Chapter 1. Landbird Monitoring of Fuel Treatments on the Lassen National Forest

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Background and Introduction

The Records of Decisions for the Sierra Nevada Forest Plan Amendment and Herger Feinstein Quincy Library Group (HFQLG) Forest Recovery Act direct the Forest Service to maintain and restore old forest conditions that provide habitat for a number of plant and animal species (HFQLG 1999, SNFPA 2001, 2004). Simultaneously, they direct the Forest Service to take steps to reduce risks of large and severe fire by removing vegetation and reducing fuel loads in overstocked forests. Striking a balanced approach to achieving these potentially competing goals is a significant challenge to effectively accomplish the various desired outcomes of forest management.

Historically, fire was the primary force responsible for creating and maintaining habitat diversity and landscape heterogeneity in the Sierra Nevada (Skinner and Chang 1996). Over the past century, fire return intervals have been lengthened and the area affected by wildfire annually has been dramatically reduced in the interior mountains of California (Taylor 2000, Taylor and Skinner 2003, Stephens et al. 2007). Thus, there is little doubt fires role in influencing the composition of the Sierra Nevada landscape has been reduced (Skinner and Chang 1996).

Fire suppression in concert with past silvicultural practices has resulted in increased stand densities, loss of landscape heterogeneity, and increased fuel loads in Sierra Nevada Forests (Vankat and Major 1978, Parsons and DeBenedetti 1979, McKelvey and Johnston 1992, Minnich et al. 1995, Taylor and Skinner 2003). While the ways in which these changes affect fire patterns and vegetation dynamics are frequently discussed, they also undoubtedly impact the wildlife species that inhabit these forests.

Mechanical silvicultural treatments have the potential to fill some of fire's historic role in maintaining disturbance-dependent habitats (Weatherspoon 1996, Arno and Fiedler 2005). There has been considerable study of silvicultural treatments and their effects on landbirds in eastern North American forests (Anand and Thompson 1997, King et al. 2001, Fink et al. 2006, Askins et al. 2007) and the Cascades (Hansen et al. 1995, Hagar et al. 2004, Chambers et al. 2007), but little published information exists on the effects of mechanical fuel treatments on the avian community in the Sierra Nevada (but see Siegel and DeSante 2003 and Garrison et al. 2005).

By monitoring the populations of a suite of landbird species we can measure the effectiveness of management actions in achieving a sustainable and ecologically functional forest ecosystem. Specifically, we are interested in determining the responses of landbirds to management practices intended to produce forests with larger trees and high canopy cover along with more open-canopy, smaller size class forest with reduced ladder and ground fuels.

In this report we summarize our efforts in 2009 intended to investigate landbird response to changes in vegetation structure and composition that occur when forests are managed to reduce fuels under the Herger Feinstein Quincy Library Group Forest Recovery Act Pilot Project (HFQLG 1999). We summarize what surveys were completed in 2009, the treatment history at each site, and some preliminary analysis of bird community indices by treatment type. We compared community indices and most abundant species among treatment types and between paired treated and reference sites. Future analyses will be more comprehensive, combining data with those from the larger HFQLG region in which PRBO is collecting bird data (e.g., Plumas National Forest). Future analysis will also include analysis of the longer-term effects of fuel treatments on the avian community.

Methods

Study Location

The study occurred in the Lassen National Forest within the boundaries of the HFQLG Forest Recovery Act Pilot Project with the exception of the Wiley Ranch sites. The study sites encompassed portions of Butte, Lassen, Plumas, Shasta and Siskiyou (Wiley Ranch) Counties at the intersection of the Sierra Nevada and Cascade mountains of Northeastern California, USA (Figure 1). Survey sites ranged in elevation from 1362 to 2074m with a mean elevation 1628m. All sites occurred within the mixed conifer, true fir, and yellow pine zones though the actual habitat structure and dominant tree species varied by site. A total of 519 point count stations across 49 transects was surveyed in 2009 (Figure 1 and Table 1).

Figure 1. Location of of PRBO's fuel treatment avian monitoring study sites in the Lassen National Forest. Black dots are point count stations and the Lassen National Forest is the area in green. Note, Brown's Ravine study area includes Lower, Middle and Upper Oak Reference transects. Wiley Ranch is located approximately 20km north of the map on the Shasta Trinity National Forest but is administered by the Lassen National Forest.

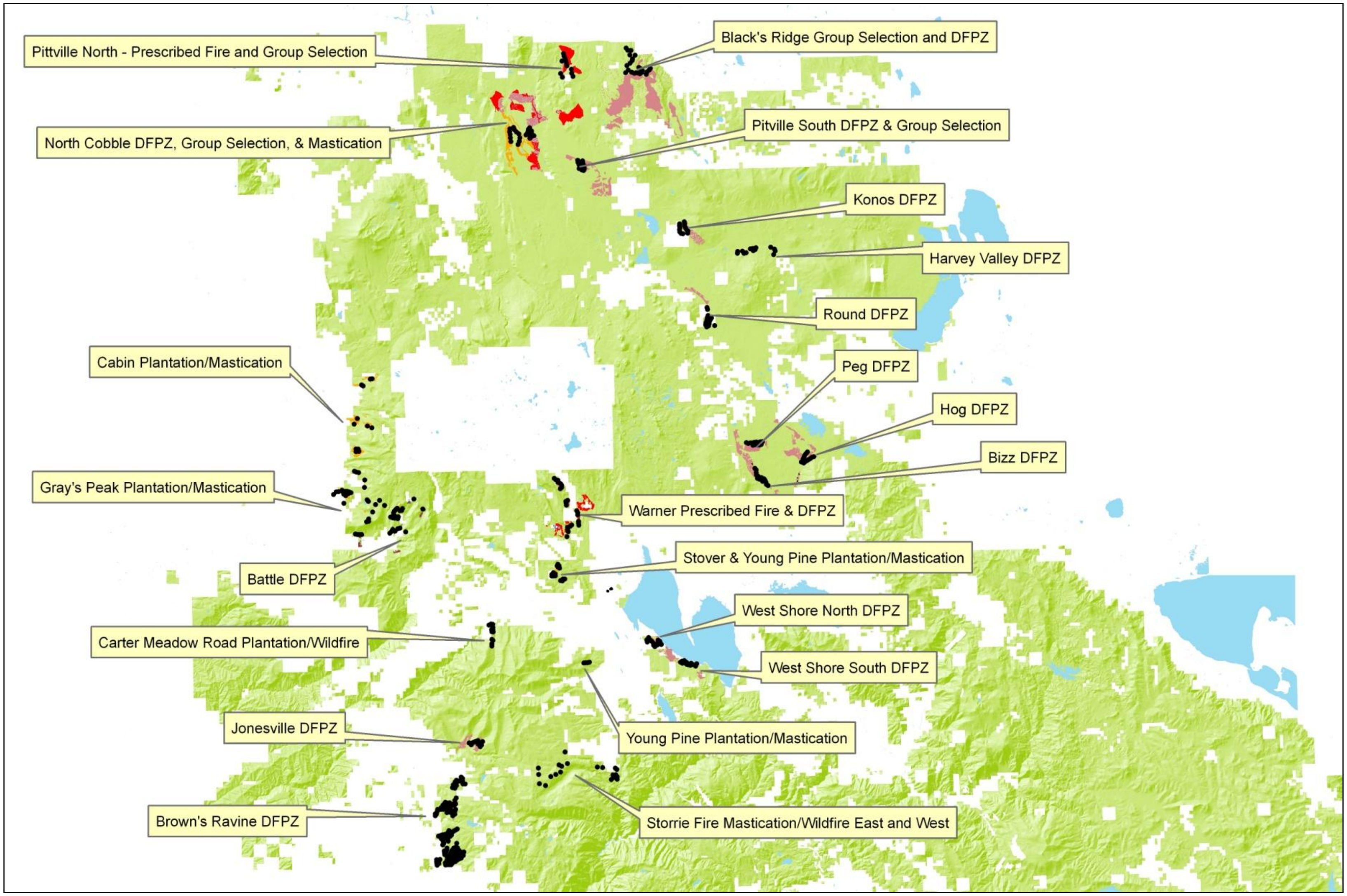


Table 1. Fuel treatment point count transects, Lassen National Forest 2009. Summary of transect, number of points per transect, treatment type and details, if treatment has occurred, and year of treatment.

Transect	Code	# Points	Ranger District	Treatment Type	Treated	Year Treated
Battle	BATL	13	Almanor	DFPZ	yes	2004
Bizz DFPZ	BIZD	7	Eagle Lake	DFPZ	yes	2005
Bizz Reference	BIZR	7	Eagle Lake	Reference	n/a	
Black's Ridge DFPZ	BRDZ	12	Hat Creek	DFPZ	yes	2004
Black's Ridge Group Selection	BRGS	12	Hat Creek	Group Selection	yes	2008
Cabin Mastication	CBMA	11	Hat Creek	Plantation/Mastication	yes	2006
Carter Meadow Road	CMRO	12	Almanor	Wildfire	n/a	(2008)
Gray's Peak Central	GPCE	10	Almanor	Plantation/Mastication	no	
Gray's Peak East	GPEA	14	Almanor	Plantation/Mastication	no	
Gray's Peak West	GPWE	13	Almanor	Plantation/Mastication	no	
Hog DFPZ	HOGD	7	Eagle Lake	DFPZ	yes	2004
Hog Reference	HOGR	7	Eagle Lake	Reference	n/a	
Harvey Valley DFPZ	HVD	7	Eagle Lake	DFPZ	no	
Harvey Valley Reference	HVR	7	Eagle Lake	Reference	n/a	
Jonesville DFPZ	JVDZ	12	Almanor	DFPZ	yes	2005/2006/2007
Konos DFPZ	KOND	7	Eagle Lake	DFPZ	yes	2007
Konos Reference	KONR	7	Eagle Lake	Reference	n/a	
Lower Oak Reference	LOKR	32	Almanor	Reference	n/a	
Middle Oak Reference	MOKR	6	Almanor	Reference	n/a	
North Cobble DFPZ	NCDZ	12	Hat Creek	DFPZ/Group Selection	yes	2006
North Cobble Mastication	NCMA	12	Hat Creek	Plantation/Mastication	yes	2007
Brown's Ravine Oak Stand 1	OAK1	7	Almanor	DFPZ	yes	2005
Brown's Ravine Oak Stand 2	OAK2	14	Almanor	DFPZ	yes	2005
Brown's Ravine Oak Stand 3	OAK3	10	Almanor	DFPZ	yes	2005
Brown's Ravine Oak Stand 4	OAK4	14	Almanor	DFPZ	yes	2006/2007
Brown's Ravine Oak Stand 5	OAK5	7	Almanor	DFPZ	yes	2006/2007
Brown's Ravine Oak Stand 6	OAK6	6	Almanor	DFPZ	no	
Brown's Ravine Oak Stand 7	OAK7	8	Almanor	DFPZ	no	
Brown's Ravine Oak Stand 8	OAK8	7	Almanor	DFPZ	no	
Brown's Ravine Oak Stand 9	OAK9	6	Almanor	DFPZ	yes	2006/2007
Peg DFPZ	PEGD	7	Eagle Lake	DFPZ	no	

Transect	Code	# Points	Ranger District	Treatment Type	Treated	Year Treated
Peg Reference	PEGR	7	Eagle Lake	Reference	n/a	
Pittville North DFPZ	PNDZ	12	Hat Creek	Group Selection/Prescribed Fire	yes	2005/2008
Pittville South DFPZ	PSDZ	12	Hat Creek	DFPZ/Group Selection	yes	2005
Round DFPZ	RNDD	8	Eagle Lake	DFPZ	yes	2005
Round Reference	RNDR	7	Eagle Lake	Reference	n/a	
Storrie Fire Mastication East	STME	10	Almanor	Plantation/Mastication	no	fall 2009
Storrie Fire Mastication West	STMW	11	Almanor	Plantation/Mastication	no	
Stover	STVR	12	Almanor	Plantation/Mastication	yes	2007
Upper Oak Reference	UOKR	36	Almanor	Reference	n/a	
Warner Burn	WABU	12	Almanor	Prescribed Fire	yes	2006
Warner DFPZ	WADZ	12	Almanor	DFPZ	yes	2006/2007
Wiley Ranch North	WRNO	16	Hat Creek	DFPZ	no	
Wiley Ranch South	WRSO	16	Hat Creek	DFPZ	no	
West Shore North DFPZ	WSND	8	Almanor	DFPZ	yes	2002/2004
West Shore North Reference	WSNR	6	Almanor	Reference	n/a	
West Shore South DFPZ	WSSD	9	Almanor	DFPZ	yes	2002/2004
West Shore South Reference	WSSR	4	Almanor	Reference	n/a	
Young Pine	YOPI	8	Almanor	Plantation/Mastication	no	
TOTAL		**519**				

Site Selection and Treatment History

We combined data across multiple projects on the Almanor, Eagle Lake, and Hat Creek Ranger Districts of the Lassen National Forest (Table 1) to investigate the effects of HFQLG treatments on landbirds. Treatments included Defensible Fuel Profile Zones (DFPZ), Group Selection, Plantation/Mastication, and fire (prescribed and wild) (Table 2). Treatments, and specific treatment histories at given transects and point count stations, are summarized in Table 1.

Table 2. Forest treatment types in the Northern Sierra Nevada for which the response of landbirds was investigated in 2009.

Treatment	Description
Defensible Fuel Profile Zones (DFPZ)	Mechanically created shaded fuel break, generally linear in shape; affects more acres than any treatments in our study area.
Group Selection	Removal of all overstory trees in 0.5 – 2 acre area, sometimes embedded within a DFPZ network.
Plantation/Mastication	Plantings of Ponderosa Pine. Mechanical shredding of shrubs that sometimes uproots shrubs but often leaves plants alive below ground to regenerate.
Burn	Generally low intensity human ignited burning. Generally consumes understory fuels and some middle story trees. Some sites experienced wildfire or backfires set during a wildfire.

DFPZ treatments monitored on the Eagle Lake Ranger District were established in 2004 after consulting ranger district staff and available GIS layers. We selected 6 sites that were slated for treatment in the next several years. At each treatment area we established between 5 to 7 point counts inside of treatment boundaries and 5 to 8 sites in similar habitat at least 100m outside the treatment but within 500m of the treated area (see Burnett et al. 2004).

A similar protocol was used for the Brown's Ravine Black Oak enhancement DFPZ project in the Almanor Ranger District of the Lassen (Table 1). In this project, treatment units were larger so we filled each unit with points spaced 220m apart. Each unit contained between 5 and 14 points. Reference sites were established in adjacent units where no treatment was planned (Burnett et al. 2004).

In 2009, 21 new transects comprising 261 point-count stations were added to the project (Table 1) in the Almanor and Hat Creek Ranger Districts. We had already established six transects in DFPZ's on the Eagle Lake rangers district in 2004, of which five had already been treated so we did not add additional sites in that district in 2009. We used GIS layers of the boundaries of fuel projects that had already been implemented to select new monitoring sites in the Almanor and Hat Creek ranger districts. We chose projects that had been completed in the past five years and were large enough to contain a minimum of 8 point count stations spaced 250m apart. We also selected projects in order to obtain a sample of each of the four treatment types described in Table 2 above. In addition to the previously treated fuel treatment sites, we also established transects within the proposed Gray's Peak project area and Storrie Fire mastication units on the ARD. We used a similar site selection protocol as described above where GIS layers of unit boundaries were employed to establish points in a way that would maximize the points a person could sample in one morning while covering the majority of treatment units in the project. Additionally three plantation study sites where we had already established monitoring in previous years – Young Pine II, Carter Meadow Road, and Stover (Young Pine I) – are included in this analysis and there site selection was very similar to that already described above. For all of these sites we had no prior knowledge of the site conditions prior to establishing the points. With the exception of the West Shore North and South DFPZ's, we did not establish adjacent reference points for any of these new transects.

For each point count station, we identified the treatment history with respect to four distinct treatment types (Tables 1 & 2). A given treatment was only considered to occur at a point if the point fell inside the treatment polygon. Of the 519 points, 277 had been treated in one or more ways prior to the 2009 point count seasons; the remaining points were considered a combination of sites that have not yet been treated (but will be) or were reference sites paired with treated units (Table 3).

Table 3. The number of point count stations by treatment type in each ranger district in PRBO's Northern Sierra study area in 2009. Each point was visited twice in 2009.

Treatment Type		Almanor	Eagle Lake	Hat Creek
Total	Number of points	319	85	115
DFPZ	Number of points	133	43	58
	Number of post-treatment points	108	29	26
Group Selection	Number of points	0	0	27
	Number of post-treatment point visits	n/a	n/a	27
Mastication	Number of points	78	0	23
	Number of post-treatment point visits	12[1]	n/a	23
Burn	Number of points	24	0	7
	Number of post-treatment point visits	24[2]	n/a	7
Reference	Number of reference points	84	42	0

[1]21 points were treated fall 2009 (after point count surveys complete, [2]12 prescribed burn, 12 wildfire (backfire)

Survey Protocol

We used a standardized five-minute variable circular plot point count census (Reynolds 1980, Ralph et al. 1993, Ralph et al. 1995) to sample the avian community in the study area. In this method, points are clustered in transects, but data were only collected from fixed stations, not along the entire transect.

In 2009, all birds detected at each station during the five-minute survey were recorded according to their initial distance from the observer. Detections were recorded to the nearest meter up to 300 meters. Beyond 300 meters observations were recorded simply as greater than 300 meters. 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 also recorded. All observers underwent intensive 14 day training in bird identification and distance estimation prior to conducting surveys. Laser rangefinders were used to assist in distance estimation at every survey point.

Counts began around local sunrise, were completed within four hours, and did not occur in inclement weather. Each transect was visited twice during the peak of the breeding season from mid-May through the first week of July (Table 4).

Table 4. Dates of point count visits, Lassen National Forest fuel treatment transects 2009.

code	visit 1	visit2
BATL	6/1/2009	6/20/2009
BIZD	5/14/2009	6/21/2009
BIZR	5/14/2009	6/21/2009
BRDZ	6/9/2009	6/18/2009
BRGS	6/9/2009	6/18/2009
CBMA	6/12/2009	6/29/2009
CMRO	6/2/2009	6/24/2009
GPCE	5/30/2009	6/15/2009
GPEA	6/1/2009	6/15/2009
GPWE	5/30/2009	6/15/2009
HOGD	5/15/2009	6/21/2009
HOGR	5/15/2009	6/21/2009
HVD	5/25/2009	6/23/2009
HVR	5/25/2009	6/23/2009
JVDZ	6/1/2009	6/14/2009
KOND	5/16/2009	6/30/2009
KONR	5/16/2009	6/30/2009
LOKR	5/18/2009, 5/19/2009	6/16/2009, 6/17/2009, 6/18/2009
MOKR	5/23/2009	6/25/2009
NCDZ	6/3/2009	6/19/2009
NCMA	6/3/2009	6/19/2009

code	**visit 1**	**visit2**
OAK1	5/18/2009, 5/19/2009	6/16/2009, 6/17/2009
OAK2	5/18/2009, 5/19/2009	6/16/2009, 6/17/2009
OAK3	5/18/2009	6/16/2009
OAK4	5/23/2009	6/25/2009
OAK5	5/23/2009	6/25/2009
OAK6	5/21/2009	6/26/2009
OAK7	5/21/2009, 5/22/2009	6/23/2009, 6/25/2009, 6/26/2009
OAK8	5/21/2009, 5/22/2009	6/23/2009, 6/25/2009
OAK9	5/19/2009	6/17/2009
PEGD	5/16/2009	6/11/2009
PEGR	5/16/2009	6/11/2009
PNDZ	6/10/2009	6/18/2009
PSDZ	6/3/2009	6/19/2009
RNDD	5/16/2009	6/11/2009
RNDR	5/16/2009	6/11/2009
STME	5/24/2009	6/20/2009
STMW	6/11/2009	6/30/2009
STVR	5/29/2009	6/24/2009
UOKR	5/21/2009, 5/22/2009	6/23/2009, 6/25/2009, 6/26/2009
WABU	6/2/2009	6/27/2009
WADZ	6/2/2009	6/27/2009
WRNO	6/12/2009	6/20/2009
WRSO	6/12/2009	6/20/2009
WSND	6/8/2009	6/29/2009
WSNR	6/8/2009	6/29/2009
WSSD	6/8/2009	6/24/2009
WSSR	6/8/2009	6/24/2009
YOPI	6/8/2009	6/24/2009

Statistical Analysis

Annual per-point species abundance, richness, and diversity metrics of birds within 50 meters were summarized for 519 points. We excluded species that are not adequately sampled using the point count method (e.g., waterfowl, shorebirds, kingfisher, and raptors), as well as species not breeding in the region (e.g., Rufous Hummingbird). 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 native bird community. Birds unidentified to species (e.g., XXWA, Unidentified Warbler) were included in abundance estimates and, if the only one of that taxa, in richness estimates, but were excluded from diversity indices.

We define species richness as the mean number of species detected within 50 meters of the observer per point across visits. The index of total bird abundance is the mean number of individuals detected per point 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 (2). Species diversity was measured using a modification of the Shannon-Wiener index (Krebs 1989) introduced by MacArthur (1965), which reflects combined species richness and equal distribution of the species. Diversity can be considered as mean species diversity (average diversity per point). The relative abundance of species is the mean number of detections of a given species per point per visit within 50 meters of observers.

We determined community indices for each transect. We also compared community indices (richness and abundance), as well as the abundance within 50 meters of the ten most common species (at all study sites combined), among treatment types. Means and confidence intervals were generated with StataIC 10.0 (StataCorp 2007). For this, we lumped untreated sites with reference sites as "Untreated/Reference". We assigned points where group selection had occurred inside of another treatment simply as group selection; we lumped prescribed burn and wildfire burned points under the "treatment" category of "Fire". The ten most abundant species were, in order: Mountain Chickadee, Audubon's Warbler, Dusky Flycatcher, Oregon Junco, Red-breasted Nuthatch, Golden-crowned Kinglet, Hermit Warbler, Chipping Sparrow, Western Tanager, and Fox Sparrow.

Additionally, we compared these indices for paired reference versus treated transects using a two-tailed t-test, and included only sites that had been treated prior to the 2009 breeding season; these included Biz, Hog, Konos, Round, West Shore North, and West Shore South (DFPZ and Reference transects, respectively).

Results

Community Indices by Transect

Ninety-six species in total were detected across the 49 transects in 2009. Seventy-nine were used in assessing community indices (17 species were removed because they were not appropriate to assess via the point count method; see *Methods* above).

Community index values were highly variable among transects (Table 5). Diversity values were as low as 0.99 (Wiley Ranch South, untreated DFPZ), with the most diverse sites having diversity values as high as 7.53 (Carter Meadow Road, hand conifer release in 2001 and burned in 2008 Cub fire), 7.63 (Battle, 5 years post DFPZ treatment), and 8.70 (West Shore South Reference). Abundance values ranged from 0.59 birds per point (Wiley Ranch South) to 7.04 (Battle), 7.06 (West Shore South DFPZ, treated in 2002 or 2004), and 7.25 (West Shore South Reference) birds per point. Species richness values ranged from 1.00 (Wiley Ranch South) up to 8.54 (Battle), 8.58 (Carter Meadow Road), and 9.5 (West Shore South Reference).

Table 5. Point count indices for fuel treatment transects, Lassen National Forest 2009.

Station	Diversity (sw)	Abundance (individuals/visit)	Species richness
BATL	7.63	7.04	8.54
BIZD	3.78	2.71	4.00
BIZR	5.40	4.71	6.00
BRDZ	6.70	6.67	7.58
BRGS	3.08	2.00	3.17
CBMA	6.20	6.14	7.00
CMRO	7.53	6.71	8.58
GPCE	5.26	4.35	5.70
GPEA	4.91	4.82	5.57
GPWE	6.85	5.96	7.54
HOGD	3.36	2.57	3.71
HOGR	3.48	2.86	3.71
HVD	4.24	3.21	4.71
HVR	3.79	2.71	4.00
JVDZ	4.96	3.67	5.33
KOND	4.12	3.21	4.43
KONR	5.22	4.07	5.57
LOKR	5.88	4.80	6.38
MOKR	6.41	4.75	6.83
NCDZ	5.04	3.79	5.42
NCMA	3.42	3.17	3.83
OAK1	6.04	4.43	6.57
OAK2	6.75	5.36	7.29
OAK3	6.46	5.35	7.20
OAK4	5.86	4.25	6.29
OAK5	4.62	4.07	4.86
OAK6	5.84	4.17	6.17
OAK7	4.88	3.69	5.25
OAK8	4.97	3.93	5.29
OAK9	4.84	3.00	5.00
PEGD	3.94	3.57	4.43
PEGR	5.31	4.14	5.86
PNDZ	5.74	4.29	6.25
PSDZ	5.33	4.00	5.75

Station	Diversity (sw)	Abundance (individuals/visit)	Species richness
RNDD	2.48	2.00	2.63
RNDR	4.17	3.07	4.43
STME	6.15	5.75	6.80
STMW	5.24	4.05	5.55
STVR	3.86	3.25	4.17
UOKR	6.20	4.93	6.75
WABU	7.31	4.88	7.67
WADZ	6.58	5.21	7.17
WRNO	2.88	1.88	3.00
WRSO	0.99	0.59	1.00
WSND	6.01	5.06	6.75
WSNR	5.16	3.83	5.50
WSSD	7.18	7.06	8.11
WSSR	8.70	7.25	9.50
YOPI	5.18	4.44	5.75

Community Indices between Treated and Untreated Paired Transects

Comparing indices of abundance and richness between paired transects, a general pattern was observed of higher community indices at the reference sites than at the treated DFPZ sites (Figures 2 and 3; Table 5). The mean total bird abundance per point was significantly higher in the reference transect than the treated transect for BIZ (2.71 versus 4.71 birds/pt; t-statistic = -2.77, P = 0.02). The mean richness per point was significantly higher in the reference transect than the treated transect for RND (2.63 versus 4.43 species/pt; t-statistic = -2.31, P = 0.04). Differences also approached significant between treated and reference sites for Bizz, Konos and West Shore South species richness and for Round total abundance; for all, they were again greater in the reference site.

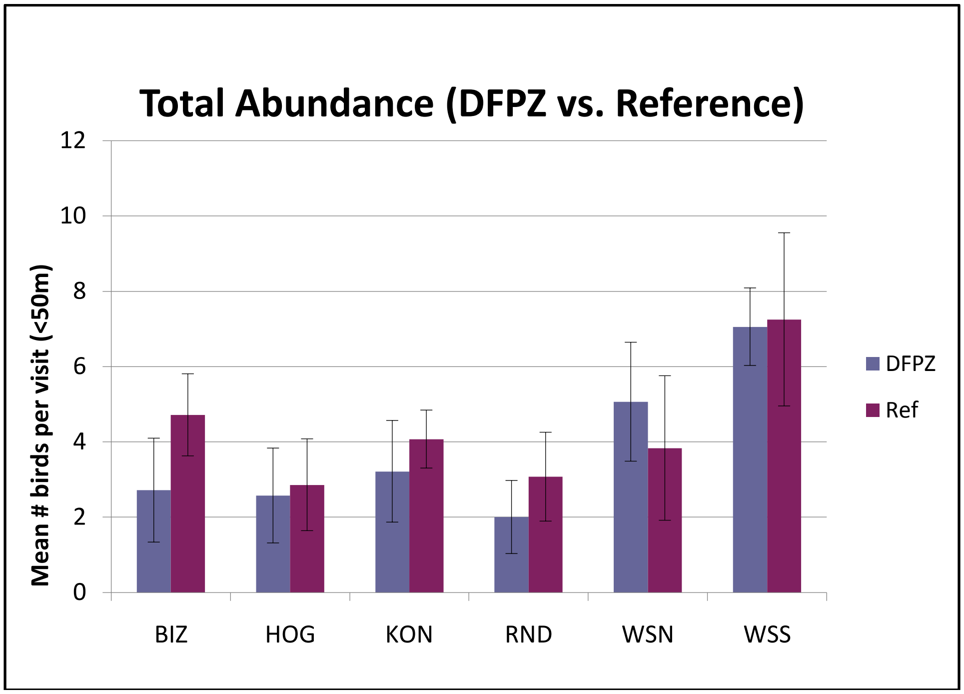
Table 5. Comparison between paired treated DFPZ versus reference transects, Lassen National Forest 2009.

	Index of Abundance				Species Richness			
	DFPZ Mean (SE)	Ref Mean (SE)	Test statistic	P Value	DFPZ Mean (SE)	Ref Mean (SE)	Test statistic	P Value
BIZ	2.71 (0.56)	4.71 (0.45)	-2.77	0.02*	4.00 (0.87)	6.00 (0.58)	-1.91	0.08
HOG	2.57 (0.52)	2.86 (0.5)	-0.40	0.70	3.71 (0.36)	3.71 (0.68)	0	1.00
KON	3.21 (0.55)	4.07 (0.32)	-1.34	0.20	4.43 (0.48)	5.57 (0.48)	-1.68	0.12
RND	2.00 (0.37)	3.07 (0.48)	-1.70	0.11	2.63 (0.33)	4.43 (0.72)	-2.31	0.04*
WSN	5.06 (0.67)	3.83 (0.75)	1.22	0.25	6.75 (0.75)	5.50 (1.18)	0.94	0.37
WSS	7.06 (0.44)	7.25 (0.72)	-0.24	0.82	8.11 (0.39)	9.50 (0.65)	-1.92	0.08

*significant at the $P \leq 0.05$ level

In a few cases (e.g., Hog richness and abundance and West Shore South abundance), indices were similar between paired treated and reference transects. Although the opposite pattern was observed for West Shore North, the results are not significant as the confidence intervals overlap.

Figure 2. Index of abundance from paired DFPZ versus reference point count stations, Lassen National Forest 2009. Error bars represent 95% confidence intervals.



Community Indices and Species Abundance Among Treatment Types

Figures 3, 4 and 5 summarize community indices among treatment types. The treatment type with the highest indices overall, and higher than any of the other treatment types ($P<0.05$), was burn. DFPZ treatment points overall had the second highest indices; diversity and richness there were higher ($P<0.05$) than any other treatment type except burn. Group selection treatment sites had the lowest community indices.

Figure 3. Mean per point richness values for paired DFPZ versus reference point count stations, Lassen National Forest 2009. Error bars represent 95% confidence intervals.

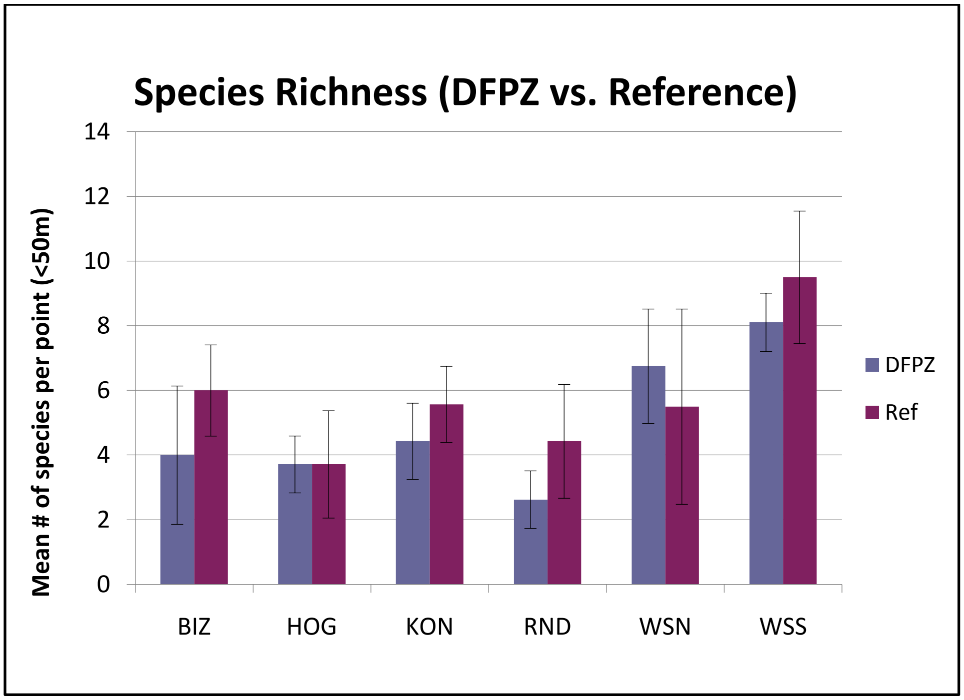


Figure 3. Species diversity (mean diversity per point per visit within 50m) for Lassen National Forest fuel treatment point counts 2009. Error bars represent 95% confidence intervals.

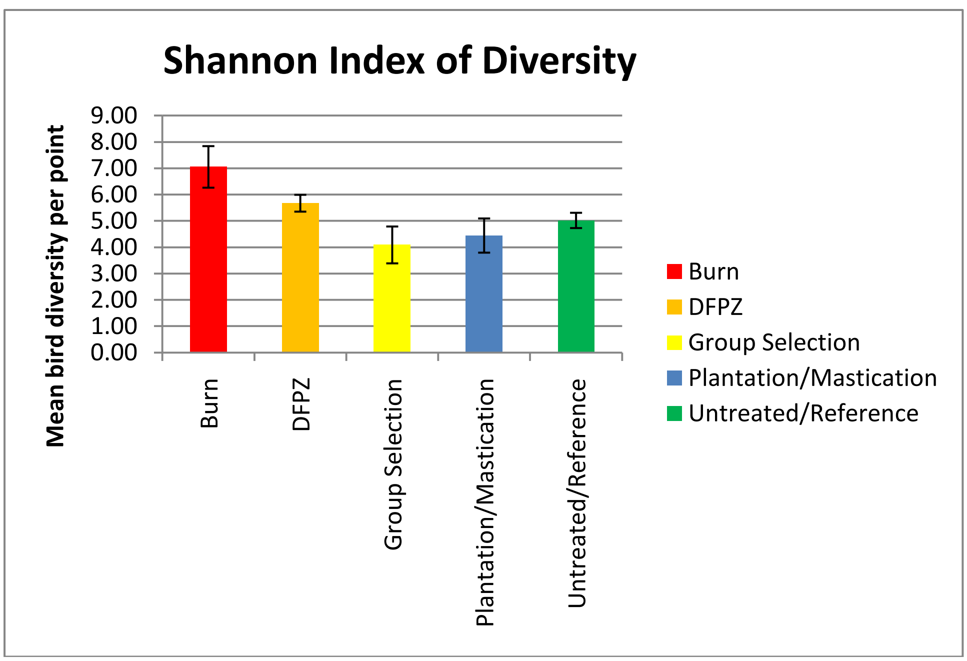


Figure 4. Bird abundance (mean number of individual birds per point per visit within 50m) for Lassen National Forest fuel treatment point counts 2009. Error bars represent 95% confidence interval.

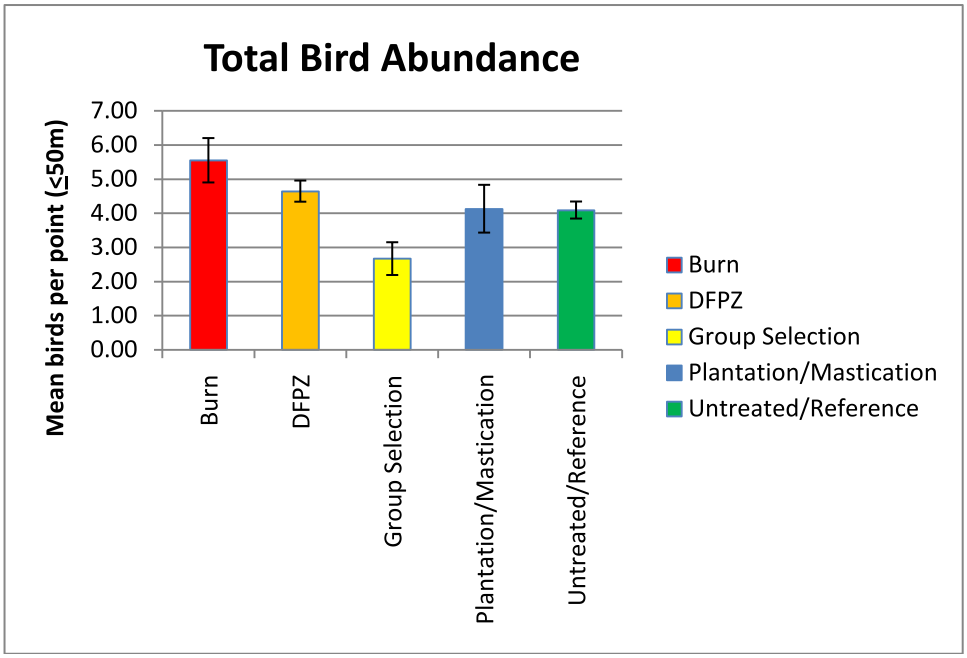
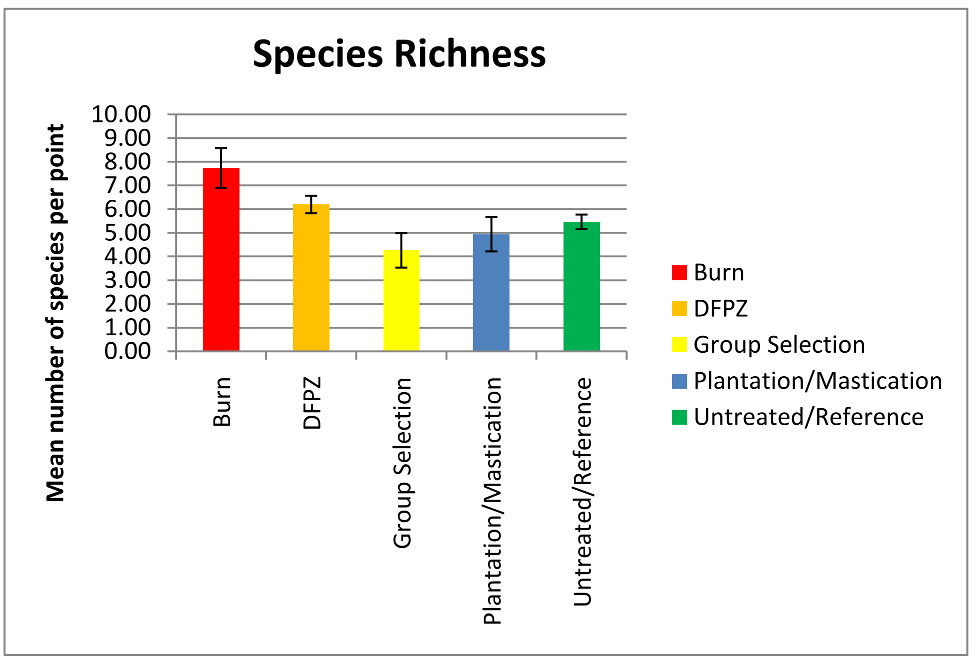


Figure 5. Species richness (mean number of species per point per visit within 50m) for Lassen National Forest fuel treatment point counts 2009. Error bars represent 95% confidence interval.



Bird species more associated with trees and canopy (e.g., Mountain Chickadee, Hermit Warbler, and Western Tanager), as well as those associated with open understory (Oregon Junco) were most common at the treated DFPZ points. Species associated with a shrub understory were most common in the burn treatment category.

Table 6. Mean species abundance (and standard error) for top 10 most abundant species (detections ≤50m from observer) over the project area, by treatment type, Lassen National Forest 2009. Highest value of a given index across all treatment levels is shown in bold. Species are listed in taxonomic order.

	Burn n=31	DFPZ n=184	Group Selection n=27	Plantation/ Mastication n=35	Untreated/ Reference n=242
Dusky Flycatcher	**0.62 (0.12)**	0.35 (0.04)	0.04 (0.03)	0.47 (0.09)	0.50 (0.04)
Mountain Chickadee	0.35 (0.07)	**0.58 (0.04)**	0.28 (0.06)	0.57 (0.10)	0.38 (0.03)
Red-breasted Nuthatch	0.24 (0.06)	0.24 (0.03)	0 (0)	0.17 (0.06)	**0.25 (0.03)**
Golden-crowned Kinglet	**0.24 (0.08)**	0.19 (0.02)	0 (0)	0.14 (0.05)	**0.24 (0.03)**
Audubon's Warbler	0.16 (0.04)	0.51 (0.04)	0.20 (0.06)	**0.54 (0.11)**	0.41 (0.03)
Hermit Warbler	0.16 (0.05)	**0.27 (0.03)**	0 (0)	0.11 (0.07)	0.17 (0.02)
Western Tanager	0.19 (0.05)	**0.26 (0.03)**	0.07 (0.033)	0.17 (0.05)	0.13 (0.02)
Chipping Sparrow	0.27 (0.11)	0.23 (0.04)	**0.46 (0.09)**	0.26 (0.08)	0.11 (0.02)
Oregon Junco	0.32 (0.07)	**0.48 (0.04)**	0.37 (0.07)	0.21 (0.06)	0.31 (0.03)
Fox Sparrow	**0.45 (0.14)**	0.02 (0.01)	0.02 (0.02)	0.13 (0.07)	0.25 (0.03)

Discussion

In 2009, PRBO monitored 49 point count transects totaling 519 points as part of our long-term landbird response to fuel treatments project. Such long-term monitoring is allowing us to assess how fuel reduction treatments change the composition and abundance of landbird species over space and time. Along with our Plumas-Lassen study these two data sets provide us with the most comprehensive study of the response of landbirds to fuel treatments anywhere in the Sierra Nevada.

Overall, we found that bird community indices were highest at burned sites, consistent with findings from our Plumas-Lassen study (Burnett et al. 2009). Sites selected for prescribed fire may be in areas with lower fuel loads which allow for the use of prescribed fire. The other treatment type with relatively high indices overall were DFPZ's. As with fire, it will be important to tease out the effect of time since treatment in order to truly understand the impacts of DFPZ management practices on landbirds but our preliminary data and that from the Plumas-Lassen study suggest that the effects of DFPZ treatments on landbirds are mixed both in terms of species response and site to site differences. The pre-existing conditions at a site and the prescription of the DFPZ treatment are both factors that likely contribute to the response of the avian community to treatments. We continue to suggest that treatments that retain variable canopy cover and target areas of lower overall avian diversity (e.g. overly dense 2nd growth white fir forest) will likely have the greatest positive impact on the landbird community.

The treatment type with the lowest community indices overall was Group Selection – a treatment that removes all of the overstory of trees in a 1- 2 acre area. However, the fact that all Group Selection transects were in the Hat Creek Ranger District may be biasing this result and as with DFPZ's, the effects of group selections on the avian community is likely heavily contingent on the pre-existing condition at the site and landscape context of the treatment. For example, we did not find a significant effect of group selections on avian diversity in denser west side forest on Plumas National Forest (Burnett et al. 2009). This may be because our group selection sites often straddled the edges of treatments since they were established prior to treatments and boundaries were moved slightly. Whereas in the LNF we established points after treatments had been implemented and thus were able to place our point count stations in the center of the group selections and thus surveyed less edge. We would expect lower bird diversity within group selections immediately following treatments as the vast majority of vegetation structure has been removed however, few negative effects were found in group selection treatments in pine-hardwood dominated stands in the central Sierra Nevada (Garrison et al. 2005).

Of the top ten most abundant species, each treatment type could boast having the highest abundance of at least one of the species across all five treatments. The two treatments that had the greatest abundance of the largest number of species were, again, DFPZ and burn. The species most common in burn varied in life history from species associated with understory shrub habitat (Dusky Flycatcher, Fox Sparrow) to a species associated with large trees (Golden-crowned Kinglet), reflecting the diversity in habitats created after fires, especially when combining sites that burned in different years and different intensities. The species most common in DFPZ were generalists (Mountain Chickadee and Oregon Junco) or mature forest associated species (Hermit Warbler and Western Tanager).

When we compared indices of abundance and richness between paired transects, a general pattern was observed of significantly higher community indices at the reference sites than at the treated DFPZ sites. Because this result differs from the higher indices observed across all five treatment types at DFPZ than reference sites, when not restricted to the paired sites, this underscores the usefulness of conducting studies with paired sites when possible. This also suggests there maybe some at least short-term loss in habitat quality for the landbird community at sites that have been converted to shaded fuel breaks. In the northern Sierra Nevada, many species are associated with foliage volume in the middle and especially understory (Verner and Larson 1989). It is this component (fuel ladders) of the habitat that is often removed during DFPZ treatments (as well as in group selection, pre-commercial thinning, and mastication) and could result in short-term declines of a number of species following fuel reduction treatments. However, in group selections and mastication understory, foliage volume is likely to return whereas in shaded fuel breaks (>40% canopy cover retained) it may be less likely to return. It is for these reasons that we suggest a mosaic design of varying canopy covers in fuel treatments be prescribed.

Consistent with previous results, our preliminary data from the LNF fuel treatments suggest that sites treated with low to moderate intensity fire – including prescribed fire – harbor some of the highest landbird diversity in the Northern Sierra Nevada. The use of low to moderate intensity fire should be greatly increased in these forests.

We focused in this report on summarizing 2009 efforts and results, but intend in the coming years to conduct more comprehensive analyses, both spatially and temporally. We remain conservative about generalizing patterns thus far, as a more in depth analysis will take into account time since treatment, pre versus post treatments, and spatial patterns unrelated to treatment.

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Literature Cited

Anand, E.M. and F.R. Thompson III. 1997. Forest bird response to regeneration practices in central hardwood forests. The Journal of Wildlife Management 61, 159-171.

Arno, S.F., and C.E. Fiedler. 2005. Mimicking Nature's Fire: Restoring Fire Prone Forests in the West. Island Press, Washington D.C.

Askins, R.A., B Zuckerberg, and L. Novak. 2007. Do the size and landscape context of forest openings influence the abundance of breeding success of shrubland songbirds in southern New England? Forest Ecology and Management 250, 137-147.

Burnett, R.D., D.Humple, T.Gardali, and M.Rogner. 2004. Avian Monitoring in the Lassen National Forest. A PRBO report to the USFS. Contribution # 1242.

Burnett, R.D., N.Nur, and C.A.Howell. *In prep*. Implications of spotted owl management for landbirds in the Sierra Nevada, CA, USA. Forest Ecology and Management.

Burnett, R.D., D. Jongsomjit, and D. Stralberg. 2009. Avian monitoring in the Plumas and Lassen National Forest: 2008 Annual Report. PRBO report to the U.S. Forest Service. Contribution # 1684.

Chambers, C.L., W.C. McComb, and J.C. Tappeiner II. 1999. Breeding bird responses to three silvicultural treatments in the Oregon Coast Range. Ecological Applications 9: 171-185.

ESRI 2000. Arc View GIS 3.2a. Environmental Systems Research Institute. Redlands, CA.

Fink, A.D., F.R. Thompson III, and A.A. Tudor. 2006. Songbird use of regenerating forest, glade, and edge habitat types. Journal of Wildlife Management 70, 180-188.

Garrison, B.A., M.L. Triggs, and R.L. Wachs. 2005. Short-term effects of group-selection timber harvest on landbirds in montane hardwood-conifer habitat in the central Sierra Nevada. Journal of Field Ornithology 76: 72-82.

Hagar, J., S. Howlin, and L.Ganio. 2004. Short-term response of songbirds to experimental thinning of young Douglas-fir forests in the Oregon Cascades. Forest Ecology and Management 199: 333-347.

Hansen, A.J., W.C. McComb, R. Vega, M.G. Raphael, and M. Hunter. 1995. Bird habitat relationships in natural and managed forests in the west cascades of Oregon. Ecological Applications 5: 555-569.

HFQLG (Herger-Feinstein Quincy Library Group Forest Recovery Act) 1999. Final Environmental Impact Statement, U.S. Department of Agriculture, Forest Service, Pacific Southwest Region, Vallejo, CA. http://www.fs.fed.us/r5/hfqlg/publications/1999_feis/TOC.htm

King, D.I., R.M. Degraaf, and C.R. Griffin. 2001. Productivity of early successional shrubland birds in clearcuts and groupcuts in an eastern deciduous forest. Journal of Wildlife Management 65: 345-350.

Krebs, C.J. 1989. Ecological Methodology. Harper and Row Publishers, New York, New York: 654 pp.

MacArthur, R.H. 1965. Patterns of species diversity. Biological Reviews 40:510-533.

Martin, T.E. and G.R. Geupel. 1993. Nest monitoring plots: Methods for locating nests and monitoring success. J. Field Ornith. 64:507-519.

McKelvey, K.S. and J.D. Johnston. 1992. Historical perspectives on forests of the Sierra Nevada and the Transever Ranges of Southern California: Forest conditions at the turn of the century. Pp. 225-246 In *The California spotted owl: a technical assessment of its current status*. Tech Coordination by J. Verner, K.S. McKelvey, B.R. Noon, R.J. Gutierrez, G.I. Gould Jr., and T.W. Beck. Pacific Southwest Research Station General Technical Report 133. Albany, CA.

Minnich, R.A., M.G. Barbour, J.H. Burk, and R.F. Fernau. 1995. Sixty years of change in California coniferous forests of the San Bernardino mountains. Conservation Biology 9:902-914.

Parsons, D.J. and S.H. Benedetti. 1979. Impact of fire suppression on a mixed-conifer forest. Forest Ecology and Management 2: 21-33.

Ralph, C.J., G.R. Geupel, P. Pyle, T.E. Martin, and D.F. DeSante 1993. Field Methods for Monitoring Landbirds. U.S. Department of Agriculture, Forest Service, General Technical Report PSW-144.

Ralph, C.J., S. Droege, and J.R. Sauer. 1995. Managing and monitoring birds using point counts: standards and applications. In C. J. Ralph, J. R. Sauer and S. Droege (eds.), Monitoring Bird Populations by Point Counts. USDA Forest Service Publication, Gen. Tech. Rep. PSW-GTR-149, Albany, CA .

Reynolds, R.T., J.M. Scott, and R.A. Nussbaum. 1980. A variable circular plot method for estimating bird numbers. Condor 82:309:313.

Siegel, R.B. and D.F. DeSante. 2003. Bird communities in thinned versus unthinned sierran mixed conifer stands. Wilson Bulletin 115: 155-165.

Skinner, C.N. and C.Chang. 1996. Fire regimes, past and present. Sierra Nevada Ecosystem Project: Final Report to Congress. Vol. 2, Assessments and scientific basis for management options, pp. 1041-1069. University of California Centers for Water and Wildland Resources, Davis, CA, USA.

SNFPA 2001. Sierra Nevada Forest Plan Amendment Final Environmental Impact Statement, Record of Decision. United States Department of Agriculture, Forest Service, Pacific

Southwest Region, Vallejo, CA. http://www.fs.fed.us/r5/snfpa/library/archives/rod/rod.pdf

SNFPA 2004. Sierra Nevada Forest Plan Amendment, Final Supplemental Environmental Impact Statement, Record of Decision. United States Department of Agriculture, Forest Service, Pacific Southwest Region, Vallejo, CA. http://www.fs.fed.us/r5/snfpa/final-seis/rod/

Stata Corp. 2007. Intercooled Stata 10 for Windows. Stata Corp. LP College Station, TX.

Stephens, R.E. Martin, and N.E. Clinton. 2007. Prehistoric fire area and emissions from California forests, woodlands, shrublands, and grasslands. Forest Ecology and Management 251: 205-216.

Taylor, A.H. 2000. Fire regimes and forest changes along a montane forest gradient, Lassen Volcanic National Park, southern Cascade Mountains, USA. Journal of Biogeography 27:87-104.

Taylor, A.H. & C.N. Skinner. 2003. Spatial patterns and controls on historical fire regimes and forest structure in the Klamath Mountains. Ecological Applications 13:704-719.

Vankat, J.L. and J. Majors 1978. Vegetation changes in Sequoia National Park, California. Journal of Biogeography 5:377-402.

Weatherspoon, C.P. 1996. Fire-silvicultural relationships in Sierra forests. *In* Sierra Nevada Ecosystem Project Final Report to Congress, Vol. 2: Assessments and Scientific Basis for Management Options. Centers for Water and Wildland Resources, University of California, Davis, pp. 1167-1176.