

Estimating Impact of Mowing in the Silage Fields of Point Reyes National Seashore on Breeding Birds

FINAL REPORT TO THE NATIONAL PARK SERVICE

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INTRODUCTION AND BACKGROUND

This document summarizes findings and observations from a single-season study conducted by Point Blue Conservation Science to estimate the impacts of silage mowing on breeding birds. The overarching goal of this project was to provide information with which informed management decisions can be made in regards to silage mowing.

Our project objectives were to:

- estimate the impact of silage mowing on breeding birds (relative abundance, diversity, and potential nest loss);
- collect baseline data on breeding birds in an area where conversion to silage field is a future management consideration, in order to inform that process;
- provide this and related information as a starting point for discussions about what management actions could be taken to potentially help avoid, minimize, or mitigate impacts.

To meet these objectives we investigated the following questions:

1. Do silage fields contain the same bird communities as reference (non-silage pastureland) fields?
2. What was the impact of silage mowing to breeding bird richness and abundance?
3. What species were confirmed or likely breeding and potentially impacted by silage mowing?
4. Did we observe a distributional clumping of birds related to fencelines and edges in silage fields?
5. What are the potential impacts of future silage planting and mowing at B Ranch?

Point Blue Conservation Science (hereafter Point Blue) has been studying birds in Point Reyes National Seashore (hereafter PORE) since 1965, and established a long-term research and monitoring station in 1966 at the south end of the seashore at the Palomarin Field Station. Point Blue has worked in close collaboration with PORE on numerous studies, some ongoing, and has provided land managers throughout the West with management recommendations based on these and other monitoring programs, including in grassland systems.

METHODS

Study Design

In order to estimate the impact of silage mowing on breeding birds, we surveyed a subset of silage fields from three ranches within PORE: H Ranch, I Ranch, and J Ranch. At each of these ranches, we established six area search plots (see below for description of field methods): three treatment area search plots within silage fields where silage is grown and mowed annually; and three paired reference area search plots in nearby or adjacent non-silage grazed pastureland (Figure 1). Study plots were not selected at random, although attempts were made to choose representative sites within the study area while also considering logistical constraints (e.g., ability to establish contiguous-habitat plots within the silage or grazed-pastureland, and feasibility of surveying all six plots on a given ranch during a single morning within the appropriate survey window). Hence, inferences beyond these areas should be made with caution.

The purpose of the paired reference sites was to allow us to evaluate whether the silage fields and adjacent grazed pasturelands attracted a similar or substantially different bird community. Plots in the silage fields were established in representative locations within the field; most were bordered at least partially by fencelines or field edges, although site selection did not formally consider distance from edge. The size of each area search plot was largely determined by the observer's ability to adequately cover the area within a 20 minute period, which varied somewhat depending on topography, density of vegetation, and other habitat characteristics. Treatment plots varied in size from about 6 to 10 hectares (73 ha total), and reference plots varied from about 7 to 11 hectares (76 ha total).

Each plot was surveyed four times during the breeding season, roughly once per month from March through June (Table 1). The original study design intended for two surveys before and two surveys after the silage fields were mowed. However, the drought conditions of 2015 forced ranchers to mow much earlier than usual or what was originally anticipated, and thus it was not possible to conduct two surveys prior to that date for the treatment plots that were mowed the earliest. As a result, although the first round of surveys was completed before any mowing had occurred, the second round of surveys was completed after 5 out of the 9 treatment plots had been mowed, with the remaining 4 plots mowed between the second and third round of surveys as originally intended (Table 1). Although the intention was to survey all plots on each ranch on the same day for a given visit (visit 1-4), sometimes they had to be surveyed on multiple dates when weather or mowing activities precluded completion of all surveys on the same day.

To collect baseline data on breeding birds at B Ranch in an area where conversion to silage field is a future management consideration, we established four area search plots there (Figure 2): one in an area proposed for silage production (there was not enough proposed silage area here to establish three treatment plots), and three comparable reference sites. As with the surveys conducted at J, H, and I Ranches, the B Ranch plots were surveyed four times, following a similar timeline, for potential comparison to future years if silage fields are established there (Table 1).

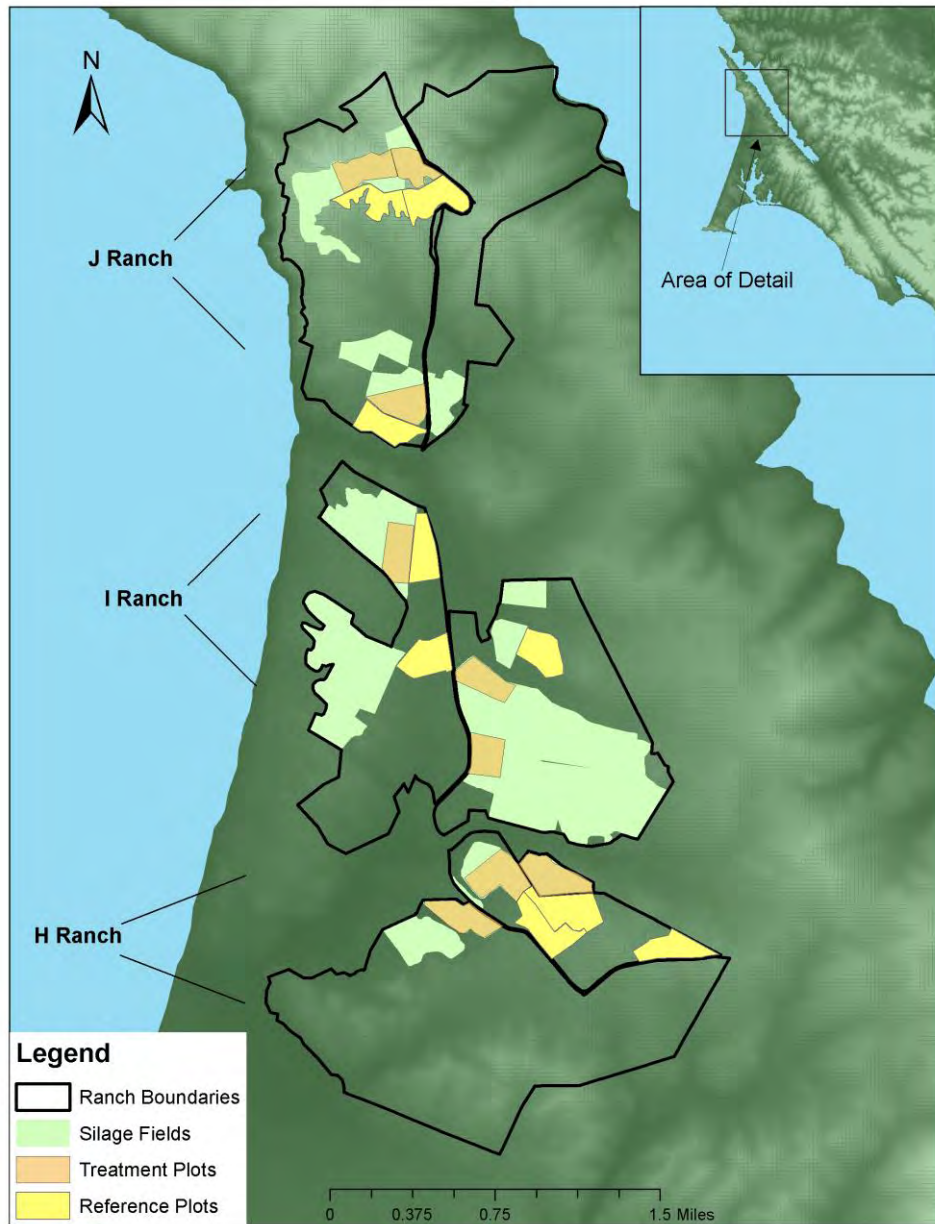


Fig. 1. Area search plots at H, I, and J Ranches surveyed by Point Blue Conservation Science in PORE in 2015: 9 treatment plots (in orange) in silage area, and 9 reference plots (in yellow) in nearby pasturelands.

Table 1. Dates of surveys conducted by Point Blue Conservation Science in PORE in 2015 for each of the four visits. Dark-shaded cells indicate post-mow surveys for the treatment plots; light-shaded cells indicate mowing had occurred across at least part of that reference plot for weed control.

Ranch	Plot Type	Visit 1	Visit 2	Visit 3	Visit 4
I Ranch	Treatment 1	3/24/15	4/14/15	5/9/15	6/5/15
	Treatment 2	"	"	5/18/15	"
	Treatment 3	"	"	5/9/15	"
	Reference 1	"	"	"	"
	Reference 2	"	"	"	"
	Reference 3	"	"	5/7/15	"
H Ranch	Treatment 1	3/25/15	4/24/15	5/11/15	6/8/15
	Treatment 2	"	"	"	"
	Treatment 3	"	4/20/15	"	"
	Reference 1	"	"	"	"
	Reference 2	"	"	"	"
	Reference 3	"	"	"	"
J Ranch	Treatment 1	3/26/15	4/16/15	5/8/15	6/9/15
	Treatment 2	"	"	"	6/11/15
	Treatment 3	"	"	"	"
	Reference 1	"	"	"	6/9/15
	Reference 2	"	"	"	6/11/15
	Reference 3	"	"	"	"
B Ranch	Treatment 1	3/27/15	4/24/15	5/18/15	6/12/15
	Reference 1	"	"	"	"
	Reference 2	"	"	"	"
	Reference 3	"	"	"	"



Fig. 2. Area search plots at B Ranch surveyed by Point Blue Conservation Science in PORE in 2015: 1 treatment plot (in orange) in the proposed future silage area, and 3 reference plots (in yellow) in nearby pasturelands.

Field Methods

We used the area search method to survey birds within and outside of silage areas for relative abundance (frequency of detection of a species) and species richness (number of species detected). The area search method involves surveying a predefined plot, and typically is time constrained such that each plot is adequately covered within a 20 minute period (Ralph et al. 1993). All bird species detected were counted and recorded to detection type (e.g., song, call, and/or visual). Notes on behavior, especially those related to breeding status, were recorded. We noted the distance from fenceline and field edges in intervals of 0-50m, 50-100m, and 100+m for each detection and noted whether or not individual birds were observed perching on a fenceline. Surveys were not conducted under weather conditions known to reduce bird activity or detectability (e.g., strong wind, heavy fog, precipitation). More information on the area search method can be found at <http://data.prbo.org/cadc2/index.php?page=songbird-area-searches> and data will be archived and managed online at the California Avian Data Center. All surveys were conducted by Ryan DiGaudio, an experienced field biologist with intimate knowledge of the songs and calls of birds in coastal California with additional expertise in grassland bird ecology.

Analysis

To focus on the local breeding bird community, we filtered the survey data to remove wintering or transient-migrant species when reporting relative abundance (frequency of detection) and species richness (number of species detected). Since we were interested in characterizing the overall breeding bird community using silage fields and pasturelands, we only included locally-breeding species for data analysis, which include those that are known to breed in grassland habitat, as well as species that breed locally but nest outside our study plots as they require trees, shrubs, or structures as nest substrates (Shuford 1993; expert opinion) and were detected using silage for foraging. Detections of known juveniles were also removed, since they are not considered part of the breeding population. In order to understand how silage mowing specifically impacts species that potentially nest within silage, we also selected and examined five focal species: Northern Harrier, Savannah Sparrow, Grasshopper Sparrow, Song Sparrow, and Red-winged Blackbird (Table 2; see Appendix 1 for scientific names of all bird species). These species were chosen as focal species because they were documented as either confirmed or likely breeding within the silage fields, represent a range of habitat attributes as a group, and include species of conservation concern. Common Raven, a species that does not nest in these fields due to the lack of appropriate nesting substrate for them (Boarman and Heinrich 1999), was also included as a sixth focal species because it is a species of potential management interest within PORE as well as regionally (Roth et al. 1999, Roth et al. 2004, Kelly et al. 2005). Table 2 summarizes various natural history and conservation attributes of the six focal species.

Table 2. Focal species for the 2015 Point Blue Conservation Science silage study in PORE along with conservation status and natural history information, including migratory status, number of broods reared per year, and notes on nest location and ecology.

Focal Species	Conservation Status ¹	Migratory Status	Broods per year ²	Nest Characteristics and Other Notes ²
Northern Harrier	SSC	Resident	1	Open cup nest placed on ground among dense vegetation.
Savannah Sparrow	SSC	Resident	2	Open cup nest placed on ground in grassland habitat.
Grasshopper Sparrow	SSC	Migratory	2	Partially domed-over nest placed on ground in grassland habitat.
Song Sparrow		Resident	2-3	Open cup nest placed in dense vegetation about 0.5 m off the ground.
Red-winged Blackbird		Resident	2-3	Nests in loose colonies; open cup nest placed about 0.5 m off ground in dense vegetation, often in or close to wetlands.
Common Raven		Resident	1	Does not nest in silage but forages in fields and pastures; a species of management interest in PORE.

¹California Department of Fish and Wildlife Species of Special Concern (Shuford and Gardali 2008).

²Source: Ehrlich et al. 1988, Rodewald 2015.

To determine whether silage fields contain the same bird community characteristics as reference fields (Question 1), we examined overall relative abundance, overall species richness, and relative abundance of each of the focal species. Relative abundance is the number of birds detected per 10 ha to standardize for slight differences in plot sizes. Species richness is simply the total number of species detected. These metrics were calculated for each plot using data from the first visit, and then averaged across all plots (n=9 for both treatment and reference groups). Only the first visit was used because afterwards one or more of the silage plots had been mowed, altering the bird composition. We used bar charts to graphically compare these metrics, and standard error bars to indicate uncertainty around the means.

To evaluate the impact of silage mowing to breeding bird richness and abundance (Question 2), we examined the same set of metrics at pre-mowed silage plots, post-mowed silage plots, and reference plots. To compare the reference plot data with the silage plot data along similar time scales, in case any changes to the bird community in the silage fields were more an artifact of seasonality than mowing activity, we divided the reference plot surveys into “pre-mow” and “post-mow” periods, where “pre-mow” is defined as visits 1 and 2, and “post-mow” as visits 3 and 4. Since there were an uneven number of visits between pre and post-mowed plots within the silage plots, we controlled for the number of visits by calculating a mean metric per visit for each plot, and then averaged these values across all plots within each treatment, with 9 plots each for pre-mow silage, post-mow silage, pre-mow reference, and post-mow reference, respectively.

To determine which species were confirmed or likely breeding and potentially impacted by silage mowing (Question 3), we evaluated breeding status based on behavioral cues, physical evidence, and expert opinion. A species was a *confirmed* breeder if at least one of the following was observed in the silage plots: nest found; distraction display; copulation; feeding young or fledglings; and food, nesting material, or fecal sac carries. A species was considered a *likely* breeder if observed exhibiting breeding behavior (singing, paired, courtship and/or territorial behavior) on ≥ 2 visits during the breeding season ≥ 10 days apart and if expert opinion supported this. Birds were considered *potential* breeders if observed singing or exhibiting breeding behavior in suitable habitat only 1 time during the breeding season and if expert opinion supported this. Expert opinion was a factor, especially with regards to knowing the nesting habitat preferences of each species observed. For example, Grasshopper Sparrows will nest in relatively dense grasslands similar to silage, thus observations of singing Grasshopper Sparrows suggested that they may have been on territory and nesting within the plot. Conversely, Brewer’s Blackbirds were observed singing several times in many of the plots, but this species is not a grassland or ground-nesting bird, and thus their presence simply indicated that they were using the fields for other activities such as foraging. It should also be noted that since this was not a nest-monitoring study, confirming the breeding status of birds within the study area was not one of our primary objectives, and thus most of the cues that help us document breeding (e.g. finding a nest) were only discovered opportunistically during the time of the surveys; therefore the lack of confirmation of breeding for some species is not necessarily an indication that they were unlikely to be breeding.

We explored whether there was distributional clumping of birds related to the field edges or fencelines in pre-mowed silage fields (Question 4), to determine whether leaving buffer strips along field edges and fencelines, as a potential management technique, might help reduce impacts to nesting birds. We determined the relative percentage of birds that were within 50 m of the field edge or fenceline of the total number of birds detected within each plot, and compared that with the relative area of the survey plots encompassed in the 0 – 50 m distance from fencelines or field edges. Similarly, we determined the relative percentage of birds that were detected perched directly on fencelines. Because we were interested in whether edges appeared to influence the distribution of breeding birds, we only included detections of species that were potentially nesting within silage plots. We also examined Savannah Sparrow distribution separately because it yielded enough detections to produce meaningful results on this metric, and in order to evaluate whether patterns in this species may have been obscured when all species were lumped together.

To assess potential impacts of future silage planting and mowing at B Ranch (Question 5), we report the species detected at the proposed silage area, which species were confirmed or likely breeding, and compared overall relative abundance, species richness, and the relative abundance of the six focal species to the reference pastureland plots at B Ranch and to the reference plots at I, J, and H Ranches.

RESULTS

A detailed summary of each survey is given in Appendix A, including plot area (hectares), a species list, tally of individuals detected, and whether a silage plot was in pre-mow or post-mow status on a given visit.

1. Do silage fields contain the same bird communities as reference (non-silage pastureland) fields?

Prior to mowing, the relative abundance of locally-breeding birds (all species combined) and species richness were similar between reference and silage plots (Fig. 3).

However, the relative abundance of individual focal species were considerably different in that most focal species were more abundant in the silage plots (Fig. 4), with Red-winged Blackbird particularly more abundant in the silage plots. Common Raven, a non-grassland-nesting species, is the exception to this pattern: they were not present in the pre-mowed silage plots, but were present to some extent in the reference fields. Savannah Sparrows, although slightly more common in silage, were not significantly so, as indicated by overlapping error bars.

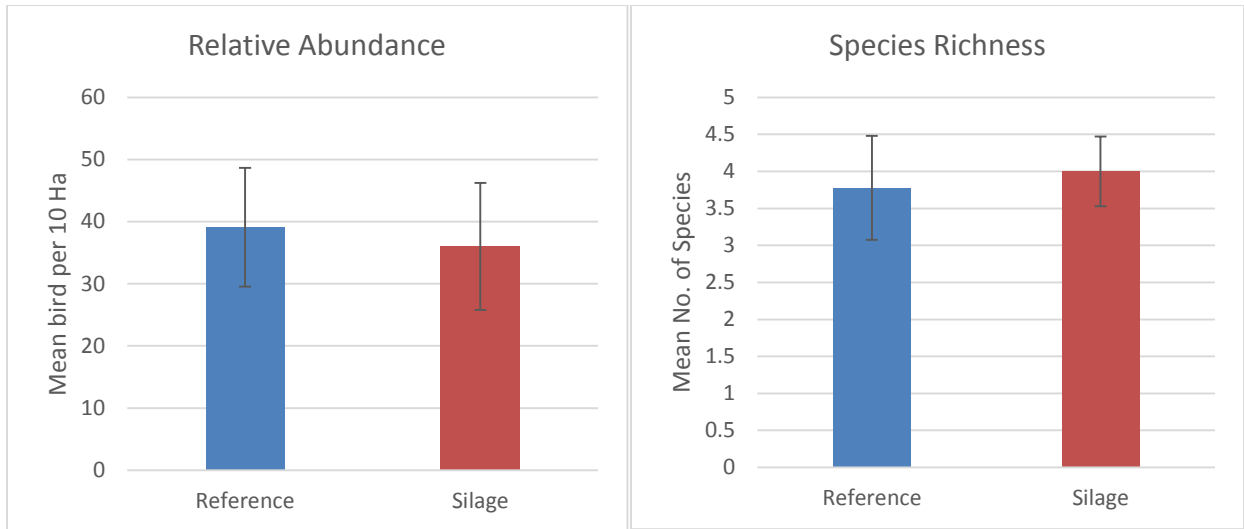


Figure 3. Mean relative abundance (birds per 10 ha) and species richness of locally-breeding species, with standard error bars, detected by Point Blue Conservation Science in PORE in 2015, at reference sites (n=9 plots) and silage plots (n=9 plots) on the first visit in March before mowing had occurred.

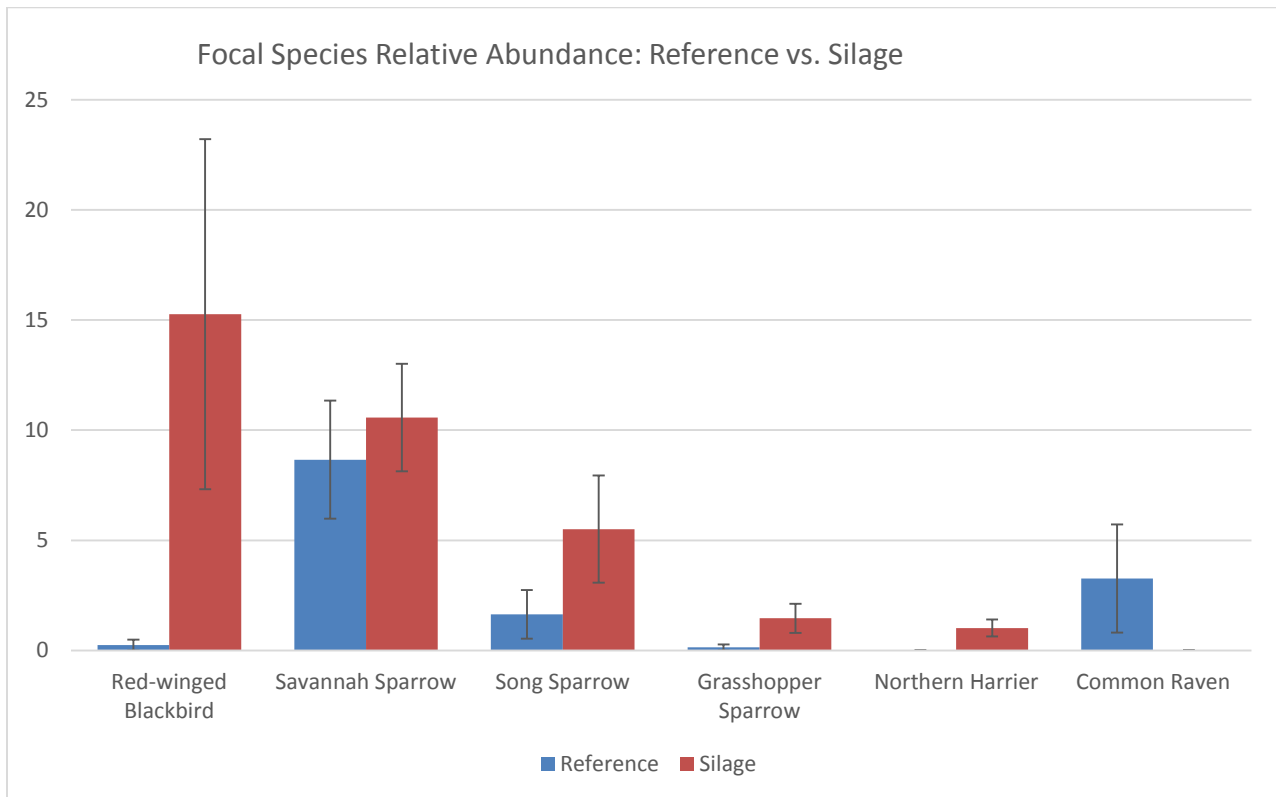


Figure 4. Mean relative abundance (birds per 10 ha) of focal species at reference sites (n=9 plots) and silage plots (n=9 plots) with standard error bars, detected by Point Blue Conservation Science in PORE in 2015, on the first visit in March before mowing had occurred.

2. What was the impact of silage mowing to breeding bird richness and abundance?

Mean relative abundance was about 35 birds per 10 ha per visit per plot for both the reference sites (pre and post-mow visits) and the pre-mowed silage sites, while the silage sites post-mowing averaged 18 birds per 10 ha post-mowing (Fig. 5). Mean richness per visit per plot at the pre-mowed reference, post-mowed reference, pre-mowed silage, and post-mowed silage was 4.1, 5.2, 3.9, and 3.1, respectively (Fig. 5). Mean relative abundance for each of the five breeding focal species in the silage plots also decreased after mowing had occurred, especially Red-winged Blackbird and Song Sparrow (Fig. 6). Common Raven, however, was the exception to this pattern, which increased in both the silage and reference plots after mowing had occurred (Fig. 6).

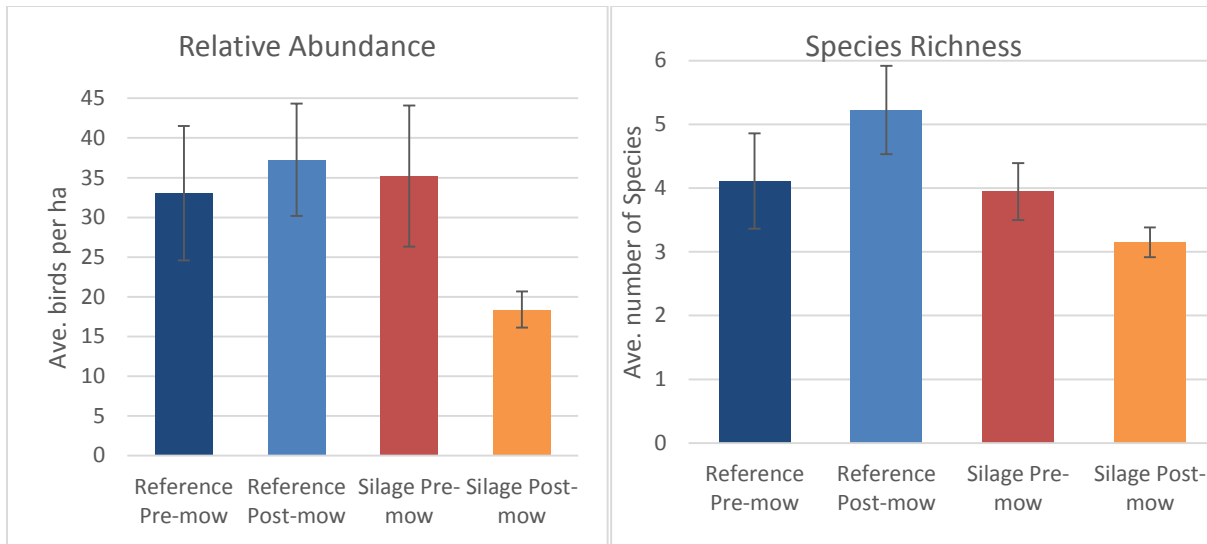


Figure 5. Mean relative abundance and species richness per visit per plot (with standard error bars) for pre-mowing and post-mowing periods in reference and silage plots (n=9 plots for each) as detected by Point Blue Conservation Science in PORE in 2015.

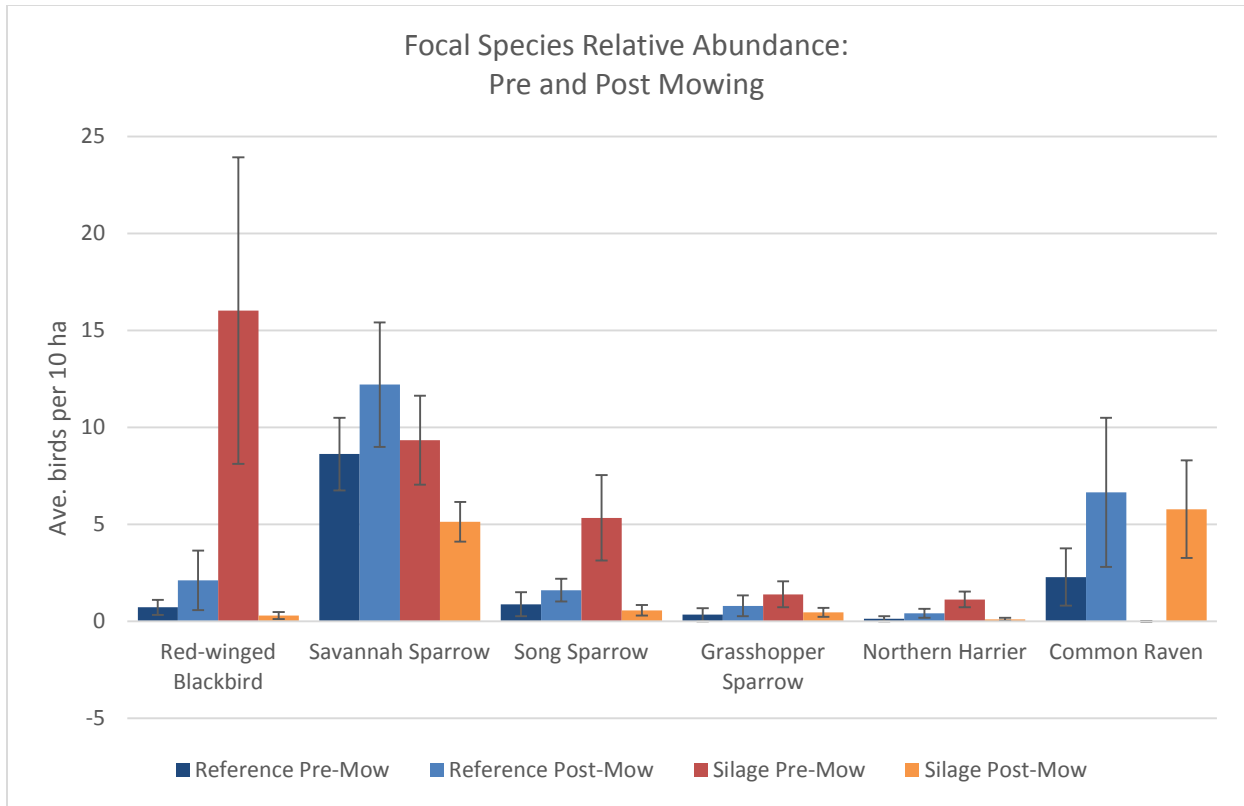


Figure 6. Mean relative abundance (birds per 10 ha) of focal species per visit per plot (with standard error bars) for pre-mowing and post-mowing periods in reference and silage plots (n=9 plots for each) as detected by Point Blue Conservation Science in PORE in 2015.

3. What species were confirmed or likely breeding and potentially impacted by silage mowing?

Nine species were confirmed or suspected of having nested within the silage and/or reference plots, with eight of them in the silage and five in the reference plots (Table 3). Four species were confirmed nesting in the silage plots pre-mowing (Savannah Sparrow, Song Sparrow, White-crowned Sparrow, and Red-winged Blackbird), an additional three were likely to have nested (Mallard, Northern Harrier, and Grasshopper Sparrow), and an additional one potentially bred there (Brown-headed Cowbird). Three of these – Northern Harrier, Savannah Sparrow, and Grasshopper Sparrow – are California Department of Fish and Wildlife Species of Special Concern (Shuford and Gardali 2008). Appendix B details the evidence of breeding (other than singing individuals) observed at each site and visit by species.

Table 3. Species that were confirmed, likely, or potentially nesting in silage plots pre- and post-mowing, reference plots, or the B Ranch proposed silage plot that were surveyed by Point Blue Conservation Science in PORE in 2015. A blank cell indicates no evidence detected, though lack of evidence does not necessarily mean nesting did not occur.

Species	Conservation Status	Breeding Status			
		Silage Pre-Mow	Silage Post-Mow	Reference Plots	B-Ranch Proposed Silage
Mallard		Likely			
Northern Harrier	SSC ¹	Likely			
Savannah Sparrow ²	SSC ¹	Confirmed	Potential	Confirmed	Confirmed
Grasshopper Sparrow	SSC ¹	Likely	Potential	Confirmed	Potential
Song Sparrow		Confirmed		Confirmed	
White-crowned Sparrow		Confirmed		Confirmed	
Red-winged Blackbird		Confirmed			
Brown-headed Cowbird		Potential			
American Goldfinch				Potential	

¹California Department of Fish and Wildlife Species of Special Concern (Shuford and Gardali 2008).

²The local race of Savannah Sparrow in Point Reyes, “Bryant’s” (*Passerculus sandwichensis alaudinus*), is a California Species of Special Concern (Shuford and Gardali 2008).

4. Did we observe a distributional clumping of birds related to fencelines and edges in silage fields?

From the pre-mow survey data in silage fields, the majority of the locally-nesting bird species (64%) were detected greater than 50 m from fencelines or field edges, and birds that were seen perched on fencelines only accounted for 8% of the total detections. Savannah Sparrows showed a similar pattern, where 63% were detected greater than 50 m from fencelines or field edges, and only 13% were seen perched on fencelines. Given that the proportion of the collective plot’s area that was within 50 m vs. greater than 50 m away from fencelines and field edges were about 55% and 45% respectively, the observed distribution of bird detections does not suggest a pattern of distributional clumping biased towards fencelines and field edges.

5. What are the potential impacts of future silage planting and mowing at B Ranch?

A comparison of avifauna observed at the 9.8 hectare plot in the proposed silage area at B Ranch (one plot) with the three pastureland reference plots at B Ranch and the nine other reference plots at the I, J, and H Ranches reveals some similarities but also distinctive differences (Figs. 7 and 8). Though overall relative abundance were similar between these pastoral habitats, the B Ranch proposed silage area appeared to support fewer species (Fig. 7). However, Savannah Sparrows were about three times more abundant at B Ranch at both at the proposed silage area and reference plots when compared to the reference plots at I, J, and H Ranches (Fig. 8). Savannah Sparrow was also a confirmed breeder at the proposed silage area (Table 3).

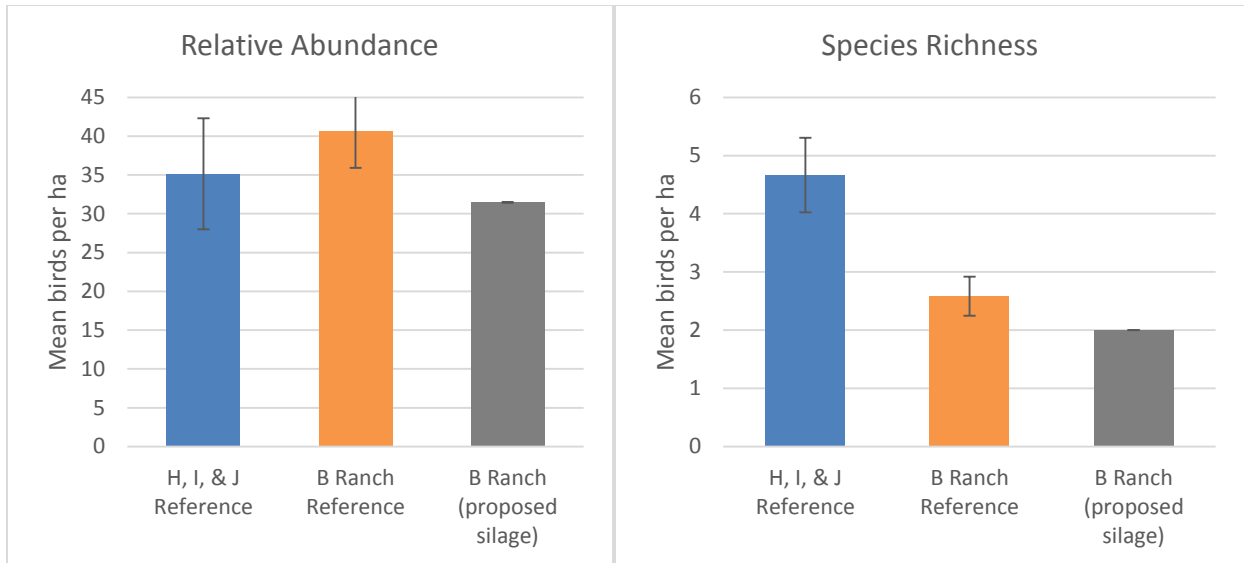


Figure 7. Mean relative abundance and species richness per visit per plot (with standard error bars) for reference plots at H, I, and J Ranches (n=9 plots), B Ranch reference plots (n=3 plots), and the proposed silage area at B Ranch (n=1 plot), as detected by Point Blue Conservation Science in PORE in 2015.

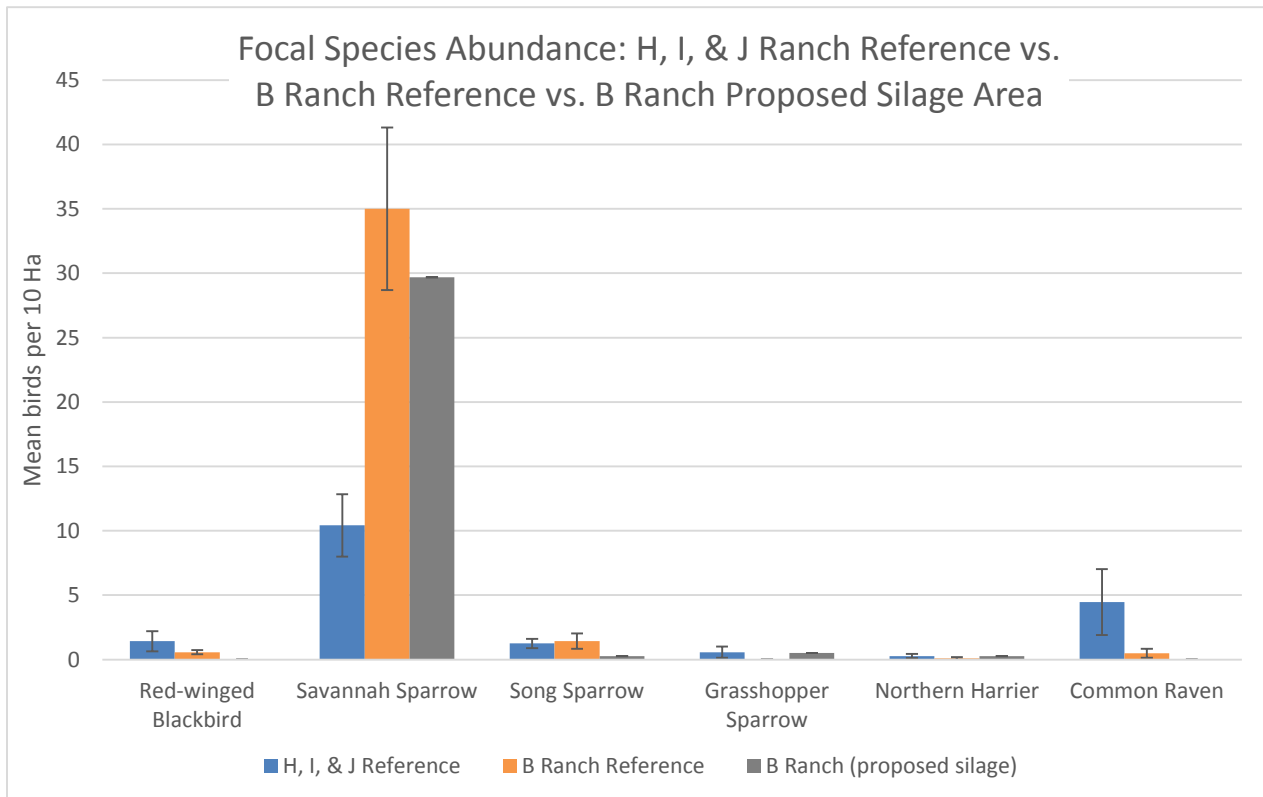


Figure 8. Mean relative abundance per visit (birds per 10 ha) of focal species per visit per plot with standard error bars at I, J, and H Ranch reference plots (n=9 plots), Ranch B reference plots (n=3), and Ranch B proposed silage area (n=1 plot), as detected by Point Blue Conservation Science in PORE in 2015.

DISCUSSION

A Comparison of Bird Communities in Silage vs. Pastureland Habitat Prior to Mowing

Prior to mowing, the silage fields provided habitat for several species of birds, especially Red-winged Blackbird, Savannah Sparrow, Grasshopper Sparrow, Song Sparrow, and, to a lesser extent, Mallard, Northern Harrier, and White-crowned Sparrow. Some of these species – Red-winged Blackbird, Northern Harrier, and Mallard – were absent or scarcely present in the reference pasture sites. Although both silage and reference sites contained Song Sparrow and Grasshopper Sparrow, silage appeared to attract more individuals of these species.

Despite this pattern of focal species being of greater abundance in the pre-mowed silage fields than in the reference fields, collective abundance of all locally-breeding species was similar between the reference and silage plots. This is explained by a large number of non-focal species detected in the reference plots, many not nesting in the silage but instead nesting nearby in more suitable habitat; this was particularly driven by the sizeable foraging flocks of Brewer's Blackbirds which likely nested nearby.

Although we did not quantify vegetation characteristics as part of this project, there were obvious qualitative differences between the silage and reference pasture sites that would explain these results. The pasture reference sites can be described as grazed short stature grasslands (~<15 cm high) with scattered clumps of *Juncus* and coyote bush (*Baccharis pilularis*), whereas the pre-mowed silage fields in the spring season were composed of dense, tall (~1 m high) grasses (mostly cultivated varieties of rye, oats, and barley) with varying amounts of 'weeds' mixed in throughout the grasses, especially wild radish (*Raphanus raphanistrum*) and wild mustard (*Brassica* sp.). The wild radish and mustards were probably key to attracting the scrub-associated bird species, especially Song Sparrow and White-crowned Sparrow, since they are rigid and hence function structurally like shrubs to provide appropriate nesting substrate. For example, a White-crowned Sparrow nest was found (feeding young) in a pre-mowed silage field; it was built within a mix of wild radish and mustard about 50 cm off the ground. These plant species may have also attracted Red-winged Blackbirds, since wild radish and mustards were present in the same silage fields as Red-winged Blackbird colonies. Wild radish may have also played a role in attracting a pair of Northern Harriers to begin building a ground nest within one of the silage fields, albeit for a different reason (reducing visibility rather than use as a nesting substrate); harriers were observed carrying nesting material to the middle of a dense, isolated patch of wild radish in the middle of a large silage field.

Impacts of Silage Mowing to Breeding Bird Richness, Abundance, and Nesting

Several studies have found that the agricultural practice of mowing (whether for silage or hay) has detrimental impact to breeding birds because nests, flightless young, and sometimes adults are destroyed (e.g., Mitchell et al. 2000, Vickery et al. 2001, Tews et al. 2013). Since we did not conduct nest monitoring as part of this study, we can only indirectly measure the effect mowing may have had on nesting birds based on the species and numbers of birds detected before and after mowing, and by assessing their potential for nesting in the silage fields. Prior to mowing, there were eight bird species confirmed or suspected of breeding in the silage fields. Four of these were ground-nesting species:

Mallard, Northern Harrier, Savannah Sparrow, and Grasshopper Sparrow. Three other species – Song Sparrow, White-crowned Sparrow, and Red-winged Blackbird – typically nest within 1 m of the ground in sturdy vegetation. The eighth species – Brown-headed Cowbird – is a brood parasite, laying its eggs in the nests of other bird species for them to raise. Because we surveyed only a portion of the silage fields, and only in a single year, this should not be considered a comprehensive list of all bird species using PORE silage for breeding. Relatedly, the abundance of the potential or confirmed breeding species during this single-year study may also not be indicative of typical or future use; this may be particularly true for Grasshopper Sparrow, a species known for its low breeding site fidelity and higher inter-annual variability in breeding distribution and abundance in this region than typical of most songbirds (Vickery 1996, Point Blue unpubl. data).

Since the overall abundance of breeding focal species averaged higher in pre-mowed silage than in the reference pasturelands, the silage fields likely also hosted more nests than the pasturelands, and thus incurred a concurrent amount of nest loss when mowing occurred. We do not know if birds moved from the mowed silage fields and were able to subsequently re-nest elsewhere, thus we cannot assess the demographic or overall population impacts of silage mowing in PORE without more study (Perlut et al. 2008).

A key factor affecting the extent of nest loss is the timing of mowing in relation to the birds' phenological nesting phase. Generally speaking, the nesting season window for the breeding focal species in the Point Reyes area is March through July, though there are always exceptions on both the early and late side, and there may also be climatic effects producing interannual variation in timing (DeSante 1989, Shuford 1993, Chase et al. 2005). The PORE silage fields were mowed in 2015 beginning in early April and finished by the end of April, a time frame corresponding with when nesting activity is typically ramping up (Kreitinger and Gardali 2006; Point Blue unpubl. data). In the pre-mow surveys in both silage and reference fields, we found nests in all possible stages (construction, egg laying, incubating, and feeding nestlings), as well as observed nesting material carries, courtship, and territorial displays (Appendix B). Collectively, this evidence suggests that nesting was asynchronous within and across species; thus, at the time of mowing, nests probably ranged in stage from nest construction to containing nestlings. A White-crowned Sparrow nest that was opportunistically found prior to mowing and revisited on the following visit appeared to have fledged young prior to mowing, suggesting that some nests could have successfully fledged young before mowing occurred. However, this nest seemed to be early relative to other individuals and species, with most other birds at that time at an earlier phase of the nesting cycle (Appendix B), including at the Palomarin Field Station elsewhere in PORE (Point Blue unpubl. data).

It should be noted that in the year of this study, the PORE silage fields were mowed 4 – 6 weeks earlier than usual due to the severe drought. In typical years in which mowing occurs later, more nests may have already fledged young by that point in the season; however, nesting activity in typical years would still be occurring through at least July, because some individuals initiate nesting later in the season, early nesters re-nest after nest failure, and many species re-nest after successfully fledging young (Kreitinger

and Gardali 2006; Point Blue unpubl. data). Additionally, recently-fledged young at the time of mowing may not yet be mobile enough to avoid the mower.

On the survey visits immediately following mowing, the silage fields did not appear to be suitable nesting habitat for any of the focal species. The fields were mowed and scraped, leaving the majority of ground cover as bare ground with some sparse stubble remnants. The small number of breeding focal species that were detected in the post-mowed silage fields were observed foraging near the edges, possibly feeding on exposed invertebrates and waste seeds dropped from the harvest (Peach et al. 2010). In the weeks and months following the mowing, some regeneration of grasses was apparent in some areas of a few fields, though fields varied with regard to their propensity to regenerate. The sandier soils at I Ranch and H Ranch had minimal regeneration, and still appeared relatively bare at the time of the last surveys in June. Sections with loamier and moister soils had sufficient regrowth, and even attracted a few singing grassland birds that may have attempted to nest there. Nonetheless, overall abundance in silage plots was lower in the post-mowing visits for all breeding focal species. In the reference plots, however, overall abundance and species richness appeared to increase in the post-mow time period, which is also reflected in an apparent increase in abundance of certain focal species.

A caveat that should be noted in interpreting these results is that small sections within two of the reference pastureland plots were mowed during the course of this study, although this was not anticipated in our study design: about 20% of two of the H Ranch reference plots had been mowed before the 3rd visit on 5/11/15, and about 1% of one of the I Ranch reference plots had been mowed before the 4th visit on 6/5/15. The likely reason for mowing was to control areas infested with thistle (*Carduus pycnocephalus* and *Silybum marianum*). This mowing likely disturbed any nesting birds present; however, its potential impact is difficult to evaluate since the mowing was patchily distributed within the plots and its evaluation not an objective of this study. This practice may have impacted data from these reference plots later in the season, even though the change to the habitat structure was less dramatic than in the silage fields. However, this pasture mowing likely did not change the direction of the observed pattern (that reference sites had more birds than post-mowed silage fields), possibly only dampening the extent of that pattern. It may be beneficial for park resource managers to consult with ranchers about the timing and application of this practice in order to maximize weed control benefits and minimize impacts to nesting birds.

The dominant species observed in the mowed silage was Common Raven, which does not breed in these fields (as it nests on cliffs, in trees, and on structures; Boarman and Heinrich 1999). On two occasions, flocks of about 35 individuals were observed foraging on the ground in a recently mowed field, apparently scavenging for food items that were likely made accessible by the mowing, including one observation of what appeared to be a dead pocket gopher (*Thomomys bottae*). Having a better understanding of how silage fields in PORE affect the local raven population could inform future management decisions related to this species of potential management concern (Roth et al. 1999), although that is beyond the scope of this study.

Bird Distribution Related to Fencelines and Field Edges

We were interested in determining how birds were distributed in the silage fields relative to fencelines and field edges to assess whether there might be any benefit to maintaining un-mowed buffers near fences and edges. Our results did not suggest any clear bird distribution patterns. Even if we had detected a clear pattern for birds to clump along edges, we would not necessarily expect to see a similar pattern of nest distribution, given that grassland songbirds maintain relatively large territories and may sing from tall perches far from their nests (e.g., Grasshopper Sparrow territory sizes can range from 30 to 100 hectares; Vickery 1996), and because any observed clumping at edges (and especially on fencelines) could have been attributed to differences in detectability. Additionally, many area-sensitive grassland birds are known to avoid field edges (Delisle and Savidge 1996).

Potential Impacts of Future Silage Planting and Mowing at B Ranch

The results from surveys at B Ranch showed pasture habitat in both the reference and proposed silage area to support a similar and comparable bird community. Therefore, if a new silage field is established there in the future and PORE wishes to monitor its impacts on birds, data from this year can be used as a baseline and the reference plots at B Ranch as reference sites. Results also showed B Ranch, including the proposed silage plot, to be an apparent ‘hot spot’ for Savannah Sparrows relative to the other ranches surveyed as part of this study, with this species about three times more abundant here compared to the I, J, and H Ranch reference sites along Pierce Point Rd. This could potentially be due to B Ranch’s appearance of being more mesic and lush than the other ranches, perhaps due to soil properties or that it receives ample fog moisture given its location; or it may relate to differences in grazing and management. Were conversion to silage to occur here, we would expect a slightly different bird community to be impacted by the mowing than that found in this year’s survey results on B Ranch, given differences in habitat structure and associated landbird community that we observed on the I, J, and H Ranches this year between the silage and reference sites there.

MANAGEMENT CONSIDERATIONS

We present a range of potential management considerations related to silage field mowing and management. The majority of these considerations are derived from existing publications and supplemented with the preliminary observations made during this study. In addition, PORE may wish to explore some of the topics brought up elsewhere in this report as having the potential for further study.

These management considerations are merely meant to be a starting point for ideas and discussions with stakeholders. It is beyond the scope of the report to evaluate the compatibility of any of them with park goals and ranching operations.

1. Find alternatives to ranchers’ forage needs.
2. Defer mowing with a silage buy-out program – a strategy used for Tricolored Blackbird nest colony conservation (Meese 2009).

3. Delay mowing until after most breeding is complete (Jones and Vickery 1997, Hyde and Cambell 2012, Perkins et al. 2013).
4. Plant silage later in season to avoid mowing at the peak of breeding season.
5. Mow very early (before mid-March) before nesting is underway for most species. This would also allow enough time for birds to re-nest within the same breeding season should they lose their nest to early mowing (Perlut et al. 2006).
6. Consider impacts of the second mowing cycle that is conducted in some years.
7. Mow from inside the middle of the field toward the outside in a circular manner- this increases the likelihood for wildlife to escape (Ochterski 2006, NRCS 2009 Hyde and Cambell 2012).
8. Use flushing bars attached to the mower, a mechanism that helps to flush incubating birds and mammals (especially deer and rabbit) before the mower reaches them (Jones and Vickery 1997, Hyde and Cambell 2012).
9. Avoid mowing at night. Mowing at night results in higher wildlife mortality, including adult birds that do not flush from their nests as readily then (Jones and Vickery 1997, NRCS 2009, Hyde and Cambell 2012).
10. Implement avian surveys to identify 'high-priority' or high-density breeding areas within the silage and avoid mowing there (Jones and Vickery 1997). High priority areas could be those identified as having nests of species with special conservation status, or areas with particularly high concentrations of nesting birds, such as Red-winged Blackbird colonies (however, in 2015, the Red-winged Blackbird colonies found in silage were fairly evenly distributed and not clumped)
11. Employ wildlife hazing and/or deterrents to discourage birds from establishing territories and nesting until after mowing. Hazing methods may include pyrotechnics (e.g. propane canons), audio devices emitting distress or predator calls, electronic noises. Deterrents may include visual devices such as mylar ribbons, predator decoys, lasers, or mechanical devices such as rotating rods. The use of hazing techniques to prevent breeding of Tricolored Blackbirds suggest that the practice must be consistently and intensively applied (CDFW 2015).
12. Use rotational mowing – rotate which silage fields are mowed early, late, or rested entirely for a year or two. Rotational mowing can maintain grassland communities in various stages of growth and vegetative diversity, thus potentially providing more nesting habitat for grassland birds (Hyde and Cambell 2012; NRCS 2009; Ochterski 2006).
13. Raising mower blades to six inches or more may avoid crushing some nests and young (Jones and Vickery 1997); however one study of this practice yielded negligible benefits (Buckingham et al. 2015).
14. During drought years when the silage may be less productive, discuss whether the option of not mowing may be more cost effective or have other management considerations associated with it.
15. Explore ways to reduce the amount of wild radish (*Raphanus raphanistrum*) and mustards (*Brassica* sp.) in silage fields that may attract certain nesting birds. These plants provide nesting habitat for species like Song Sparrow and White-crowned Sparrow that prefer more rigid nesting substrates, and may also contribute to attracting other nesting species such as Northern Harrier and Red-winged Blackbird.

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Common Name <i>Latin Name</i>	Plot:	H Ranch						J Ranch						I Ranch						B Ranch			
		R-1	R-2	R-3	T-1	T-2	T-3	R-1	R-2	R-3	T-1	T-2	T-3	R-1	R-2	R-3	T-1	T-2	T-3	R-1	R-2	R-3	T-1
		HA:	11	9.15	7.84	9.97	10.2	8.3	8.08	9.44	7.28	8.09	8.22	5.92	8.08	8.71	8.11	7.32	6.87	8.1	7.75	8.60	4.80
Bewick's Wren <i>Thryomanes bewickii</i>	Visit # 1																						
	Visit # 2																						
	Visit # 3																						
	Visit # 4								1														
Western Bluebird <i>Sialia mexicana</i>	Visit # 1									2													
	Visit # 2																						
	Visit # 3			2																			
	Visit # 4							1	2	1													
Sage Thrasher <i>Oreoscoptes montanus</i>	Visit # 1																						
	Visit # 2																						
	Visit # 3									1													
	Visit # 4																						
European Starling <i>Sturnus vulgaris</i>	Visit # 1																						
	Visit # 2									1													
	Visit # 3			18																			
	Visit # 4			1						4													
American Pipit <i>Anthus rubescens</i>	Visit # 1								6														1
	Visit # 2									1													
	Visit # 3																						
	Visit # 4																						
Spotted Towhee <i>Pipilo maculatus</i>	Visit # 1																						
	Visit # 2																						
	Visit # 3																						
	Visit # 4									1													
Savannah Sparrow <i>Passerculus sandwichensis</i>	Visit # 1	9	1	7	7	6	9		4	3	2	14	3	6	5	23	19	5	11	22	13	22	23
	Visit # 2	7	13	1	4	4	7	12	4	7	4	4		5	4	13	9	6	5	25	24	19	34
	Visit # 3	9	8	8	2	1	4	1	6	6	1	8	1	4	5	21	2	3	7	29	27	25	28
	Visit # 4	22	15	19	7	1	4		4	11	2	6	1	11	4	34		4	1	36	17	21	31
Grasshopper Sparrow <i>Ammodramus savannarum</i>	Visit # 1				6	2	1					1		1			2						
	Visit # 2													4									
	Visit # 3	1		1										5			1	2					
	Visit # 4		1	1							2			3				2	1				2

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Common Name <i>Latin Name</i>	Plot:	H Ranch						J Ranch						I Ranch						B Ranch					
		R-1	R-2	R-3	T-1	T-2	T-3	R-1	R-2	R-3	T-1	T-2	T-3	R-1	R-2	R-3	T-1	T-2	T-3	R-1	R-2	R-3	T-1		
		HA: 11	9.15	7.84	9.97	10.2	8.3	8.08	9.44	7.28	8.09	8.22	5.92	8.08	8.71	8.11	7.32	6.87	8.1	7.75	8.60	4.80	9.77		
Song Sparrow <i>Melospiza melodia</i>	Visit # 1				5		2						3	2	1	3	1	8	14	2	4	1			
	Visit # 2												4	2	6			1		2					
	Visit # 3	1	1				1		4	6			1	1		2		1	2		1	1			
	Visit # 4	3				1		2	4	1			3						1		4			1	
Lincoln's Sparrow <i>Melospiza lincolnii</i>	Visit # 1																								
	Visit # 2											1													
	Visit # 3																								
	Visit # 4																								
White-crowned Sparrow <i>Zonotrichia leucophrys</i>	Visit # 1				1			2	1	4			3			2		3							
	Visit # 2					7		5	2	2			3	2		1					1		1		
	Visit # 3					2	1	5	1	4				13								5			
	Visit # 4								2	2			1	1		1						6			
Golden-crowned Sparrow <i>Zonotrichia atricapilla</i>	Visit # 1									1															
	Visit # 2											6													
	Visit # 3																								
	Visit # 4																								
Oregon Junco <i>Junco hyemalis oregonus</i>	Visit # 1									1															
	Visit # 2																								
	Visit # 3																								
	Visit # 4																								
Red-winged Blackbird <i>Agelaius phoeniceus</i>	Visit # 1		2			5						25	27	4											
	Visit # 2		2					2				55	23	29			5								
	Visit # 3		1				1								12	1			1	1	3				
	Visit # 4		8				3								1				1			1			
Western Meadowlark <i>Sturnella neglecta</i>	Visit # 1							3								2	1		14				3		
	Visit # 2						1									3									
	Visit # 3																								
	Visit # 4						1																		
Brewer's Blackbird <i>Euphagus cyanocephalus</i>	Visit # 1	14						46	36	5				6		56									
	Visit # 2							22	16							7		14					3		
	Visit # 3		2	2				5				5	3	3		8		2							
	Visit # 4	7	4			2	4	24	2					1		5		8				2			

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Common Name <i>Latin Name</i>	Plot:	H Ranch						J Ranch						I Ranch						B Ranch			
		R-1	R-2	R-3	T-1	T-2	T-3	R-1	R-2	R-3	T-1	T-2	T-3	R-1	R-2	R-3	T-1	T-2	T-3	R-1	R-2	R-3	T-1
		HA: 11	9.15	7.84	9.97	10.2	8.3	8.08	9.44	7.28	8.09	8.22	5.92	8.08	8.71	8.11	7.32	6.87	8.1	7.75	8.60	4.80	9.77
Brown-headed Cowbird <i>Molothrus ater</i>	1																						
	2							2	1		1												
	3						18	8								3							
	4									1													
House Finch <i>Carpodacus mexicanus</i>	1																						
	2										3												
	3						5																
	4						4																
American Goldfinch <i>Spinus tristis</i>	1																						
	2						1				2												
	3									13					2								
	4									4											1		

