probable breeder: singing individual encountered on two or more days of point count surveys (within a season, at least one week apart); territorial behavior noted more than once at the same location; pair observed in courtship behavior.
- 3) Confirmed breeder: nest building observed; nesting material or fecal sac being carried by adult; active nest observed; dependent juveniles with adults.

Table includes both avian point counts and vegetation surveys, using all data; an asterisk (\*) indicates CPIF grassland focal species (Mountain Plover not detected) and any secondary species encountered (for more information on CPIF see Section 11.4). Note again that this table reflects observations made on grassland point counts and vegetation surveys. It does not cover other habitat types within district parkland.

Species	Brushy Peak	Chabot Ridge	Morgan Territory	Pleasanton Ridge	Sunol-Ohlone	Sycamore Valley	Vasco Caves	Number of parks in which species was observed, 2004-2009
Acorn Woodpecker	•		•	•	•	2		5
Allen's Hummingbird	•							1
American Coot				•				1
American Crow	•		2	1	•	2	•	6
American Goldfinch		•	1					2
American Kestrel	3	3	•	•	•	1	•	7
American Pipit	•		•	•				3
American Robin		1	2	2	1	•	1	6
Anna's Hummingbird	•	2	1	•	2	3		6
Ash-throated Flycatcher	1		1	1	1	2		5
Band-tailed Pigeon		•	•	•	•			4
Barn Swallow	•	•	•	•	•	•	1	7
Bewick's Wren	1	2	2	2	2			5
Black Phoebe	•	1	•	2	1	1		6
Black-crowned Night-Heron		3						1
Black-headed Grosbeak		1	2	2	2	1		5
Black-necked Stilt	•							1
Blue-gray Gnatcatcher				•				1
Blue Grosbeak*						•		1
Brewer's Blackbird	•		•	•	•	•	•	6
Brown-headed Cowbird	•	•	•		•	•		5
Bufflehead					•			1
Bullock's Oriole	1	2	1	•	2	2	2	7
Burrowing Owl							3	1
Bushtit		1	1	•				3
California Quail	•	•	2	1	1	2		6
California Towhee	1	1	2	2	2	2		6
Canada Goose	•					•		2

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Species	Brushy Peak	Chabot Ridge	Morgan Territory	Pleasanton Ridge	Sunol-Ohlone	Sycamore Valley	Vasco Caves	Number of parks in which species was observed, 2004-2009
Cassin's Vireo			1		2			2
Cedar Waxwing		1	•					2
Chestnut-backed Chickadee		2	•	2	2	1		5
Cliff Swallow	•	3	•	•	•	•	1	7
Common Raven	1	•	•	•	•		3	6
Cooper's Hawk			•		•	•		3
Dark-eyed Junco		2	2	2	2	1	2	6
Double-crested Cormorant							•	1
European Starling	3	3		•	2	•	•	6
Golden Eagle	•		•	•	•		•	5
Golden-crowned Sparrow	1	1		•	1	1		5
Grasshopper Sparrow*	2		2	3	2	2	2	6
Great Blue Heron				•				1
Great Egret				•				1
Great-horned Owl			2	1			3	2
Greater Yellowlegs				•				1
Hairy Woodpecker		•			•			2
Horned Lark*	2		3	3	2	1	3	6
House Finch	2	2	•	2	2	2	1	7
House Wren			2		1	1		3
Hutton's Vireo			2	•	2	1		4
Killdeer	2	•		1	•	•	•	6
Lark Sparrow			2	2	2			3
Lazuli Bunting		2	2	1	2	2		5
Lesser Goldfinch	•	•	2	2	2	2	1	7
Loggerhead Shrike	•					•	1	3
Long-billed Curlew		•					•	2
MacGillivray's Warbler				1	1			2
Mallard*	•	•	•	3	•		•	6
Mourning Dove	3	2	3	2	2	2	2	7
Northern Flicker		•	1	•	•		•	5
Northern Harrier*	•				•		•	3
Northern Mockingbird	1	2		2	1	2	1	6
Northern Rough-winged Swallow			•		•			2
Nuttall's Woodpecker		1	1	2	•	2	1	6
Oak Titmouse		1	2	2	3	2	•	6
Orange-crowned Warbler		1	2	2	2	1		5
Pacific-slope Flycatcher		1	•					2
Prairie Falcon	•						3	2
Purple Finch		1	1	2				3
Red-shouldered Hawk			2	•	•			3
Red-tailed Hawk	1	•	1	2	•	1	•	7
Red-winged Blackbird	2		2	2	1	3	3	6
Ring-necked Pheasant*						2		1

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Species	Brushy Peak	Chabot Ridge	Morgan Territory	Pleasanton Ridge	Sunol-Ohlone	Sycamore Valley	Vasco Caves	Number of parks in which species was observed, 2004-2009
Rock Dove	•	•		•		•	3	5
Rock Wren					2		2	2
Rufous-crowned Sparrow		2			•	•		3
Ruby-crowned Kinglet	1			•				2
Savannah Sparrow*	•	1	1	1		2	2	6
Song Sparrow*			1	•		2		3
Spotted Towhee		2	2	1	2	1		5
Steller's Jay	•	•	2	2	•	•		6
Swainson's Hawk*							•	1
Tree Swallow	•	•				•		3
Tricolored Blackbird*	•					•	•	3
Turkey Vulture	•	•	•	•	•	•	•	7
Vaux's Swift			•					1
Violet-green Swallow			•		3	•	•	4
Warbling Vireo	•		2	1	2			4
Western Bluebird	3	1	•	1	1	1	•	7
Western Kingbird	2	1	•	•	1	2	2	7
Western Meadowlark*	2	1	2	2	2	2	3	7
Western Scrub Jay		2	2	2	1	2	•	6
Western Tanager	•	•	1		1		•	5
Western Wood-Pee wee			1		1			2
White-breasted Nuthatch						2		1
White-crowned Sparrow	•	•		1		1	1	5
White-tailed Kite*	•		•		2	•	•	5
White-throated Swift	•	•	•	•	•	•		6
Wild Turkey		•	1	2	3	3		5
Willet	•							1
Wilson's Warbler	1		1					2
Wrentit	•	2	1	2	2			5
Yellow billed Magpie					•			1
Yellow-rumped Warbler	1	•		•				3
<b>Total confirmed breeders</b>	<b>4</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>8</b>	
<b>2004-2009 Cumulative Species Richness</b>	<b>53</b>	<b>60</b>	<b>69</b>	<b>70</b>	<b>71</b>	<b>62</b>	<b>45</b>	

## 12.0 References

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## **Appendix A: Published and unpublished work from the East Bay Regional Park District Grassland Monitoring Project**

### A.1 Published articles and theses based on EBRPD project

Hopkinson, P., M. Stevenson, M. Hammond, S. Gennet, D. Rao, and J.W. Bartolome. 2009. Annual rye-grass: a new central California dominant? **Grasslands** 19: 4-8.

Bartolome, J.W., R.D. Jackson, and B.H. Allen-Diaz. 2008. Developing data-driven descriptive models for Californian grasslands. Pages 124-135 in: Hobbs, R.J. and K. N. Suding (eds.) / **New models for ecosystem dynamics and restoration**. Island Press, Washington DC.

D. Rao, S. Gennet, M. Hammond, P. Hopkinson, and J. Bartolome. 2008. A landscape analysis of grassland birds in a Valley Grassland-oak woodland mosaic. Pages 385-397 in Merenlender, A, D McCreary, and KL Purcell, tech. eds. / **Proceedings of the sixth California oak symposium: today's challenges, tomorrow's opportunities**. General technical report PSW-GTR-217. Albany, CA: U.S.D.A. Forest Service, Pacific Southwest Research Station.

*Abstract.* While little research has been done on California grassland birds, their populations are thought to be declining due to habitat loss, fragmentation, and degradation. We investigated the association between California grassland birds and their landscape-scale habitat matrix. The habitat is a mosaic of valley grassland with blue oak and coast live oak woodlands. In this study, we used logistic regression to analyze presence of Grasshopper Sparrows (*Ammodramus savannarum*), Horned Larks (*Eremophila alpestris*), Western Meadowlarks (*Sturnella neglecta*), Savannah Sparrows (*Passerculus sandwichensis*), and the guild as a whole in response to patch size, cover-type richness, and proportion of high intensity development, low intensity development, deciduous forest, and evergreen forest in the landscape. These landscape variables were analyzed for the 2004 and 2005 breeding seasons at three spatial scales: 500 m, 1 km, and 2 km buffer zones from the point count center. We found that the grassland bird guild as a whole was positively associated with patch size, proportion of low intensity development, and proportion of evergreen forest and negatively associated with cover-type richness, proportion of high intensity development, and proportion of deciduous forest. Patch size and cover-type richness were the most commonly significant variables across spatial scales and across years. Individual species showed similar trends to that of the guild.

Dalke, Amber. 2008. **The relationship between *Trifolium* spp. abundance and environmental variables in East Bay grasslands**. Senior thesis, U.C. Berkeley, Berkeley, CA.

*Abstract-* California grasslands are complex, unique ecosystems comprised of many species of native and nonnative vegetation. One group of species widely used for range improvement is the *Trifolium* (wild clover) genus. However, *Trifolium* are among the more understudied vegetation types. *Trifoliums* are important to grassland ecosystems because they replenish deficient nitrogen in N-limited ecosystems and serve as forage when food is scarce. Therefore, understanding clover abundance in relation with environmental variables is important in the management of California's vulnerable grasslands. To examine these relationships an

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observational study was conducted in 63 plots within seven parks of the East Bay Regional Park District over three years (2005-2007). Variables tested relating to *Trifolium* abundance included geographical variables (slope, aspect, elevation, and heat load) and soil composition (total N, total C, P, X-Ca, sand, silt, clay, and pH). Of the *Trifolium* found, the majority came from a single nonnative species, *T. hirtum*. With the use of linear regressions, this study found *Trifolium* spp. abundance positively related to slope ( $\sum xR^2=0.22$ ,  $\sum xp=0.01$ ) and elevation ( $\sum xR^2=0.25$ ,  $\sum xp=0.02$ ) throughout the three-year time frame. Other relationships were observed including a positive relationship to silt ( $R^2=0.20$ ,  $p<0.01$ ) in 2005, a negative relationship to pH ( $R^2=0.10$ ,  $p=0.05$ ) in 2005, and negative relationships to total N ( $\sum xR^2=0.15$ ,  $\sum xp=0.04$ ) and total C ( $\sum xR^2=0.57$ ,  $\sum xp=0.06$ ) in 2006 and 2007. This research provides an important description of variables that may influence the abundance and distribution of *Trifolium* spp. in the East Bay.

Gaber, Christine. 2008. **Small mammal habitat associations in East Bay Regional Park District grasslands**. Master's thesis, U.C. Berkeley, Berkeley, CA.

*Abstract-* The responses of California Valley Grassland vegetation and wildlife species to grazing by livestock and native herbivores are generally species-specific. However, few studies have examined the potentially different effects of sheep and cattle grazing on small mammals or the interactions between these species. This study investigated the relationships between livestock grazing, numerous community level environmental variables, and the presence of California vole (*Microtus californicus*), California ground squirrel (*Spermophilus beecheyi*) and valley pocket gopher (*Thomomys bottae*) within grassland habitats of Alameda and Contra Costa counties, California. The results of traditional logistic regression and non-parametric multiplicative regression in HyperNiche were compared. In addition, this study compared vegetation functional group characteristics of plots with different grazing regimes to test the hypothesis that selective foraging by livestock species can result in observable differences in grassland vegetation composition. Small mammal associations with grassland habitat elements and livestock species were species-specific. Habitat modeling results indicated that the presence of sheep grazing and abiotic factors, such as clay and a pH of approximately 5.8, best predicted the presence of California vole on the study plots. Percent clay in soils was negatively associated with vole presence. Location effects were important in determining the distribution of California ground squirrels as this species was concentrated at Vasco Caves and Brushy Peak. Variables identified in valley pocket gopher models as positively associated with species presence included elevation and native plant species cover. Cattle grazing and litter were negatively associated with pocket gopher presence. HyperNiche modeling results were similar to those derived through logistic regression. HyperNiche is an effective technique for identifying important predictor variables and interactions, and modeling wildlife habitat relationships without the constraints of traditional parametric techniques. While California ground squirrel distribution was fairly stable at the plot scale during the study, California voles colonized and abandoned multiple plots. Voles were the most sensitive of the three focal species to livestock grazing and the presence of other small mammals. I identified positive associations between voles and sheep grazing, and negative associations between voles and both cattle grazing and the presence of pocket gophers. Similar to other studies, I documented increased forbs on cattle grazed plots. However, spatial variability and differences among parks prevented conclusions about the effect of grazing regime on other vegetation characteristics. Interactions between livestock species and native herbivores also may complicate these results.

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Hopkinson, Peter, Matt Stevenson, Michele Hammond, Sasha Gennet, Devii Rao, and James W. Bartolome. 2008. Annual rye-grass: a new central California dominant? **Fremontia** 36: 20-24.

*Abstract-* Is exotic annual rye-grass coming to dominate San Francisco Bay Area annual grasslands? How might this affect native plant species, not to mention your grass pollen allergies? This article argues that yes, rye-grass is now a common dominant, and native plants, endangered butterflies, and people with hay fever may suffer as a result.

Bartolome, J.W., W.J. Barry, T. Griggs, and P. Hopkinson. 2007. Valley grassland. Chapter 14 in Barbour, Michael, Todd Keeler-Wolf, and Allan A. Schoenherr, eds. / **Terrestrial vegetation of California**. 3<sup>rd</sup> edition. Berkeley, CA: University of California Press.

Jackson, R.D. and J.W. Bartolome. 2007. Grazing ecology of California's grasslands. Pages 197-206 in: M.R. Stromberg, J.D. Corbin, and C.M. D'Antonio (eds.) / **California grasslands: ecology and management**. Berkeley, CA: University of California Press.

Huntsinger, L., J.W. Bartolome, and C.M. D'Antonio. 2007. Grazing management on California's Mediterranean grasslands. Pages 233-253 in: M.R. Stromberg, J.D. Corbin, and C.M. D'Antonio (eds.) / **California grasslands: ecology and management**. Berkeley, CA: University of California Press.

Gennet, Alexandra S. 2007. **Environmental determinants of plant community composition and songbird abundance in a California Coast Range Grassland**. Ph.D. dissertation, U.C. Berkeley, Berkeley, CA.

*Abstract-* I examined the effects of abiotic and biotic factors on plant community composition and how vegetation structure mediates abundance of grassland-specialist songbirds in a grassland east of San Francisco Bay, California. These biologically diverse and complex grasslands have experienced widespread invasion by non-native plants and are highly threatened by the effects of human development and land use in the rapidly urbanizing Bay Area. In addition, grassland songbirds are known to have been declining sharply for several decades nationwide, yet almost no studies have been conducted to better understand their breeding habitat requirements in California.

I used hierarchical agglomerative classification (cluster analysis) to develop a State-Transition model that describes plant community composition and inter-annual dynamics of this grassland. Eleven unique vegetation states are defined. The model can be used as a decision-support tool by resource managers and supports the differentiation of Coast Range grassland from other grassland types in California.

To better understand species distribution relative to land use and environmental factors, I analyzed the relationship between key plant species and topography, soil texture, soil chemistry, species richness, canopy structure, and livestock grazing using general linear models and logistic regression. The results suggest that Coast Range grasslands are a non-equilibrium ecosystem,

and that community composition is not driven by a single or small set of environmental factors, but rather that individual species have unique ecological niches in which they persist.

I examined the mediating effects of topographic site factors and vegetation structure on populations of four grassland songbirds, including Western Meadowlark (*Sturnella neglecta*), Horned Lark (*Eremophila alpestra*), Savannah Sparrow (*Passerculus sandwichensis*), and Grasshopper Sparrow (*Ammodramus savannarum*). The analysis showed that although they tend to co-occur at the landscape scale, each of the four members of the grassland songbird guild have unique habitat selection and utilization preferences at the community scale. Livestock grazing does not appear to negatively affect abundances of these birds. Conservation management for these species should include a patchwork, or mosaic, of habitat types.

Gea-Izquierdo, Guillermo, Sasha Gennet, and James W. Bartolome. 2007. Assessing plant-nutrient relationships in highly invaded Californian grasslands using non-normal probability distributions. **Applied vegetation science** 10: 343-350.

*Abstract-* Today, invasion of natural ecosystems by exotic species is an ecological issue of great concern in many regions of the world. California's grasslands are dominated by introduced Mediterranean annual plant species. Understanding the distribution of the remaining native species is of great ecological and conservation interest. We investigated the effects of soil characteristics and livestock grazing on native plant occurrence at 40 sites during the period 2003-2005. Low absolute cover (<5.8%) of native species resulted in strongly skewed, zero inflated data sets. To overcome problems in the analysis created by non-normality and correlations within plots, we used generalized models (GLM's and GLMM's), either with a Poisson or a Negative binomial distribution, to analyze native species richness and *Nassella pulchra* cover. Native species richness was highest in soils with low available nitrogen (high C:N), whereas *N. pulchra* cover was strongly associated with low phosphorus in sandy soils. Under current conditions, phosphorus seems to be a most critical factor influencing abundance of *N. pulchra*. We conclude that low-fertility soils may be providing refugia for native species in highly invaded California grasslands because the soils in which native species persist at low levels are below a threshold required for non-native annuals to completely dominate. The use of generalized models with non-normal probability distributions is uncommon in ecology whereas being quite common in other biological sciences. However, they are simple and well-suited to analysis of highly non-normal data sets, which strongly suggests valuable applications for ecological data analysis.

Sasha Gennet, Michele Hammond, and James W. Bartolome. 2007. Association of vegetation composition and canopy structure with songbirds in California Valley Grasslands. **Keeping landscapes working** 4: 2-3.

Robertson, Dina M. 2004. **Relationships between historic land use, plant species composition and environmental factors in the foothills south of Mount Diablo, California.** Master's thesis, U.C. Berkeley, Berkeley, CA.

*Abstract.* This study examined how historic dry-land farming and environmental factors correlate with grassland species composition in the foothills south of Mount Diablo in California. Dry-land farming, or farming without irrigation, was practiced in the Diablo Range from the 1800's until the 1990's. Aerial photographs, archival research and interviews with long time

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residents were used to locate and confirm areas where past cultivation occurred. Archival research required extensive consideration to determine the chain of title and land use practices of the numerous owners, tenant farmers and ranchers that have populated the area since European settlement. Plant species cover was estimated using point line transects, and environmental data collected included percent slope, aspect, soil texture and chemistry. Ordination analysis was used to identify the relationships between environmental factors, historic land use and grassland plant composition. Results show that sites with similar cultivation history (1940 to 1990) have similar species composition, especially in occurrences of exotic invasive forbs, native perennial grasses and native annual forbs. The distribution of exotic invasive forbs occurred predominantly on historically cultivated sites and areas high in nutrients. Native perennial grasses and native annual forb species occurred on the uncultivated lower nutrient sites. Results also show that native annual forbs occur more often on north facing slopes, and exotic invasives on south facing slopes. No trends could be drawn for native perennial forbs, due to the low density of these species at the study site.

### A.2 On-going student work and potential publications from EBRPD project

Terry, Chris. *In preparation*. The effect of landscape variables on Valley Grassland vegetation. Master's thesis, San Francisco State University, San Francisco, CA.

Gennet, Sasha, Michele Hammond, Erica Spotswood and James W. Bartolome. *In preparation*. Habitat Associations of California Grassland Songbirds.

*Abstract.* Grasslands are the most highly converted and least protected of all terrestrial habitats. Agricultural and urban conversion, altered fire regime, decimation of populations of native grazers, and introduction of domestic livestock and invasive plant species are among the impacts to grasslands occurring globally. Not surprisingly, grassland songbird communities throughout the western U.S. are declining faster than any other comparable bird guild. In California, however, this guild has been little studied and the species' habitat preferences are poorly known. California's Valley grassland is dominated by exotic annual grasses with occasional patches of native bunchgrass and forbs. We investigate the effects of native and exotic plant community composition, grassland structure, and presence of livestock grazing on the breeding season occurrence of three grassland bird species in California's Valley grasslands over a seven year period (2004-2010). These species include Western Meadowlark (*Sturnella neglecta*), Horned Lark (*Eremophila alpestra*), and Grasshopper Sparrow (*Ammodramus savannarum*). Using a generalized linear mixed model approach, we find that these three species have strong positive associations with native plant abundance. In grassland areas dominated by exotic plant cover, Horned Larks appear to also show a preference for grassland disturbance by livestock grazing especially in areas of low native plant cover. This study suggests that conserving California's grassland bird community requires further research into managing vegetation with livestock grazing as a tool to encourage native plant abundance and fine-scale vegetation heterogeneity.

**Appendix B: Oral presentations and posters from the East Bay Regional Park District Grassland Monitoring Project**

East Bay Grassland Monitoring Project: habitat associations of California grassland birds. Michele Hammond. Oral presentation at the U.C. Berkeley Wildlife-Fisheries & Conservation Biology Seminar, February 12, 2010, Berkeley, CA.

Grassland research in the East Bay. Michele Hammond. Oral presentation at the Global Environment Theme House Seminar, February 4, 2010, Berkeley, CA.

Grassland communities in East Bay Regional Parks. Peter Hopkinson. Oral presentation at the U.C. Berkeley Wildlife-Fisheries & Conservation Biology Seminar, January 22, 2010, Berkeley, CA.

Grassland birds of Alameda and Contra Costa counties. Michele Hammond. Oral presentation at the 5<sup>th</sup> Annual Summit of the California Rangeland Conservation Coalition, January 7, 2010, Sacramento, CA.

Native grassland species and livestock grazing: does it really matter? Michele Hammond. Oral presentation at the California Society for Ecological Restoration and California Native Grasslands Association SERCAL-CNGA 2009 Joint Conference, May 1, 2009, Folsom, CA.

Monitoring for grassland birds. Michele Hammond. Oral presentation at the Central Coast Rangeland Coalition Meeting, October 16, 2008, King City, CA.

Management implications of East Bay grasslands research 2003-2008. Peter Hopkinson. Oral presentation at the Central Coast Rangeland Coalition Meeting, October 16, 2008, King City, CA.

*Trifolium* spp. abundance in East Bay grasslands. Amber Dalke. Oral presentation at the U.C. Berkeley Environmental Science 196 Symposium, May 2008, Berkeley, CA

Small mammal habitat associations in East Bay Regional Park District grasslands. Christine Gaber. Oral presentation at the 2008 Annual Conference of the Western Section of The Wildlife Society, February 7, 2008, Redding, CA.

Birds of the East Bay grasslands. Michele Hammond. Oral presentation at the 2008 Annual Conference of the Western Section of The Wildlife Society, February 7, 2008, Redding, CA.

*Lolium multiflorum*, Poaceae (annual ryegrass): a new regional grassland dominant. Peter Hopkinson, Matt Stevenson, Michele Hammond, Sasha Gennet, Devii Rao, Philip Brownsey, and James Bartolome. Poster at the 2<sup>nd</sup> Annual Symposium of the Northern California Botanists, January 2008, Chico, CA.

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How the EBRPD project can help in the classification of California's grasslands. James Bartolome and Peter Hopkinson. Oral presentation to the Vegetation Committee of the California Native Plant Society, December 7, 2007, Berkeley, CA.

EBRPD project overview and research findings. Peter Hopkinson. Oral presentation to the U.C. Berkeley Range Ecology Group, December 6, 2007.

Small mammal habitat associations in East Bay Regional Park District grasslands. Christine Gaber. Oral presentation to the U.C. Berkeley Range Ecology Group, October 25, 2007.

Birds of the East Bay grassland. Michele Hammond. Oral presentation to the EBRPD Stewardship Seminar, October 30, 2007.

EBRPD project overview. James Bartolome. Oral presentation to the Regional Parks Association, October 15, 2007, Orinda, CA.

Birds of the East Bay grassland. Michele Hammond. Oral presentation at the California Partners in Flight (Cal-PIF) meeting, September 6-7, 2007.

Comparing spatial and temporal variability in the California annual grassland of the San Francisco Bay Area. Peter Hopkinson, James Bartolome, Reginald Barrett, Michele Hammond, Sasha Gennet, and Devii Rao. Oral presentation at the 60<sup>th</sup> Annual Meeting of the Society for Range Management, February 13, 2007, Reno, NV.

Association of vegetation composition and canopy structure with songbirds in California Valley Grasslands. Sheila Barry. Report on talk by Sasha Gennet for Society for Range Management symposium in June 2006 in: *Keeping landscapes working* 4: 2-3, Winter 2007.

A landscape analysis of grassland birds in oak woodland mosaics. Devii Rao. Oral presentation to the EBRPD Stewardship Seminar, October 19, 2006.

Grassland research in the East Bay Regional Park District. Peter Hopkinson. Oral presentation to the EBRPD Stewardship Seminar, October 19, 2006.

A landscape analysis of grassland birds in oak savanna mosaics. Devii Rao, Michele Hammond, Sasha Gennet, Peter Hopkinson, and James Bartolome. Oral presentation at the Sixth California Oak Symposium: Today's Challenges, Tomorrow's Opportunities, October 11, 2006, Rohnert Park, CA.

East Bay Regional Park District Vegetation and Wildlife Monitoring Study: Years 2002-2005. Michele Hammond and Sasha Gennet. Oral presentation to the EBRPD Natural and Cultural Resources Committee, August 2, 2006.

Effects of vegetation structure as a result of grazing on grassland songbirds. Sasha Gennet, Michele Hammond, and James W. Bartolome. Oral presentation at the Cal-Pac Section, Society

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for Range Management Symposium held in conjunction with the Society for Conservation Biology Annual Meeting, June 28, 2006, San Jose, CA.

Effect of livestock grazing on plants and songbirds in Valley Grasslands, California, USA. S Gennet, JW Bartolome, M Hammond, and P Hopkinson. Poster at the 20<sup>th</sup> Annual Meeting of the Society for Conservation Biology, June 2006, San Jose, CA.

EBRPD Grasslands Monitoring Project overview. Peter Hopkinson and Sasha Gennet. Oral presentations for the University of California, Division of Agriculture and Natural Resources, 2006 Natural Resource Coordinating Conference Tour, March 15, 2006, Vasco Caves.

*Lolium multiflorum* population dynamics: preliminary assessment of a long-term monitoring study. Matthew Stevenson and James Bartolome. Poster at the 59<sup>th</sup> Annual Meeting of the Society for Range Management, February 2006, Vancouver, B.C., Canada.

Effects of grassland structure and landscape variables on grassland-obligate songbirds in Valley Grasslands, CA. Sasha Gennet and James Bartolome. Oral presentation at the 59<sup>th</sup> Annual Meeting of the Society for Range Management, February 2006, Vancouver, B.C., Canada. *1<sup>st</sup> place – Ph.D. Graduate Student Paper Contest.*

Habitat fragmentation and grassland diversity in Eastern Contra Costa County. Chris Terry. Oral presentation at the 8<sup>th</sup> Annual Conservation Biology Symposium, February 4, 2006, San Francisco State University.

Bird and vegetation communities of the East Bay grasslands. Sasha Gennet and James Bartolome. Oral presentation at the Wildlife and Conservation Biology Seminar Series, ESPM, U.C. Berkeley, November 18, 2005.

Effects of vegetation structure and species composition on grassland songbirds in EBRPD Valley Grasslands. Michele Hammond. Oral presentation to the EBRPD Stewardship Meeting, September 27, 2005.

East Bay Grassland Monitoring Program and vegetation of Sunol Regional Wilderness. Sasha Gennet and James Bartolome. Oral presentation for San Francisco Bay Area Grazing Lands Conference, September 15-16, 2005, Sunol Regional Wilderness and The Presidio, San Francisco.

EBRPD Grasslands Monitoring Project overview. Michele Hammond and James Bartolome. Oral presentation for the California Grazing Lands Coalition Tour, May 3, 2005, Sunol Regional Wilderness.

EBRPD Grasslands Monitoring Project overview. Michele Hammond and Peter Hopkinson. Oral presentation for Interpretive Staff training, EBRPD Interpretive and Recreation Services Department, March 23, 2005, Vasco Caves.

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East Bay Regional Park District Vegetation and Wildlife Monitoring Study: Years 2002-2004. Michele Hammond and Andrew Scavullo. Oral presentation to the EBRPD Natural and Cultural Resources Committee, February 2005.

Effects of vegetation structure and species composition on grassland songbirds in Coast Range grasslands, CA. Sasha Gennet, Andrew Scavullo, Michele Hammond, and James Bartolome. Oral presentation at the 7<sup>th</sup> Annual Conservation Biology Symposium, January 2005, Stanford University.

East Bay Regional Park District Vegetation and Wildlife Monitoring Study. Peter Hopkinson and Michele Hammond. Oral presentations to the Plant Ecology and Ecosystem Sciences (PEES) Group, September-October, 2004, U.C. Berkeley.

Influence of historic land use and environmental factors on grassland species composition in the southern Diablo Foothills of California. Dina Robertson and James Bartolome. Oral presentation at the Ecology and Management of California Grasslands Conference, April 2-3, 2004, U.C. Berkeley.

EBRPD Grasslands Monitoring Project overview. Michele Hammond, Dina Robertson, and James Bartolome. Oral presentation at Elkhorn Slough Coastal Training Program Field Series. March 2004.

Historic land use on grassland in the southern Diablo Foothills of California. Dina Robertson and James Bartolome. Oral presentation at the 15th Annual International Society for Ecological Restoration Conference, November 2003, Austin, TX.

EBRPD monitoring project 2003-2003 functional group analysis. Aimee Betts. Oral presentation to the Plant Ecology and Ecosystem Sciences (PEES) Group, October 1, 2003, U.C. Berkeley.

Update for East Bay Regional Park District Grassland Monitoring Project. James Bartolome, Reginald Barrett, Karen Haubensak, and Dina Robertson. Oral presentation to the EBRPD Natural and Cultural Resources Committee, Fall 2003.

East Bay Regional Park District Vegetation and Wildlife Monitoring Pilot Study. James Bartolome, Reginald Barrett, Karen Haubensak, and Dina Robertson. Oral presentation to the EBRPD Natural and Cultural Resources Committee, February 14, 2003.

**Appendix C: Former interannual subset of plots (2003-2007)**

In reports prior to 2008, for interannual comparisons, we used the Valley grassland “interannual subset” of parks and plots, which consisted of data for 40 plots in 6 parks from 2003 through 2007 (Table C-1). See Section 4.0 of this report for details of the new interannual subset, 2005-2009.

**Table C-1:** Former Valley grassland “interannual subset” of plots, 2003-2007

2003-2007						
Brushy Peak	Chabot Ridge	Morgan Territory	Pleasanton Ridge	Sycamore Valley	Vasco Caves	
BP4	CR1	MT1	PR4	SV1	VC1	VC7
BP5	CR2	MT2	PR5	SV2	VC2	VC8
BP6	CR3	MT3	PR6	SV3	VC3	VC9
BP7	CR4	MT4	PR7	SV4	VC4	VC10
BP8	CR5	MT5	PR8	SV5	VC5	
BP9	CR6	MT6	PR9	SV6	VC6	