



Grassland Bird Monitoring at the Jenner Headlands:

A report of the 2010 field season

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Executive Summary

In December 2009, the Sonoma Land Trust (SLT) purchased the 5,630 acre coastal Jenner Headlands property, which contains 1,628 acres of coastal prairie grassland that has been grazed continuously by livestock for more than 120 years. The SLT plans to develop an Integrated Resource Management Plan for the property, which will include using livestock grazing in the grassland habitat as a tool for vegetation management, with the goal of maintaining or enhancing habitat quality for grassland-dependent species, including birds.

During the spring and summer of 2010, PRBO Conservation Science conducted point-count avian surveys to assess birds using the grassland habitat at Jenner Headlands during the bird nesting season. We also assessed habitat structure and vegetation composition around survey locations to relate with indices of the grassland bird community. To evaluate how grazing may influence the grassland bird community and their habitat in this region, we also conducted a subset of surveys in an area of un-grazed grasslands on the adjacent Sonoma Coast State Park.

The two most abundant species in Jenner Headlands grasslands during the breeding season were Bryant's Savannah Sparrow and Grasshopper Sparrow, both of which are California bird species of special concern. The grazed Jenner Headlands property supported significantly higher indices of species richness, species diversity, and relative abundance than did the ungrazed state park. Furthermore, Jenner Headlands supported 10 species of grassland birds that the state park did not, including Grasshopper Sparrow. Differences in the grassland bird community between the two sites may be explained by differences in the vegetation composition and structure-characteristics heavily influenced by the presence or absence of livestock grazing.

Our results suggest that livestock grazing in coastal prairie habitat such as the Jenner Headlands may benefit certain grassland bird species. Grazing per se, however, is only one aspect of the management equation for grassland habitat, and applying the optimal timing and intensity of grazing within the context of an adaptive management framework is the key for achieving overall management objectives.

Introduction and Background

Many grassland bird species have experienced significant declines throughout the United States (Peterjohn and Sauer 1999, Brennan and Kuvlesky 2005). In California, declines of grassland birds have been attributed to the loss, degradation, and fragmentation of grassland habitat to urban sprawl and agricultural development (Johnson and Schwartz 1993, CPIF 2000, Gennet 2007). Additionally, remaining grassland ecosystems are impacted by non-native plant species and changes in grazing and disturbance regimes (CPIF 2000, Gennet 2007). While there is acknowledgment of grassland bird declines, there have been relatively few studies on grassland birds on the west coast (Gennet 2007, Rao et al. 2008).

In December 2009, the Sonoma Land Trust (SLT) purchased the 5,630 acre coastal Jenner Headlands property to protect the natural and cultural resources from subdivision and private development. The property is a mix of coniferous forest (3,137 acres), coastal scrub and chaparral (678 acres), oak woodland (185 acres), and coastal prairie grassland (1,628 acres). The SLT plans to develop an Integrated Resource Management Plan for the property, including a strategy for adaptive management. This will include using livestock grazing in the grassland habitat on the property as a tool for vegetation management, with the goal of maintaining or enhancing habitat quality for grassland-dependent species, including birds.

During the spring and summer of 2010, PRBO Conservation Science conducted point-count avian surveys to gather baseline information on birds using the grassland habitat at Jenner Headlands during the bird nesting season. Additionally, we also assessed habitat structure and vegetation composition around survey locations to relate with indices of the grassland bird community. We focused most of our survey efforts on the livestock-grazed Jenner Headlands, however we also conducted a subset of surveys in an area of un-grazed grasslands on the adjacent Sonoma Coast State Park to evaluate how grazing may influence the grassland bird community and their habitat in this region. This report summarizes the results of the 2010 field season, describes how the grassland bird and vegetation community differs between the grazed

Jenner Headlands and the ungrazed Sonoma Coast State Park, and discusses the merits of using grazing as a management tool for California grassland birds.

Methods

Point Count Surveys. Standardized point count surveys are an efficient method for estimating the relative abundance, richness and diversity of a bird community (Ralph et al. 1993). At the Jenner Headlands property, point count survey stations were established at 66 randomly chosen locations throughout the grassland habitat, where points were evenly distributed 250-300 meters apart from each other (Figs. 1 and 2); random point locations were generated using GIS software and were subsequently ground-truthed to ensure they were located in grassland habitat. At the adjacent Sonoma Coast State Park, an additional 20 stations were established in un-grazed grassland habitat (Figs. 1 and 3). Unlike the Jenner Headland point count stations, the station locations in the park were not established at random because we lacked the vegetation map layer necessary for generating random locations. All point count stations were surveyed three times during the breeding season- twice in May (at least 10 days apart) and once in early June. Surveys began 15 minutes after local sunrise and were completed within 4 hours of the start time. The stations were divided into 8 transects, in which each transect contained between 9 and 15 stations; this grouping of the stations into transects allowed for one observer to complete a given transect within a single morning of surveys. All birds seen or heard at each station were recorded during a 5-minute sampling period, during which each individual bird was recorded as a separate observation. Each bird detection was classified according to the type of detection (visual, song or call) and by exact distance from the observer in meters. Distance to each bird detection was determined using laser range finders. Birds flying over were recorded as “flyover” and were not ascribed a distance. Count data coupled with distance is known as “distance sampling”, a method that allows for estimates of densities rather than relative abundance (Thomas et al. 2002). More specifics about the PRBO point count method can be found at <http://data.prbo.org/cadc2/index.php?page=songbird-point-counts>. All point count data was entered online at the California Avian Data Center (<http://data.prbo.org/cadc2/>) and has been made password protected.

Evidence of breeding for each species was noted, where we considered a species a confirmed breeder if at least one of the following behaviors were observed: nest found, distraction display, copulation, feeding young or fledglings, and food or fecal sac carries. We considered a species as a probable breeder if observed exhibiting breeding behavior (singing, paired, courtship and/or territorial behavior) on ≥ 2 visits during the breeding season ≥ 10 days apart. Birds were considered potential breeders if observed singing or exhibiting breeding behavior in suitable habitat only 1 time during the breeding season.

All incidental observations (observations made apart from standardized surveys) were also noted, including species seen on the property in habitat types other than grassland. These observations were included in the species list for the Jenner Headlands property but were kept separate from analyses.

Vegetation Surveys. Grassland vegetation and habitat features were quantified to characterize the habitat surrounding each point count station with two methods: 1) relevé; and 2) residual dry matter (RDM) assessments. The relevé method described by Ralph et al. (1993) was originally conceived of to assess forest habitat, thus we modified the standard relevé approach to make it more suitable for characterizing grassland habitat. Grassland plant species composition was assumed to be generally uniform around each station for up to 100 m, however estimating the percent cover of each plant species within such a large area is extremely difficult and prone to observer bias. Therefore, we sampled three 10 m relevé subplots for each station, in which the 10 m subplots were located 50 m away from the station and spaced 120° apart from each other relative to the station. In order to randomize how the subplots were oriented relative to the station, we spun a compass dial and chose the bearing the compass arrow landed on for the first subplot location; the two remaining subplots were oriented 120° relative to the first bearing. For each relevé subplot, we estimated the percent cover of seven cover types: graminoids (grass, sedges, and rushes), forbs, shrubs, trees, thatch, rocks, and bare ground. Within each of the three vegetation cover types, we estimated the percent cover of individual plant species. We also estimated the average height of graminoids, forbs, and shrubs separately, while ignoring exceptionally tall outlier individuals not representative of the overall average height. If there were individual plants exceptionally taller than the average height, we would separately record

the species and average height of that particular species (e.g. 2 m tall poison hemlock in a plot with an average forb height of 0.5 m). All relevé data were conducted during the breeding season in June and early July, a time during which most grasses and forbs at the study site were flowering and thus identifiable.

RDM is considered by some rangeland scientists as the standard index for assessing grazing intensity (Bartolome et al. 2002). RDM is expressed as the dry weight per acre of forage remaining at the end of the grazing season. We assessed RDM at Jenner Headlands and the state park in mid October, when annual grasses were dead and dry and perennial grasses had gone to seed and were predominantly dormant and dry. We assessed RDM for 44 of the 86 stations (34 at Jenner Headlands, 10 at state park) by sampling, and assessed RDM for the remaining 42 stations by visual estimations. Sampling was done by clipping a square foot of the grassland vegetation as close to the ground as possible, collecting the clippings in a brown paper bag, and then drying (if needed) and weighing the sample. The vegetation clipped and collected included all grasses (both annuals and perennials) and small forbs, but excluded woody vegetation and robust forbs such as thistles and poison hemlock. For each station sampled, five subsamples were collected and weighed within 50 m of the station. The mean weight of the five subsamples was used to extrapolate an RDM value out to a pounds-per-acre unit. RDM values were overlaid on the point count stations on a map to illustrate variability in RDM across the landscape.

Statistical Analysis

Point Counts. We standardized detection rates by only including detections within 100 m of the observer for analyses, thus assuming that detection probabilities in grassland habitat were similar within this distance. Excluding detections that were beyond 100 m also removed most non-grassland bird species associated with the adjacent coastal scrub and forest habitats.

Analyses of point count data provided information on the relative abundance by species, species richness, and species diversity. These community indices were calculated per point then averaged separately for Jenner Headlands and the state park; averaging the indices in this way controls for the different number of point count stations surveyed at the two properties. *Relative abundance* is the total number of individual birds detected within 100 m of the station for all

visits combined (3 visits total). *Species richness* is the number of unique species detected within 100 m for all visits combined. *Bird species diversity* measures ecological diversity based on the number of species detected, weighted by the proportional abundance of each species. A high score indicates high ecological species diversity. Species diversity was measured using a transformation of the usual Shannon-Weiner index, which is symbolized by H' (also called the Shannon-Weaver index or Shannon index; Nur et al. 1999). This transformed index, which was introduced by MacArthur (1965) is N_1 where $N_1 = e^{H'}$. The advantage of N_1 over H' is that N_1 is measured in terms of species, whereas H' is measured in terms of bits of information. Thus, N_1 is more easily interpretable, and species diversity (measured as N_1) and richness can be compared. P_i is the proportion of the total number of individuals for the i th species:

$$N_1 = e^{H'} \text{ and } H' = \sum_{i=1}^{i=S} (p_i)(\ln p_i)$$

We compared the avian community indices (diversity, richness, and abundance) from the grazed Jenner Headlands with the ungrazed state park grasslands using two-sample t-tests.

Additionally, we used Mann-Whitney U tests, a test for non-parametric data, to compare the relative abundance of selected grassland indicator species between the two sites, which included Northern Harrier, Horned Lark, Savannah Sparrow, Grasshopper Sparrow, and Lark Sparrow.

Vegetation. For each point count station, we combined data from the three relevé subplots and averaged each of the relevé data parameters (percent of each cover type, percent cover each plant species, and average heights). In order to test for significant differences between Jenner Headlands and the state park among the cover types, we used two-sample t-tests where the data were parametric and Mann-Whitney U tests for non-parametric data. To examine relationships between vegetation parameters and grassland birds, we calculated Spearman's rho correlation coefficients (a non-parametric measure of dependence between two variables) between pre-selected (a priori) vegetation variables (including RDM) and the relative abundance of the 4 most common species in Jenner Headlands grasslands: Savannah Sparrow, Grasshopper Sparrow, Song Sparrow, and White-crowned Sparrow; the former two are grassland specialists whereas the latter two are more typical of coastal scrub habitat. Additionally, we evaluated the relevance of using RDM as a metric of breeding season habitat condition by using a linear regression

model to relate RDM, which was measured in fall, with average grass height, which was measured during the breeding season.

Results

Avian Community. A total of 110 bird species were detected at Jenner Headlands and 46 species were detected at Sonoma Coast State Park during the 2010 field season, including incidental observations from the fall (mid October) while collecting RDM data from both sites (Appendix A). Since much of the grassland habitat surveyed at Jenner Headlands was adjacent to mixed evergreen forest and the state park grassland was surrounded by coastal scrub, the majority of bird species that accounted for the higher species richness at Jenner Headlands were forest-associated birds (e.g. woodpeckers and warblers). However, there were a number of grassland birds that occurred at Jenner Headlands that were rare or entirely absent from the state park; these included Horned Lark, Lark Sparrow, and Grasshopper Sparrow during the breeding season, and Burrowing Owl, Ferruginous Hawk, Golden Eagle, Vesper Sparrow, Lapland Longspur, and Chestnut-collared Longspur during the fall (Appendix A). Additionally, the grasslands at Jenner Headlands in October supported large flocks of Western Meadowlarks (e.g. ~300 individuals in one flock), whereas only one meadowlark was observed during the same period in the state park. Eurasian Collared-Dove was the only species detected in the state park but not in the Jenner Headlands (Appendix A).

Mean bird species diversity (Shannon-Weaver index) and species richness at Jenner Headlands derived from the point count surveys were 6.51 and 7.82 respectively, whereas diversity and richness at the state park were significantly less at 3.27 and 4.1 respectively (Table 1). Average relative abundance (total individuals detected) at Jenner Headlands was 17.39 birds per survey station, whereas the state park supported an average of 13.6 birds per survey station; this difference was statistically significant at the 0.10 level (Table 1).

Bird species composition and relative abundance (RA) of individual species were also different between Jenner Headlands and the state park. The five most abundant species at Jenner Headlands during the breeding season, in descending order of abundance, were Savannah Sparrow, Grasshopper Sparrow, Song Sparrow, White-crowned Sparrow, and California

Towhee, whereas the most abundant species at the state park were Song Sparrow, Savannah Sparrow, American Goldfinch, White-crowned Sparrow, Northern Harrier, and Wrentit (the latter two tied for fifth place; Table 2). Savannah Sparrow RA was essentially equal at both sites, however, as previously stated, Jenner Headlands supported three breeding species of grassland bird species that the state park did not: Grasshopper Sparrow, Lark Sparrow, and Horned Lark (Table 3, Appendix A). Northern Harrier was found at both sites, however they were more abundant at the state park (RA = 0.25) than at Jenner Headlands (RA = 0.02; Table 3). Additional species found during the breeding season in Jenner Headlands grasslands but not in the state park included Rock Wren and Rufous-crowned Sparrow (Appendix A).

Breeding Status. We confirmed breeding for 11 species, which were Red-tailed Hawk, Great Horned Owl, Common Raven, Violet-green Swallow, Rock Wren, Western Bluebird, European Starling, Lark Sparrow, Song Sparrow, Savannah Sparrow, and Grasshopper Sparrow (Appendix A). One nest each was opportunistically found for Savannah, Grasshopper, and Lark sparrows, all of which contained eggs when found. An additional 51 species were considered probable breeders, and 15 additional species were considered potential breeders, the majority of which represent species associated with the surrounding scrub and forest habitats (Appendix A).

Special Status Species Occurrence. Fourteen special status species (those with status designations of special conservation concern from various state, regional, continental, and global assessments) were detected at Jenner Headlands during spring and fall field work in 2010 (Appendix B). These were Bald Eagle, Northern Harrier, Ferruginous Hawk, Peregrine Falcon, Long-billed Curlew (fly over only), Burrowing Owl, Allen's Hummingbird, Nuttall's Woodpecker, Purple Martin (aerial foraging only), Yellow Warbler, Vesper Sparrow, Bryant's Savannah Sparrow (the race of Savannah Sparrow that breeds along the California coast from Humboldt Bay south to Morro Bay), Grasshopper Sparrow, and Chestnut-collared Longspur (Appendix B). Breeding was confirmed for Bryant's Savannah Sparrow and Grasshopper Sparrow (both are California bird species of special concern), and breeding suspected for Northern Harrier and Allen's Hummingbird (Appendix A).

Vegetation. The state park had significantly more shrub cover than Jenner Headlands (20% vs. 10%, respectively; Mann-Whitney U, $p < 0.001$; Fig. 4). Furthermore, the state park had an average of 6% thatch cover (accumulated dead grass) whereas Jenner Headlands did not have any thatch. Jenner Headlands, however, had significantly more bare ground cover than the state park (t-test, $p < 0.001$; Fig. 4). A complete list of all plant species recorded along with their mean percent cover at each site is given in Appendix C.

There were also differences in the grass community composition between the two sites. The state park grasslands had significantly more native and perennial grasses than Jenner Headlands (t-test, $p < 0.001$), however both sites were dominated by introduced grasses (96% of grass cover at Jenner Headlands and 68% at state park; Fig. 5). In terms of duration, Jenner Headlands was dominated by annual grasses (65%) whereas state park was dominated by perennial grasses (73%; Fig. 5). Thirty-one species of grass were recorded from Jenner Headlands' relevés, compared to 17 grass species in the state park (Appendix C). The dominant grass species at Jenner Headlands was dogtail (*Cynosurus echinatus*), an introduced annual, followed closely by an introduced perennial bunch grass presumed to be *Nassella manicata*; the species identification of this introduced *Nassella* spp. remains questionable (L. Bush pers. com.). The dominant grass species at the state park was velvet grass (*Holcus lanatus*), an introduced perennial (Appendix C).

Sonoma Coast State Park had significantly higher RDM than Jenner Headlands, with an average of 2,545 lb/acre at the state park and 1,954 lb/acre at Jenner Headlands (Mann-Whitney U, $p < 0.05$). On Jenner Headlands, RDM varied considerably across the landscape, ranging from 288 lb/acre to 5,760 lb/acre (Appendices D and E). There is a significant linear relationship between RDM (measured in the fall) and the mean grass height during breeding season (Fig. 6).

Vegetation/Habitat and Bird Abundance Associations. Using only Jenner Headlands data, Spearman's rho correlation coefficients were calculated between 10 vegetation/habitat variables and the relative abundance of the four most common species: Grasshopper Sparrow, Savannah Sparrow, Song Sparrow and White-crowned Sparrow (Table 3). Grasshopper Sparrow abundance appeared to be significantly and positively correlated with percent graminoid cover

(Table 3). Savannah Sparrow abundance was also positively correlated with graminoid cover, but negatively correlated with the amount of RDM and mean grass height. Song Sparrow was negatively correlated with graminoid, forb, rock, and bare ground cover, yet highly and positively correlated with shrub cover, RDM, and mean grass height. White-crowned Sparrow was positively correlated with shrub cover (Table 3). The proportion of perennial and native species in the grass cover did not appear to be related to bird abundance, nor did there appear to be any relationship between bird abundance and the cover of *Nassella manicata*, an invasive bunch grass of management interest.

Discussion

The two most abundant bird species found in the Jenner Headlands grasslands during the breeding season were grassland specialists: Bryant's Savannah Sparrow (*Passerculus sandwichensis alaudinus*) and Grasshopper Sparrow (*Ammodramus savannarum*). Both species are currently listed as California bird species of special concern, primarily because of historic and ongoing habitat loss throughout their breeding range in California due to urban development, conversion to agriculture, and the succession of grassland habitat to scrub and forest due to removal of livestock grazing and fire suppression (Shuford and Gardali 2008). Following these two grassland birds, the next most abundant birds detected around a 100 m radius of the point count stations were species typically associated with coastal scrub rather than grassland, e.g. Song Sparrow and White-crowned Sparrow. Indeed, there were patches of coastal scrub interspersed in the grasslands, particularly near gullies and ravines.

The cattle-grazed Jenner Headlands grassland supported a substantially different bird community than the ungrazed Sonoma Coast State Park grassland. We detected more species at Jenner Headlands than at the state park, both in terms of the average species richness per point count station (7.82 at Jenner Headlands vs. 4.1 at the state park; Table 1), and also in the overall number species detected, including incidental observations (110 at Jenner Headlands and 43 at the state park). Since there were 66 point count stations at Jenner Headlands versus 20 stations at the state park, survey effort bias may in part explain the higher number of species observed at Jenner Headlands. However, we controlled for survey effort bias by comparing the average

species richness per point, which were calculated by averaging richness across all point count stations for each properties (Table 1). The difference in the overall number of species detected that included incidental observations, however, may have been influenced by survey effort bias. Nevertheless, we documented several grassland specialist and associated bird species at Jenner Headlands that we did not see at the state park; these include Grasshopper Sparrow, Lark Sparrow, and Horned Lark during the breeding season, and Burrowing Owl, Ferruginous Hawk, Golden Eagle, Western Meadowlark, Vesper Sparrow, Lapland Longspur, and Chestnut-collared Longspur in the fall (Appendix A).

There were physical differences independent of grazing between Jenner Headlands and the state park that may explain some of the differences in the bird community, including the fact that much of the area surveyed in the state park consisted of a flat marine terrace with poorly drained soils (B. O'Neil, pers. com.). In contrast, the Jenner Headland study area was topographically varied and appeared to have generally well-drained soils compared to the state park.

Nonetheless, the presence/absence of grazing has a strong influence on grassland habitat characteristics in terms of its plant community composition and structure (Hayes and Holl 2003).

As one would expect, there were many differences in the plant community between the two sites (Figs. 4 and 5). Perhaps the most significant difference from a bird habitat perspective was that the ungrazed state park had twice as much shrub cover than the grazed Jenner Headlands. The Savannah Sparrow appears to tolerate an increase in shrub cover, given the comparable abundance of this species between the two sites (Table 3). However, the most common species in the state park grasslands was Song Sparrow, a species indicative of coastal scrub habitat. The scrub vegetation in the state park grasslands (e.g. Coyote Bush, *Baccharis pilularis* and Douglas-Fir, *Pseudotsuga menziesii*) appeared to be relatively nascent, and its presence may be explained by the absence of livestock grazing pressure. The state park grassland had been grazed by sheep in the past, but has not been grazed in nearly 20 years (B. O'Neil, pers. com.), whereas the Jenner Headlands grassland has been grazed continuously by livestock for more than 120 years (B. Edwards, pers. com.). In the absence of a disturbance regime like grazing or fire, grasslands often transition into scrubland or forest through succession, a process that appears to be in

progress at Sonoma Coast State Park. In fact, the state park actively manages for open grassland areas by mechanically removing shrubs and trees.

Preventing shrubs from invading grassland as a lone management objective, however, may not be a sufficient measure for managing grassland bird habitat. Another major difference between the Jenner Headlands grazed grassland and the ungrazed state park was that Jenner Headlands had evenly distributed patches of bare ground and no thatch cover, whereas the state park had thatch cover and virtually no bare ground (Fig. 4). The bare patches at Jenner Headlands appeared to be a result of a combination of forces, including cattle grazing, gopher mounds, pig rooting, and the natural groupings of bunch grasses. Bare ground, such as that provided by interstitial space between clumps of vegetation or bunch grasses, has been shown to be an important habitat component for many grassland birds, including Grasshopper Sparrow and Savannah Sparrow (Whitmore 1981, Bock and Webb 1984, Shuford 1993, Fisher and Davis 2010). At the state park, the interstitial spaces between vegetation clumps were typically composed of thatch rather than bare ground. Though we did not find a direct correlation between the amount of bare ground and grassland bird abundance, it is plausible that the presence of bare ground at Jenner Headlands may in part explain the presence of Grasshopper Sparrows as well as the other grassland bird species.

Future Research. We intend to conduct distance sampling analysis with the 2010 point count data, which will correct for how detection rates decline with distance, and therefore can yield an estimate of true population density of the grasslands birds rather than relative abundance (Thomas et al. 2002). With additional years of survey and vegetation data, we should be able to develop robust habitat association models to identify key habitat features driving grassland bird abundance and habitat selection. Although considerably more intensive, it would be interesting to investigate the demographic parameters of productivity and survivorship of the grassland birds at Jenner Headlands through color banding territorial adults and nest monitoring.

In addition to breeding season surveys, we recommend conducting standardized fall and winter bird surveys to assess the non-breeding season bird use of the Jenner Headlands grasslands. While we were on site in October to collect RDM data, we serendipitously discovered that there

is a diverse and abundant group of grassland birds that use the Jenner Headlands grasslands in the fall, including species that are not present during in the breeding season, such as Burrowing Owl, a special status species. One potential standardized method for conducting fall and winter bird surveys is the area search method, which could potentially employ volunteers as citizen scientists (Ralph et al. 1993).

We explored the use of RDM as a novel habitat metric in predicting grassland bird abundance and found that birds correlated with RDM were similarly correlated with average grass height (negative for Savannah Sparrow, positive for Song Sparrow; Table 3). Since measuring RDM was fairly labor intensive, and since RDM was found to be closely related to average grass height, we recommend measuring average grass height in lieu of RDM in future years.

Furthermore, the use of RDM as an index of grazing intensity, which was originally conceived of as a tool for annual grasslands, may be confounded by the abundance of gopher mounds and perennial bunch grasses (especially *Nassella manicata*) at Jenner Headlands (Bartolome et al. 2002, L. Bush, pers. com.).

Conclusions. The effects of various grazing, burning, and mowing regimes on grassland bird communities have been shown to have complex and often contradictory results (Saab et al. 1995, Krausman et al. 2009). However, results from this study and others suggest that livestock grazing in a highly productive, mesic coastal prairie system such as the Jenner Headlands may benefit certain grassland birds, including the Savannah Sparrow and Grasshopper Sparrow (Fitton 2008 and Unitt 2008). In addition to benefiting grassland birds, other studies have shown that grazing may also be a useful management tool for promoting native plant diversity in California coastal prairies, the most species rich grassland type in North America (Stromberg et al. 2002, Hayes and Holl 2003). Determining the appropriate amount of grazing in terms of intensity and timing remains a challenge, however, because these factors can vary year to year and region to region depending on climate, soil type, topography, and plant community (Krausman et al. 2009). Fire and mechanical vegetation removal appear to be the only alternatives to livestock grazing as a disturbance management tool in California coastal prairies, and while these practices can be useful under certain circumstances, they can also be costly and in the case of fire, possibly risky. Grazing per se, however, is only one aspect of the

management equation for grassland habitat, and applying the optimal timing and intensity of grazing within the context of an adaptive management framework is the key for achieving overall management objectives.

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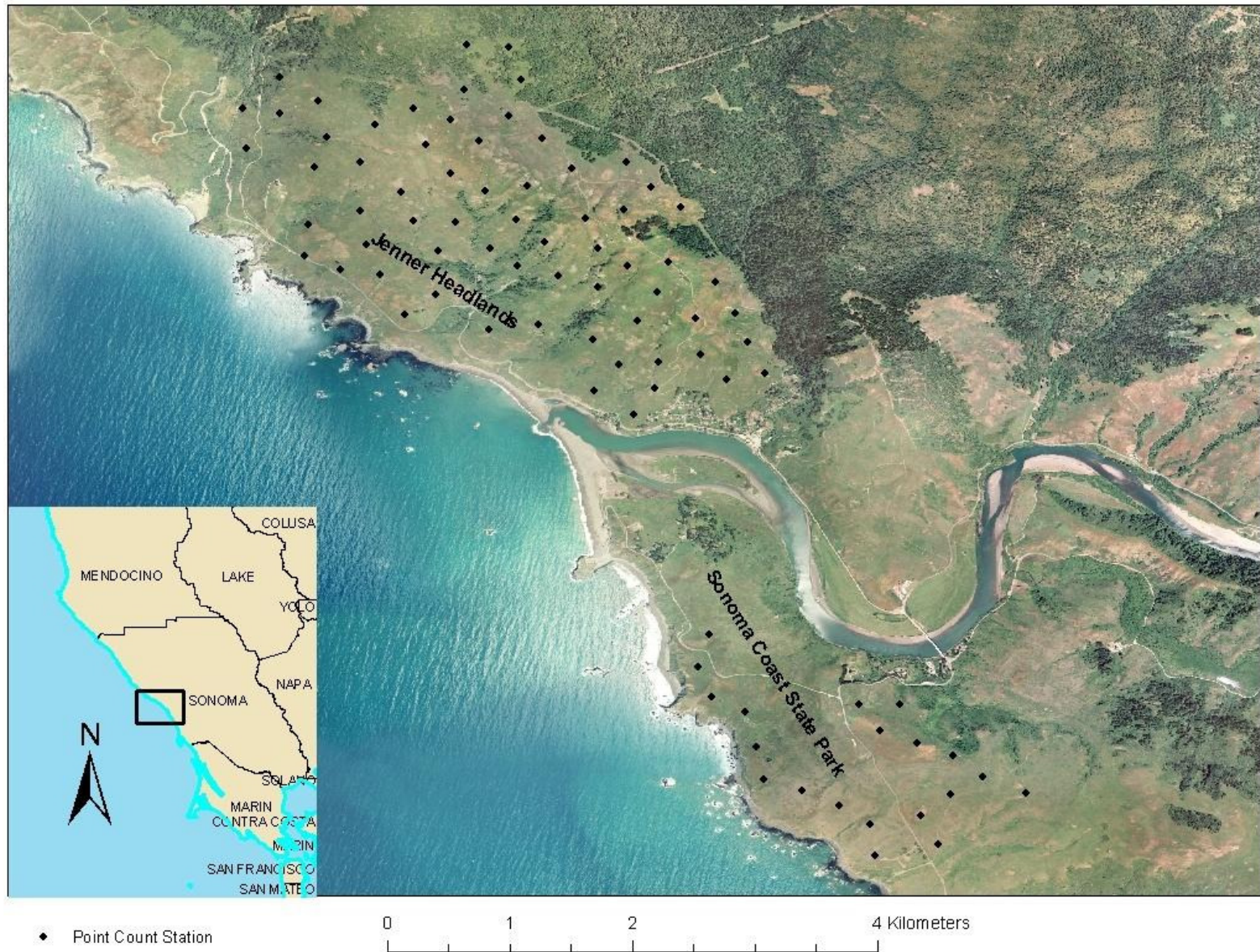


Figure 1. Location of the grassland study areas and the 86 point count stations on either side of the Russian River mouth: the grazed Jenner Headlands to the north (66 point count stations) and the ungrazed Sonoma Coast State Park to the south (20 point count stations).

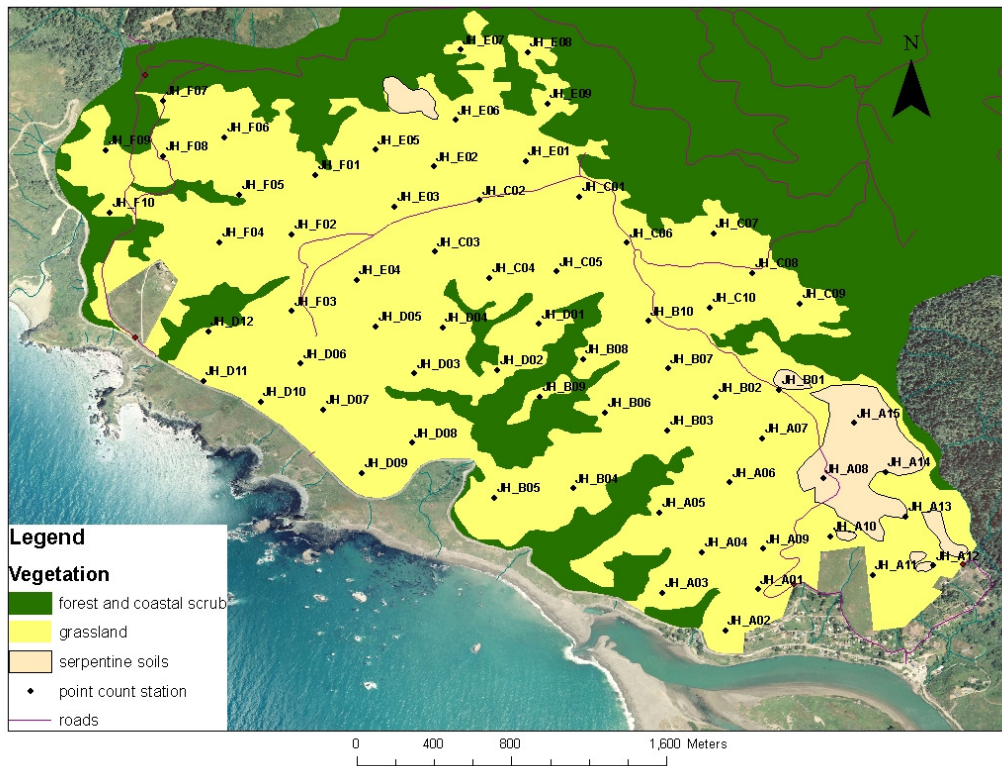


Figure 2. Locations of the 66 point count stations in grassland habitat at Jenner Headlands overlaid on vegetation type.

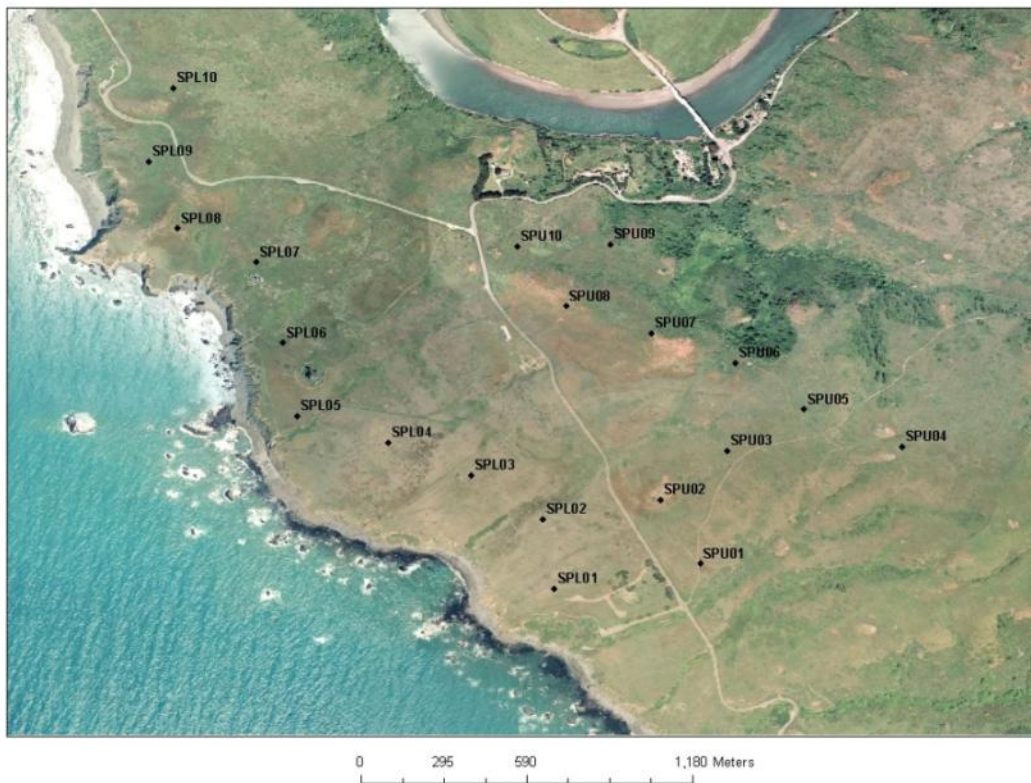


Figure 3. Locations of the 20 point count stations in grassland habitat at Sonoma Coast State Park (vegetation information unavailable).

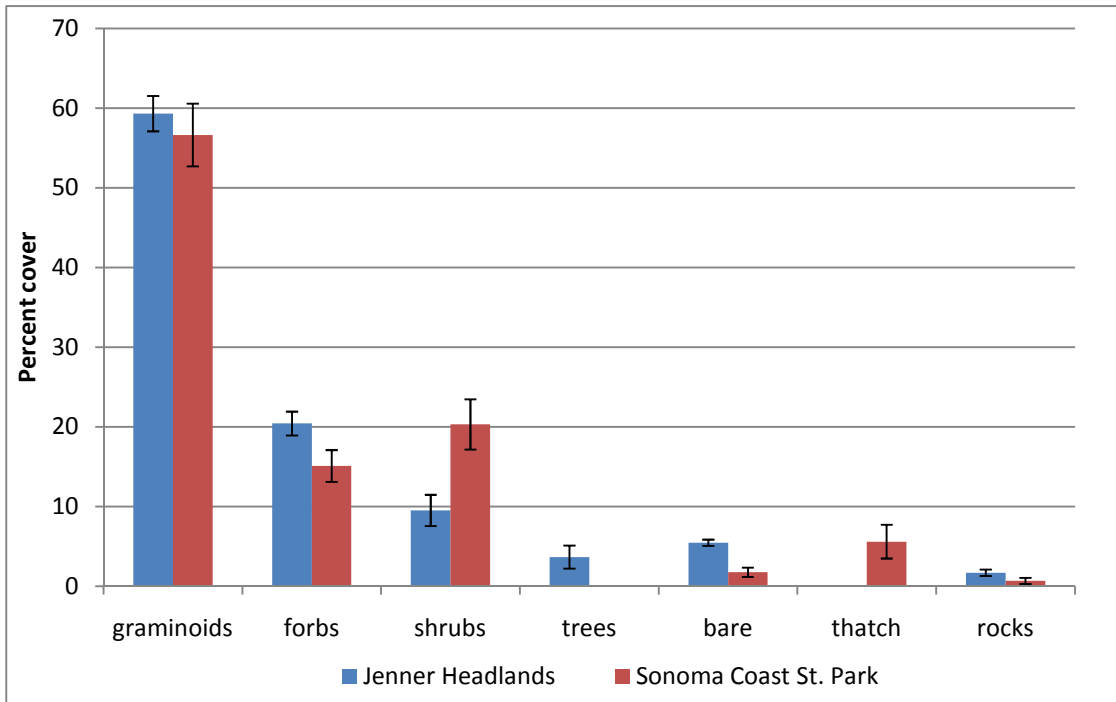


Figure 4. Average percent cover (with standard error bars) of graminoids, forbs, shrubs, trees, bare ground, thatch, and rocks around point count stations in Jenner Headlands vs. Sonoma Coast state park grasslands. State park grasslands have significantly more shrubs and thatch, whereas Jenner Headlands has significantly more bare ground.

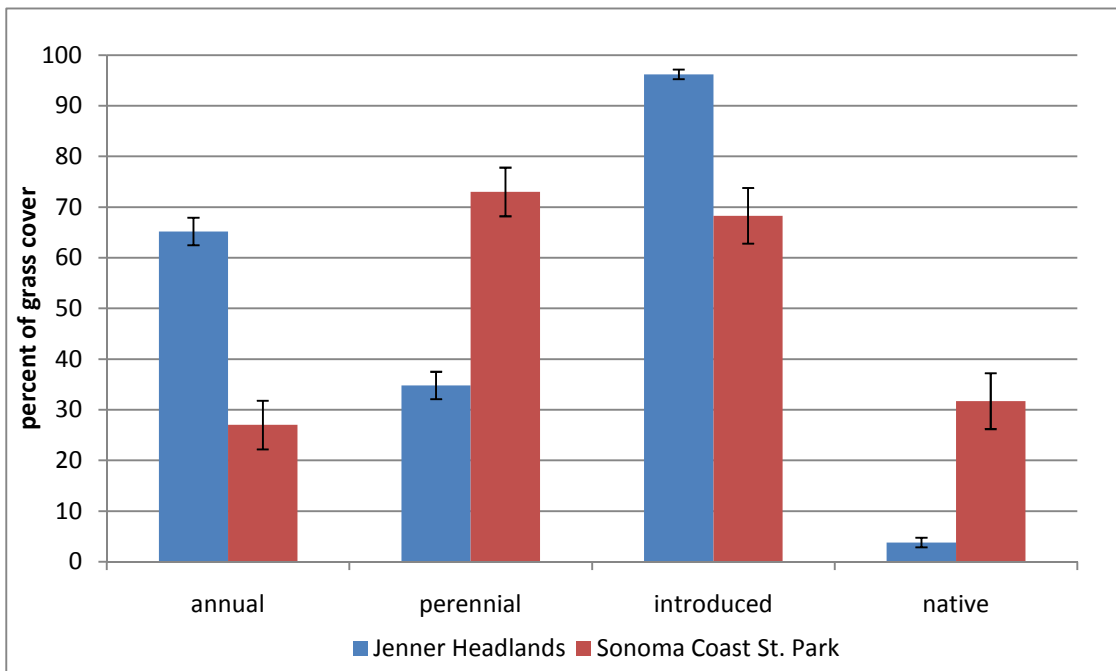


Figure 5. Average composition of grass species by duration (annual vs. perennial) and by native status (with standard error bars). Sonoma Coast state park had significantly more grass cover composed of species that are perennial and native.

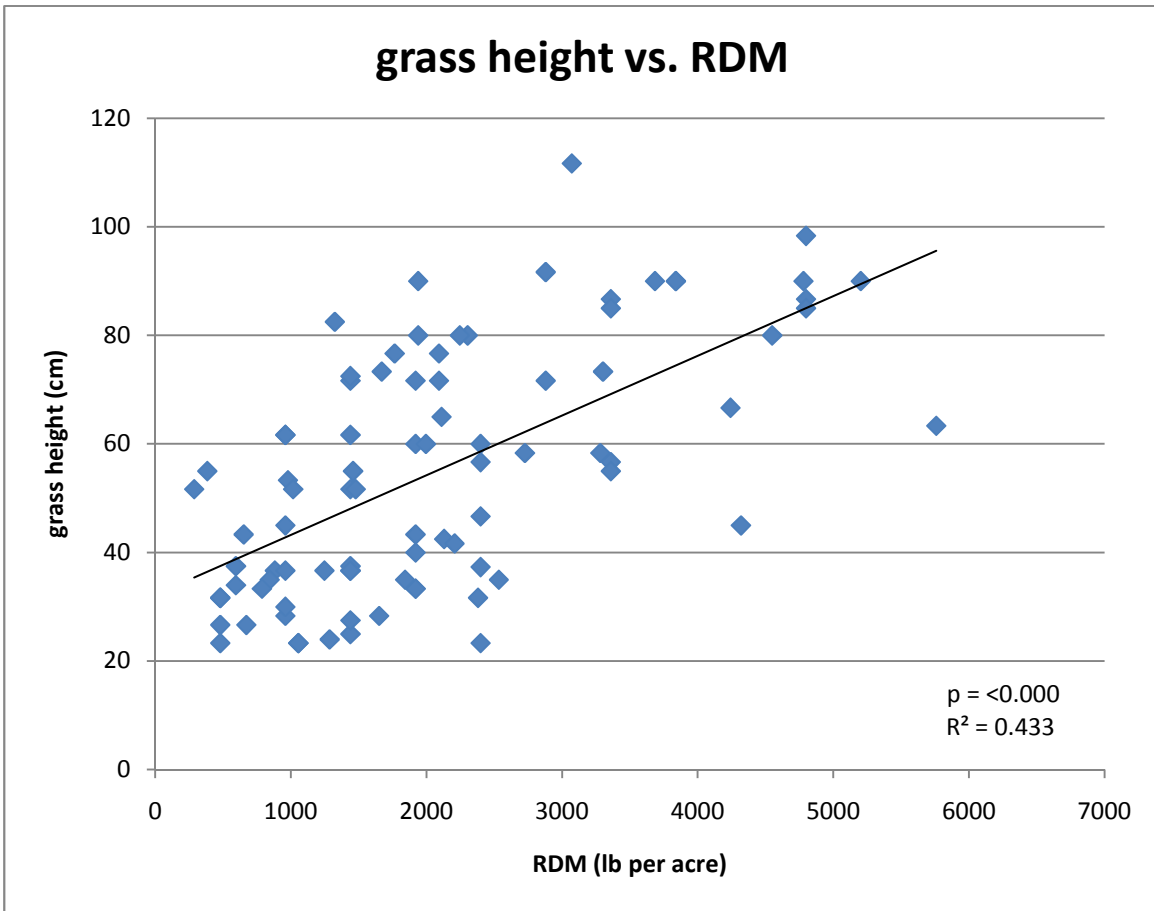


Figure 6. Linear relationship between average grass height measured in late June / early July and residual dry matter (RDM) measured in mid October at all Jenner Headland and state park point count stations in 2010.

Table 1. Means (with standard errors) of Shannon-Weiner (SW) diversity index, species richness, and total individuals (relative abundance) of all bird species detected within 100 m of each point count station at Jenner Headlands and Sonoma Coast state park during the 2010 breeding season. Significance levels are given for t-tests between the two means of each index.

	Jenner Headlands (n = 66)	State Park (n=20)	t-test significance
Diversity (SW index)	6.51 (± 0.38)	3.27 (± 0.20)	p < 0.001
Species Richness	7.82 (± 0.44)	4.10 (± 0.25)	p < 0.001
Total Individuals	17.39 (± 1.17)	13.60 (± 1.28)	p < 0.10

Table 2. The 10 most abundant species detected during breeding season point count surveys at Jenner Headlands and Sonoma Coast State Park in 2010, listed in descending order of abundance. The abundance index represents the total number of individuals detected within 100 m of each point count station for all visits combined, averaged over all stations for each site.

Site / Species	Abundance (SE)
Jenner Headlands (n = 66)	
Savannah Sparrow	2.53 (± 0.39)
Grasshopper Sparrow	1.53 (± 0.22)
Song Sparrow	1.52 (± 0.25)
White-crowned Sparrow	0.94 (± 0.22)
California Towhee	0.91 (± 0.17)
American Goldfinch	0.56 (± 0.17)
European Starling	0.53 (± 0.20)
Spotted Towhee	0.52 (± 0.13)
Western Scrub-jay	0.49 (± 0.16)
Wrentit	0.49 (± 0.15)
Sonoma Coast State Park (n = 20)	
Song Sparrow	6.20 (± 0.73)
Savannah Sparrow	2.55 (± 0.53)
American Goldfinch	1.60 (± 0.45)
White-crowned Sparrow	1.45 (± 0.41)
Northern Harrier	0.25 (± 0.12)
Wrentit	0.25 (± 0.18)
Western Scrub-jay	0.20 (± 0.20)
Brown-headed Cowbird	0.20 (± 0.12)
California Quail	0.15 (± 0.15)
California Towhee	0.10 (± 0.07)

Table 3. Relative abundance (average number of individuals detected within 100 m of each point count station) of 5 grassland bird species from Jenner Headlands and Sonoma Coast State Park, breeding season 2010.

Grassland Bird	Jenner Headlands (n = 66)	State Park (n = 20)	Mann-Whitney U significance
Savannah Sparrow	2.53 (±0.39)	2.55 (±0.53)	0.57
Grasshopper Sparrow	1.53 (±0.22)	0	N/A
Lark Sparrow	0.18 (±0.06)	0	N/A
Horned Lark	0.11 (±0.06)	0	N/A
Northern Harrier	0.02 (±0.02)	0.25 (±0.12)	0.002

Table 3. Correlation coefficients (Spearman’s rho) and associated significance levels (2-tailed) between the abundance of select bird species and select habitat variables from Jenner Headlands point count station (n = 66).

Variable	Grassland species				Coastal scrub species			
	Grasshopper Sparrow		Savannah Sparrow		Song Sparrow		White-crowned Sparrow	
	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.	Coefficient	Sig.
Graminoid cover	0.45	0.00**	0.27	0.03*	-0.36	0.00**	-0.13	0.31
Forb cover	-0.06	0.66	0.10	0.42	-0.31	0.01**	-0.10	0.44
Shrub cover	-0.15	0.24	-0.18	0.16	0.74	0.00**	0.47	0.00**
Rock cover	-0.02	0.87	0.04	0.76	-0.24	0.05*	-0.17	0.17
Bare ground cover	0.02	0.85	0.21	0.09	-0.31	0.01**	-0.15	0.22
Perennial grass cover	-0.08	0.50	-0.01	0.93	0.22	0.08	0.13	0.31
Native grass cover	-0.20	0.10	0.03	0.79	-0.05	0.71	0.06	0.61
RDM	-0.01	0.91	-0.24	0.05*	0.30	0.01**	0.09	0.47
Mean grass height	0.13	0.29	-0.26	0.03*	0.31	0.01**	0.03	0.82
<i>N. manicata</i> cover	0.23	0.07	-0.02	0.89	0.11	0.38	0.04	0.76
**correlation is significant at the 0.01 level								
* correlation is significant at the 0.05 level								

Appendix A. All species (111 total) detected and associated breeding status from 2010 field work at Jenner Headlands and Sonoma Coast State Park, including incidental observations. Spring observations are from May and early June and fall observations are from mid-October. Species listed in taxonomic order.

Common Name	Scientific Name	Jenner Headlands			State Park	
		Breeding Status ^a	Spring	Fall	Spring	Fall
Cackling Goose	<i>Branta hutchinsii</i>			x		
Common Merganser	<i>Mergus merganser</i>		x			
Mountain Quail	<i>Oreortyx pictus</i>	3	x	x		
California Quail	<i>Callipepla californica</i>	2	x	x	x	
Wild Turkey	<i>Meleagris gallopavo</i>	2	x	x		
Great Blue Heron	<i>Ardea Herodias</i>		x		x	
Turkey Vulture	<i>Cathartes aura</i>	2	x	x	x	
Osprey	<i>Pandion haliaetus</i>	2	x			
White-tailed Kite	<i>Elanus leucurus</i>	3	x	x	x	
Bald Eagle	<i>Haliaeetus leucocephalus</i>			x		
Northern Harrier	<i>Circus cyaneus</i>	3	x	x	x	x
Sharp-shinned Hawk	<i>Accipiter striatus</i>			x		
Cooper's Hawk	<i>Accipiter cooperii</i>	3	x	x		x
Red-shouldered Hawk	<i>Buteo lineatus</i>			x		x
Red-tailed Hawk	<i>Buteo jamaicensis</i>	1	x	x	x	x
Ferruginous Hawk	<i>Buteo regalis</i>			x		
Golden Eagle	<i>Aquila chrysaetos</i>			x		
American Kestrel	<i>Falco sparverius</i>			x		x
Peregrine Falcon	<i>Falco peregrines</i>	3	x	x		
Killdeer	<i>Charadrius vociferus</i>			x		
Long-billed Curlew	<i>Numenius americanus</i>		x			
Wilson's Snipe	<i>Gallinago delicata</i>			x		
Band-tailed Pigeon	<i>Patagioenas fasciata</i>	2	x	x		
Eurasian Collared-Dove	<i>Streptopelia decaocto</i>				x	
Mourning Dove	<i>Zenaida macroura</i>	2	x		x	
Great Horned Owl	<i>Bubo virginianus</i>	1	x			
Burrowing Owl	<i>Athene cunicularia</i>			x		
Anna's Hummingbird	<i>Calypte anna</i>	2	x	x	x	
Allen's Hummingbird	<i>Selasphorus sasin</i>	2	x			
Acorn Woodpecker	<i>Melanerpes formicivorus</i>	2	x			
Nuttall's Woodpecker	<i>Picoides nuttallii</i>			x		
Hairy Woodpecker	<i>Picoides villosus</i>	2	x	x		
Northern Flicker	<i>Colaptes auratus</i>		x	x	x	x
Pileated Woodpecker	<i>Dryocopus pileatus</i>	2	x	x		
Olive-sided Flycatcher	<i>Contopus cooperi</i>	2	x			
Western Wood-Pewee	<i>Contopus sordidulus</i>	2	x		x	
Pacific-slope Flycatcher	<i>Empidonax difficilis</i>	2	x		x	

Common Name	Scientific Name	Jenner Headlands			State Park	
		Breeding Status ^a	Spring	Fall	Spring	Fall
Black Phoebe	<i>Sayornis nigricans</i>	2	x	x	x	x
Say's Phoebe	<i>Sayornis saya</i>			x		
Ash-throated Flycatcher	<i>Myiarchus cinerascens</i>	2	x			
Western Kingbird	<i>Tyrannus verticalis</i>	3	x			
Cassin's Vireo	<i>Vireo cassinii</i>	3	x			
Hutton's Vireo	<i>Vireo huttoni</i>	2	x	x		
Warbling Vireo	<i>Vireo gilvus</i>	2	x			
Steller's Jay	<i>Cyanocitta stelleri</i>	2	x	x		
Western Scrub-Jay	<i>Aphelocoma californica</i>	2	x	x	x	x
American Crow	<i>Corvus brachyrhynchos</i>	3	x			
Common Raven	<i>Corvus corax</i>	1	x	x	x	
Horned Lark (California)	<i>Eremophila alpestris actia</i>	2	x	x		
Purple Martin	<i>Progne subis</i>	2	x			
Violet-green Swallow	<i>Tachycineta thalassina</i>	1	x	x		
Northern Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>	3	x		x	
Cliff Swallow	<i>Petrochelidon pyrrhonota</i>	2	x		x	
Barn Swallow	<i>Hirundo rustica</i>	2	x		x	
Chestnut-backed Chickadee	<i>Poecile rufescens</i>	2	x	x	x	
Bushtit	<i>Psaltriparus minimus</i>	2	x	x	x	
White-breasted Nuthatch	<i>Sitta carolinensis</i>	3	x			
Red-breasted Nuthatch	<i>Sitta canadensis</i>	3	x	x		
Pygmy Nuthatch	<i>Sitta pygmaea</i>	2	x	x		
Brown Creeper	<i>Certhia americana</i>	2	x	x		
Rock Wren	<i>Salpinctes obsoletus</i>	1	x	x		
Bewick's Wren	<i>Thryomanes bewickii</i>	2	x	x	x	x
House Wren	<i>Troglodytes aedon</i>			x		x
Winter Wren	<i>Troglodytes troglodytes</i>	3	x	x		
Golden-crowned Kinglet	<i>Regulus satrapa</i>	2	x	x		x
Ruby-crowned Kinglet	<i>Regulus calendula</i>			x		
Western Bluebird	<i>Sialia mexicana</i>	1	x	x	x	
Swainson's Thrush	<i>Catharus ustulatus</i>	2	x		x	
Hermit Thrush	<i>Catharus guttatus</i>	2	x			
American Robin	<i>Turdus migratorius</i>	2	x	x		
Varied Thrush	<i>Ixoreus naevius</i>			x		
Wrentit	<i>Chamaea fasciata</i>	2	x	x	x	x
European Starling	<i>Sturnus vulgaris</i>	1	x	x		
American Pipit	<i>Anthus rubescens</i>			x		x
Cedar Waxwing	<i>Bombcilla cedrorum</i>		x	x		x
Orange-crowned Warbler	<i>Vermivora celata</i>	2	x		x	

Common Name	Scientific Name	Jenner Headlands			State Park	
		Breeding Status ^a	Spring	Fall	Spring	Fall
Yellow Warbler	<i>Dendroica petechia</i>			x		
Yellow-rumped Warbler	<i>Dendroica coronata</i>	2	x	x		x
Townsend's Warbler	<i>Dendroica townsendi</i>			x		
Hermit Warbler	<i>Dendroica occidentalis</i>	3	x			
Palm Warbler (Western)	<i>Dendroica palmarum</i>			x		x
Wilson's Warbler	<i>Wilsonia pusilla</i>	2	x		x	
Spotted Towhee	<i>Pipilo maculatus</i>	2	x	x	x	
California Towhee	<i>Pipilo crissalis</i>	2	x	x	x	x
Rufous-crowned Sparrow	<i>Aimophila ruficeps</i>	2	x			
Chipping Sparrow	<i>Spizella passerina</i>	2	x			
Clay-colored Sparrow	<i>Spizella pallida</i>			x		
Vesper Sparrow	<i>Pooecetes gramineus</i>			x		
Lark Sparrow	<i>Chondestes grammacus</i>	1	x			
Savannah Sparrow (Byant's)	<i>Passerculus sandwichensis alaudinus</i>	1	x	x	x	x
Grasshopper Sparrow	<i>Ammodramus savannarum perpallidus</i>	1	x		x	
Song Sparrow	<i>Melospiza melodia</i>	1	x	x	x	x
Lincoln's Sparrow	<i>Melospiza lincolni</i>			x		
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>	2	x	x	x	x
Golden-crowned Sparrow	<i>Zonotrichia atricapilla</i>			x		
Dark-eyed Junco (Oregon)	<i>Junco hyemalis</i>	2	x	x		
Lapland Longspur	<i>Calcarius lapponicus</i>			x		
Chestnut-collared Longspur	<i>Calcarius ornatus</i>			x		
Western Tanager	<i>Piranga ludoviciana</i>	2	x			
Black-headed Grosbeak	<i>Pheucticus melanocephalus</i>	2	x			
Lazuli Bunting	<i>Passerina amoena</i>	3	x			
Red-winged Blackbird	<i>Agelaius phoeniceus</i>			x		
Western Meadowlark	<i>Sturnella neglecta</i>		x	x		x
Brewer's Blackbird	<i>Euphagus cyanocephalus</i>	3	x	x		
Brown-headed Cowbird	<i>Molothrus ater</i>	2	x		x	
Bullock's Oriole	<i>Icterus bullockii</i>	2	x			
Purple Finch	<i>Carpodacus purpureus</i>	2	x	x	x	
House Finch	<i>Carpodacus mexicanus</i>	2	x	x	x	
Pine Siskin	<i>Spinus pinus</i>	2	x	x		
Lesser Goldfinch	<i>Spinus psaltria</i>			x		
American Goldfinch	<i>Spinus tristis</i>	2	x	x	x	x

^aBreeding status pertains to Jenner Headlands only. Code key: 1 = confirmed breeder (evidenced by nest building, active nest found, distraction display, fecal sac carry, repeated food carry, adult with dependent juveniles); 2 = probable breeder (singing, courtship behavior by pair or otherwise territorial individual encountered ≥ 2 times during standardized census ≥ 10 days apart,); 3 = possible breeder (singing or otherwise territorial individual encountered in suitable habitat only 1 time during breeding season; blank = no evidence (not encountered during breeding season or detected in stopover/non-breeding habitat)

Appendix B. Species detected on Jenner Headlands property in 2010 with status designations of special conservation concern from state, regional, continental, and global assessments.

Common Name	BSSC ^a	T&E ^b	USFWS 2008 ^c	IUCN 2008 ^d
Bald Eagle		SE	R, 32	
Northern Harrier	3			
Ferruginous Hawk			[R]	NT
Peregrine Falcon		SE	R, 32	
Long-billed Curlew			R, 32	NT
Burrowing Owl	2		R, 32	
Allen's Hummingbird			R, 32	
Nuttall's Woodpecker			32	
Purple Martin	2			
Yellow Warbler	2		32	
Vesper Sparrow	2			
Bryant's Savannah Sparrow	3			
Grasshopper Sparrow	2			
Chestnut-collared Longspur			[R]	

^aSpecies, subspecies, and distinct populations on the 2006 list of California Bird Species of Special Concern (Shuford and Gardali 2008) that occur in the Central Valley. Numbered designations indicate priority levels within the list (1, 2, or 3; highest to lowest).

^bSpecies listed as threatened or endangered by state or federal law. ST, state threatened; SE, state endangered; FT, federally threatened; FE, federally endangered.

^cSpecies or subspecies on the USFWS list of Birds of Conservation Concern 2008 (USFWS 2008); includes taxa of lesser concern than those listed as Federally threatened or endangered (see footnote ^b above). R refers to USFWS Region 8 (CA and NV); the number 32 refers to Bird Conservation Region 32 (Northern California); and [R] refers to USFWS regions other than for Region 8.

^dSpecies with IUCN Red List global conservation status ranks (listed here in descending order of conservation concern): CR, critically endangered; EN, endangered; VU, vulnerable; and NT, near threatened (IUCN 2008).

Appendix C. Point count station relevé plant species composition and average percent cover in Jenner Headlands and Sonoma Coast State Park, 2010.

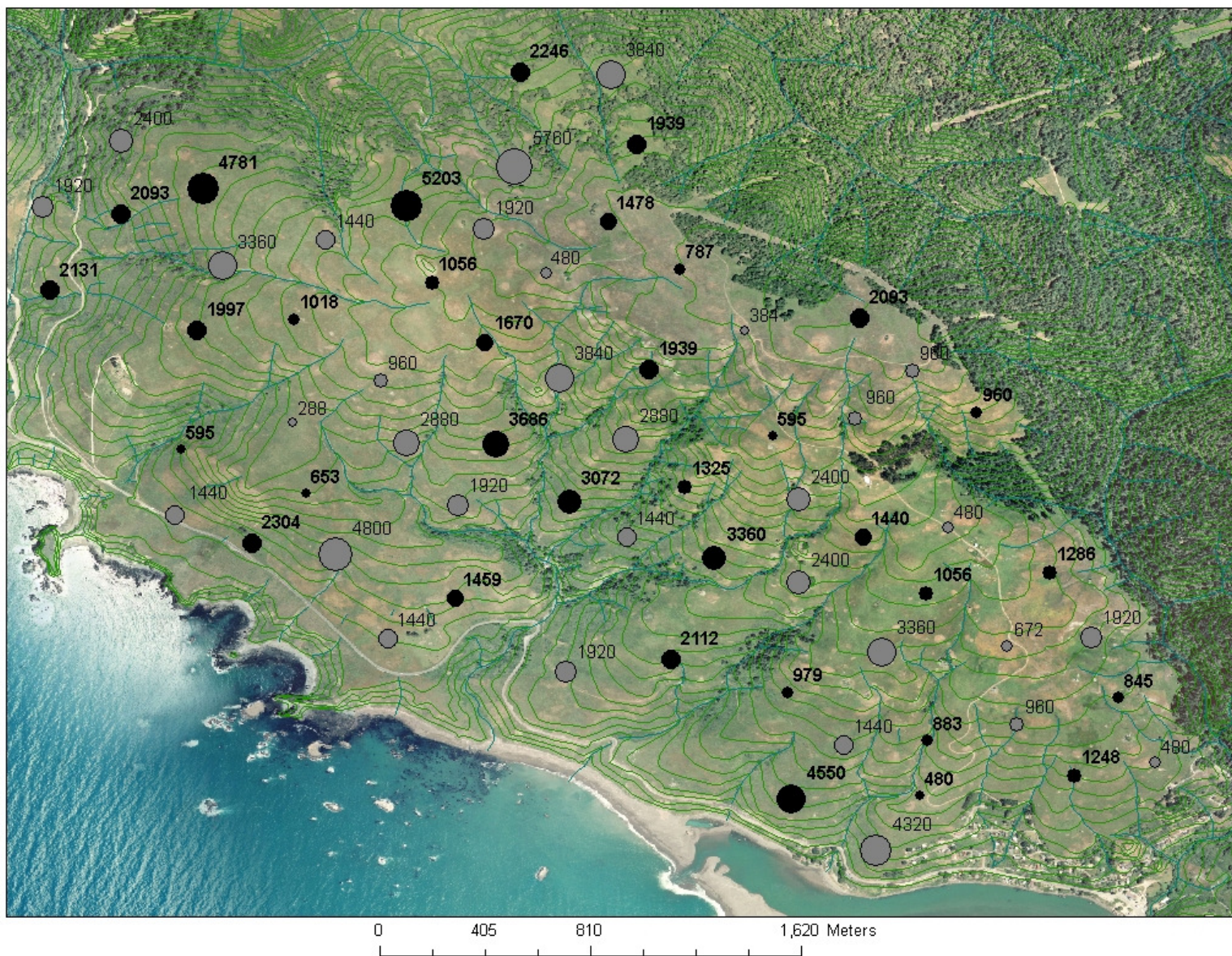
Family	Latin Name	Common Name	Jenner Headlands	State Park
Anacardiaceae	<i>Toxicodendron diversilobum</i>	Pacific poison oak	0.15%	1.08%
Apiaceae	<i>Conium maculatum</i> L.	poison hemlock	0.03%	0.02%
Apiaceae	<i>Eryngium armatum</i>	coyote-thistle	0.05%	0.07%
Apiaceae	<i>Heracleum maximum</i>	common cowparsnip	0.00%	2.31%
Asteraceae	<i>Achillea millefolium</i>	common yarrow	0.13%	0.65%
Asteraceae	<i>Anaphalis margaritacea</i>	Western pearly everlasting	0.001%	0.01%
Asteraceae	<i>Baccharis pilularis</i> DC.	coyotebrush	3.22%	10.79%
Asteraceae	<i>Carduus pycnocephalus</i> L.	Italian plumeless thistle	0.95%	2.39%
Asteraceae	<i>Cirsium vulgare</i>	bull thistle	0.08%	0.65%
Asteraceae	<i>Erechtites glomerata</i>	New Zealand fireweed	0.00%	0.48%
Asteraceae	<i>Erigeron glaucus</i>	seaside daisy	0.00%	0.02%
Asteraceae	<i>Hemizonia congesta</i> ssp. <i>congesta</i>	hayfield tarweed	3.01%	0.15%
Asteraceae	<i>Hypochaeris radicata</i>		8.71%	0.37%
Asteraceae	<i>Lasthenia californica</i>	goldfields	0.24%	0.00%
Asteraceae	<i>Microseris bigelovii</i>		0.01%	0.00%
Asteraceae	<i>Silybum marianum</i>	milk thistle	0.21%	0.00%
Asteraceae	<i>Sonchus oleraceus</i>	common sow-thistle	0.002%	0.81%
Asteraceae		Unk. Aster	0.16%	0.00%
Asteraceae		unknown thistle	0.00%	0.02%
Caryophyllaceae	<i>Silene gallica</i>		0.04%	0.00%
Convolvulaceae	<i>Convolvulus arvensis</i>	field bindweed	0.01%	0.00%
Convolvulaceae	<i>Dichondra donelliana</i>	California ponysfoot	0.24%	0.37%
Crassulaceae	<i>Dudleya farinosa</i>	coast live-forever	0.01%	0.00%
Cucurbitaceae	<i>Marah fabaceus</i>	California man-root	0.00%	0.08%
Cyperaceae	<i>Carex</i> L.	sedge	0.43%	3.60%
Dennstaedtiaceae	<i>Pteridium aquilinum</i> var. <i>pubescens</i>	bracken fern	0.21%	1.39%
Fabaceae	<i>Lotus corniculatus</i>	bird's-foot trefoil	0.66%	0.00%
Fabaceae	<i>Lotus</i> L.	trefoil	0.14%	0.45%
Fabaceae	<i>Lotus wrangelianus</i>		0.19%	0.00%
Fabaceae	<i>Lupinus arboreus</i>	bush lupine	0.003%	0.03%
Fabaceae	<i>Lupinus bicolor</i>	miniature lupine	0.09%	0.00%
Fabaceae	<i>Trifolium</i> sp.	clover	0.14%	0.00%
Fagaceae	<i>Lithocarpus densiflora</i>	tanbark oak	0.15%	0.00%
Grossulariaceae	<i>Ribes californicum</i>	hillside gooseberry	0.00%	0.11%
Iridaceae	<i>Iris douglasiana</i>	Douglas's iris	0.14%	2.56%
Iridaceae	<i>Sisyrinchium bellum</i>	blue-eyed grass	0.11%	0.00%
Juncaceae	<i>Juncas occidentalis</i>	western juniper	0.16%	0.00%

Family	Latin Name	Common Name	Jenner Headlands	State Park
Juncaceae	<i>Juncus bufonius L.</i>	toad rush	0.03%	0.00%
Juncaceae	<i>Juncus effusus var. (?)</i>	common rush	0.02%	0.00%
Juncaceae	<i>Juncus L.</i>	unk. Juncus	0.06%	3.55%
Juncaceae	<i>Juncus patens</i>	spreading rush	0.14%	0.93%
Lamiaceae	<i>Mentha pulegium</i>	pennyroyal	0.14%	0.00%
Lamiaceae	<i>Monardella villosa ssp. ?</i>	coyote mint	0.02%	0.58%
Lamiaceae	<i>Stachys bullata</i>	coast hedge-nettle	0.01%	0.03%
Lauraceae	<i>Umbellularia californica</i>	California Bay	0.20%	0.00%
Liliaceae	<i>Brodiaea elegans</i>	elegant brodiaea	0.18%	0.00%
Liliaceae	<i>Brodiaea terrestris</i>	dwarf brodiaea	0.01%	0.00%
Liliaceae	<i>Chlorogalum pomeridianum</i>	wavyleaf soap plant	0.05%	0.00%
Liliaceae	<i>Triteleia laxa</i>	Ithuriel's spear	0.29%	0.00%
Linaceae	<i>Linum bienne</i>		1.12%	0.08%
Myricaceae	<i>Myrica californica</i>	California wax myrtle	0.05%	0.00%
Papaveraceae	<i>Eschscholzia californica</i>	California poppy	0.07%	0.03%
Pinaceae	<i>Pseudotsuga menziesii</i>	Douglas-fir	2.64%	0.69%
Plantaginaceae	<i>Plantago lanceolata</i>	english plantain	2.30%	0.22%
Poaceae	<i>Aegilops triuncialis</i>	barbed goatgrass	0.25%	0.00%
Poaceae	<i>Aira caryophyllea</i>	silver hairgrass	0.39%	0.00%
Poaceae	<i>Anthoxanthum odoratum</i>		0.02%	0.00%
Poaceae	<i>Avena barbata Pott ex Link</i>	slender oat	5.96%	2.12%
Poaceae	<i>Brachypodium distachyon</i>	false brome	4.64%	0.08%
Poaceae	<i>Briza maxima</i>		1.26%	4.40%
Poaceae	<i>Briza minor</i>		0.92%	0.00%
Poaceae	<i>Bromus carinatus ssp. carinatus</i>	California brome	0.02%	0.00%
Poaceae	<i>Bromus diandrus</i>	ripgut brome	0.01%	0.13%
Poaceae	<i>Bromus hordeaceus</i>	Soft Chess	1.06%	0.00%
Poaceae	<i>Bromus L.</i>	Unk. Bromus	0.004%	0.00%
Poaceae	<i>Calamagrostis nutkaensis</i>	Pacific Reed Grass	0.00%	5.82%
Poaceae	<i>Cynosurus echinatus L.</i>	dogtail	14.90%	1.63%
Poaceae	<i>Dactylis glomerata</i>	Orhard Grass	0.00%	0.20%
Poaceae	<i>Danthonia californica</i>	California oatgrass	0.36%	0.46%
Poaceae	<i>Deschampsia cespitosa</i>	tufted hairgrass	0.29%	3.32%
Poaceae	<i>Elymus glaucus var. glaucus</i>	blue wildrye	0.09%	0.30%
Poaceae	<i>Festuca idahoensis</i>	Idaho fescue	0.00%	0.34%
Poaceae	<i>Festuca L.</i>	Fescue spp (Idaho or red)	0.00%	0.15%
Poaceae	<i>Holcus lanatus</i>	Velvet Grass	5.40%	19.14%
Poaceae	<i>Hordeum brachyantherum</i>	meadow barley	0.12%	0.00%
Poaceae	<i>Hordeum marinum ssp. gussoneanum</i>	Mediterranean barley	0.64%	0.00%

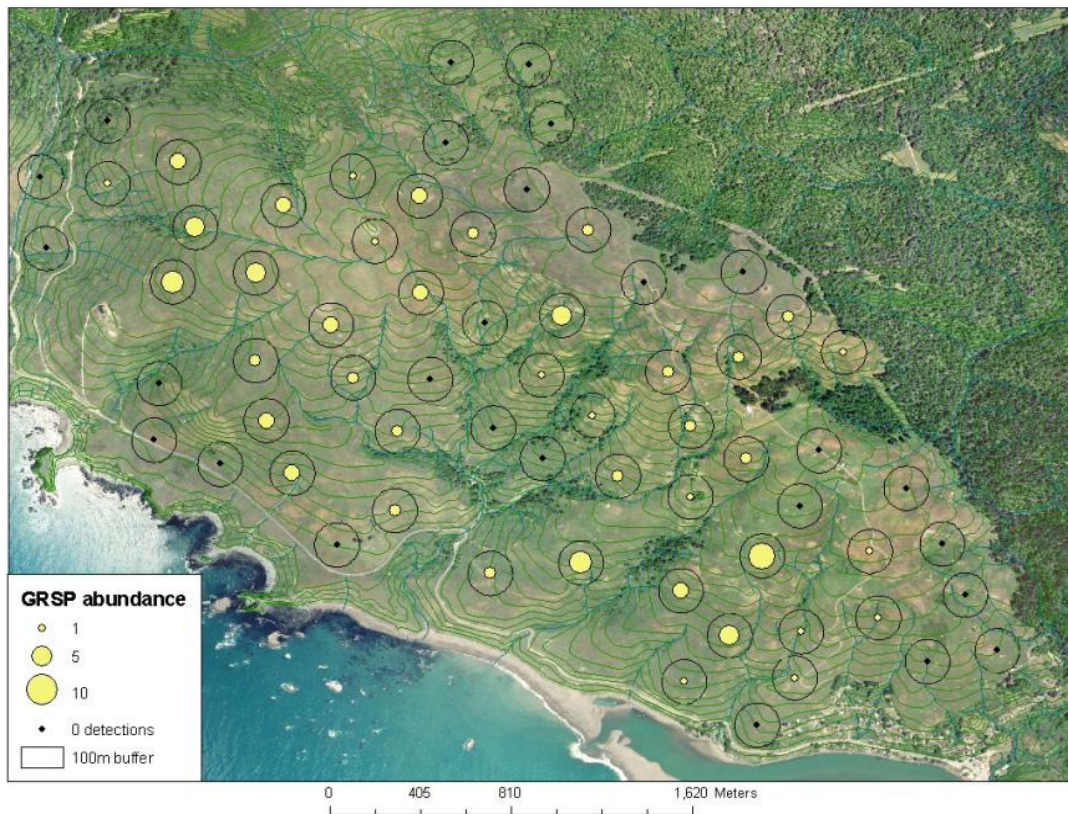
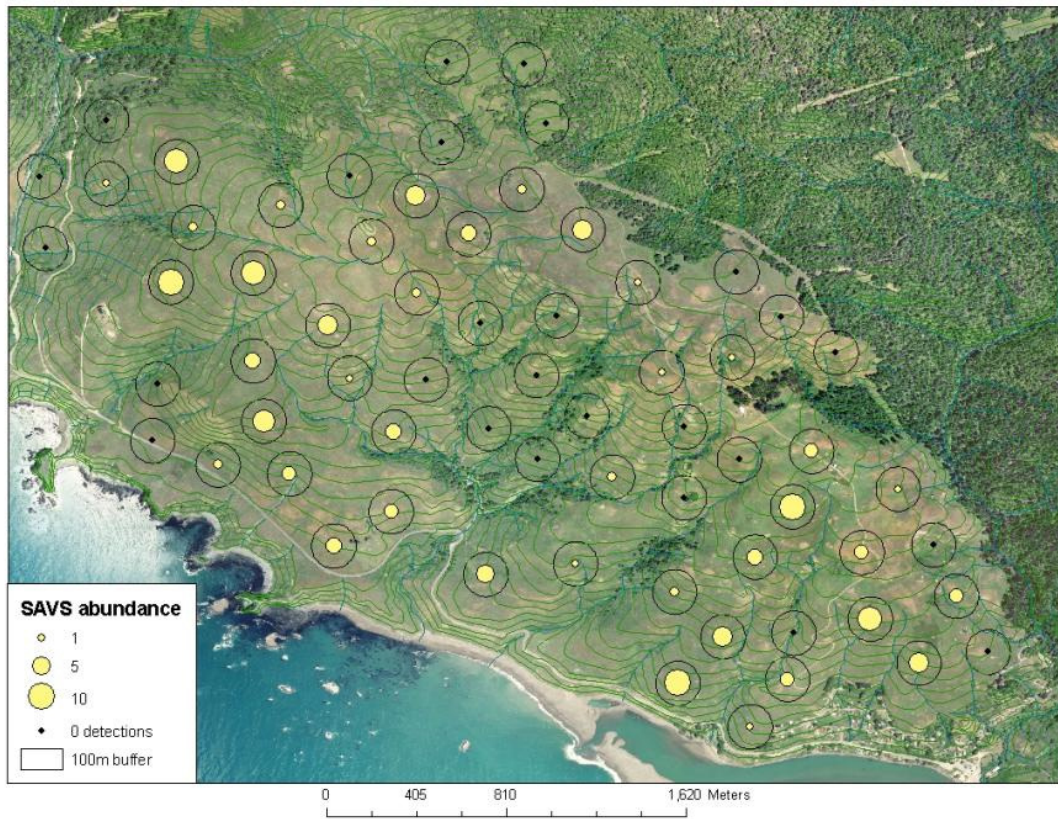
Family	Latin Name	Common Name	Jenner Headlands	State Park
Poaceae	<i>Hordeum murinum ssp. leporinum</i>	Hair Barley	0.07%	0.00%
Poaceae	<i>Koeleria macrantha</i>	Junegrass	0.004%	0.00%
Poaceae	<i>Lolium multiflorum</i>	Italian ryegrass	5.79%	0.00%
Poaceae	<i>Lolium perenne L.</i>	perennial ryegrass	0.82%	0.00%
Poaceae	<i>Nassella manicata</i>	ant Needlegrass (?)	11.49%	0.00%
Poaceae	<i>Nassella lepida</i>	foothill needlegrass	0.03%	1.21%
Poaceae	<i>Nassella pulchra</i>	purple needlegrass	1.02%	4.57%
Poaceae	<i>Phalaris aquatica</i>	Harding Grass	0.27%	0.00%
Poaceae	<i>Poa pratensis</i>	Kentucky Bluegrass	0.06%	0.02%
Poaceae	<i>Polypogon Desf.</i>	rabbitsfoot grass	0.02%	0.00%
Poaceae	<i>Schedonorus arundinaceus</i>	tall fescue	0.05%	0.00%
Poaceae	<i>Vulpia bromoides</i>	brome fescue	2.27%	4.66%
Poaceae	<i>Vulpia myuros var. (?)</i>	rat-tail fescue	0.11%	0.00%
Poaceae	N/A	unk. grass	0.10%	0.00%
Polygonaceae	<i>Eriogonum latifolium</i>	seaside buckwheat	0.16%	0.04%
Polygonaceae	<i>Rumex pulcher</i>	fiddle dock	0.06%	0.20%
Primulaceae	<i>Anagallis arvensis</i>	scarlet pimpernel	0.05%	0.00%
Ranunculaceae	<i>Ranunculus californicus</i>	California buttercup	0.05%	0.00%
Rhamnaceae	<i>Rhamnus californica</i>	California coffeeberry	0.00%	0.22%
Rosaceae	<i>Argentina egedii</i>	Pacific silverweed	0.00%	0.58%
Rosaceae	<i>Fragaria chiloensis</i>	beach strawberry	0.00%	0.41%
Rosaceae	<i>Rosa californica</i>	California wildrose	0.00%	0.21%
Rosaceae	<i>Rubus ursinus</i>	California blackberry	0.15%	7.16%
Salicaceae	<i>Salix L.</i>	willow	0.61%	0.00%
Scrophulariaceae	<i>Mimulus aurantiacus</i>	bush monkey flower	0.27%	0.00%
Scrophulariaceae	<i>Mimulus aurantiacus</i>	bush monkey flower	0.27%	0.00%
Scrophulariaceae	<i>Triphysaria eriantha ssp. rosea</i>	Johny-tuck	0.03%	0.00%
unknown forb			0.33%	0.13%
"scrub"			3.19%	0.00%
Bare ground			5.45%	1.75%
Thatch			0.00%	5.58%
Rock			1.67%	0.67%

Appendix D. Residual dry matter (RDM) and coordinates of each point count station in grassland habitat at Jenner Headlands and Sonoma Coast State Park. RDM was assessed in October 2010.

station	Lat.	Long.	RDM (lb/acre)	Station	Lat.	Long.	RDM (lb/acre)
JH_A01	38.45335	-123.122	480	JH_D09	38.45874	-123.141	1440
JH_A02	38.45144	-123.124	4320	JH_D10	38.46202	-123.145	2304
JH_A03	38.45319	-123.127	4550.4	JH_D11	38.463	-123.148	1440
JH_A04	38.45506	-123.125	1440	JH_D12	38.46529	-123.148	595.2
JH_A05	38.45689	-123.127	979.2	JH_E01	38.47315	-123.133	1478.4
JH_A06	38.45829	-123.124	3360	JH_E02	38.47291	-123.137	1920
JH_A07	38.46032	-123.122	1056	JH_E03	38.47106	-123.139	1056
JH_A08	38.45848	-123.119	672	JH_E04	38.46767	-123.141	960
JH_A09	38.45522	-123.122	883.2	JH_E05	38.4737	-123.14	5203.2
JH_A10	38.45579	-123.119	960	JH_E06	38.47506	-123.136	5760
JH_A11	38.45401	-123.117	1248	JH_E07	38.47832	-123.136	2246.4
JH_A12	38.45446	-123.114	480	JH_E08	38.47821	-123.133	3840
JH_A13	38.45671	-123.115	844.8	JH_E09	38.47583	-123.132	1939.2
JH_A14	38.45878	-123.116	1920	JH_F01	38.47252	-123.143	1440
JH_A15	38.46104	-123.118	1286.4	JH_F02	38.46978	-123.144	1017.6
JH_B01	38.46257	-123.121	480	JH_F03	38.46622	-123.144	288
JH_B02	38.46223	-123.124	1440	JH_F04	38.46941	-123.147	1996.8
JH_B03	38.46069	-123.126	2400	JH_F05	38.47162	-123.146	3360
JH_B04	38.45802	-123.131	2112	JH_F06	38.47427	-123.147	4780.8
JH_B05	38.45759	-123.134	1920	JH_F07	38.47595	-123.15	2400
JH_B06	38.46152	-123.129	3360	JH_F08	38.4734	-123.15	2092.8
JH_B07	38.46356	-123.126	2400	JH_F09	38.47367	-123.153	1920
JH_B08	38.464	-123.13	1324.8	JH_F10	38.47077	-123.152	2131.2
JH_B09	38.46225	-123.132	1440	SPL01	38.4194	-123.106	1651.2
JH_B10	38.46576	-123.127	595.2	SPL02	38.42162	-123.106	3360
JH_C01	38.47153	-123.131	787.2	SPL03	38.42302	-123.109	3302.4
JH_C02	38.47136	-123.135	480	SPL04	38.42406	-123.111	4800
JH_C03	38.46898	-123.137	1670.4	SPL05	38.42492	-123.114	3283.2
JH_C04	38.46775	-123.135	3840	SPL06	38.42725	-123.115	4800
JH_C05	38.46806	-123.132	1939.2	SPL07	38.42983	-123.116	4243.2
JH_C06	38.46938	-123.128	384	SPL08	38.43091	-123.118	960
JH_C07	38.46981	-123.124	2092.8	SPL09	38.43305	-123.119	1766.4
JH_C08	38.468	-123.123	960	SPL10	38.43541	-123.118	2400
JH_C09	38.46656	-123.12	960	SPU01	38.4202	-123.101	1440
JH_C10	38.46637	-123.125	960	SPU02	38.42223	-123.103	2726.4
JH_D01	38.46563	-123.132	2880	SPU03	38.4238	-123.101	1920
JH_D02	38.46349	-123.134	3072	SPU04	38.42395	-123.095	1843.2
JH_D03	38.46334	-123.138	1920	SPU05	38.42513	-123.098	1440
JH_D04	38.46545	-123.137	3686.4	SPU06	38.42662	-123.1	2380.8
JH_D05	38.46552	-123.14	2880	SPU07	38.42756	-123.103	2400
JH_D06	38.46379	-123.143	652.8	SPU08	38.42843	-123.106	2208
JH_D07	38.46165	-123.142	4800	SPU09	38.43039	-123.104	1440
JH_D08	38.46013	-123.138	1459.2	SPU10	38.43035	-123.107	2534.4



Appendix E. Residual dry matter (RDM) values for all 66 point count stations, where each circle is proportional to its RDM value. RDM values indicate pounds per acre, where black circles with emboldened numbers indicate stations that were sampled and gray circles were visually estimated.



Appendix F. Savannah Sparrow (top map) and Grasshopper Sparrow abundance (bottom map) during the 2010 breeding season. Yellow circles are proportional to relative abundance within a 100m radius (buffer outline shown) around each point count station.