Chapter 2. Resident and Neotropical Migratory Bird Response to Aspen Enhancement on the Lassen National Forest

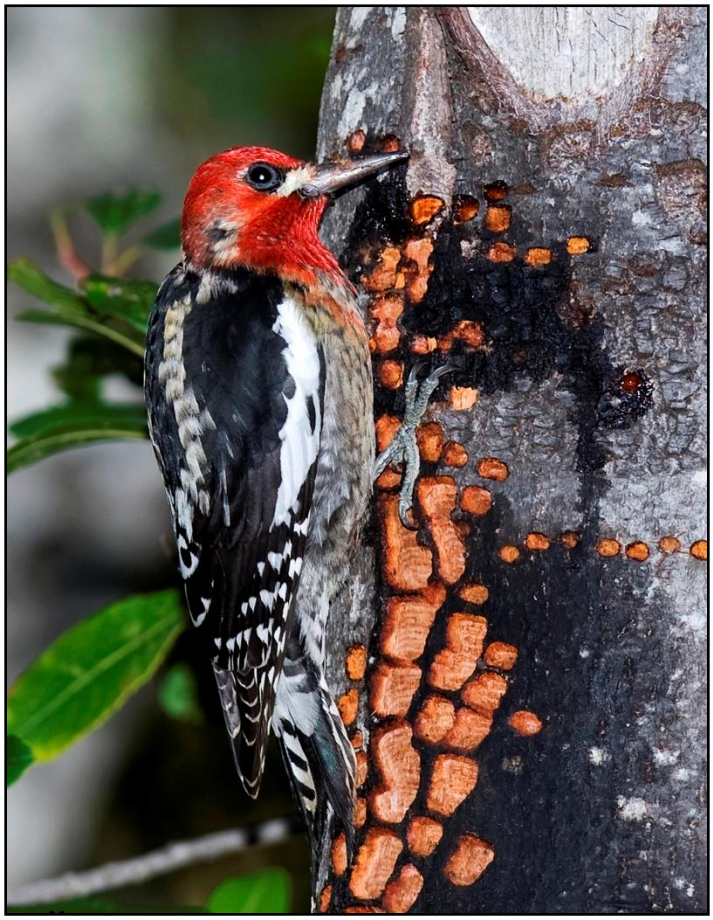

Photo by Kevin Cole

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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 reduced as much as 96% (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 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 2009 into those from 2004 – 2008 and use the knowledge gained from this additional information to help guide future restoration treatments and long-term management of aspen habitat on the Lassen National Forest.

Project Area

All avian survey work was 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 represent 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 2009 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 2009 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 unlimited distance variable circular plot point count censuses (Reynolds 1980, Ralph et al. 1993) were conducted at 181 stations along 18 transects in 2009 (Table 1, Figure 1, and Appendix 1). 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 1 July in each year, including 2009 (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 transects, ranger district, number of stations, and dates surveyed in 2009 in Lassen National Forest.

Site Name	# of Stations	Ranger District	Date, 1st Survey	Date, 2nd Survey
Brown's Ravine Aspen	4	Almanor	6/14/2009	6/26/2009
Coon Hollow Aspen	14	Almanor	6/14/2009	7/1/2009
Philbrook Aspen	10	Almanor	6/14/2009	7/1/2009
Robber's Creek Aspen	16	Almanor	5/28/2009	6/23/2009
Ruffa Aspen	12	Almanor	6/14/2009	7/1/2009
West Dusty Aspen 1	10	Almanor	5/26/2009	6/21/2009
West Dusty Aspen 2	6	Almanor	5/28/2009	6/24/2009
West Dusty Aspen 3	8	Almanor	5/26/2009	6/24/2009
West Dusty Aspen 4	8	Almanor	5/26/2009	6/21/2009
Willow Creek Aspen	9	Almanor	5/28/2009	6/21/2009
Butte Creek Aspen	8	Eagle Lake	5/27/2009	6/30/2009
Crazy Harry Aspen	7	Eagle Lake	5/29/2009	6/30/2009
Feather Lake Aspen	5	Eagle Lake	5/29/2009	6/30/2009
Harvey Valley Aspen	15	Eagle Lake	5/28/2008	6/20/2008
Lower Pine Creek Aspen	12	Eagle Lake	5/27/2009	6/22/2009
Martin Creek Aspen	11	Eagle Lake	5/25/2009	6/29/2009
Pine Creek Aspen	14	Eagle Lake	5/27/2009	6/22/2009
Susan River Aspen	12	Eagle Lake	5/29/2009	6/29/2009

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. However, 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 point 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 by dividing the total number of detections within 50 meters by the number of stations and the number of visits.

Index of Species Abundance

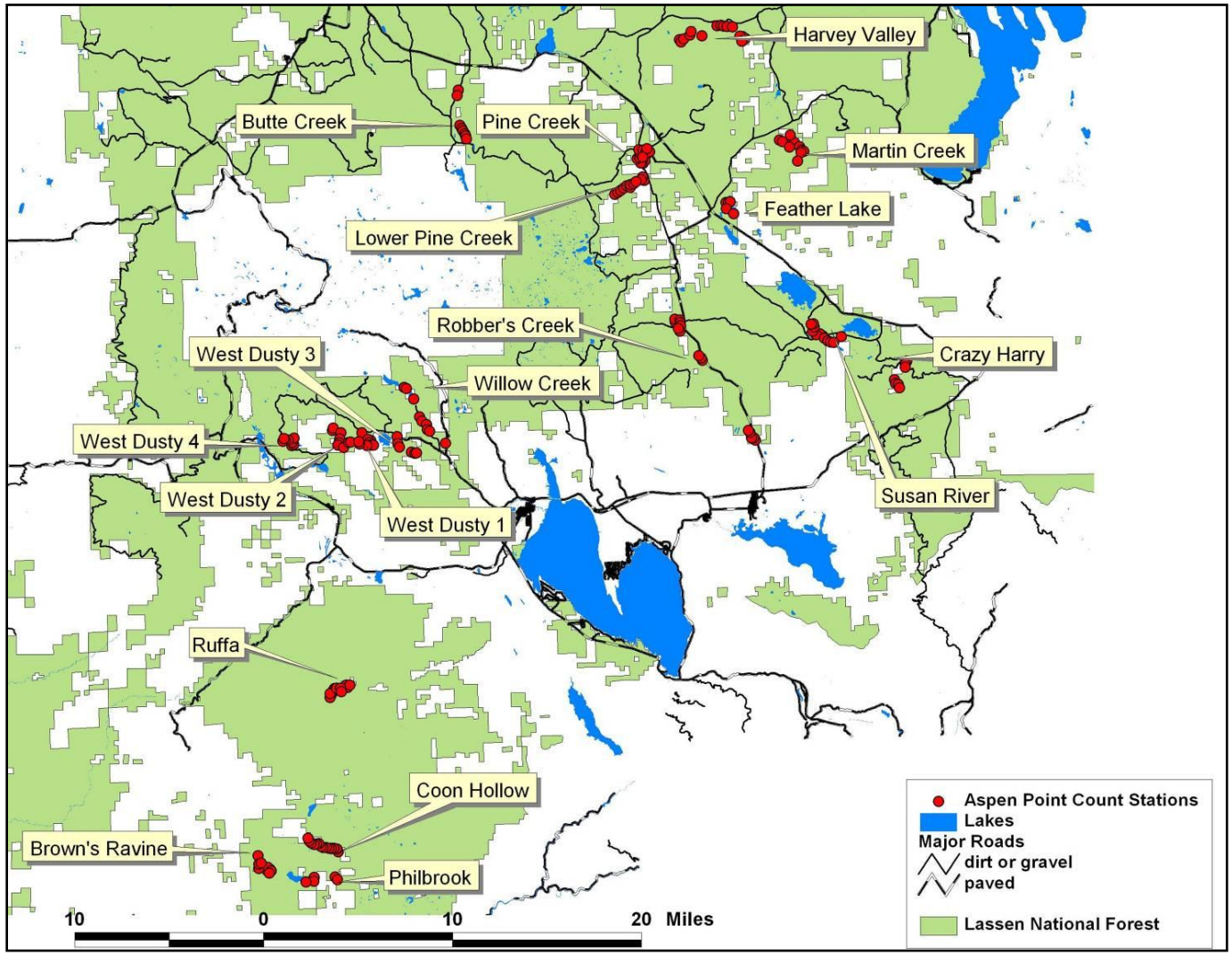
An index of the abundance of species was calculated as the total detections of a given species within 50m of an observer per point count visit. For sites with multiple years (most) we summed the detections and then divided by total visits across years versus averaging the means for each year.

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 was 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 an $\alpha = 0.05$ level. Stata 10.0 statistical software was used to conduct all statistical analyses (Stata Corp 2007).

Figure 1. Location of PRBO Aspen point count stations in the Lassen National Forest surveyed in 2009.



Results

In 2009, total bird abundance in aspen stands monitored across the two ranger districts ranged from a high of 7.83 at Ruffa Aspen to a low of 2.86 at Crazy Harry, and species richness ranged from 10.67 at Ruffa Aspen to 4.29 at Crazy Harry (Table 2). The mean total bird abundance by transect in 2009 was 5.29 while the mean species richness was 7.23. In comparison, total bird abundance in upland unburned habitat in the Plumas-Lassen study area in 2009 was 5.08 and species richness was 6.37.

We compared the total bird abundance and species richness at untreated aspen sites in the ARD to untreated aspen sites in the ELRD in 2009. Species richness was 7.98 in the ARD and 6.60 in the ELRD. Total bird abundance in the ARD was 5.84 compared to 4.90 in the ELRD (Figure 2); these differences were not statistically significant. When sites in both ranger districts that have been treated were included, both species richness and total bird abundance decreased slightly in both districts but these changes were not statistically significant (Figure 2).

When data from all years were combined, total bird abundance and species richness were higher at treated sites compared to untreated sites on the Eagle Lake Ranger District between 2006 and 2009 (Figure 3). Across this four year period, total bird abundance averaged 5.54 at treated sites and 4.53 at untreated sites ($F = 4.25$, $p = 0.04$). Species richness at treated sites averaged 6.99 compared to 6.33 at untreated sites ($F = 0.81$; $p<0.37$).

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 – 2009. 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.

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

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 2009 with standard error.

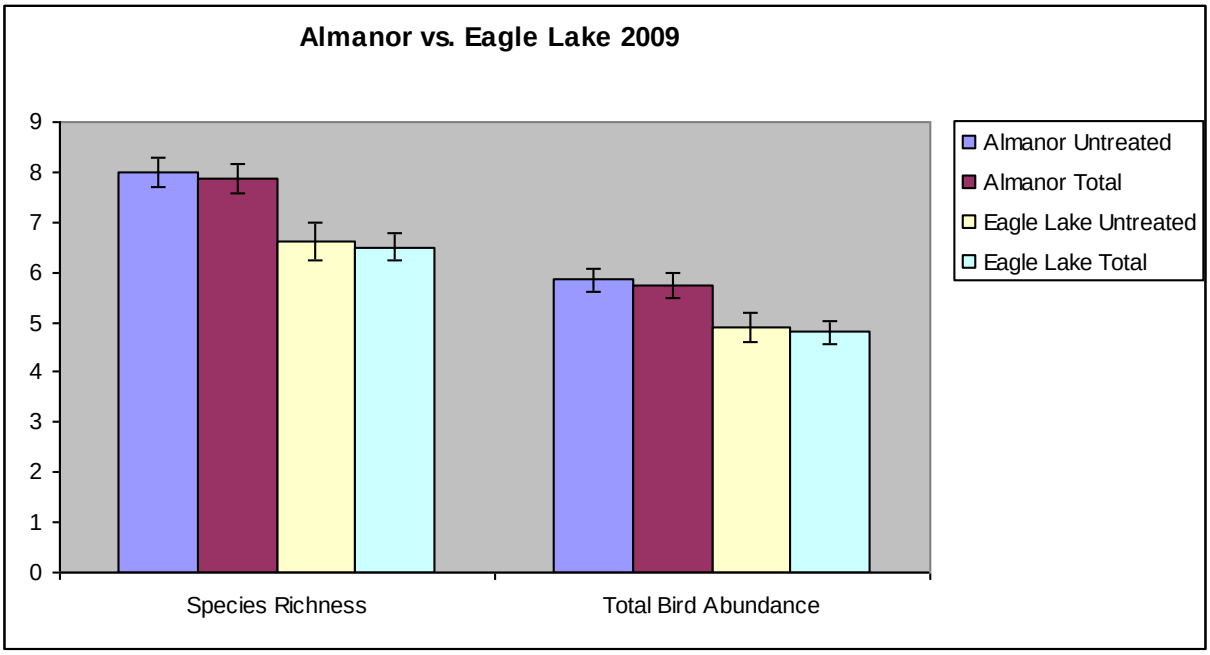
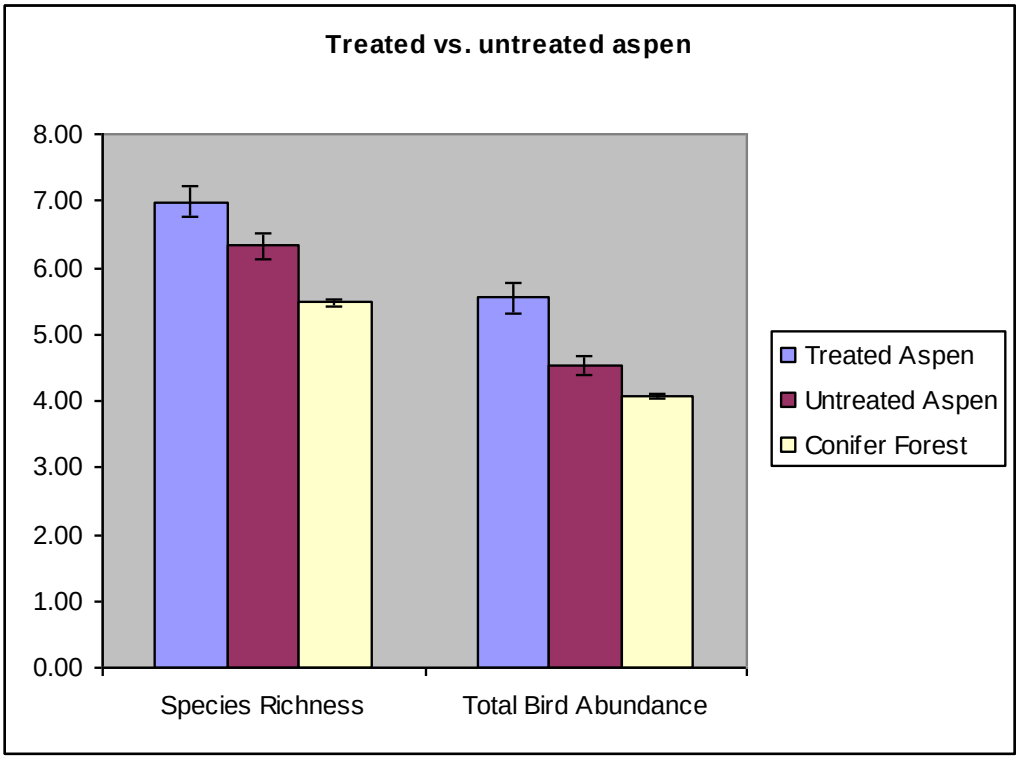


Figure 3. Mean per point species richness and total bird abundance at treated and untreated aspen sites on the Eagle Lake Ranger District from 2006 – 2009 compared to coniferous forest in the Plumas-Lassen study area from 2003 – 2006 with standard error.



Species richness decreases substantially in 2009 at treated sites on ELRD to its lowest value since the beginning of the study (Figure 4). Including a quadratic term for year improved model fit ($F = 8.2$, $p = 0.005$). Species richness at untreated sites on ELRD continued to show a significant increasing linear trend ($F = 9.6$, $p < 0.002$) between 2004 and 2009. Total bird abundance from 2004 through 2009 at treated sites also decreased to its lowest value since the beginning of the study and including a quadratic term for year improved model fit for this metric as well ($F = 10.0$, $p = 0.002$). Untreated sites continued to show a significant increasing linear trend ($F = 6.63$, $p = 0.01$).

Figure 4. Mean per point species richness (with standard error) at treated and untreated aspen sites from 2004 -2009 in Eagle Lake Ranger District (Lassen National Forest) with standard error and fitted linear and quadratic trend lines.

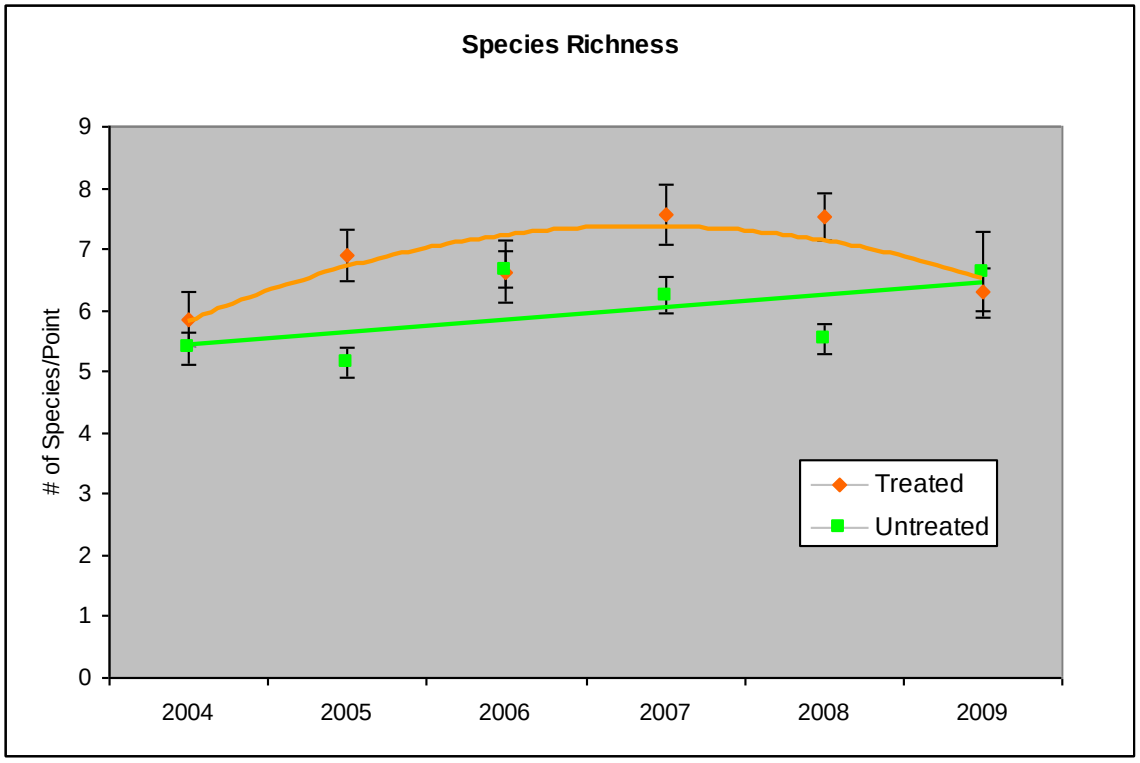
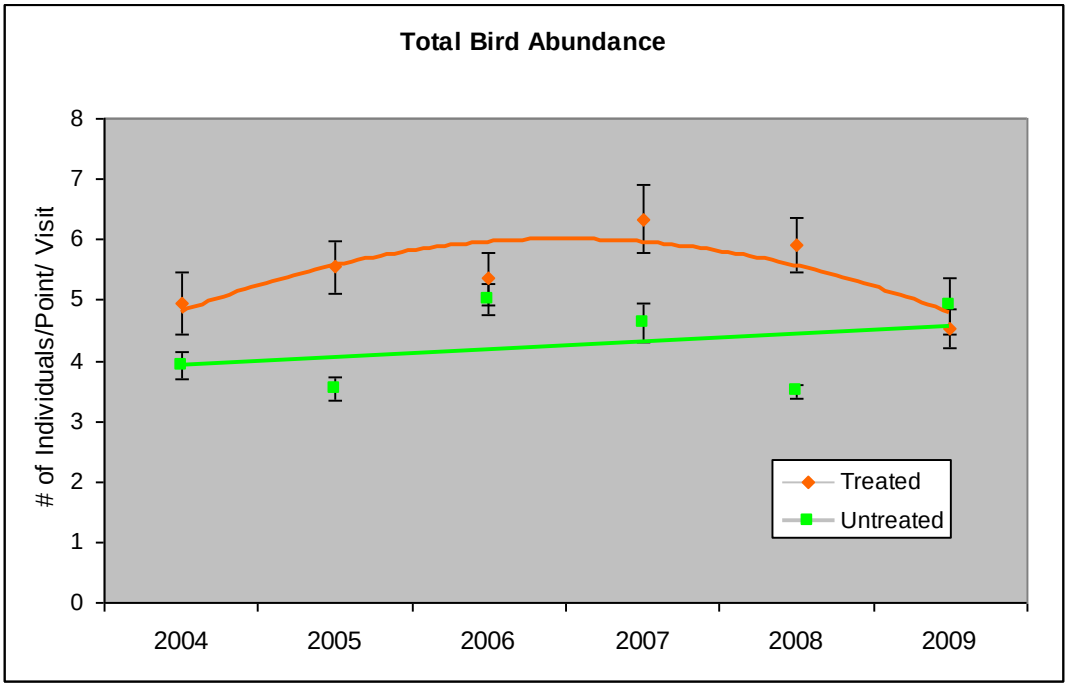


Figure 5. Total bird abundance per point count visit (with standard error) by year at treated and untreated aspen sites from 2004 - 2009 on the Eagle Lake Ranger District (Lassen National Forest) with standard error and fitted linear and quadratic trends.



We investigated an index of the abundance of ten of the twelve previously identified aspen focal species (Burnett *in press*), at treated aspen, untreated aspen, and conifer forest across the six-year study period in both ranger districts. 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, Figure 6). 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. Additionally, total bird abundance was significantly greater in treated stands compared to untreated stands while species richness was similar. Western Wood-Pewee and Warbling Vireo showed a small non-significant difference between treated and untreated aspen though these species were far more abundant in aspen stands than conifer forest. Only two focal species, Dusky Flycatcher and MacGillivray's Warbler, remained more abundant in untreated than treated aspen, with a

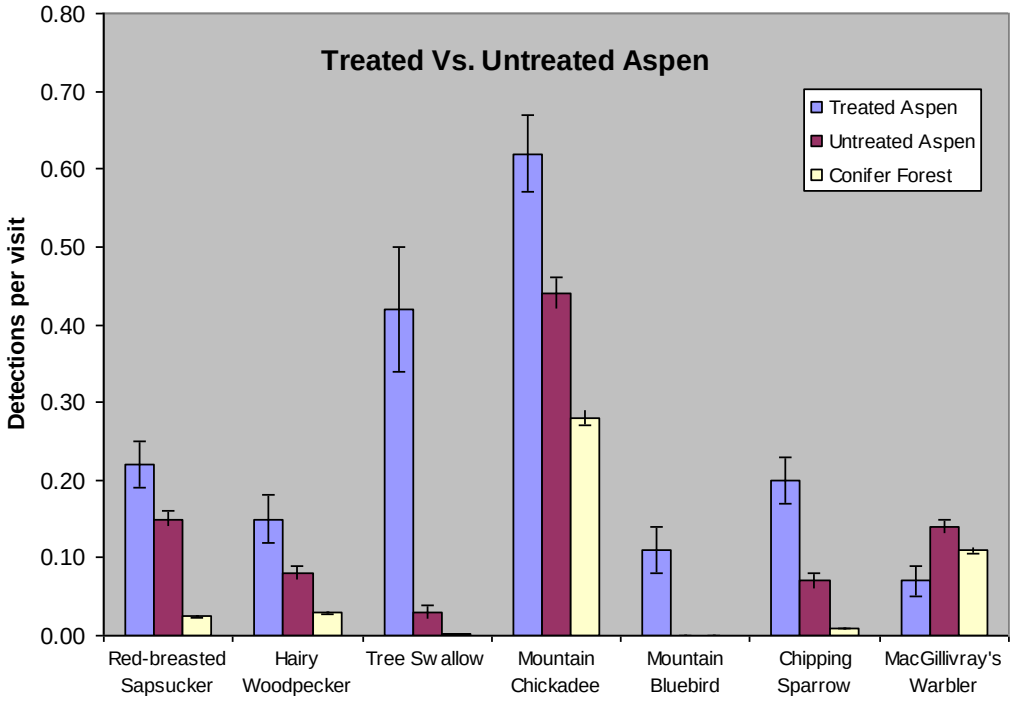
significant difference for MacGillivray's Warbler, and both were similarly abundant in conifer forest as in aspen.

Table 3. Species Richness, total bird abundance, and an index of the abundance of ten aspen focal species at treated and untreated sites across the Lassen National Forest, 2006-2009. P-value is from linear (species richness & total bird abundance) or negative binomial regression (all other metrics) 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	6.94	6.63	0.23	5.47
Total Bird Abundance	5.48	4.76	<0.01	4.08
Red-breasted Sapsucker	0.22	0.15	0.03	0.03
Hairy Woodpecker	0.15	0.08	0.01	0.03
Western Wood-Pewee	0.17	0.16	0.66	0.02
Dusky Flycatcher	0.16	0.20	0.29	0.26
Warbling Vireo	0.52	0.50	0.75	0.09
Tree Swallow	0.42	0.03	<0.01	0.01
Mountain Chickadee	0.62	0.44	<0.01	0.28
Mountain Bluebird	0.11	0.00	<0.01	0.00
Oregon Junco	0.50	0.49	0.82	0.36
Chipping Sparrow	0.20	0.07	<0.01	0.01
MacGillivray's Warbler	0.07	0.14	0.01	0.11

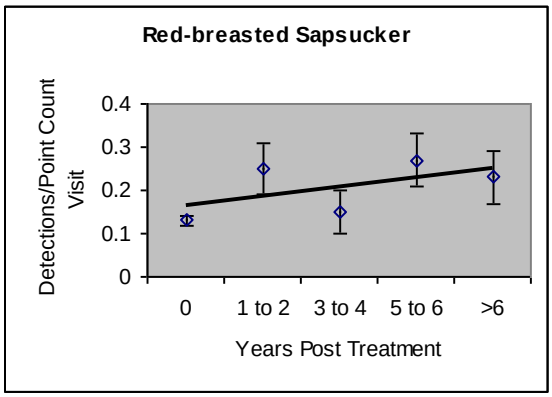
We investigated the effect of time since treatment on total bird abundance and species richness during 2004-2009 for all aspen sites on the Lassen National Forest while controlling for year. When all treated and untreated sites are included (with those that have not been treated coded as zero) there is a significant positive effect ($F = 15.0$, $p<0.01$) of time since treatment on total bird abundance (Figure 7). When untreated sites were not included there was no effect of time since treatment ($F = 0.07$, $p = 0.79$) on total bird abundance. For species richness, the effect of time since treatment was positive and significant when untreated sites were included ($F = 4.96$, $p = 0.03$; Figure 8), but was not when they were excluded ($F = 1.41$, $p = 0.24$). This pattern is consistent with what we have observed in previous years.

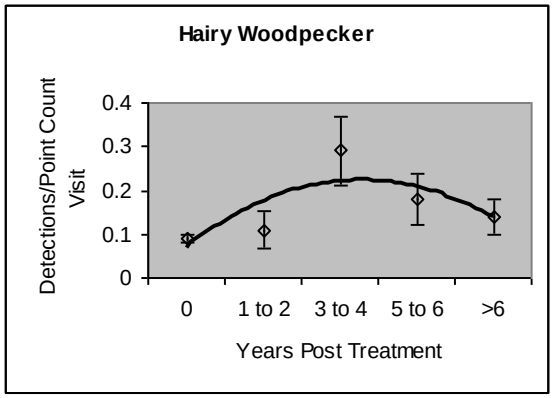
Figure 6. Abundance per point count visit ± standard error for the seven aspen focal species with a significant difference in abundance ($p<0.05$) between treated and untreated aspen stands in the Lassen National Forest from 2006-2009. Conifer habitat indices are shown for comparison using data from the Plumas-Lassen Administrative Study from 2003 – 2006.

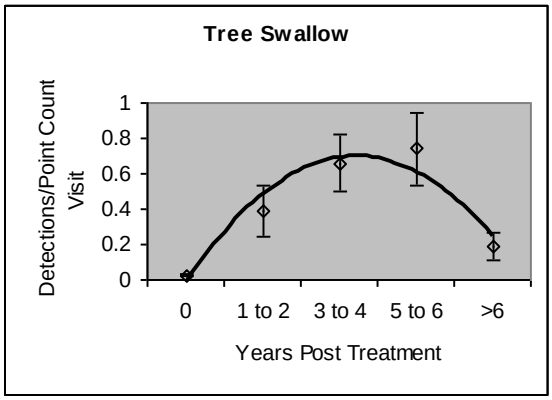


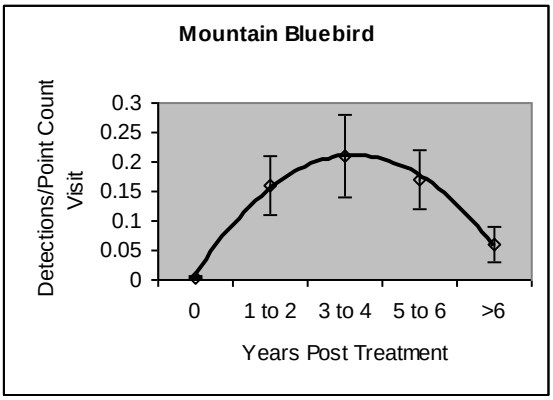
The time since aspen stands had been treated had a significant effect on the abundance of six of the ten focal species (Figure 9). For Red-breasted Sapsucker and Chipping Sparrow the effect was positive and the best fit was linear. For each of the other five species the effect was more complex. For Hairy Woodpecker, Tree Swallow, Mountain Bluebird, and Dusky Flycatcher, the best fit model was one with a quadratic effect of treatment. For all of these except Dusky Flycatcher there was an increasing trend peaking in the four to five year post treatment period followed by a significant decrease after that. Dusky Flycatcher was the only species to show a negative effect of time since treatment; it decreased in the years immediately following treatment but showed an increase in abundance in the longest time since treatment interval. MacGillivray's Warbler also showed a weakly significant ($p = 0.06$) negative linear trend with time since treatment.

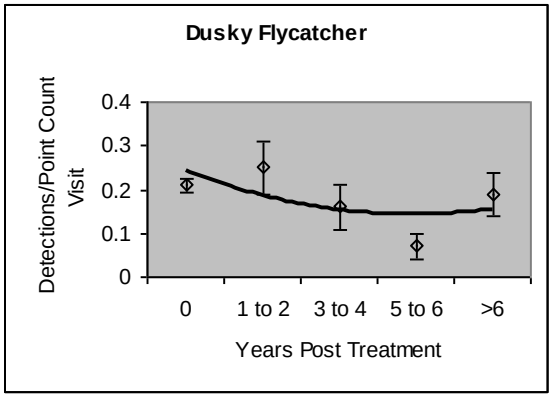
Figure 9. The mean abundance per point count visit with standard error and predicted values for the six focal species showing a significant effect of time since treatment from 2004 - 2009. Graphs show time since treatment in intervals for illustrative purposes but regression was conducted with all data. All aspen sites surveyed on the Lassen National Forest are included. All untreated sites were coded as zero years post treatment.

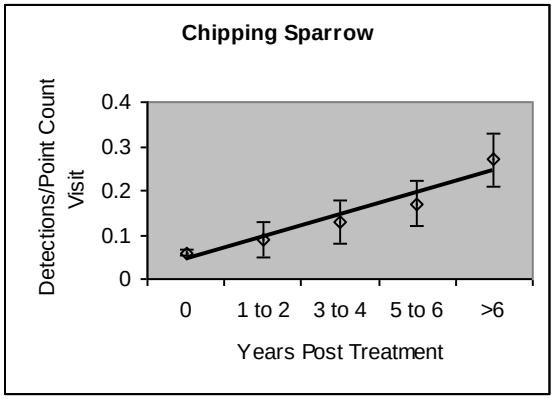








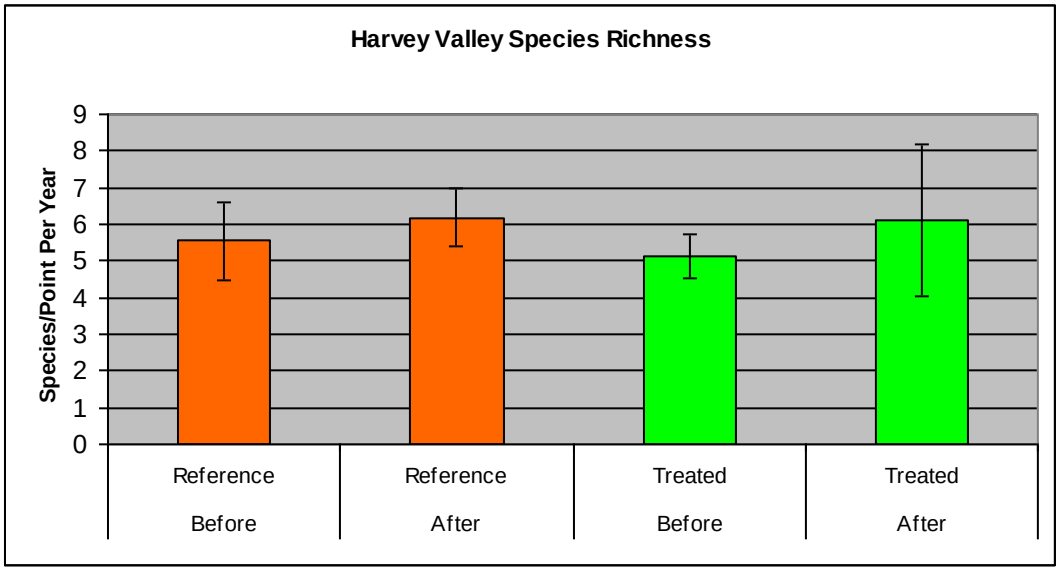


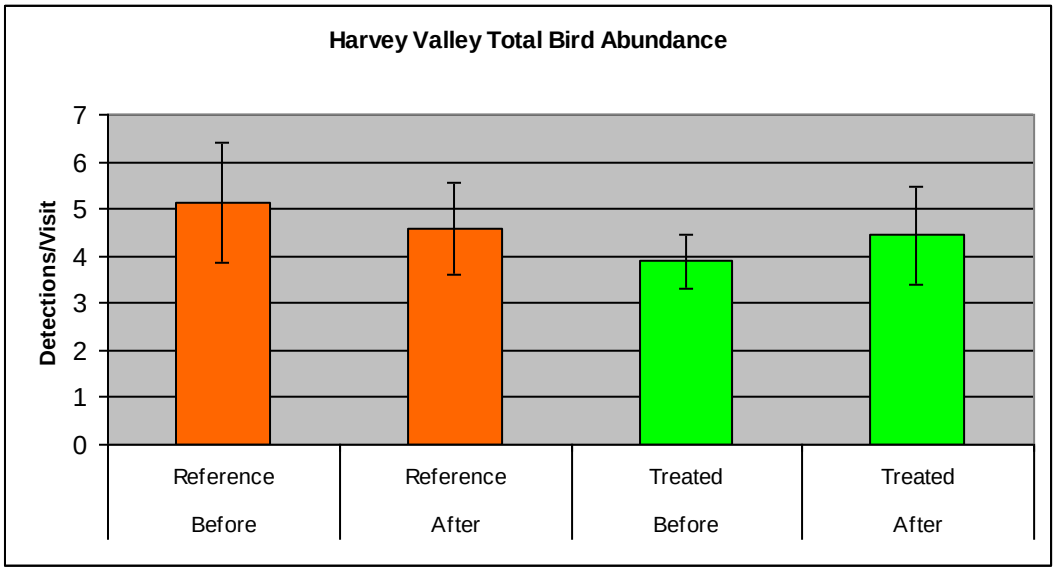


In Harvey Valley, species richness and total bird abundance increased following treatment (Figure 10). Species richness increased at treated sites 19% over pre-treatment levels while untreated sites increased 11%. Total bird abundance increased 14% at treated sites

following treatment while it decreased 11% at untreated sites. Due to relatively small sample size (15 total points) none of these differences were statistically significant.

Figure 10. Species richness and total bird abundance at six reference and nine treated sites before (2004-2007) and after (2009) 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.

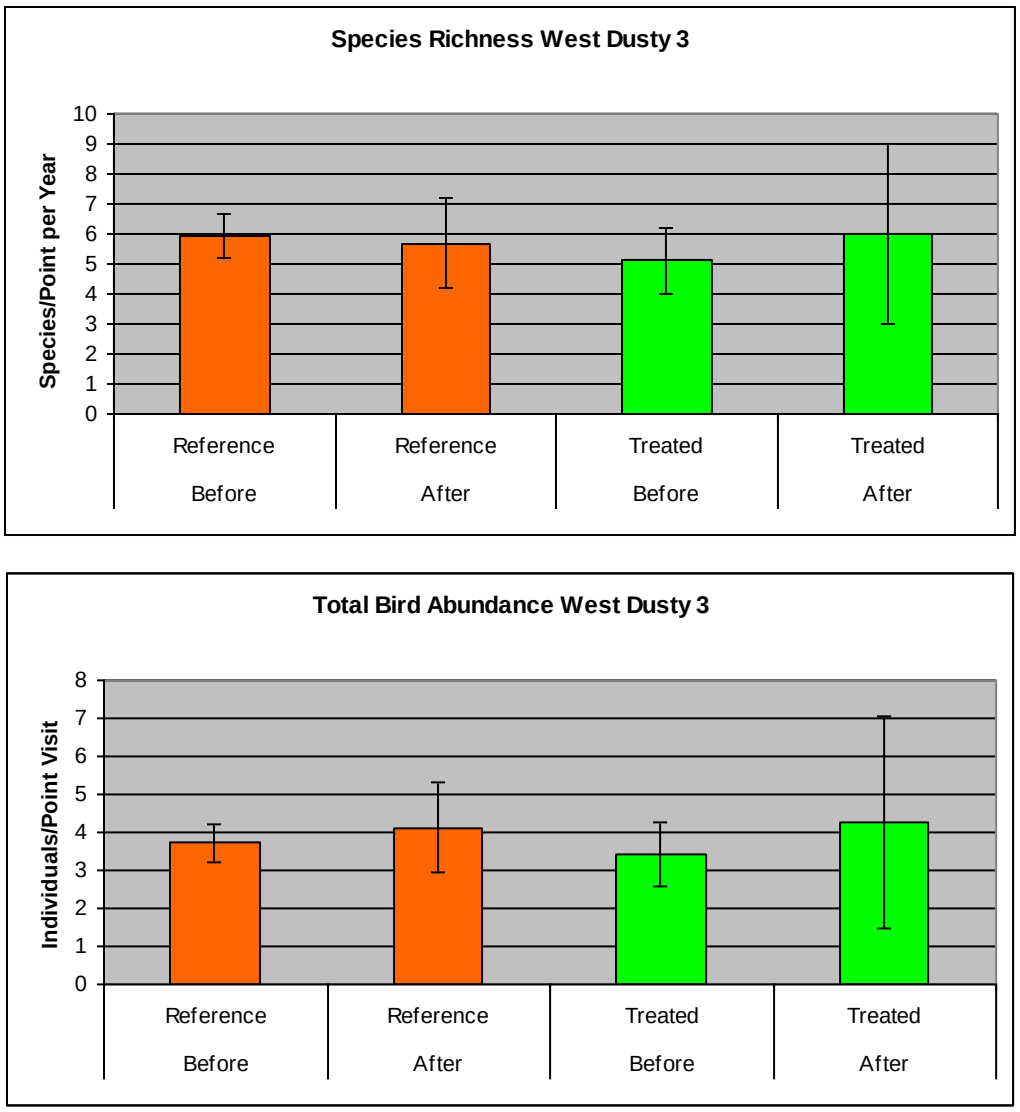




Similar to Harvey Valley, treated stands in the Feather aspen project on the ARD showed a modest increase in 2009 the first year after treatment was implemented (Figure 11). Species richness increased at treated sites 17% while it declined 4% at untreated sites. Total bird

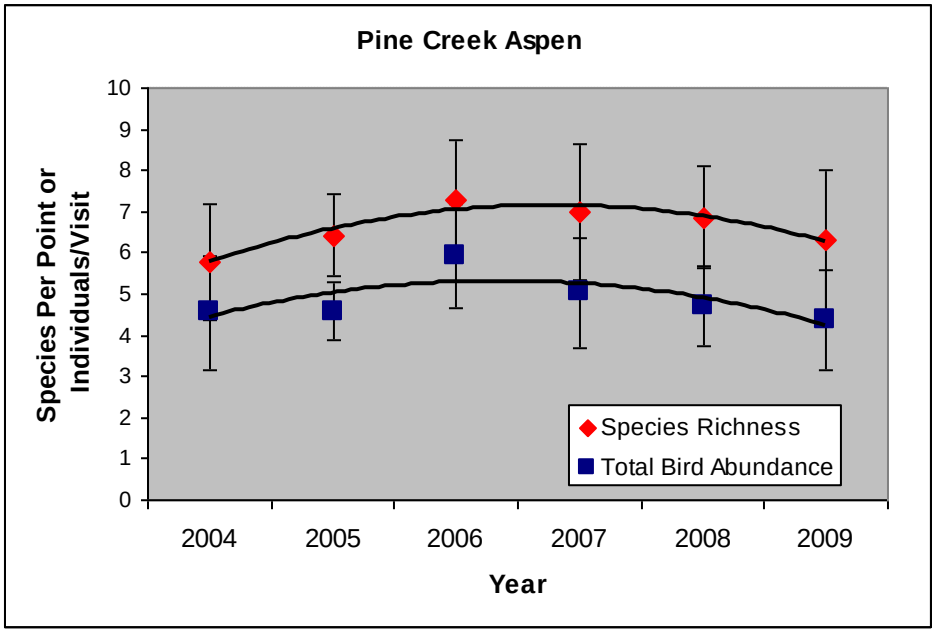
abundance increased 24% at treated sites while it increased 11% at untreated sites. Again, with small sample sizes none of these differences were statistically significant.

Figure 11. Species richness and total bird abundance at nine treated aspen sites and five untreated aspen sites in the Feather aspen restoration project with 95% confidence intervals. All sites were treated in the fall of 2008.



At the Pine Creek aspen site, the trends in species richness and total bird abundance have been decreasing in the last three years from highs recorded in 2006 and in 2009 were at similar levels to those recorded in 2004 (Figure 12). The inclusion of a quadratic term in the model did significantly improve the fit compared to a linear model.

Figure 12. Mean per point species richness and total bird abundance (<50m from observers) at the Pine Creek Aspen transect from 2004 – 2009 with 95% confidence intervals. The majority of treatment was implemented in the winter of 2003/2004, fall 2006, and winter 2007/2008.



Discussion

Aspen habitat on the Lassen National Forest harbors greater total bird abundance, species richness, and abundance of almost all of the aspen focal species compared to conifer-dominated forest in the region. On average, aspen habitat on the ARD harbored greater species richness and total bird abundance compared to the ELRD, though there continues to be considerable site to site and annual variation in these indices as well as in the abundance of individual species.

Treated vs. Untreated

In the ELRD, the short term response of the avian community to aspen treatments has been decidedly positive. From 2004 - 2009 species richness and total bird abundance showed a significant increase at both treated and untreated aspen. However, in 2009 these consistent increasing trends showed a downturn at treated sites while they continued to increase at untreated sites. The fit of the trend at untreated site is not as good as that for treated sites with considerable annual variation. The untreated sites used as reference sites have almost all been released from livestock grazing pressure which has been shown to result in an increase in bird species richness and the abundance of many of our aspen focal species (Earnst et al. 2006). Thus they may be

undergoing passive restoration resulting in the observed increasing trends. As for the decline in richness and abundance at treated sites in 2009, it appears as though the short-term benefits of aspen treatments may be rather short-lived. However, due to potential bias in how treated sites were selected and the lack of true controls (untreated sites have been switching into the treated sample as more sites get treated) and the potential bias in how sites are selected for treatment by the Forest Service (selecting poorer quality sites with unhealthier aspen), we continue to advise some caution in interpreting these trends.

However, based on several recently treated sites, the pattern of an immediate increase following treatment followed by a slow but steady declines remains consistent. For example, Harvey Valley, treated in winter 2007-2008 showed an increase in richness and abundance in 2009 compared to the mean from the four years prior to treatment as did West Dusty 3 (part of the Feather project treated in 2008) on the Almanor Ranger district. However, Pine Creek showed a substantial decrease in 2009 from previous years. The decline at this site may be a result of the riparian areas being treated in 2007, further reducing the habitat for conifer associated species; but we also observed a decline here in many of the focal species in 2009. We also observed decreases in these metrics at Feather Lake in 2009. We had originally hypothesized treatments would result in a decrease in species richness and 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. As the Pine Creek and Feather Lake represent 45% of our treated sample and the majority of our older sites, the decreases observed here in 2009 appear to be driving the overall trends. Continued monitoring will help provide greater insight into these patterns in order to more fully determine the response of the avian community to treatments over time.

While we documented declines of many focal species in treated stands in 2009, the overall abundance of most of the focal species from 2006 – 2009 are still higher at treated sites than at untreated. All of the seven 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 in 2009. This species often nests in understory trees in areas with a substantial herbaceous layer where it forages on insects and seeds (Middleton 1998).

Thus, treated aspen stands appear to be ideal habitat for this species, which is very rare 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 are 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 key to improving habitat for MacGillivray's Warbler – as they are rarely found in aspen stands away from riparian areas. They are quite abundant at Martin Creek in the treated and fenced stand with a dense understory. Removing conifers from riparian zones that can support deciduous riparian vegetation and reducing the grazing in order to allow a dense understory to return will benefit this species and likely a number of bird species that rely on this unique but limited habitat.

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). While aspen often contain relatively high numbers of 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). 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. At numerous treated aspen – including those at Feather Lake, Butte Creek, Pine Creek, and Martin Creek – we confirmed active woodpecker nest cavities within treated stands. In 2008 we documented seven species of woodpecker present during one visit to the Pine Creek transect (Hairy, Downy, White-headed, Black-backed, Pileated, Northern Flicker, and Red-breasted Sapsucker). 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. There is little doubt that aspen supports far greater abundance of woodpeckers than coniferous forest and that treating aspen results in even greater increases in these species of management interest. In turn, 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, 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 once 2009 data, including five treated sites on the ARD were added. The best fit models for four of the six species showing a significant effect of time since treatment included a quadratic term. For three of these species their abundance peaked in the three to four years post-treatment time period and then declined in the following time intervals. This suggests the immediate positive increase after aspen treatments may be relatively short-lived for at least some species and mimics the general pattern observed with species richness and total bird abundance. However, it is important to remember that that the post-treatment sample is relatively small (42 sites in 2009) and any inherent biases in how sites were chosen for treatment could easily be magnified in this analysis.

These patterns 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). 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 2009 continue to suggest that aspen treatments employed on the LNF are having a positive effect on the aspen breeding bird community. Key species such as Red-breasted Sapsucker, Mountain Bluebird, 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. We also 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.

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