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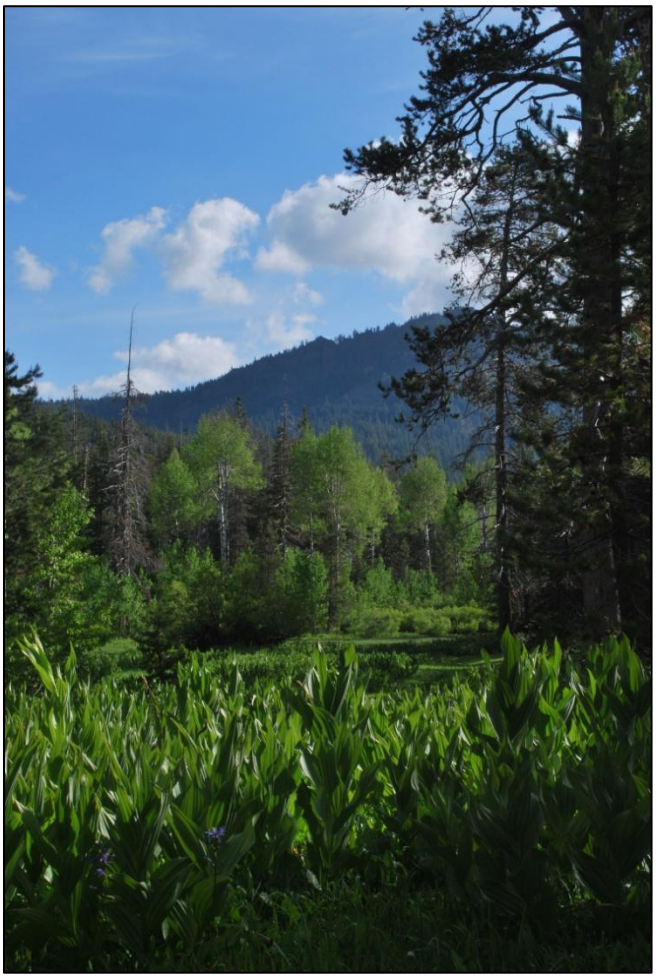
PRBO Northern Sierra 2010
Aspen and Meadow Monitoring Reports



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PRBO Conservation Science

Contribution Number 1813

Executive Summary

PRBO Conservation Science (PRBO) has been conducting songbird monitoring in the Northern Sierra since 1997. In this report we present results from avian monitoring in 2010 of two of the most important habitats for birds in the Sierra Nevada.

In the first chapter we discuss results from the ongoing monitoring of aspen habitat (since 2004) on the Lassen National Forest. Results show that treated aspen stands support greater total abundance of birds and abundance of key species such as Mountain Bluebird, Chipping Sparrow, and Red-breasted Sapsucker. Before and after comparisons of two aspen restoration projects and adjacent reference sites suggest a positive effect of treatment in the short term. However, longer term trends suggest that, at least for some species, the initial benefits of treatment may be short-lived. In 2010, avian abundance and richness indices increased following two years of declines across all aspen sites surveyed.

In the second chapter we present results from monitoring of meadows across the Northern Sierra Nevada, primarily within the Feather River watershed. We compared avian community indices across sites and where applicable compared treated areas to adjacent reference sites. Results suggest some Northern Sierra meadows still support diverse and abundant bird populations including several species of conservation concern. In general meadow sites in the northwestern part of the study area had higher avian community indices than those in the southern and eastern. Comparisons of restored and unrestored sites in the Red Clover watershed suggests restoration actions undertaken by the Feather River Coordinated Resource Management group are having positive impacts on the avian community. Across the study area, sites with lowest indices all had a lack of deciduous riparian shrubs and trees and most had a lack of herbaceous vegetation with incised stream channels now isolated from their floodplains.

With over a century of management incompatible with maintaining suitable habitat for meadow dependent bird species restoration actions on many of these sites appears warranted. Management actions that restore ecological function and minimize the negative impacts created through past management actions will likely benefit a number of avian species including several that are of conservation concern.

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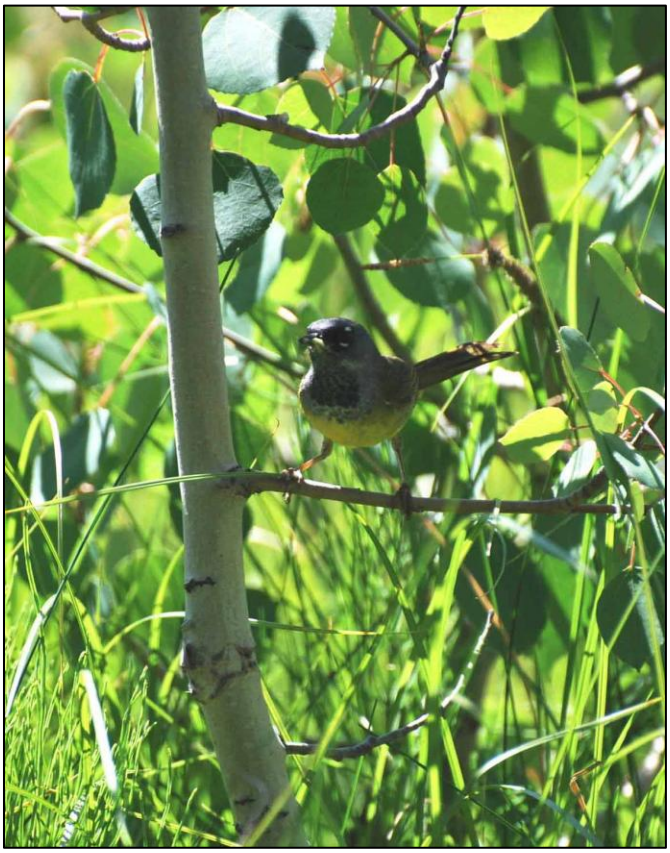
Chapter 1. Resident and Neotropical Migratory Bird Response to Aspen Enhancement on the Lassen National Forest

2010 Report



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Background and Introduction

In the Sierra Nevada, with extensive livestock grazing and the absence of regular fire, aspen are often out-competed by conifers (Mueggler 1985). As a result, the health of aspen has deteriorated and its extent throughout western North America has been dramatically reduced (Bartos and Campbell 2001). Aspen inventories and assessments on the Lassen National Forest found the vast majority of aspen stands to be in poor health and in need of management actions to avoid further degradation or complete stand loss. As a result, the Forest has implemented strategies to restore aspen habitat by removing competing conifers and excluding livestock grazing (Jones et al. 2005).

Aspen habitat in western North America can support a disproportionately rich and abundant avian community compared to the surrounding upland habitats (Flack 1976, Winternitz 1980, Mills et al. 2000, Griffis-Kyle and Beier 2003). Several bird species demonstrate a strong affinity with aspen, including Northern Goshawk (*Accipiter gentilis*), Red-naped and Red-breasted Sapsuckers (*Sphyrapicus nuchalis/ruber*), Dusky Flycatcher (*Empidonax oberholseri*), Warbling Vireo (*Vireo gilvus*), Swainson's Thrush (*Catharus ustulatus*), and MacGillivray's Warbler (*Oporornis tolmiei*) (Salt 1957, Flack 1976, Finch and Reynolds 1988, Heath and Ballard 2003, Richardson and Heath 2004).

In 2004, PRBO began an adaptive management based project monitoring birds across aspen habitat on the Eagle Lake and Almanor Ranger Districts of the Lassen National Forest. The primary objective of this study is to guide and evaluate aspen restoration treatments by monitoring the response of a suite of landbird species associated with a broad range of aspen habitat characteristics. In this report we incorporate results from 2010 into those from 2004 – 2009 and use the knowledge gained from this additional information to provide specific recommendations for future restoration treatments and long-term management of aspen habitat on the Lassen National Forest and across the Sierra Nevada.

Project Area

All avian surveys were conducted on the Lassen National Forest in the Eagle Lake and Almanor Ranger Districts at the junction of the Sierra Nevada and Cascade Mountains of California (Lat 40^0 N, Long 120^0 W). Sites ranged in elevation from approximately 1500 – 2000 meters (Figure 1).

Methods

Aspen Sampling Design

For all aspen sites we used GIS layers containing polygons of known aspen stands based upon aspen inventories conducted by Forest Service staff. In the Eagle Lake Ranger District (ELRD) we selected sites non-randomly that represented the range of conditions in which aspen are found throughout the District. We limited our selection to areas that could be covered by one observer in a four-hour morning count window and that contained enough acres of aspen habitat to fit a minimum of 4 point count stations with at least 220 meter spacing between points. We attempted to maximize the number of post-treatment sites, which were limited in number, as they could provide us with information on bird response to aspen treatments that were already five to nine years old. The transects with treated stands on the ELRD in 2010 included Harvey Valley, Pine Creek, Martin Creek, Feather Lake, and Butte Creek.

In the Almanor Ranger District (ARD) we selected sites that were within proposed aspen enhancement projects (e.g., Minnow – Coon Hollow, Creeks II – Ruffa, Brown's Ravine, Feather – West Dusty 1-3, Lott's – Philbrook/Coon Hollow, and Mini – Robber's Creek) and established points with at least 220 meter spacing in delineated aspen polygons. Two additional transects, Willow Creek and West Dusty 4 were once part of proposed projects but were dropped for various reasons. A total of 6 points (four points on the West Dusty 3 transect, one point on the West Dusty 1 transect, and one point on the Willow Creek transect) were treated as of the 2010 breeding season on the ARD.

On both districts we attempted to maximize the number of points within the delineated aspen stands in the areas selected. In some areas where stands were not in

high densities, we limited transect size to allow for the extra time to walk between stands in order to allow for completion within the limited morning hours allowed by the standardized protocol. Generally, the first stand chosen was the one closest to the nearest road. Once the first stand was chosen, the next closest stand that was at least 200 meters from the previous was selected, and so on. All sites were selected without previous knowledge of the local micro habitat attributes or condition.

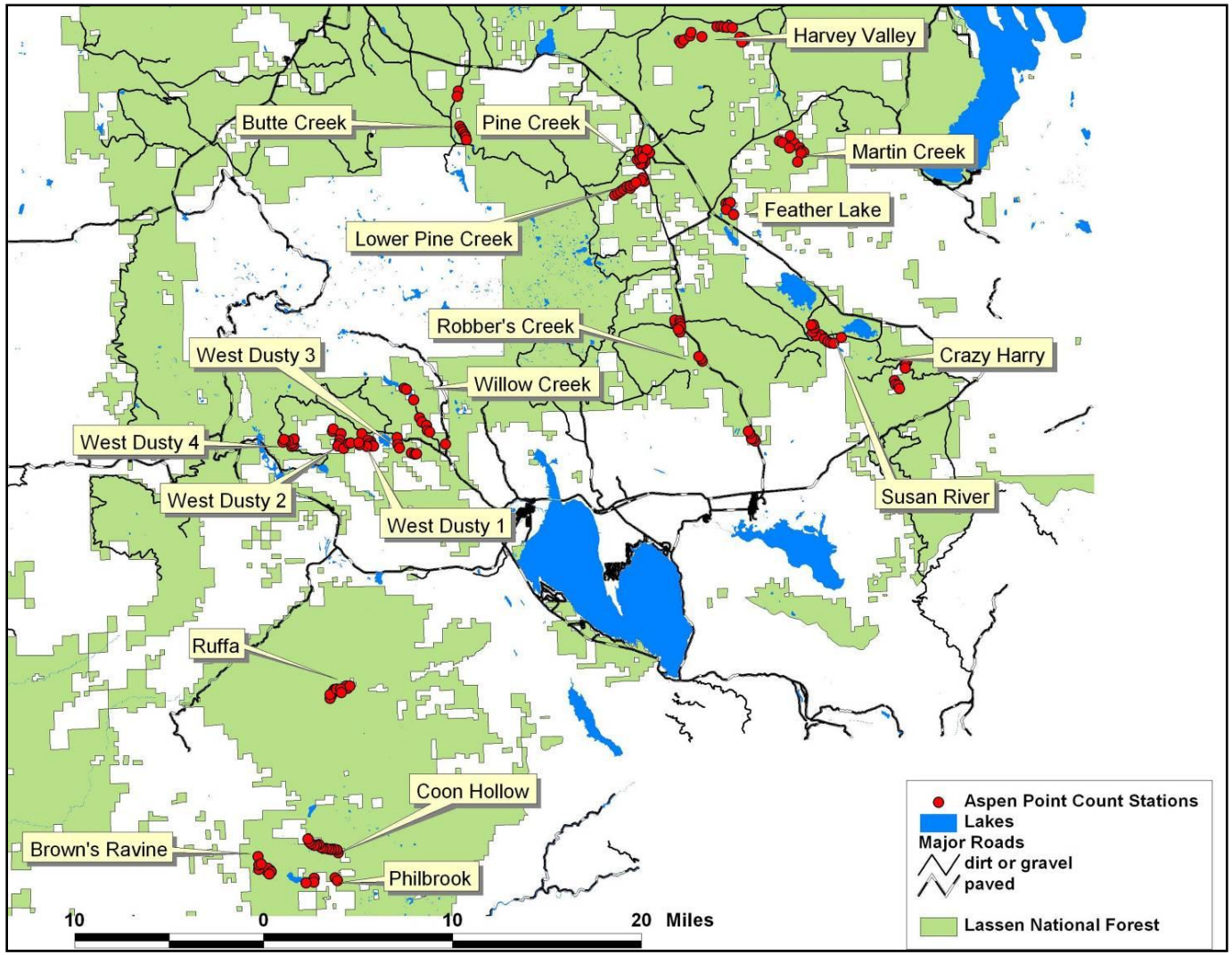
Survey Protocol

Standardized five minute exact distance circular plot point count censuses (Reynolds 1980, Ralph et al. 1993), were conducted at 167 stations along 17 transects in 2010 (Table 1, Figure 1, and Appendix 1). The Coon Hollow transect was inaccessible in 2010 due to snowpack and thus was not surveyed. All birds detected at each station were recorded along with the exact distance from the observer where it was first detected (to the nearest meter). Birds flying above the station in transit but not observed landing were recorded separately. The method of initial detection (song, visual or call) for each individual was recorded. Counts began around local sunrise and were completed within four hours. Each transect was surveyed twice between 15 May and 2 July in each year, including 2010 (Table 1). An electronic range finder was used to assist with distance estimation at each point count station and all observers had previous songbird field work experience and went through intense three week training on bird identification and distance estimation.

Table 1. Aspen point count transect names, codes, ranger district, number of stations, and dates surveyed in 2010 in Lassen National Forest. Coon Hollow could not be accessed in 2010 because of snow.

Site	Code	# of Stations	Ranger District	Date, 1st Survey	Date, 2nd Survey
Brown's Ravine Aspen	BRAS	4	Almanor	6/10/2010	6/25/2010
Coon Hollow Aspen	COHO	14	Almanor	--	--
Philbrook Aspen	PHAS	10	Almanor	6/24/2010	7/02/2010
Robber's Creek Aspen	ROCA	16	Almanor	6/09/2010	7/01/2010
Ruffa Aspen	ASPN	12	Almanor	6/18/2010	6/30/2010
West Dusty Aspen 1	WDA1	10	Almanor	6/13/2010	6/22/2010
West Dusty Aspen 2	WDA2	6	Almanor	6/13/2010	6/28/2010
West Dusty Aspen 3	WDA3	8	Almanor	6/13/2010	6/28/2010
West Dusty Aspen 4	WDA4	8	Almanor	6/18/2010	6/29/2010
Willow Creek Aspen	WICA	9	Almanor	6/08/2010	6/23/2010
Butte Creek Aspen	BCA	8	Eagle Lake	6/07/2010	6/22/2010
Crazy Harry Aspen	CHA	7	Eagle Lake	6/09/2010	6/28/2010
Feather Lake Aspen	FLA	5	Eagle Lake	6/14/2010	6/22/2010
Harvey Valley Aspen	HVA	15	Eagle Lake	6/01/2010	6/14/2010
Lower Pine Creek Aspen	LPA	12	Eagle Lake	6/14/2010	6/26/2010
Martin Creek Aspen	MCA	11	Eagle Lake	6/08/2010	6/21/2010
Pine Creek Aspen	PCA	14	Eagle Lake	6/08/2010	6/18/2010
Susan River Aspen	SRA	12	Eagle Lake	6/02/2010	6/14/2010

Figure 1. Location of PRBO Aspen point count stations in the Lassen National Forest.



Analyses

Avian community point count analysis was restricted to a subset of the species encountered. We excluded species that do not breed in the study area as well as those that are not adequately sampled using the point count method (e.g., waterfowl, kingfisher, and raptors). We also excluded European Starling and Brown-headed Cowbird from analysis of species richness and total bird abundance because they are invasive species regarded as having a negative influence on the bird community, though we did investigate the abundance of these two species separately.

Species richness

We present species richness as the average number of species detected within 50 meters per station across visits within a year for the species adequately sampled using the point count method.

Total Bird Abundance

The index of total bird abundance is the mean number of individuals detected per station per visit. This number is obtained for a transect by dividing the total number of detections within 50 meters by the number of visits and stations.

Index of Individual Species Abundance

An index of the abundance of species was calculated as the total detections of a given species within 50m of an observer per station per visit. For sites with multiple years we summed the detections and then divided by total visits across years versus averaging the means for each year.

Statistical Tests

We employed a suite of statistical tests in comparing treated aspen to untreated aspen. Negative binomial regression was used to test for differences in indices of abundance of individual species between treated and untreated aspen stands; while linear regression and t-tests were used to compare the community indices of species richness and total bird abundance. The test statistic (F for linear & Likelihood Ratio for

negative binomial) and p-values are presented. For the analysis of trends, linear regression was used with year as the independent variable and we included a quadratic term for year if the linear fit was poor. F-tests were used to evaluate the addition of the quadratic term. For all tests significance was assumed at $\alpha = 0.05$ level. R 2.10.0 statistical software was used to conduct all statistical analyses (R Development Core Team 2009).

Sierra Nevada Avian Monitoring Information Network

All data from this project is stored in the California Avian Data Center and can be accessed through the Sierra Nevada Avian Monitoring Information Network web portal (http://data.prbo.org/apps/snamin). At this site, species list, interactive maps of study locations, as well as calculations of richness, density, and occupancy can be conducted as selected by the user. Study site locations can also be downloaded in various formats for use in GPS, GIS, or online mapping applications as well.

Results

In 2010, total bird abundance in aspen stands monitored across the two ranger districts ranged from a high of 7.43 at Crazy Harry to a low of 4.33 at West Dusty 2, and species richness ranged from 9.44 at Robber's Creek to 5.50 at West Dusty 2 (Table 2). The mean total bird abundance by transect in 2010 was 5.49 while the mean species richness was 7.48. In comparison, total bird abundance in upland unburned habitat in the Plumas-Lassen study area in 2010 was 6.00 and species richness was 7.36.

We compared total bird abundance and species richness at untreated aspen sites in the ARD to untreated aspen sites in the ELRD in 2010. Species richness was 7.62 in the ARD and 7.54 in the ELRD. Total bird abundance in the ARD was 5.58 compared to 5.53 in the ELRD (Figure 2); these differences were not statistically significant. When sites in both ranger districts that have been treated were included, there was no difference in both species richness and total bird abundance (Figure 2).

When data from all years were combined, total bird abundance and species richness were significantly higher at treated sites compared to untreated sites on the Eagle Lake Ranger District between 2006 and 2010 (Figure 3). Across this five year

period, total bird abundance averaged 5.53 at treated sites and 4.73 at untreated sites ($F = 12.0$, $p < 0.001$). Species richness at treated sites averaged 7.17 compared to 6.56 at untreated sites ($F = 5.05$; $p = 0.03$).

Species richness values increased at both treated and untreated sites on ELRD from 2009 to 2010 (Figure 4). Including a quadratic term for year did not improve model fit for either treatment conditions ($p > 0.10$). Between 2004 and 2010, species richness at untreated sites on ELRD continued to show a significant increasing linear trend ($F = 26.1$, $p < 0.001$), as did treated sites, but that trend was less significant ($F = 4.3$, $p = 0.04$). There was not a significant interaction between year and treatment for species richness values ($F = 1.62$, $p = 0.20$). Total bird abundance at treated and untreated sites was also very similar in 2010 and linear trend analysis indicated that abundance was increasing on untreated sites ($F = 22.81$, $p < 0.001$) but remained flat on treated sites ($F = 0.07$, $p = 0.79$). Including a quadratic term for year improved model fit for years 2004-2009 but this pattern was not as significant when data from 2010 was added ($F = 3.19$, $p = 0.08$). There was a significant interaction between year and treatment ($F = 8.05$, $p = 0.005$) indicating the trend in total bird abundance was not consistent across treatment or years.

Figure 2. Mean per point species richness (per year) and total bird abundance (per visit) based on detections within 50 meters of observers at treated and untreated aspen sites on Almanor and Eagle Lake ranger districts in 2010 with standard error.

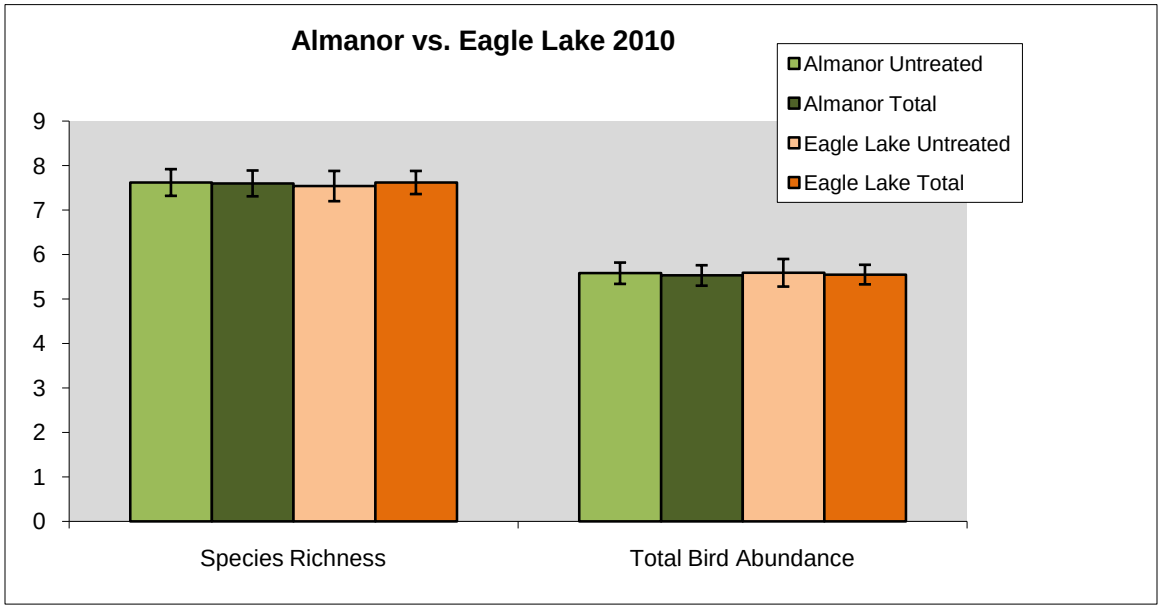
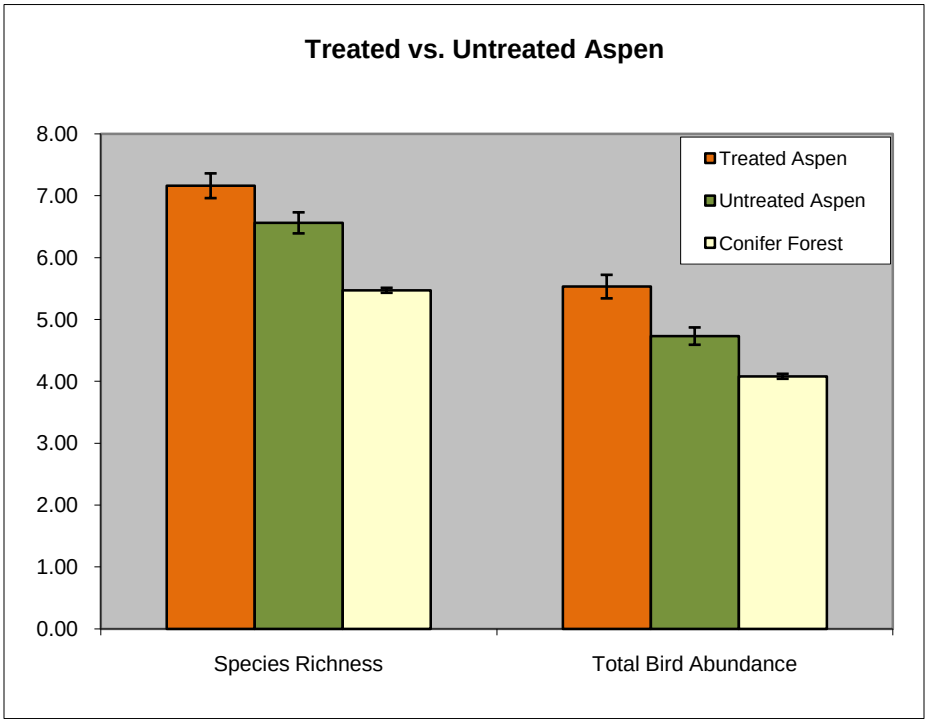


Table 2. Mean per point total bird abundance (detections/point/visit) and species richness (within 50 m of observers) at aspen sites surveyed in the Lassen National Forest from 2004 – 2010. Sites not surveyed are represented by double dashes. Coon Hollow and Philbrook transects were surveyed only once in 2008 due to fire access restrictions, thus they were not included in 2008 figures. Coon Hollow could not be accessed in 2010 due to snow conditions.

Station	**Total Bird Abundance**							**Species Richness**						
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Ruffa Aspen	5.72	7.11	5.92	6.88	6.33	7.83	6.25	7.56	7.33	7.50	8.92	8.42	10.67	8.00
Brown's Ravine	2.38	3.25	4.13	3.75	2.75	5.63	5.75	2.75	5.25	6.25	5.00	4.25	7.75	7.00
Butte Creek	4.63	5.81	7.31	5.69	5.50	7.13	5.25	5.75	8.00	9.63	8.38	7.75	8.63	7.13
Coon Hollow	--	--	--	4.75	--	6.86	--	--	--	--	6.71	--	8.43	--
Crazy Harry	4.50	4.00	5.43	3.64	3.57	2.86	7.43	6.43	5.43	8.00	5.85	5.71	4.29	9.00
Feather Lake	4.60	7.40	5.30	9.50	8.00	4.80	5.40	6.40	7.20	5.80	7.80	7.80	6.20	7.20
Harvey Valley	3.47	3.03	5.93	4.17	2.43	4.50	5.27	4.93	4.47	6.93	4.67	3.47	6.13	7.13
Lower Pine Creek	4.00	2.67	4.04	4.67	3.96	5.21	4.46	5.75	4.42	5.92	6.83	6.17	7.00	6.67
Martin Creek	3.78	4.18	3.91	6.32	5.86	3.73	6.27	5.09	5.45	5.27	8.00	8.36	5.27	8.36
Philbrook	--	--	--	3.65	--	6.10	5.55	--	--	--	5.30	--	8.80	7.40
Pine Creek	4.60	4.57	5.90	5.04	4.71	4.36	6.07	5.93	6.43	7.21	7.00	6.86	6.29	8.64
Robber's Creek	--	--	5.72	5.78	5.09	4.94	6.66	--	--	7.63	7.31	7.63	7.12	9.44
Susan River	3.67	3.13	3.09	4.92	1.29	5.58	4.88	4.75	5.00	4.50	6.50	2.25	7.83	7.00
West Dusty 1	--	--	3.75	4.30	3.00	3.80	5.15	--	--	5.50	6.80	5.00	5.30	6.30
West Dusty 2	--	--	3.33	3.67	4.08	3.83	4.33	--	--	4.00	3.67	5.67	5.50	5.50
West Dusty 3	--	--	3.63	3.81	3.19	4.63	4.63	--	--	5.50	5.63	5.38	6.38	7.63
West Dusty 4	--	--	4.75	5.25	4.56	6.56	5.25	--	--	6.75	7.88	5.75	8.63	7.63
Willow Creek	--	--	4.28	5.44	4.61	6.00	4.72	--	--	5.33	7.22	6.78	8.44	7.11
Total	**4.16**	**4.67**	**5.36**	**5.32**	**4.42**	**5.29**	**5.49**	**5.53**	**5.90**	**6.68**	**6.79**	**6.08**	**7.23**	**7.48**

Figure 3. Mean per point species richness and total bird abundance at treated and untreated aspen sites on the Eagle Lake Ranger District from 2006 – 2010 compared to coniferous forest in the Plumas-Lassen study area from 2003 – 2006 with standard errors.



We investigated an index of the abundance of ten of the twelve previously identified aspen focal species (Burnett 2011), at treated aspen, untreated aspen, and conifer forest across the seven-year study period in both ranger districts (Table 3). We also included Mountain Chickadee, another potential focal species. There were not adequate detections of Swainson's Thrush and Olive-sided Flycatcher – the remaining two focal species – to include them in the analysis. Six of the eleven species were significantly more abundant in treated aspen than untreated aspen; each of these six species were also more abundant in aspen of any kind compared to coniferous forest in the region (Table 3). Red-breasted Sapsucker, Hairy Woodpecker, Mountain Bluebird, Tree Swallow, Mountain Chickadee and Chipping Sparrow were all significantly more abundant in treated aspen than untreated aspen. Total bird abundance was also significantly greater in treated stands compared to untreated stands while species richness was similar between treated and untreated. Western Wood-Pewee, Dusky Flycatcher, and Warbling Vireo were equally abundant in both aspen types but these species

were all more abundant in aspen stands than conifer forest. Only one focal species, MacGillivray's Warbler, remained significantly more abundant in untreated than treated aspen.

Figure 4. Mean per point species richness and total bird abundance (with standard error) at treated and untreated aspen sites from 2004 -2010 in Eagle Lake Ranger District (Lassen National Forest) with standard error and fitted linear and quadratic trend lines.

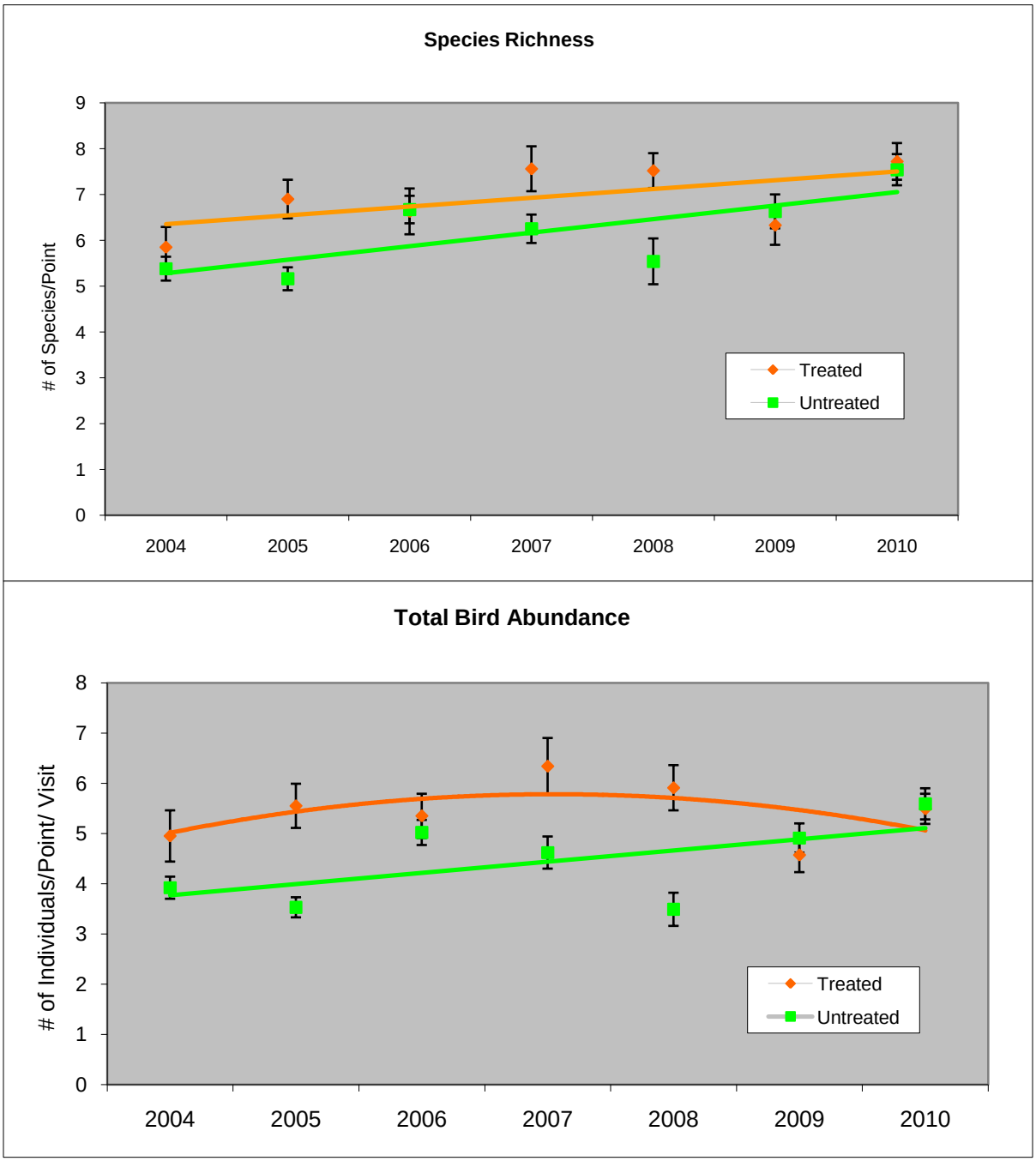


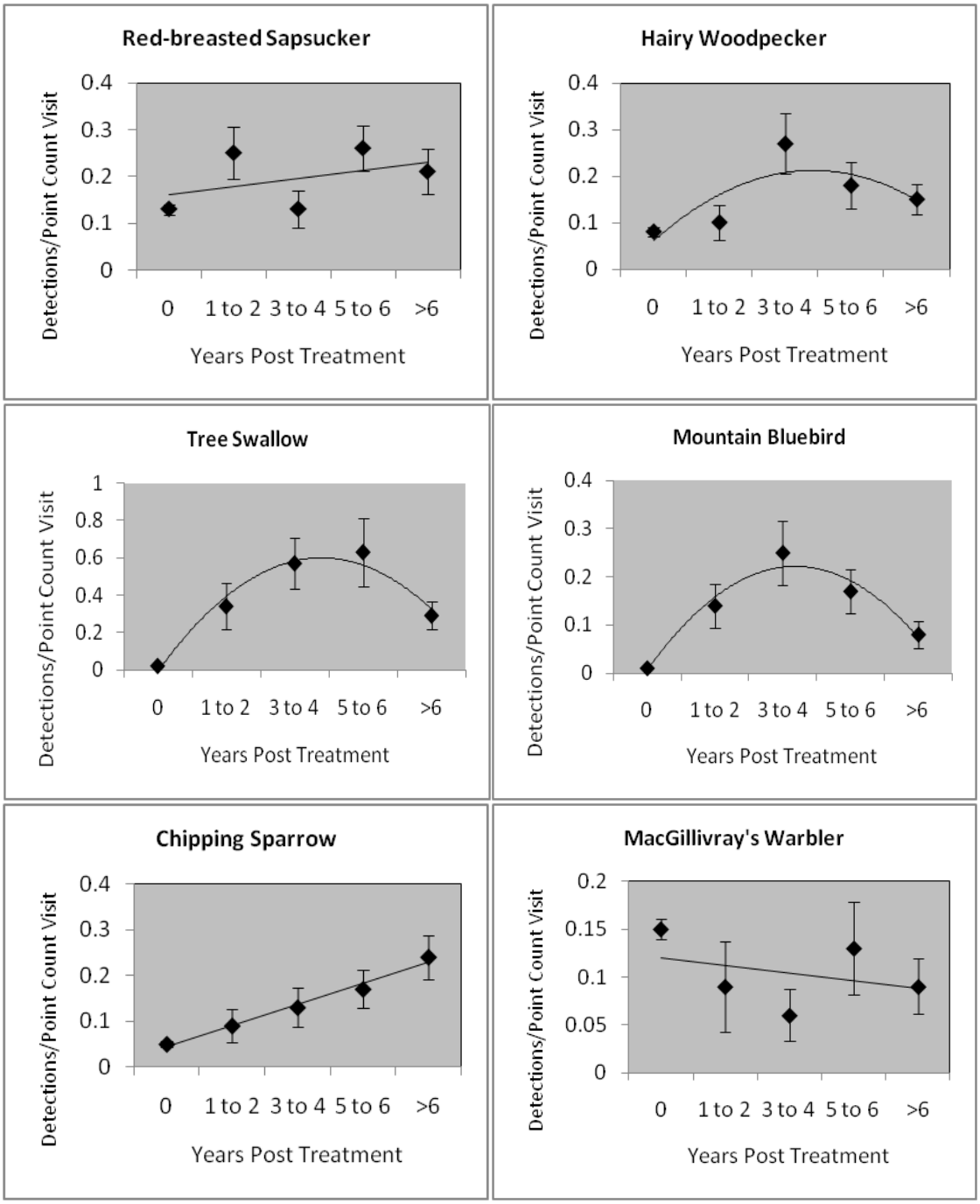
Table 3. Species Richness, total bird abundance, and index of abundance for ten aspen focal species at treated and untreated sites across the Lassen National Forest, 2006-2010. P-value is from univariate regression comparing treated to untreated aspen. Means from conifer forest in the Plumas-Lassen Administrative Study from 2003-2006 are also presented for comparison.

	Treated Aspen	Untreated Aspen	P	Conifer Forest
Species Richness	7.13	6.81	0.17	5.47
Total Bird Abundance	5.46	4.92	<0.01	4.08
Red-breasted Sapsucker	0.21	0.15	0.05	0.03
Hairy Woodpecker	0.15	0.07	<0.01	0.03
Western Wood-Pewee	0.17	0.18	0.59	0.02
Dusky Flycatcher	0.22	0.22	0.97	0.26
Warbling Vireo	0.48	0.52	0.38	0.09
Tree Swallow	0.38	0.03	<0.01	0.01
Mountain Chickadee	0.63	0.47	<0.01	0.28
Mountain Bluebird	0.13	0.01	<0.01	0.00
Oregon Junco	0.51	0.49	0.84	0.36
Chipping Sparrow	0.18	0.06	<0.01	0.01
MacGillivray's Warbler	0.08	0.16	<0.01	0.11

We investigated the effect of time since treatment on total bird abundance and species richness from 2004-2010 for all aspen sites on the Lassen National Forest while controlling for year. When all treated and untreated sites were included (with those that have not been treated coded as zero) there is a significant positive effect ($F = 6.0$, $p < 0.01$) of time since treatment on total bird abundance. When untreated sites were not included there was no effect of time since treatment ($F = 2.2$, $p = 0.11$) on total bird abundance. For species richness, the effect of time since treatment was positive and significant when pre-treatment sites were included ($F = 10.74$, $p = <0.01$), but was not significant when they were excluded ($F = 0.85$, $p = 0.43$). This continues a pattern identified in previous years.

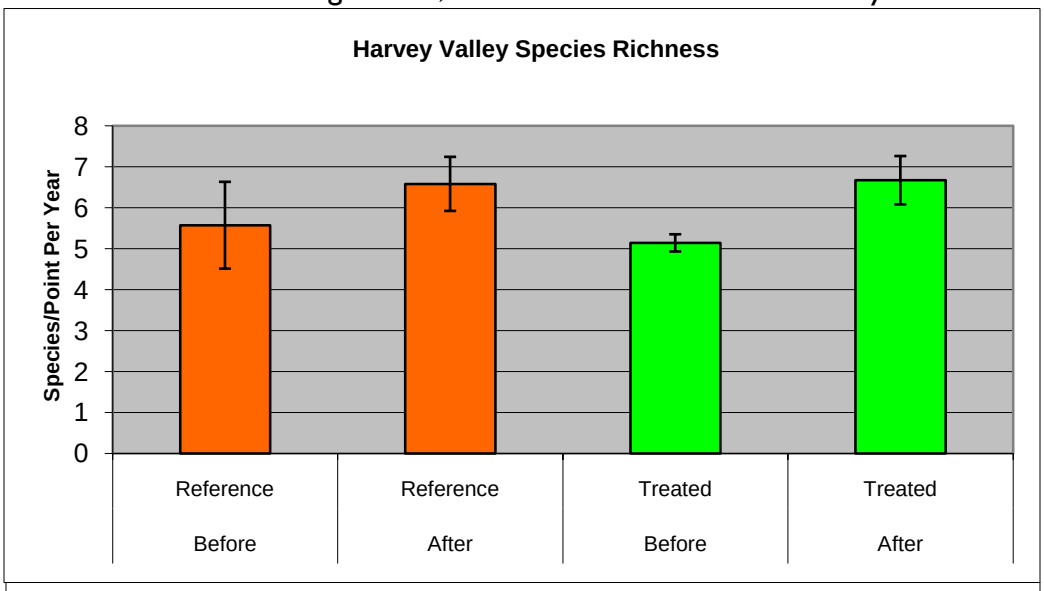
The time since aspen stands had been treated had a significant effect on the abundance of six of the eleven focal species (Figure 5). For Red-breasted Sapsucker and Chipping Sparrow the effect was positive and the best fit was linear. For three of the focal species, the effect was more complex. The best model fit for Hairy Woodpecker, Tree Swallow and Mountain Bluebird was one with a quadratic term. For each of these species there was an increasing trend peaking in the three to five year post treatment period followed by a significant decrease. Only one aspen focal species, MacGillivray's Warbler, showed a significant negative linear trend with time since treatment.

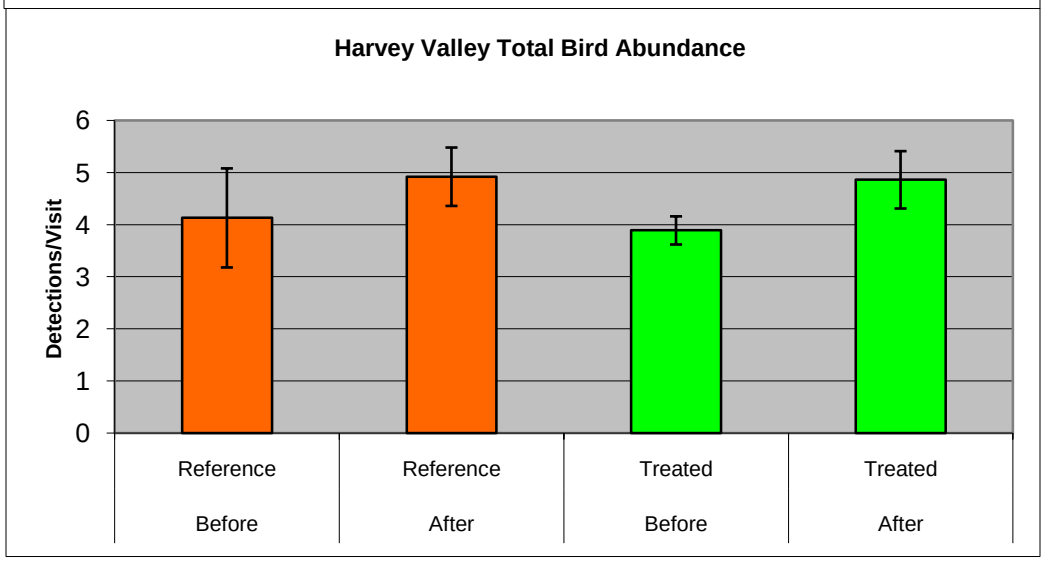
Figure 5. The mean abundance per point count visit with standard error and predicted values for the six focal species showing a significant effect of time since treatment from 2004 - 2010. Graphs show time since treatment in intervals for illustrative purposes but regression was conducted with all data. All aspen sites surveyed on the Lassen National Forest are included. All untreated sites were coded as zero years post treatment.



In Harvey Valley, species richness and total bird abundance has increased following treatment (Figure 6). Species richness increased at treated sites 30% over pre-treatment levels while untreated sites increased 18%. Total bird abundance increased 25% at treated sites following treatment while it decreased 19% at untreated sites. T-tests indicated that these differences were not statistically significant at the untreated sites but were significant at treated sites for both species richness ($p = 0.01$) and total bird abundance ($p = 0.04$).

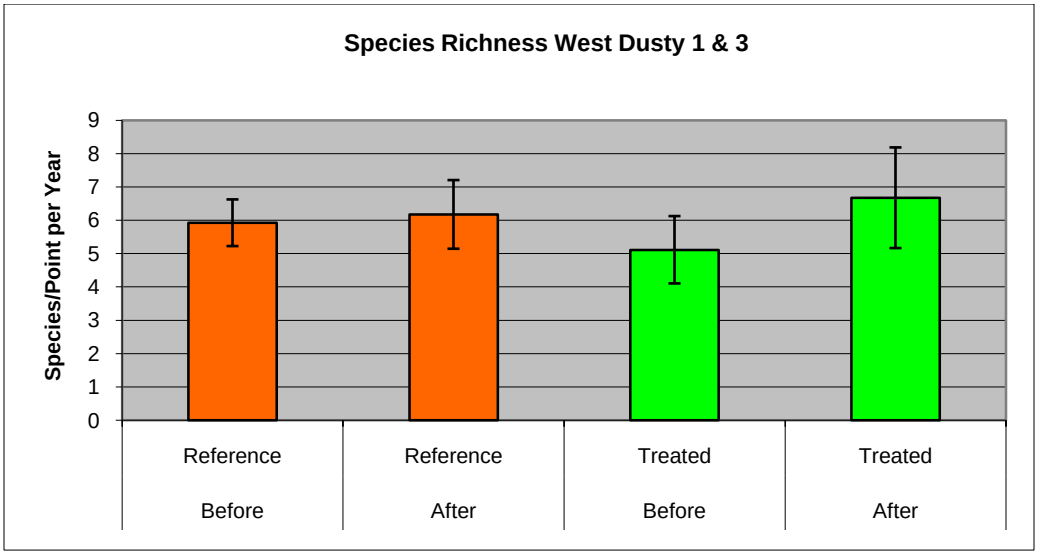
Figure 6. Species richness and total bird abundance at six reference and nine treated sites before (2004-2007) and after (2009-2010) treatment with 95% confidence intervals for the Harvey Valley Aspen transect. All treatments were implemented in the winter of 2008 but not completed until after the breeding season, so 2008 was excluded from analysis.

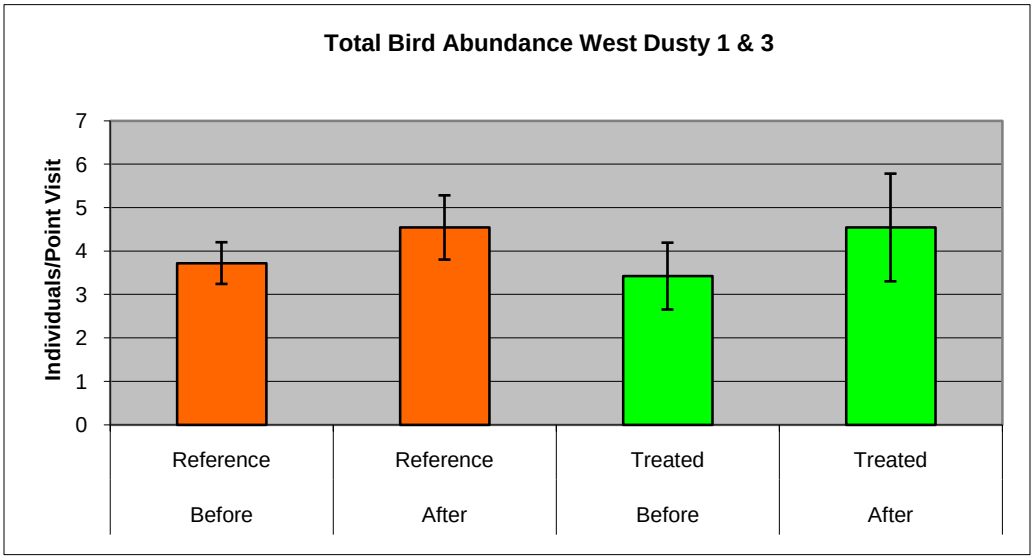




Similar to Harvey Valley, treated stands in the Feather aspen project on the ARD showed increases in species richness and abundance after treatments were implemented (Figure 7). Species richness increased at treated sites 31% while it only increased 4% at untreated sites. Total bird abundance increased 33% at treated sites while it increased 22% at untreated sites. Again, t-tests indicated that these differences were not statistically significant at the untreated sites but were only marginally significant (due to a small sample size) at treated sites for species richness ($p = 0.09$) and total bird abundance ($p = 0.12$).

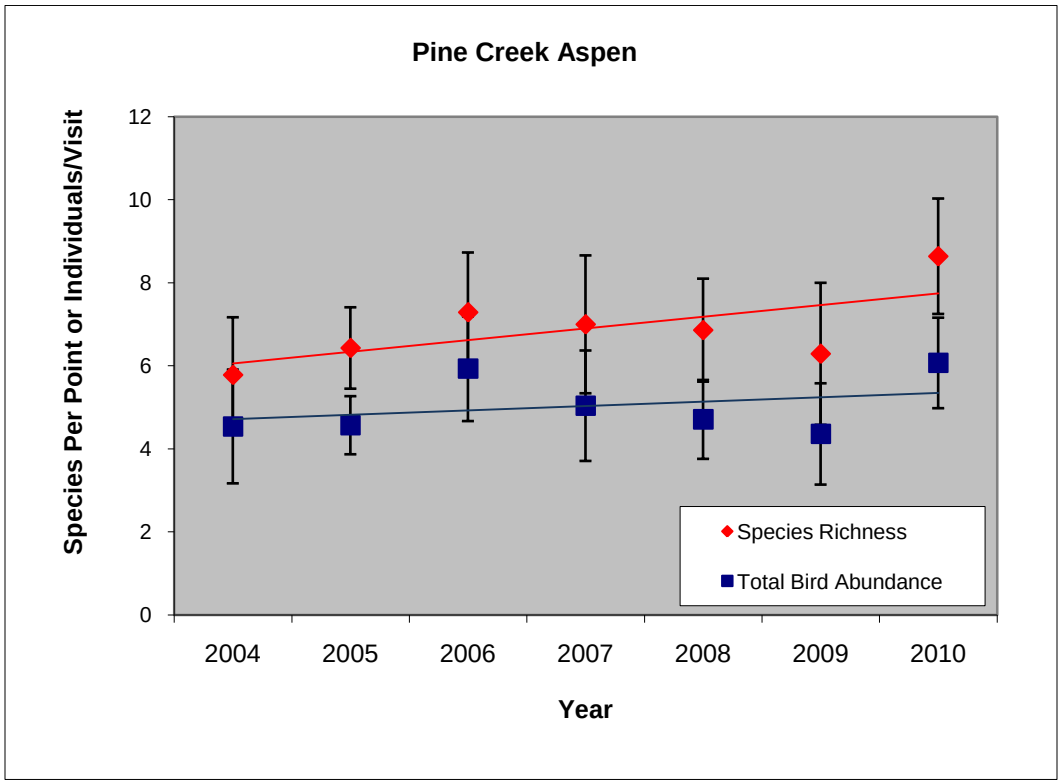
Figure 7. Species richness and total bird abundance at six treated sites and 12 untreated reference sites in the Feather aspen restoration project with 95% confidence intervals. All sites were treated in the fall of 2008.





At the Pine Creek transect, species richness and total bird abundance both increased significantly over 2009 levels halting a three year decrease in both of these metrics at this site. Species richness was the highest we have recorded for this transect since we began monitoring here in 2004 while total bird abundance was the second highest (Figure 8). Linear regression analysis indicated that species richness is significantly increasing ($p = 0.03$) along this transect while there is no statistically significant trend in total bird abundance.

Figure 8. Mean per point species richness and total bird abundance at the Pine Creek Aspen transect from 2004 – 2010 with 95% confidence intervals. The majority of treatment was implemented in the winter of 2003/2004, fall 2006, and winter 2007/2008.



Discussion

Overview

The abundance and diversity of avian species continue to show a long-term positive response to aspen habitat restoration on the Lassen National Forest, though in 2010 avian metrics were equal when all treated and untreated sites were compared. In 2010 we continued to see considerable site to site and forest wide annual in avian metrics in aspen habitat.

Treated vs. Untreated

In both the ELRD and ARD, the short term response of the avian community to aspen treatments has been positive. The Pine Creek transect, which has more extensive treatment, than any other area on the two ranger districts had higher species richness and total bird abundance in 2010 than any previous year we have monitored the site and species richness has shown a significant positive trend since 2004. Similarly comparing pre-and post treatment data for Harvey Valley and West Dusty sites we found significant (or near significant) increases at treated sites with no significant increase at untreated sites for species richness. We had originally hypothesized treatments would result in a decrease in species richness and total bird abundance in the lag between the loss of foliage volume and structural diversity from conifer removal and the time it takes for aspen to regenerate. Our results continue to show an immediate increase in the avian community following treatment, but as the Pine Creek site demonstrates, the complete benefits of the Harvey Valley and West Dusty treatments to the avian community may not be realized for a decade or more.

All of the six focal species that were significantly more abundant in treated aspen compared to untreated aspen were also significantly more abundant in treated aspen than conifer forest. Chipping Sparrow, declining at a rate of 3.4% per year from 1968-2007 in the Sierra Nevada (Sauer et al. 2008) have been increasing significantly in treated aspen stands and that patterned continued to hold true in 2010. Thus, treated aspen stands appear to be ideal habitat for this species, which is relatively uncommon in conifer-dominated forest in the region. Likewise, Mountain Bluebird and Tree Swallow are all but absent from conifer forest and untreated aspen, but are fairly common to abundant (respectively) in treated aspen. Mountain Bluebird has been declining over the past 40 years in the Sierra Nevada at a rate of 2.5% per year, though due most likely to their rarity this trend is not significant (Sauer et al. 2008).

All of the aspen focal species were more abundant or as abundant in treated aspen compared to untreated aspen with the exception of MacGillivray's Warbler. Restoring dense willow and alder cover in riparian habitat within aspen stands will be important for improving habitat for MacGillivray's Warbler – as they are rarely found in aspen stands away from riparian areas. Removing conifers from riparian zones that can support deciduous riparian vegetation and reducing the grazing in order to allow a dense understory to return should benefit this species and likely a number of other bird species that rely on this unique but limited habitat. MacGillivray's Warbler are quite abundant at Martin Creek in the treated and fenced stands with a dense understory as well as at Ruffa Aspen on the ARD. They are uncommon but present along Pine Creek and it will be interesting to see if they respond positively to conifer removal from the riparian zone at this site.

Aspen habitat often supports a diverse and abundant guild of cavity nesting species, with many studies showing cavity nesters disproportionately select aspen trees for nesting (Li and Martin 1991, Dobkin et al. 1995, Martin and Eadie 1999, Martin et al. 2004). Both Red-breasted Sapsucker and Hairy Woodpecker continued to be significantly more abundant in treated aspen than untreated aspen or conifer forest in the region. Removing encroaching conifers from within and surrounding aspen stands, resulting in the expansion of stands and increased density of large diameter aspen stems over time, should increase habitat for woodpeckers. On the Lassen National Forest aspen supports far greater abundance of woodpeckers than coniferous forest and treated aspen results in even greater increases in these species of management interest. While aspen often contain numerous natural cavities, secondary cavity nesting species have been found to nest predominantly in woodpecker created holes in both live aspen and aspen snags (Li and Martin 1991, Dobkin et al. 1995, Martin and Eadie 1999). Thus, woodpeckers are a critical component of the aspen community as the source of cavities for an abundant and diverse group of secondary cavity nesting birds, many of which use these aspen areas in relatively high numbers (e.g., Mountain Bluebird, Tree Swallow, House Wren and Mountain Chickadee).

Time Since Treatment

The time since aspen stands had been treated continued to show a generally positive but complex effect on many of the focal species through 2010. The best fit models for three of

the six species showing a significant effect of time since treatment included a quadratic term with their abundance peaking three to four years post-treatment. This suggests the immediate positive increase after aspen treatments may be relatively short-lived for at least some species (e.g. Hairy Woodpecker, Tree Swallow, and Mountain Bluebird). The one species showing the greatest increase has been Chipping Sparrow whose abundance sharply increased in each time interval following restoration. Only one focal species, MacGillivray's Warbler is more abundant in untreated aspen stands than treated. However, the fit of this trend is not tight and this species may be naturally more abundant on the Almanor Ranger District (west of the crest) where far less aspen has been treated. As stated above, restoring riparian shrubs and promoting dense understory aspen thickets should benefit this species.

The consistent patterns we have seen in the effect of time since treatment that were reinforced in 2010 suggest that no one aspen condition or post-treatment time period is ideal for all species. The conditions created immediately following aspen treatments may be mimicking the structure found in natural post-disturbance habitat that often supports greater numbers of some of these species (Raphael et al. 1987, Burnett et al. 2010). Though Hairy Woodpecker, Tree Swallow, and Mountain Bluebird showed marked declines at sites over four years post-treatment, each was more abundant in these older sites than they were in untreated aspen. These results continue to support the notion that management of aspen habitat should consider the importance of disturbance and the early successional habitat in which it results.

Conclusions

Our results from 2010 continue to suggest that aspen treatments employed on the LNF are having a positive effect on the aspen breeding bird community. Aspen associated species such as Red-breasted Sapsucker, Mountain Bluebird, Tree Swallow and Chipping Sparrow all appear to have had a short-term positive response to treatment. Based on these and previous results, we believe that treatments that increase the size and health of aspen stands will be highly beneficial to aspen focal bird species in the Lassen National Forest in the long-term and should be a top priority of land managers here. With our results showing the importance of understory aspen habitat the removal of grazing and browsing from restored aspen stands should be consider a priority for maximizing the benefits to the avian community. Finally, we recognize the value of continuing the monitoring of landbird communities in treated aspen

habitat in order to better understand the complex patterns we have observed in recent years as treated stands mature and to help guide long-term management of aspen in the Sierra Nevada.

Acknowledgements

Funding for our Aspen project was provided by the Lassen National Forest and Herger Feinstein Quincy Library Group Forest Recovery Act monitoring funds. We especially would like to thank Coye Burnett and Bobette Jones as well as Tom Frolli, Tom Rickman, and Mark Williams of the Lassen National Forest and Colin Dillingham – the HFQLG monitoring coordinator - for their support and assistance with this project. We also wish to thank Tim Guida, Luke Owens, and Erika Taketa our 2010 field crew.

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prbo

Chapter 2. Avian Monitoring of Northern Sierra Meadows
2010 Report

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PRBO Conservation Science

Background and Introduction

Mountain meadows are among the most important habitats for birds in California (Siegel and DeSante 1999, Burnett and Humple 2003, Burnett et al. 2005); they support several rare and declining species and are utilized at some point during the year by almost every bird species that breeds in or migrates through the region. Meadows also perform a vital role as watershed wetlands that store and purify drinking water for millions of Californians. And yet, most of these meadows are in a degraded state and their value as wetlands and as critical habitat for birds and other wildlife has been dramatically reduced.

In the Sierra Nevada, meadows have been heavily degraded or lost due to well over a century of human activities including damming, diversions, vegetation removal, and overgrazing (Ratliff 1985, SNEP 1996, Siegel and DeSante 1999). John Muir lamented in 1869 about the destruction of Sierra meadows by man, "….but as far as I have seen, man alone, and the animals he tames, destroy these gardens." (Muir 1911). Indeed few, if any, meadows in the Sierra remain unaltered by human activities. The meadows that do remain are owned by a diverse set of interests including private industry, utilities, state and federal agencies, and private ranchers.

Though they have been altered, a number of meadows in the Feather River watershed support populations of declining and threatened riparian meadow bird species, including Sandhill Crane, Swainson's Thrush, Yellow Warbler, and Willow Flycatcher. The area supports breeding populations of 11 of the 16 California Partners in Flight Riparian Focal Species (Humple and Burnett 2004, RHJV 2004). With its high diversity and abundance of meadow bird species, including the largest population of Willow Flycatcher in the Sierra Nevada region (Humple and Burnett 2004), the Feather River watershed is a conservation hotspot for meadow birds.

Meadow conservation and management in the Feather River watershed and throughout the Sierra Nevada will require a collaborative effort between different land management agencies, county government, non-governmental organizations, and private landowners. In order to manage for breeding bird populations, especially meadow-dependent species such as Willow Flycatcher and Sandhill Crane, stakeholders will need to work collaboratively to ensure the long-term viability of these and other bird species.

In this chapter we summarize point count data from meadow monitoring in the Feather River and Deer Creek watersheds in 2010, including new sites in Red Clover Valley, Long

Valley, and Child's Meadow. We use a suite of meadow focal species to compare abundance and richness metrics between meadows including restored and unrestored areas in the Last Chance and Red Clover watersheds. We also provide recommendations for improving habitat for meadow-dependent bird species.

Methods

Site Selection

Several considerations went into selecting meadow sites we sampled (Table 1). Following an inventory of 16 meadows in the greater Almanor Ranger District (ARD) area between 2000 and 2001, we selected eight of these meadows to continue long-term meadow monitoring within. We were interested in surveying wet meadows that supported (or should support) a riparian deciduous shrub community, and especially those sites that had recently undergone management changes (e.g. active restoration and/or removal of grazing). With these two considerations in mind we attempted to choose sites that represented a range of elevations and habitat conditions. In 2009, we added Child's Meadow to our list of sites following its acquisition by The Nature Conservancy as it was adjacent to another long-term site and one of the larger meadows in the area and therefore of conservation interest. I believe the sites selected are not representative of all meadows in the ARD area but represent some of the higher quality riparian meadow bird habitat in the area. Sites within the Last Chance, Red Clover, and Long Valley watersheds (referred to herein as eastern Plumas sites) were selected in 2009 or 2010 to monitor proposed or completed meadow restoration projects being carried out by the Feather River Coordinated Resource Management group.

Point Count Censuses

Point count data allow us to measure secondary population parameters such as relative abundance of individual bird species and species richness. This method is useful for making comparisons of bird communities across time, locations, habitats, and land-use treatments.

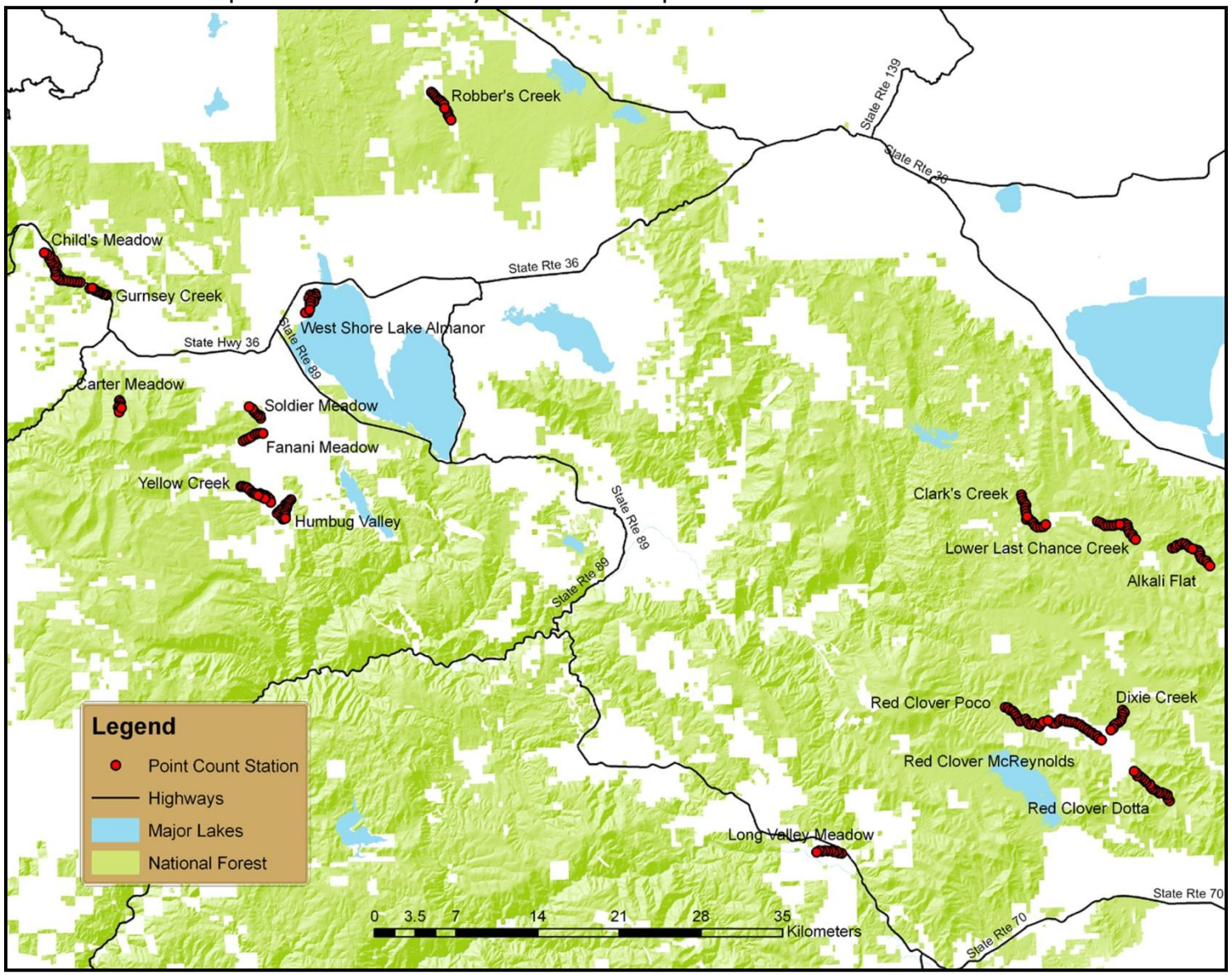
Standardized five-minute multiple distance band point count censuses (Reynolds et al. 1980, Ralph et al. 1995) were conducted at each of 247 stations in the study area in 2010 including: 77 stations on six transects in the Upper North Fork Feather River watershed, 39 points in the Deer Creek watershed, 54 points in the Last Chance Watershed, 67 points in the

Red Clover Valley, and 10 points in Long Valley (Table 1, Figure 1). Point count stations were a minimum of 50 m from meadow edges where feasible; if the riparian corridor was less than 100 m wide, points were placed equidistant from each edge. In meadows well over 100 m wide points were placed within 50 m of a stream channel. At each site points were spaced at 200 to 250 meter intervals.

Table 1. PRBO Northern Sierra meadow point count transects with transect codes, year established, and dates surveyed in 2010.

Transect	Code	# of points	Year established	1st Visit	2nd Visit
N. Fork Feather River Watershed					
Fanani Meadow	FAME	8	2003	6-June	17-June
Humbug Valley	HUVA	17	2003	7-June	20-June
Robber's Creek	ROCR	14	2004	13-June	23-June
Soldier Meadow	SOME	7	2001	6-June	17-June
West Shore Lake Almanor	WSLA	13	2004	30-May	19-June
Yellow Creek Riparian	YCRI	18	2001	2-June	16-June
Deer Creek Watershed					
Carter Meadow	CAME	7	2004	2-July	9-July
Gurnsey Creek	GUCR	10	1997	10-June	21-June
Child's Meadow	CHME	22	2010	11-June	21-June
Last Chance Watershed					
Alkali Flat	ALFL	18	2009	1-June	24-June
Clark's Creek	CKCR	18	2009	1-June	22-June
Lower Last Chance Creek	LLCH	18	2009	1-June	24-June
Red Clover Watershed					
Dixie Creek	DXCR	10	2010	10-June	30-June
Red Clover Beartooth	RCBT	11	2010	16-June	25-June
Red Clover Demonstration	RCDE	5	2010	16-June	28-June
Red Clover Dotta	RCDO	18	2010	9-June	25-June
Red Clover McReynolds	RCMC	13	2010	16-June	28-June
Red Clover Poco	RCPO	10	2010	12-June	28-June
Long Valley Watershed					
Long Valley Meadow	LVME	10	2010	15-June	29-June
Total		247		30 -May	9 -July

Figure 1. PRBO Northern Sierra meadow point count sites surveyed in 2010. Red Clover Demonstration and Beartooth transects are within the set of points labeled as McReynolds on this map.



All birds detected at each station during the five-minute survey were recorded. Detections were placed within one of six categories based on the initial detection distance from observer: less than 10 meters, 10-20 meters, 20-30 meters, 30-50 meters, 50-100 meters, and greater than 100 meters. Birds flying over the study area but not observed using the habitat were recorded separately, and excluded from all analyses. The method of initial detection (song, visual or call) for each individual was also recorded. Counts began around local sunrise and were completed within four hours. Each transect was visited twice each year between late May and the 9th of July (Table 1). Surveys were conducted by highly experienced observers with extensive knowledge of the songs and call of northern Sierra birds and well-versed in point count methodology. An electronic range finder was used by observers to assist with distance estimation at each point count station.

Table 2. Avian focal species (listed in taxonomic order) for meadow monitoring in the Northern Sierra and their conservation status. California Partners in Flight Riparian Focal species are noted in bold (RHJV 2004).

Species	**Conservation Status**
Sandhill Crane	State Threatened
Red-breasted Sapsucker	Declining in the Sierra[1]; NTMB
Willow Flycatcher	State Endangered, USFS Sensitive, NTMB
Warbling Vireo	NTMB, Declining in the Western U.S.
Swainson's Thrush	USFS Priority Land Bird Species, NTMB
Black-headed Grosbeak	NTMB
Yellow Warbler	State Species of Special Concern, NTMB
MacGillivray's Warbler	NTMB
Wilson's Warbler	Significant Decline in Sierra[1], NTMB
Song Sparrow	None
Lincoln's Sparrow	NTMB

[1] = from Sauer et al. 2008. NTMB = Neotropical Migratory Bird

Statistical Analysis

Point count analysis of community metrics was restricted to a subset of the species encountered. I excluded species that do not breed in the study area as well as those species that are not adequately sampled using the point count method (e.g., waterfowl, raptors, waders), though I did provide a separate analysis of waterfowl abundance. For a number of the analyses I used a suite of focal species (Chase & Geupel 2005), that are relatively restricted to meadow habitats and represent a range of meadow conditions that as a group are likely to provide a better measure of the quality of meadow habitat than all species (Table 2). For all

analyses I used naïve point count detections uncorrected for detectability, thus results represent an index rather than true densities of species (Johnson 2010). I have no reason to believe that detectability of species varied across sites as the vast majority of detections were auditory and listening conditions were excellent at all sites. I used two-tailed student t-tests to compare all avian indices presented in this report with significance presumed at the α=0.05 level. Stata statistical software was used to conduct all statistical tests (Stata Corp. 2005).

Species richness

The species richness index used here was obtained by summing the species detected within 50 meters of the observer across both visits to each point count station and then averaged across all points in the transect. Similarly, focal species richness is the same calculation but limited to the list of species in table 2. Presenting the mean species richness, as is done herein, allows for comparisons between transects or habitats consisting of different numbers of point count stations but does not provide a measure of the total number of species across an entire transect.

Indices of Abundance

An index of total bird abundance, defined as the mean number of individuals detected per station per visit, was calculated for each transect. This number is obtained by dividing the total number of detections within 50 meters of the observer by the number of stations and the number of visits. The same method was employed for creating focal species abundance (the total number of individuals of all focal species combined) and for individual focal species.

Sierra Nevada Avian Monitoring Information Network

All data from this project is stored in the California Avian Data Center and can be accessed through the Sierra Nevada Avian Monitoring Information Network web portal (http://data.prbo.org/apps/snamin). At this site, species list, interactive maps of study locations, as well as calculations of richness, density, and occupancy can be conducted as selected by the user. Study site locations can also be downloaded in various formats for use in GPS, GIS, or online mapping applications as well.

Results

Overview

The abundance and distribution of meadow focal species varied from site to site and across watersheds in the study area in 2010. Song Sparrow was the most abundant and ubiquitous meadow bird focal species detected in 2010 as it occurred at every site surveyed with an average index of abundance of 1.07 per point in the greater Almanor area and 0.90 at the eastern Plumas sites. Yellow Warbler was the next most abundant and ubiquitous species occurring at 17 of the 20 sites. Its index of abundance in the Almanor area was 0.90 per point while it was 0.69 at the eastern sites. Willow Flycatcher, a Forest Service sensitive and California state threatened species, had an index of abundance of 0.07 in the Almanor area; this species was not detected within 50m of observers in the Last Chance or Red Clover watersheds but was at Long Valley, resulting in an index at the eastern sites of 0.01 birds per point. Two other focal species, Wilson's Warbler and Lincoln's Sparrow, were not detected at the eastern sites surveyed in either 2009 or 2010.

Comparison of Community Indices across Meadows

Carter Meadow had the highest avian species richness in 2010 with 7.86 species detected per point, followed by Gurnsey Creek at 7.80, then Robber's Creek at 6.86 (Figure 2). These were the only sites in 2010 with richness significantly above the average for all sites combined. The lowest richness in 2010 was for the PG&E land along Yellow Creek with 1.83 species per station. Other sites with significantly lower species richness than the average in 2010 were Alkali Flat, Lower Last Chance Creek, Dixie Creek, Red Clover Dotta, and Red Clover Beartooth.

In 2010, total bird abundance was highest at West Shore Lake Almanor (Chester Meadow) with 9.12 detections per point per visit (Figure 3). The other sites with significantly higher total bird abundance than the 2010 average were Red Clover McReynolds (8.15), Gurnsey Creek (7.5), Humbug Valley (7.26), Long Valley (7.20), and Carter Meadow (7.07). Sites with significantly lower total bird abundance than the 2010 average were Yellow Creek PG&E (1.67), Lower Last Chance Creek (3.25), Soldier meadow (3.29), Child's Meadow (3.48), Dixie Creek (3.5), Red Clover Dotta (3.77), and Red Clover Beartooth (3.86). Focal species richness and abundance followed similar patterns to overall richness and abundance in 2010,

though the eastern Plumas sites generally had lower focal species indices compared to Almanor area meadows (Figure 5 & 6).

Figure 2. Avian species richness and total bird abundance at 20 meadow sites in the Northern Sierra Nevada in 2010 with 95% confidence intervals. Dashed lines represent the mean for all sites combined and dotted lines the 95% confidence interval surrounding that estimate. Four letter site codes are defined in Table 1.

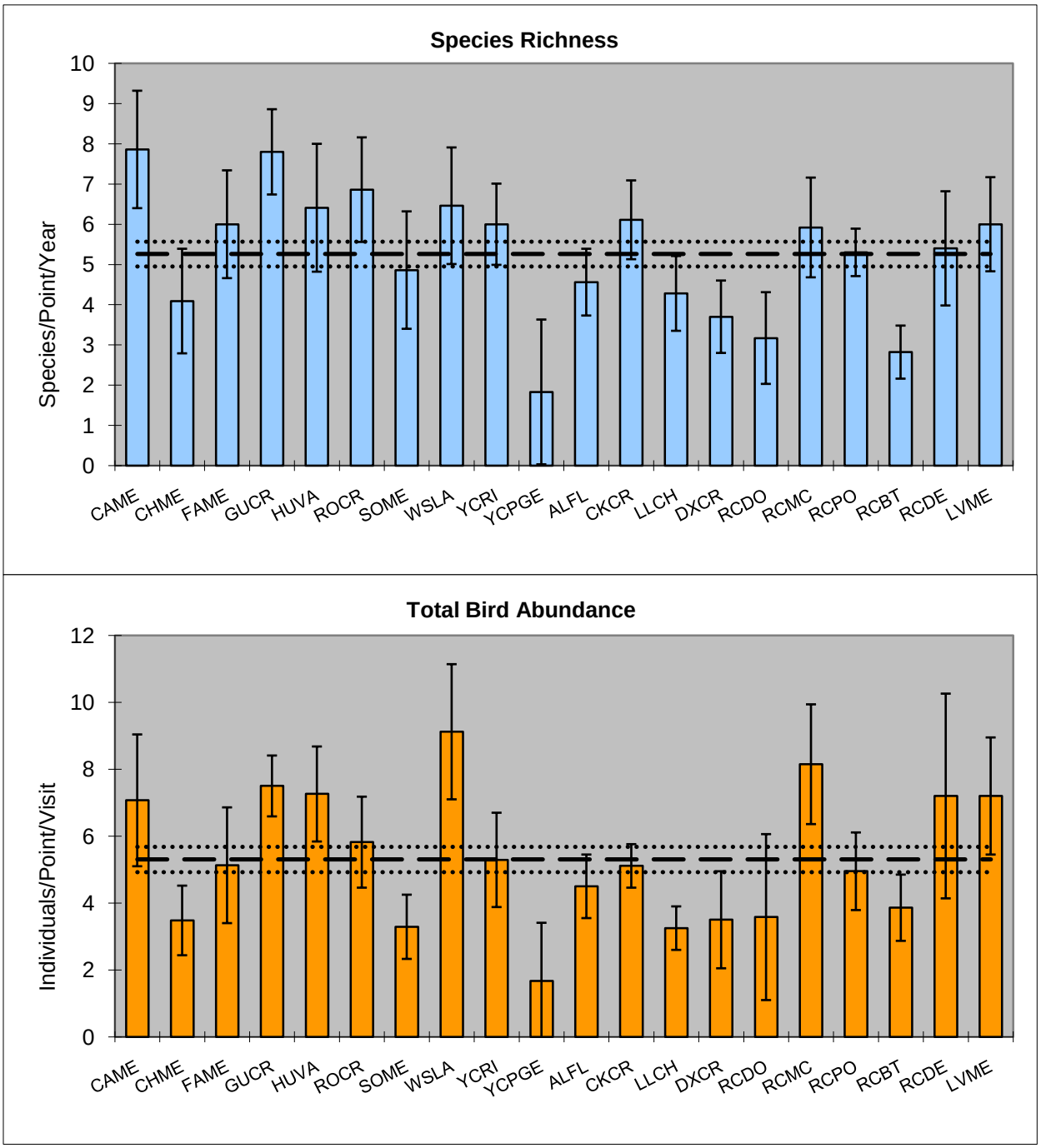
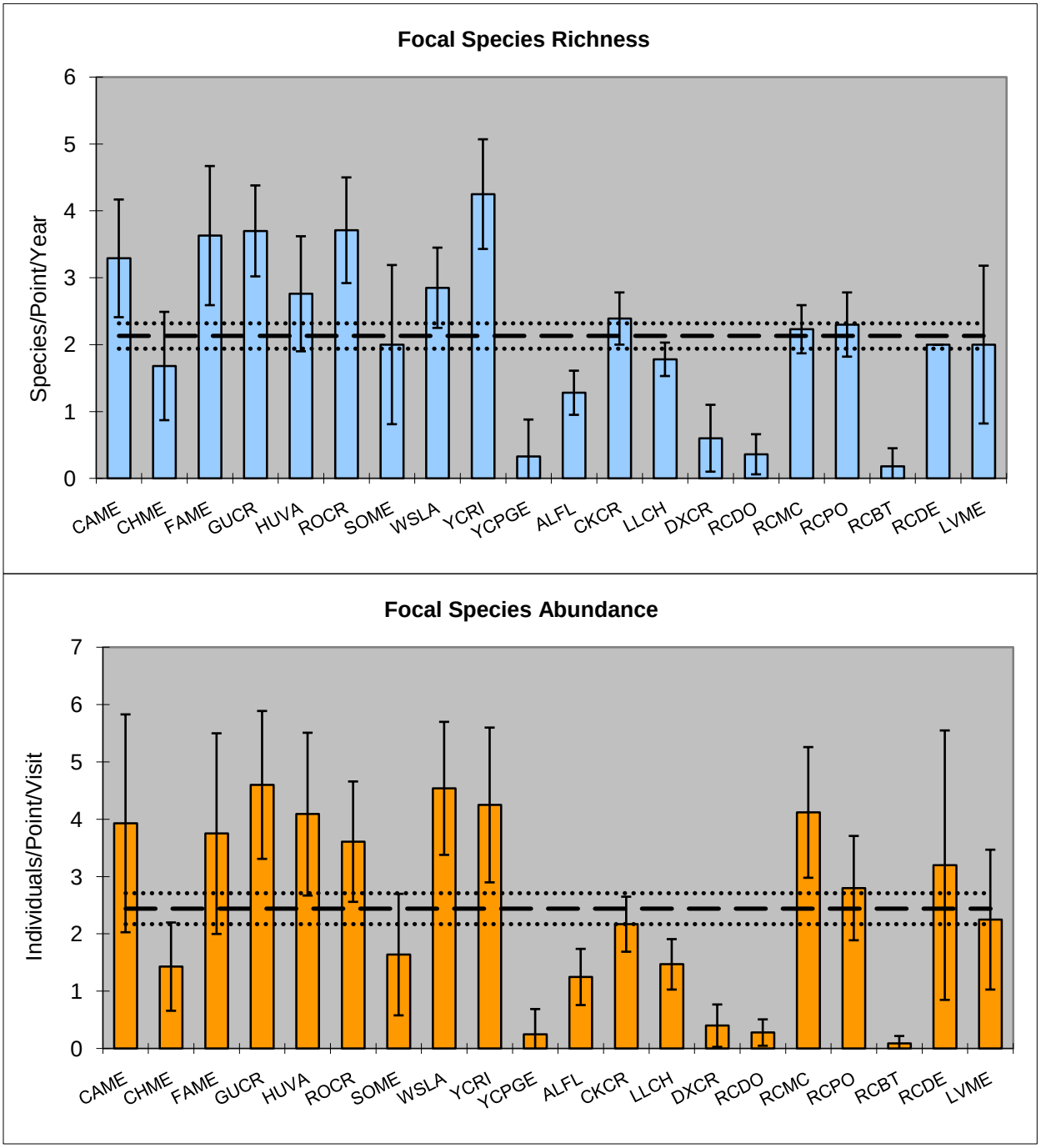


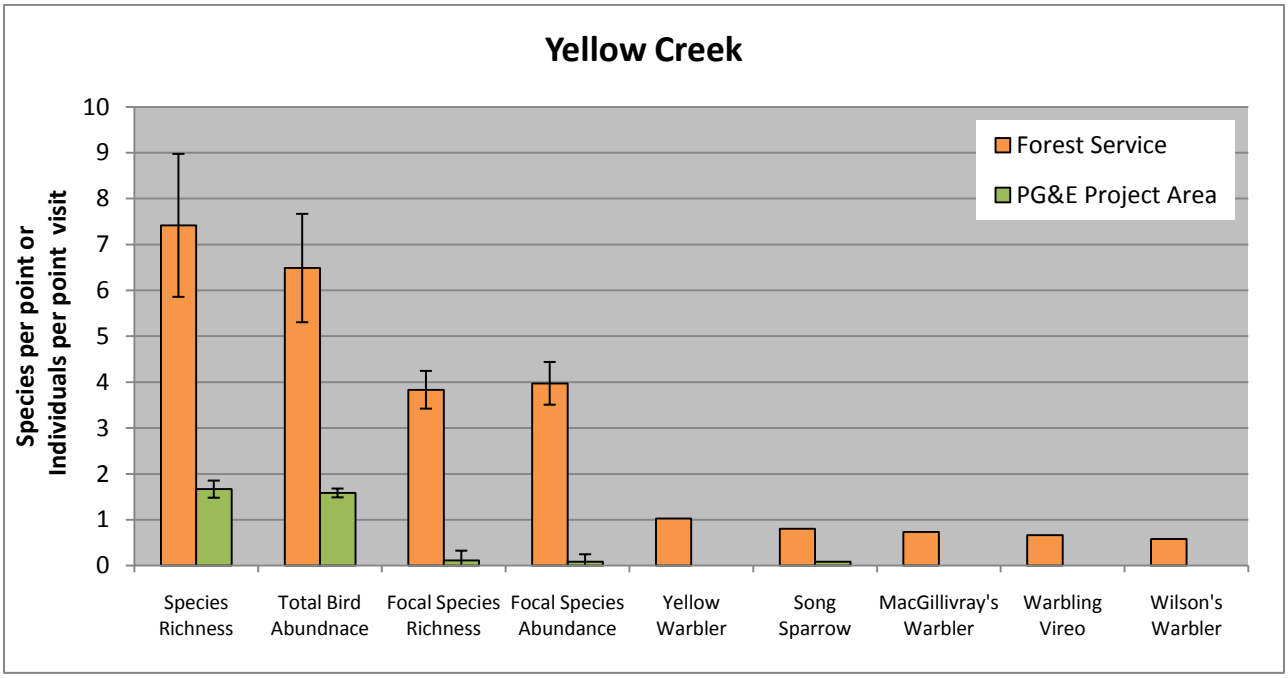
Figure 4. Avian meadow focal species richness and abundance at 20 meadow sites in the Northern Sierra Nevada in 2010 with 95% confidence intervals. Dashed lines represent the mean for all sites combined and dotted lines the 95% confidence interval surrounding that estimate. Four letter site codes are defined in Table 1.



Yellow Creek

The Feather River CRM in cooperation with PG&E has developed a restoration plan for a portion of Yellow Creek where it enters the valley floor in Humbug Valley. We have been monitoring birds upstream of this area on Yellow Creek since 2001. In 2008, an additional six point count stations were added at the downstream end of the existing transect in order to sample the project area. Using data from 2008 - 2010, I compared several avian metrics between the project area and the Forest Service land immediately above the proposed project area (Figure 6). Species richness, total bird abundance, focal richness, and the abundance of six focal species were all significantly higher outside the project area. In fact, a single Song Sparrow was the only focal species detected in the project area across the three years. Though, a pair of Sandhill Crane were observed foraging within the project area in 2010. The primary species detected in the project area were Brewers and Red-winged Blackbirds two generalist species and Horned Lark and Savannah Sparrow, two species associated with dry grassland habitat.

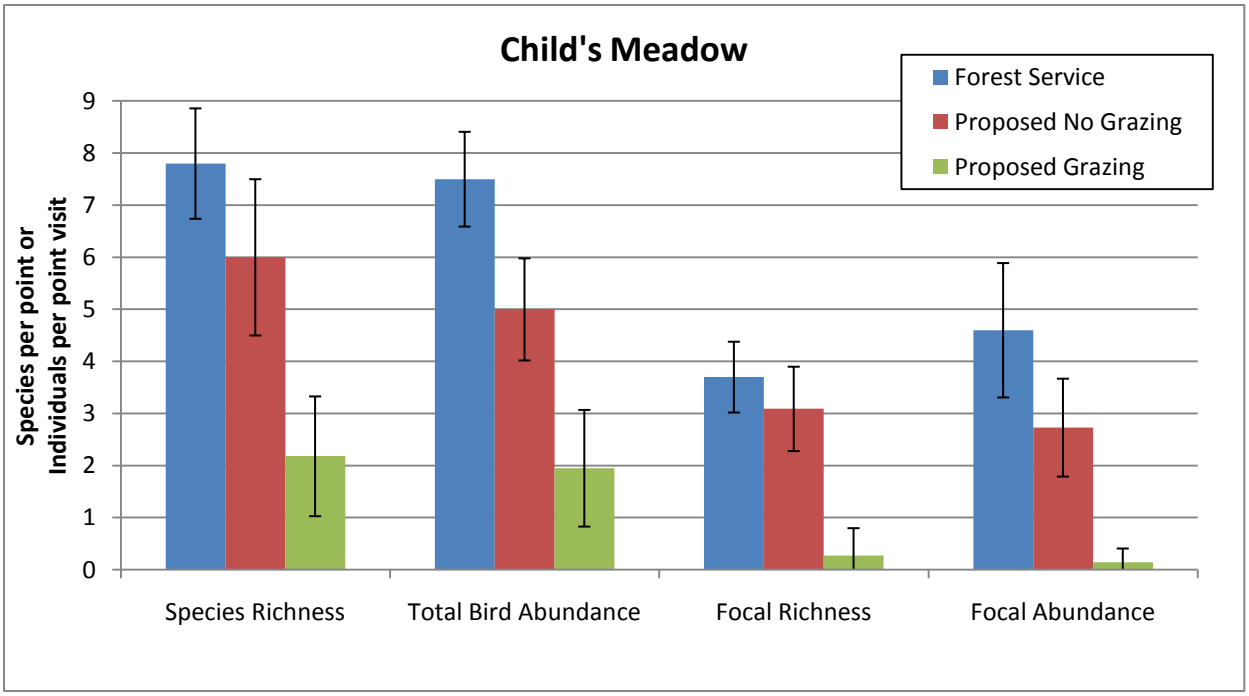
Figure 6. Per point avian indices of richness and abundance along Yellow Creek comparing the Forest Service land to the proposed PG&E-Feather River CRM project area from 2008 – 2010. Error bars are 95% confidence intervals.



Childs Meadow

The headwaters of Gurnsey Creek, including the section of Child's Meadow south of highway 36 was purchased by The Nature Conservancy several years ago. I compared the four avian metrics discussed above on Forest Service Land that has not been grazed for over 20 years, the adjacent TNC property that has been grazed but is being proposed as a grazing exclosure, and the rest of the meadow where grazing is likely to continue (Figure 7). All four metrics were higher on the un-grazed Forest Service land and lowest for the area where grazing is likely to continue. When all sites from the Gurnsey Creek and Child's Meadow transect are considered Gurnsey Creek had significantly higher richness and abundance of all birds and focal species (Figures 3 & 4).

Figure 7. Per point species richness, total bird abundance, meadow focal species richness and meadow focal species abundance in Child's Meadow in 2010 comparing the area proposed to exclude grazing and the area where grazing will continue with 95% confidence intervals.

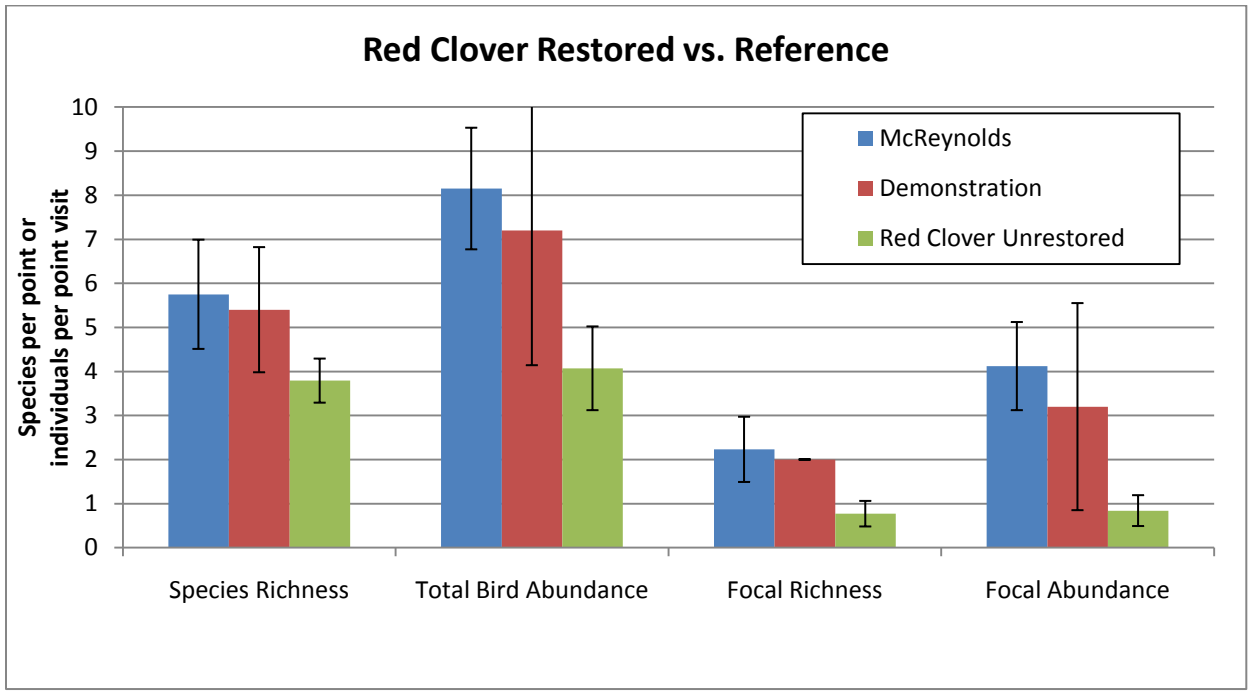


Feather River CRM Restoration

All four avian metrics in the Red Clover watershed were significantly higher at restored sites than unrestored in 2010 (Figure 8). Due to small sample size of the demonstration project the difference between that project alone and unrestored areas were not significant. I then compared these metrics for all sites restored by the Feather River CRM to all sites being

proposed for Restoration across Red Clover, Last Chance, and Long Valley watersheds. Results were similar to that found when Red Clover was considered alone with restored sites showing significantly higher indices than unrestored sites.

Figure 8. Per point species richness, total bird abundance, meadow focal species richness and meadow focal species abundance at two restored sites (McReynolds and Demonstration) and unrestored sites in Red Clover Valley (Dotta, Beartooth, Poco, and Dixie Creek) in 2010 with 95% confidence intervals.



The abundance of the five primary species of waterfowl believed to be breeding in Feather River CRM meadows were all more abundant at restored sites than unrestored. Gadwall was the most abundant followed by Mallard and Cinnamon Teal. Wood Duck were only detected at Long Valley Meadow which contains a cottonwood component unlike all of the other eastern meadows surveyed. Waterfowl abundance by site is presented in Appendix C.

Figure 9. Per point species richness, total bird abundance, meadow focal species richness, and meadow focal species abundance at Feather River CRM restored and un-restored point count stations in Red Clover, Last Chance, and Long Valley watersheds in 2010 with 95% confidence intervals.

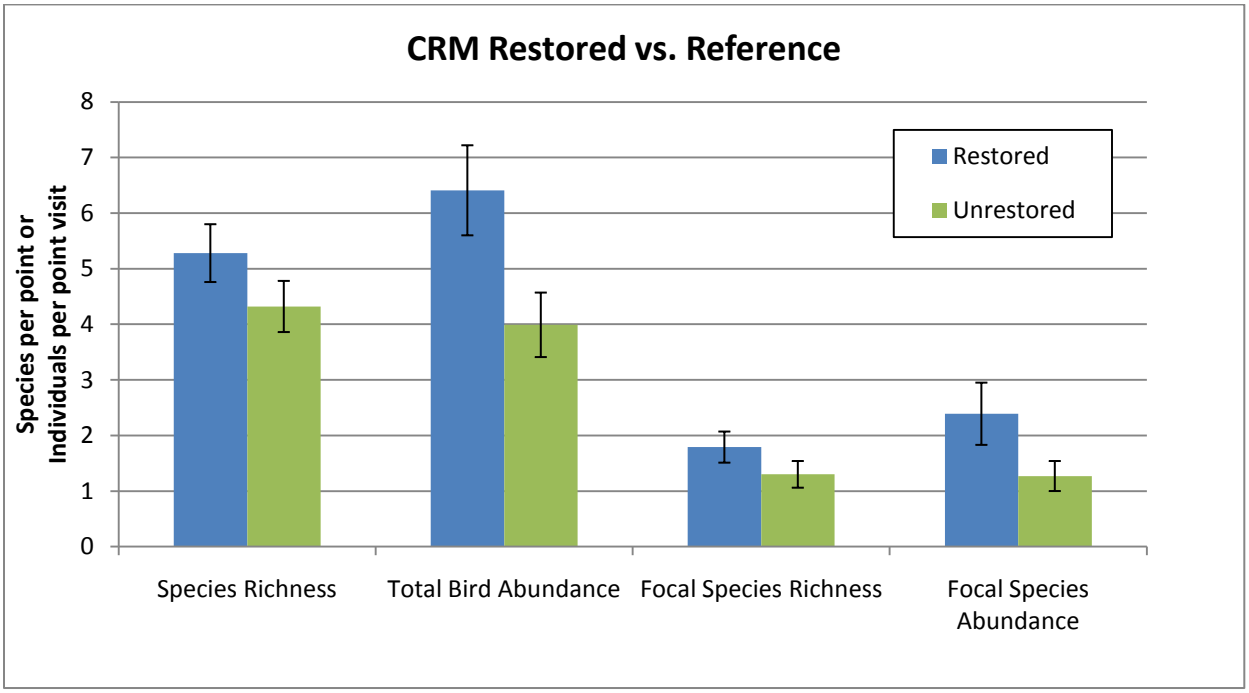
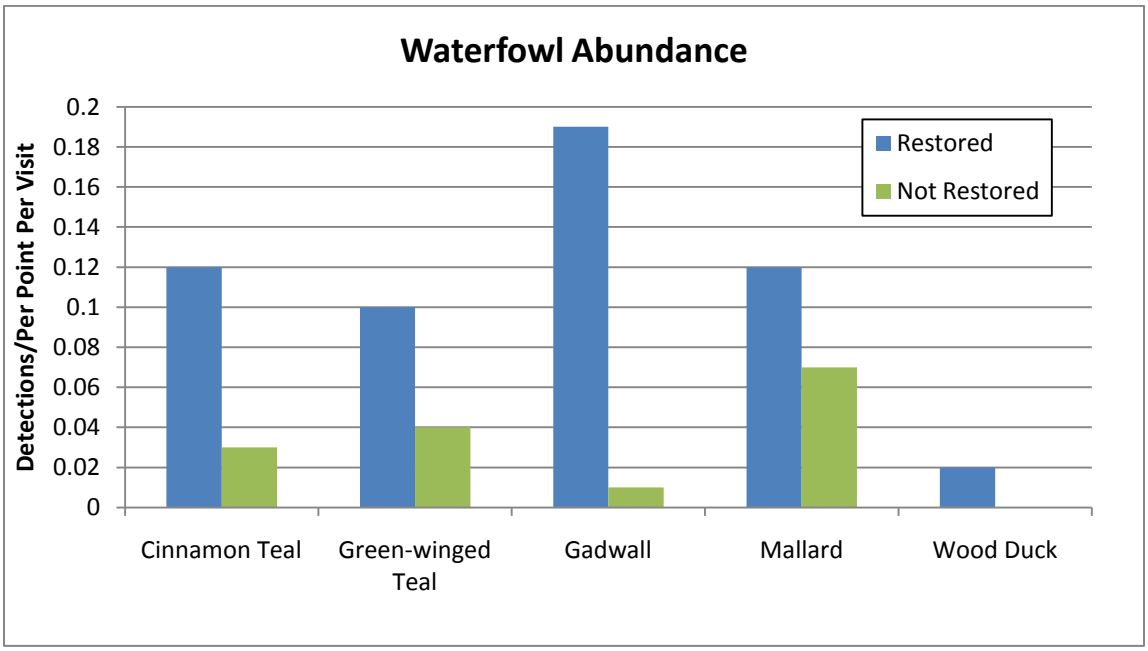


Figure 10. Per point detections (all distances) of five duck species at restored and unrestored Feather River CRM sites in Red Clover, Last Chance, and Long Valley watersheds in 2010.



Discussion

Almanor Area Meadows

The greater Almanor Ranger District area meadows (North Fork Feather River and Deer Creek watersheds) supported higher total bird abundance than any other habitat type in the Lassen region surveyed in 2010 (e.g. conifer forest, chaparral, post-fire, and aspen) and the second highest species richness (second to Aspen). Meadows in the greater Almanor Ranger District area are among the most important meadows for birds in the Sierra Nevada. Yellow Warbler, a California Bird Species of special concern, reaches its greatest reported density (RHJV 2004, Heath 2008) in the state here. The area also harbors more Willow Flycatcher than any other similarly-sized area of the Sierra Nevada and a breeding population of the state threatened Greater Sandhill Crane. With a wealth of mountain meadows and many in a degraded state, the greater Almanor Ranger District area should be considered an ideal location to focus meadow restoration and acquisitions to benefit these and other meadow dependent bird species.

Though many of the meadows sites we surveyed, especially in the ARD, support relatively diverse and abundant bird populations, many could benefit from additional restoration actions. For several sites, removal of encroaching conifers (Robber's Creek, Gurnsey Creek, Soldier Meadow) or increase in riparian deciduous vegetation (e.g. *Salix*, *Populus*, and *Alnus* spp.) (Childs Meadow, Soldier Meadow, Swain Meadow below Robber's Creek) could greatly enhance their value to meadow birds. The latter would best be achieved by limiting grazing along with willow planting programs. In Humbug Valley, Humbug Creek and Yellow Creek have sections of stream channel that have been isolated from their floodplains and may benefit from more significant restoration actions that restore a wet meadow condition.

There is little current habitat value for wet meadow bird species within the PG&E-Feather River CRM Yellow Creek project area. In fact, the site had the lowest avian indices of any meadow site we surveyed in both 2009 and 2010. In contrast, the 2000 m stretch of meadow upstream from the project area supports a diverse and abundant meadow bird community including recent detections of Swainson's Thrush and Willow Flycatcher – the two rarest meadow birds in the Sierra Nevada. Additionally, this area supports an abundant population of Yellow Warbler, a California Bird Species of Special Concern (Shuford and Gardali 2008). On Humbug Creek, 1000 m across the valley from the project area, there were

11 Willow Flycatcher territories occupied in 2010, as well as a dense population of Yellow Warblers. Restoring Yellow Creek within the proposed project area to a wet meadow with a substantial willow component is likely to have significant benefits to listed species as well as a host of other meadow dependent focal species and create suitable nesting substrate for Greater Sandhill Crane.

Child's Meadow supported significantly lower bird indices than the Gurnsey Creek area immediately downstream. The Gurnsey Creek site has not been grazed for over 20 years while the Child's meadow site has been continuously grazed for decades. TNC is planning on removing grazing from the lower half of the Child's Meadow property and our results suggest this area already supports greater avian diversity and abundance than the upstream areas. The lower section of the meadow also contained two Willow Flycatcher territories in 2010. The upstream half of the meadow until recently was very heavily grazed and herbaceous vegetation was reduced to the ground and willow cover was all but absent. Thus, it is not surprising that this area supports very few meadow focal species. Blackbirds and Savannah Sparrows were the only species consistently encountered at these stations. This upstream portion of the meadow has great potential as meadow bird habitat, and I would recommend if grazing is to continue on this part of the meadow, that it be reduced in intensity and that at least 50m on either side of the stream be fenced off and grazing excluded from this streamside area at least until the natural riparian plan community could be restored. Based on my 12 years of experience monitoring meadows in the Northern Sierra Nevada, without changes in management to exclude grazing from the streamside areas of the upper part of the meadow, its utility to meadow dependent birds will remain extremely limited.

Eastern Plumas Meadows

In general, eastern Plumas County meadows support less avian diversity and focal species richness and abundance than the Almanor area meadows. This is likely due to greater degradation of these eastern meadows as well as some natural habitat differences. Both the intensity of grazing and the fragility of these east side sites have resulted in substantial loss of floodplain form and function and with it the important riparian meadow habitat that makes meadows so valuable to Sierra Nevada birds. The size of these meadows also limits the use of streamside habitat by conifer breeding birds as is readily seen in many Almanor area meadows

with high diversity such as Gurnsey, Robbers, and Yellow creeks. Many of the meadow focal species associated with higher elevation sites (Lincoln's Sparrow, Wilson's Warbler) and those associated with a riparian tree component such as cottonwoods or aspen (Black-headed Grosbeak, Warbling Vireo) are rare to absent from these relatively monotypic east side meadow systems.

The Long Valley meadow site, which is further west than Red Clover and Last Chance watersheds does contain a cottonwood component and therefore supports species such as Black-headed Grosbeak and Warbling Vireo. It also had two territorial male Willow Flycatchers in 2010, two years after it was restored. The Willow Flycatcher were present in a patch of established willows that undoubtedly existed prior to restoration. Since 2010, was the first year of avian monitoring at this site is not clear whether the species occurred here prior to restoration. Regardless, exclusion of cattle and increased willow recruitment following reconnecting the stream with its floodplain is likely to increase the amount of suitable Willow Flycatcher habitat.

Clearly many of the sites currently being proposed for restoration by the Feather River CRM are the most in need of it, as they support the least diverse and least abundant avian communities of any meadows we have monitored (e.g. Red Clover Dotta, Red Clover Beartooth, and Yellow Creek PG&E). These sites therefore provide the greatest opportunity for increasing meadow bird habitat as little currently exists at these sites.

The restored sites in Red Clover Valley – the McReynolds and Demonstration project areas – are supporting far greater avian species richness and total bird abundance than unrestored areas in the valley. This suggests that restoration actions are warranted and that the techniques used thus far (both the check dams in the demonstration project and the plug and pond used in McReynolds) can produce benefits to the meadow bird community. The McReynolds project avian indices were a bit higher than the Demonstration Project, and a number of species not included in this analysis (because of concerns over the adequacy of sampling them with our point count method) were detected at McReynolds but not in the Demonstration project area, including waders and rails. Additionally, as willows continue to fill in at the five year old McReynolds project, I expect avian indices to increase above those recorded in 2010, whereas the 15 year old Demonstration project has likely reached its potential as meadow bird habitat. These results suggest that plug and pond restoration - like

that conducted for the McReynolds project - may have greater long-term benefits to the avian community than check dam projects. However, using check dams and excluding or (significantly limiting) grazing still has the potential to produce major benefits to the meadow bird community as well.

In 2010 we continued to see higher avian indices at unrestored sites compared to restored sites in the Last Chance Creek watershed, despite the opposite pattern being observed in the Red Clover watershed. This is both the result of higher indices at unrestored sites in the Last Chance watershed than Red Clover and higher indices for restored sites in Red Clover than in Last Chance. Why would restored sites using similar techniques in these two adjacent watersheds produce different responses by the avian community? Both sites were restored within the same basic time horizon – each has about the same number of sites that range from 5 to 15 years post restoration, so it seems unlikely that time since restoration is a determining factor. The two biggest differences appear to be willow cover and the extent of water across the floodplain. The Red Clover restored sites are associated with a stream that has considerably more volume of water and willow cover than the Clark's Creek and Alkali Flat project areas. Clearly little can be done to increase stream flows in the Last Chance watershed, but supplemental planting of willows in dense clumps to enhance existing small clumps could greatly increase the value of these sites to meadow birds. It also appears that the Alkali Flat area is subjected to a greater intensity of grazing than restored areas of Red Clover valley which is likely reducing the pace of restoration and long-term potential of this site for meadow birds. Though grazing occurs within the McReynolds project area the intensity and duration are extremely limited. The current levels of grazing here appear to be quite compatible with restoration of the site for meadow dependent birds whereas that at Alkali Flat may be excessive to ensure restoration of high quality meadow bird habitat.

Conclusions

Wet meadows with extensive riparian deciduous vegetation can support rich and abundant breeding bird populations and are used extensively following the breeding season by the majority of upland breeding species in the Sierra. Since wet meadows represent less than 1% of National Forest land in the Sierra Nevada and have been heavily degraded over the past century, meadow restoration and conservation should be among the highest priorities of land

managers in the Sierra Nevada. As meadows are arguably the single most important habitat for birds in the Sierra Nevada, and birds are a cost-effective tool to help guide ecological restoration, avian monitoring and the management recommendations generated from it should be seen as a integral tool to achieving meadow restoration in the Sierra Nevada.

Increasing the function and resiliency of wet willow-filled meadows should result in improved meadow bird habitat, but active measures such as willow planting is likely necessary to ensure habitat is provided within 5 to 10 years versus 20 or more. Meadow restoration in the Feather River watershed requires partnerships between the U.S. Forest Service, local government agencies (e.g. Feather River Coordinated Resource Management Group.), and non-profit organizations (e.g. The Nature Conservancy, Feather River Land Trust, PRBO Conservation Science). Working together, these groups have the potential to dramatically increase the value of meadow habitats for birds in this region.

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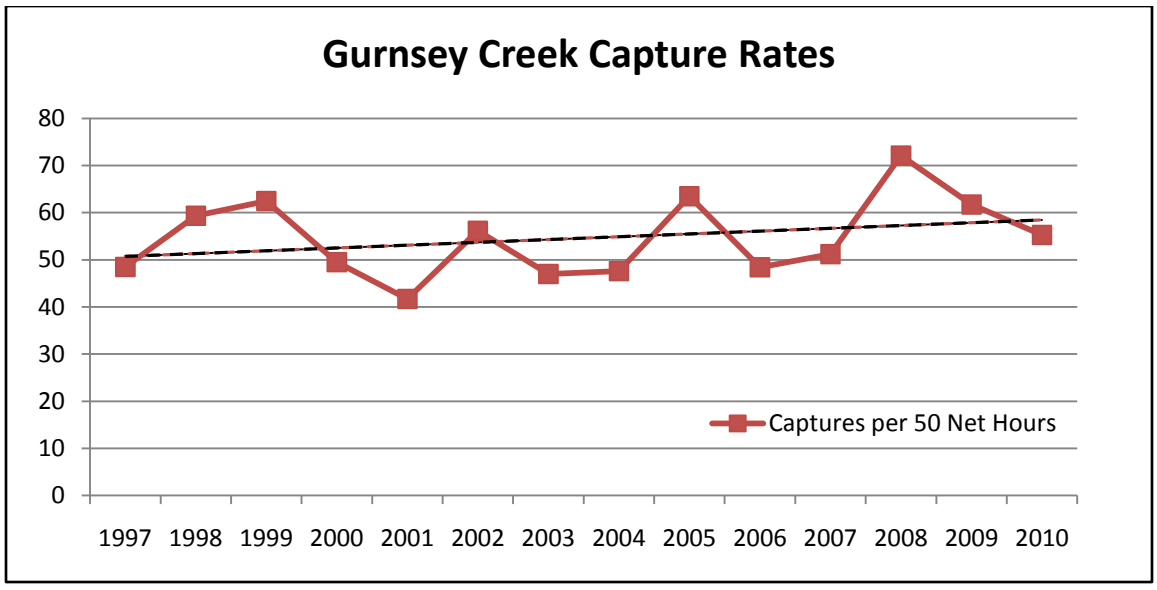
Appendix A. Summary of 2010 meadow mist-netting in the Almanor Ranger District with dates, net hours, captures, and capture rates.

Site	Date	Net Hours	Captures	Captures per 50 net hours
Gurnsey Creek	5/19/2010	38.6	59	56
Gurnsey Creek	5/29/2010	37.3	34	62
Gurnsey Creek	6/9/2010	45	42	41
Gurnsey Creek	6/18/2010	41.2	44	59
Gurnsey Creek	6/26/2010	44	63	71
Gurnsey Creek	7/8/2010	45	69	90
Gurnsey Creek	7/19/2010	45	41	69
Gurnsey Creek	7/28/2010	43.5	33	37
Gurnsey Creek	8/9/2010	45	40	65
Gurnsey Creek Total		**384.6**	**425**	56
Hay Meadow	8/2/2010	36	31	43
Swain Meadow	8/3/2010	36	137	191
Carter Meadow	8/4/2010	35	63	90
Spenser Meadow	8/6/2009	36	63	88

Appendix B. Capture rates at the Gurnsey Creek constant-effort mist-netting station by year from 1997 – 2010 with fitted linear trend line.



Appendix C. The abundance (number per point per visit all distances) of waterfowl by site and restoration status on Feather River CRM projects in 2010.

Site	Cinnamon Teal	Green-winged Teal	Gadwall	Mallard	Wood Duck
Akali Flat - Restored	0.39	0.29	0.18	0.04	0
ALFL Un-restored	0	0.13	0	0	0
CKCR Restored	0	0.2	0	0.1	0
CKCR Un-restored	0	0	0	0.04	0
Dixie Creek	0.05	0.05	0	0.1	0
Lower Last Chance	0	0	0	0	0
Long Valley Meadow	0	0	0	0.15	0.11
Red Clover Dotta	0.08	0.08	0.06	0.25	0
Red Clover McReynolds	0	0.04	0.19	0.12	0
Red Clover Poco	0.05	0	0	0.05	0
Red Clover Beartooth	0	0	0	0.05	0
Red Clover Demonstration	0.2	0	0.6	0.2	0