# Appendix D

## Plumas-Lassen Area Study Module on Landbird Abundance, Distribution, and Habitat Relationships

**2004 Annual Report**

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EXECUTIVE SUMMARY

In this document we report on the avian module of the Plumas Lassen Area Study. 2004 was the third year of data collection, though in 2002 a different study was being carried out. While some of that data has been incorporated into this study 2004 was the second year under the current study design. As of the end of the 2004 bird breeding season, none of the proposed treatments have been implemented, thus everything we report on reflects pre-treatment conditions.

Analysis and discussion in this report are intended to provide background information on the pre-treatment status of the avian community, determine habitat associations of many of those species, while providing insight into the important habitat attributes to manage for to ensure a sustainable avian community.

Our analysis shows that for the most abundant species in the study area, at the level of the treatment unit (aggregation of 4 to 6 adjacent watersheds), the bird community is very similar. However, there are some significant differences between treatment units. Units 1 and 5 have the highest species richness and unit 2, the area with the highest density of Spotted Owls, has the lowest. Additionally, several species are markedly more abundant in some units than others (e.g. Nashville Warbler). Proposed treatment sites (DFPZ's) in Treatment Unit 1 have higher species richness than the surrounding landscape while in Treatment Unit 4, proposed DFPZ sites had lower species richness than the surrounding landscape.

Habitat associations showed that while predictive power of our models was relatively low, a broad range of habitat attributes were significantly positively correlated with the abundance of more than one bird species. Large snags, large DBH trees, and shrub cover were all positively correlated with multiple species while elevation and the amount of hardwood habitat within 3 km of points were negatively correlated with several different species. We found several species were only correlated with local habitat variables (Fox Sparrow, Golden-crowned Kinglet, and Nashville Warbler) while the majority were correlated with both local and landscape level habitat attributes.

INTRODUCTION

Coniferous forest is one of the most important habitat types for birds in California (CalPIF 2002). In the Sierra Nevada, a century of intensive resource extraction and forest management practices have put at risk the ecological stability and continued functionality of the system as a whole (SNEP 1996). Loss of habitat to intensive logging operations and human development, lack of replacement of old-growth stands due to harvest rotations of insufficient duration, changes in forest structure and species composition due to fire suppression, and removal of snags and dead trees are among the most detrimental impacts (SNEP 1996, CalPIF 2002). Birds and other wildlife populations have subsequently been altered by such changes; declines and extirpations have been observed in a number of species, some of which are now afforded special status at the federal or state level.

The Record of Decision (ROD) for the Sierra Nevada Forest Plan Amendment (SNFPA) and subsequent supplemental ROD (SNFPA 2001, SNFPA 2004) directs the Forest Service to maintain and restore old forest conditions that provide crucial habitat for a number of plant and animal species. The decision focuses attention and directs actions towards both protecting and creating habitat with old forest attributes, while providing substantial amount of harvestable timber. Simultaneously, the Forest Service is taking steps to reduce risks of catastrophic fire by reducing fuel loads in overstocked forests. Achieving all of these potentially competing goals will, at the very least, be a challenging task.

Here we report on the landbird study module of the Administrative Study, one of an integrated series of research efforts intended to evaluate land management strategies designed to reduce wildland fire hazard, promote forest health, and provide economic benefits within the area covered by the Herger-Feinstein Quincy Library Group Forest Recovery Act Pilot Project (HFQLG Pilot Project). Valuable feedback can be gained by determining how the full complement of the avian community responds to different forest management regimes, particularly at the landscape scale. If forest management practices encourage old forest development and forests across landscapes trend towards larger trees and higher canopy cover, how will birds other than the Spotted Owl respond to these conditions?

Specifically, the primary objective of the landbird module is to assess the impact of forest management practices in sustaining a long-term ecologically stable forest ecosystem at the local and landscape scales. We know, *a priori*, that the avian community is comprised of species that are associated with a wide range of forest seral stages, vegetative composition, and structures (Burnett and Humple 2003). This habitat, and hence avian diversity, is due in large part to the natural ecological dynamics of these forest systems. Though humans have altered these systems, they continue to undergo non-human mediated changes through biological, geological, and stochastic processes. Therefore, it is imperative for managers to consider how these changes influence management actions temporally and spatially, and how ecological stability can be achieved in an inherently dynamic system.

In order to meet our primary objective of assessing the impacts of forest management practices on landbirds at local and landscape scales, this module will address the following:

(1) Determine landbird habitat associations at the local scale.

(2) Determine landscape effects on bird habitat associations.

(3) Based on the results of objectives 1 and 2, develop predictive bird models to forecast how individual species may respond to forest management, particularly those planned as part of the HFQLG Pilot Project.

(4) Quantitatively assess the impacts of forest management treatments on avian abundance and species diversity.

(5) Determine population trends for landbirds to identify if populations are changing temporally.

(6) Evaluate population trends to assess factors responsible for observed trends.

This multiple objective approach will allow us to interpret both the effects of specific management practices, the extent to which they influence the greater landscape (in the short term), and the integrated effects of treatments and natural processes (again over the short term).

In addition to this study PRBO has been monitoring songbird populations in the Northern Sierra since 1997. Since 2001, these efforts have aimed to complement the avian research of the Administrative Study by focusing on monitoring the non-coniferous habitats within the HFQLG area (Burnett and Humple 2003 and 2005, Humple and Burnett 2004). Specifically, these efforts have focused on avian response to meadow restoration and cessation of grazing, the viability of clear-cut regenerations in providing habitat for shrub dependent bird species, as well as avian response to aspen and black oak habitat enhancement. Working closely with the project planners from Forest Service ranger district staff these studies are being implemented as adaptive management experiments. These efforts should be seen as not only providing valuable data to guide forest management but also as models of effective collaboration between science and managers in administering public lands in the Sierra Nevada and beyond.

## METHODS

### Avian Surveys

We are using standardized five-minute variable circular plot (VCP) point count censuses (Buckland et al. 1993, Ralph et al. 1993) to sample the avian community in the study area. In this method, points are clustered in transects, but data is only collected from fixed stations, not along the entire transect.

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

All birds detected at each station during the five-minute survey are recorded according to their initial distance from the observer. These detections are placed within one of six categories: within 10 meters, 10-20 meters, 20-30 meters, 30-50 meters, 50-100 meters, and greater than 100 meters. The method of initial detection (song, visual, or call) for each individual is also recorded. Using a variable radius point count allows us to conduct distance sampling. Distance sampling should enable us to provide more precise estimates of density and detectability of individual birds as well as account for some of the observer variability inherent in the point count sampling method (Buckland et al. 1993).

Counts begin around local sunrise and are completed within four hours. Each transect is visited twice during the peak of the breeding season.

### Treatment Unit and Transect Nomenclature

In this report we use the former treatment units (TUs), those defined in the original Admin Study plan, as functional units to analyze bird indices across aggregations of watersheds (See Appendices 1-7). These aggregations of watersheds no longer have any planned "treatment" that is consistent across them and are simply used here as a tool to describe geographical linked portions of the study area. Additionally, it is important to note that while we refer to DFPZ's as treated sites and others as untreated sites, no treatment has yet been implemented to date thus all data is pre-treatment.

Transect naming protocols were different in 2002 than in 2003 and 2004. Transects established in 2002 under the previous study design are numbered transects (e.g. 222). The first number is the TU and the second and third numbers are the cover class and size class of the randomly generated starting point respectively (e.g. 222 is in TU-2, cover class 2, and size class 2). In 2003 and 2004, under the existing study plan, transects are named after the CalWater Planning Watershed (CalWater 1999). For example, SNK1 is in the Snake Lake watershed and is the first transect established while CHG3 is in the China Gulch watershed and was the third transect established. The numeric ending is simply for designating between the different transects in the same watershed and does not have any additional significance.

### 2004 Survey Effort

In 2004 we established and surveyed 18 new permanent transects and continued surveying 75 transects that had been established in 2002 or 2003, for a total of 93 transects surveyed (Table 1). These transects consist of 12 points each for a total of 1116 point count locations surveyed in 2004 in the study area (TUs 1-5). Of these 1116 points, 971 are located in areas not-currently slated for DFPZ treatment (extensive sampling) with the remaining 145 located within DFPZ's scheduled for treatment. All of these DFPZ transects are located in TUs 1 and 4 (Table 1). As the location of additional DFPZ networks is solidified in (former) TUs 2, 3, and 5, and potentially elsewhere, we will add additional transects to those sites, as described in the study plan (Stine et al 2004).

**Table 1. Extensive and DFPZ point count transects surveyed in the Plumas – Lassen Study in 2004.**

| Treatment Unit | Watershed | Code | Extensive Survey Points | DFPZ Survey Points |
|---|---|---|---|---|
| 5 | Grizzly Forebay | GRZ | 39 | 0 |
| 5 | Frazier Creek | FRC | 45 | 0 |
| 5 | China Gulch | CHG | 36 | 0 |
| 5 | Bear Gulch | BEG | 36 | 0 |
| 5 | Haskins Valley | HAV | 36 | 0 |
| 5 | Red Ridge | RED | 36 | 0 |
| **5** | **Unit Total** | | **228** | **0** |
| 4 | Silver Lake | SIL | 41 | 24 |
| 4 | Meadow Valley Creek | MVY | 51 | 0 |
| 4 | Deanes Valley | DVY | 36 | 0 |
| 4 | Snake Lake | SNK | 36 | 12 |
| 4 | Miller Fork | MIL | 36 | 24 |
| 4 | Lower Knox Flat | LKF | 36 | 0 |
| 4 | Pineleaf Creek | PLC | 31 | 12 |
| **4** | **Unit Total** | | **267** | **72** |
| 3 | Soda Creek | SOD | 36 | 0 |
| 3 | Rush Creek | RUS | 64 | 0 |
| 3 | Halsted Flat | HAL | 36 | 0 |
| 3 | Lower Spanish Creek | SPC | 36 | 0 |
| 3 | Black Hawk Creek | BLH | 24 | 0 |
| 3 | Indian Creek | IND | 12 | 0 |
| **3** | **Unit Total** | | **208** | **0** |
| 2 | Mosquito Creek | MSQ | 36 | 0 |
| 2 | Butt Valley Reservoir | BVR | 36 | 0 |
| 2 | Ohio Creek | OHC | 41 | 0 |
| 2 | Seneca | SEN | 47 | 0 |
| 2 | Caribou | CAR | 36 | 0 |
| **2** | **Unit Total** | | **196** | **0** |
| 1 | Upper Yellow Creek | UYC | 24 | 31 |
| 1 | Grizzly Creek | GCR | 24 | 17 |
| 1 | Butt Creek | BCR | 24 | 13 |
| 1 | Soldier Creek | SCR | 0 | 12 |
| **1** | **Total** | | **72** | **73** |
| | **Grand Total** | | **971** | **145** |

## Field Crew Training

Field crew members all have previous experience conducting avian fieldwork and undergo extensive training onsite for three weeks prior to conducting surveys. Training consists of long hours in the field birding and conducting simultaneous practice point counts with expert observers. Each crew member is given an audio compact disc with the songs and calls of all of the local avifauna, prior to their arrival at the study site. Each person uses the compact disc to study the local birds and is then given quizzes each evening designed to test their knowledge of the songs and calls of the local birds. Significant time is also given to calibrating each person in distance estimation. In addition each observer uses a laser range finder to calibrate distances at each point before starting a survey.

## Vegetation Sampling Methods

Vegetation is assessed using the relevé method, following procedures outlined in Ralph et al. (1993). In summary this method uses a 50-meter radius plot centered on each census station where general habitat characteristics of the site are recorded (canopy cover, slope, aspect, etc.) and the cover, abundance, and height of each vegetation stratum (tree, shrub, herb, and ground) are determined through ocular estimation. Within each vegetation stratum, the species composition is determined and each species' relative cover recorded, as a percentage of total cover for that stratum (see Ralph et al. 1993 for complete description).

## Statistical Analysis

We analyzed point count data in order to create by-point community indices for each transect. Community indices were created using a restricted list of species that excluded those that do not breed in the study area (Rufous Hummingbird, House Wren, Orange-crowned Warbler) or are not accurately surveyed using the point count method (e.g. raptors, waterfowl, grouse, nightjars, swallows, crows, ravens).

We present the mean by point (average per point per visit, per year, by transect) for the following three indices. This method allows for using the point as the individual sampling unit and therefore makes possible the stratification of points for analysis based on attributes other than the transect and comparison of uneven sample sizes.

*Species Richness*

Species richness is defined as the mean number of species detected within 50 meters of each point averaged across visits.

*Diversity*

Species diversity is defined as the mean number of species detected within 50 m (species richness) weighted by the mean number of individuals of each species. A high diversity score indicates high ecological (species) diversity, or a more equal representation of the species. Species diversity was measured using a modification of the Shannon-Wiener index (Krebs 1989). We used a transformation of the usual Shannon-Weiner index (symbolized $H'$), which reflects species richness and equal distribution of the species. This transformed index, introduced by MacArthur (1965), is $N_1$, where $N_1 = 2^{H'}$. The advantage of $N_1$ over the original Shannon-Wiener metric ($H'$) is that $N_1$ is measured in terms of species instead of bits of information, and thus is more easily interpretable (Nur et al. 1999).

*Abundance*
The index of 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.

*Landscape Statistics*
Landscape statistics were calculated using the program FRAGSTATS (McGarigal et al. 2002). Landscape statistics were measured within a 3km radius circle centered on the geographic center of each of 32 transects using the most current Vestra GIS vegetation coverage. Landscape parameters included the following measures: (a) forPLAND, percent forest coverage where classification was binary (forested and non-forested), (b) forED, forest edge density as meters of edge per hectare (m/ha), (c) C1 percent of non-vegetated area (e.g. bare ground, rock, or urban areas), (d) C4 percent of hardwoods in landscape, (e) C13 percent of conifers in stand size class 3, (f) C14 percent of conifers in stand size class 4, (g) IJI interspersion and juxtaposition index (a measure of landscape heterogeneity) where landscape classification included seven landtype categories (see below), (h) SHDI (Shannon's diversity index) increases as the number of different patch types increases and/or the proportional distribution of area among patch types becomes more equitable, and (i) CONTAG a contagion index with seven landtype categories which measures the extent to which landscape elements (patch types) are aggregated or clumped (i.e., dispersion); higher values of contagion may result from landscapes with a few large, contiguous patches, whereas lower values generally characterize landscapes with many small and dispersed patches. For the indices of contagion, interspersion, and diversity we considered seven land type categories: (i) no vegetation (C1), (ii) meadow/pasture (C2), (iii) shrub cover, burnt, or harvested areas (C3), (iv) hardwood cover (C4), (v), conifers of size class 2 (C12), (vi) conifers of size class 3 (C13), and (vii) conifers of size class 4 or 5 (C14).

A subset of extensive transects were used in the landscape analysis. We attempted to maximize our sample size without having any transects that the 3km circle, for which landscape attributes were quantified, overlapped. Thus the following point count transects were chosen:114, 213, 214, 222, 223, 224, 323, 413, 513, 514, BCR1, BEG1, BVR3,CHG1, GCR2, GRZ3, HAL2, HAV2, HSRF, IND1, LKF2, LKF3, MSQ2,MVY2, RED1, RUS1, SIL2, SIL3, SNK3, SOD3, and SPC2 (Table 1).

*Local Habitat Variables*
Detailed descriptions of the local vegetation variables used in the habitat association analysis are in Appendix 8 and are a modified version of the releve protocol described by Ralph et al. (1993). Of those variables collected at the "local" point count station, we used the following 22 in this analysis: slope, elevation (elev), basal area of all tree species combined (basal), shrub cover (realshrbco), cover of trees under 5 meters tall (treshrbcov), cover of trees less than 5 meters tall and shrubs combined (ttlshrbcov), snags 10-30cm dbh (snags1030), snags>30cm dbh (snagsg30), maximum tree dbh (maxtrdbh), minimum tree dbh (mintrdbh), high tree height (hitreeht), high shrub height (hirsht), White Fir basal area (abiconba), Black Oak basal area (quekelba), Sugar Pine basal area (pinlamba), Red Fir basal area (abimagba), Jeffrey Pine basal area (pinjefba); and the absolute cover of Sugar Pine (pinlamt1), White Fir (abicont1), Douglas Fir (psement1), Ponderosa Pine (pinpont1), and Incense Cedar (cedar).

*Regression Procedure*
The statistical package SAS (SAS Institute Inc. 1999) was used to perform various statistical tests described in Sokal and Rohlf (1981). A probability of Type I error of 0.05 or less was accepted as significant (unless otherwise noted) but greater values are shown for descriptive purposes. For this analysis we focused on 18 bird species which were detected consistently across the study area. We calculated species abundance as the average number of detections of each species at each census point for each year.

We used stepwise multiple regression models to determine which of the local and landscape variables accounted for the greatest amount of variation in species abundance for 18 of the breeding bird species following Howell et al. (2000). Stepwise multiple regression identifies which variables explain the greatest amount of variation in species abundance; the first variable to enter the stepwise model accounts for the greatest variability. We only included variables that explained at least 1.5% of the variance in the stepwise regression (partial $r^2 \geq 0.015$). A variable may be removed if variables are highly correlated, but this did not occur for variables with partial $r^2 \geq 0.015$. Only variables that made significant contributions to the overall model were kept ($P < 0.05$). Because the variable "basal" was a linear combination of the individual species tree basal areas (see Vegetation Variables above) there were potential problems with colinearity. Therefore for species where basal area was important, we ran the stepwise procedure separately for total basal area and for its separate components. After first employing the stepwise procedure to identify significant variables, we analyzed each overall model again using multiple regression.

## RESULTS

A total of 93 species were detected during point count surveys in 2004, one more than was detected in 2003 (Burnett et al. 2004), for a total of 102 species detected across all 3 years of the study (Appendix 9). We determined breeding bird species richness and abundance at all sites surveyed in 2004 (Table 2), and included indices for these same transects from all previous years they were surveyed (i.e. 2002, 2003, or both). Abundance (the average number of individuals detected within 50 meters of each point per visit) ranged from a 0.63 on the SOD3 transect to 6.83 on the SIL2. Species richness ranged from 1.17 on the SOD3 transect to 8.25 on the 313 transect. For sites surveyed in both 2003 and 2004, the mean index of abundance was lower in 2004 for 57 of the 74 transects, while richness was lower for 58 of the 74 transects. The mean abundance for all of 74 transects was 3.50 in 2004 compared to 4.25 in 2003, while species richness was 4.77 in 2004 and 5.73 in 2003.

Of the DFPZ transect surveyed, the highest mean per point abundance in 2004, was recorded at D108 (6.09) while the lowest was at D403 (1.85). The highest per point mean species richness was recorded at D108 and D109 (both 7.25) while the lowest was at D403 (2.45). Both the abundance and species richness indices were considerably higher at TU-1 DFPZ transects than at TU-4 DFPZ transects (Table 2).

**Table 2. Mean abundance, ecological diversity, and species richness for all point count transects surveyed by PRBO in the Plumas/Lassen area study in 2004 (including all data from all years they were surveyed).**

| | | Abundance | | | Richness | | |
|---|---|---|---|---|---|---|---|
| Transect Extensive | Unit | 2004 | 2003 | 2002 | 2004 | 2003 | 2002 |
| 114 | 1 | 5.67 | 3.58 | 7.63 | 6.00 | 4.58 | 8.42 |
| BCR1 | 1 | 2.41 | NS | NS | 3.73 | NS | NS |
| UYC1 | 1 | 5.18 | NS | NS | 6.33 | NS | NS |
| GCR1 | 1 | 2.75 | NS | NS | 4.17 | NS | NS |
| GCR2 | 1 | 3.71 | NS | NS | 4.92 | NS | NS |
| HSRF | 1 | 3.88 | NS | NS | 5.75 | NS | NS |
| **Subtotal** | **1** | **3.93** | | | **5.06** | | |
| 213 | 2 | 2.38 | 5.13 | 1.89 | 2.92 | 6.17 | 2.29 |
| 214 | 2 | 1.42 | 1.63 | 3.92 | 2.08 | 2.25 | 5.58 |
| 222 | 2 | 3.50 | 5.25 | 4.46 | 5.17 | 7.58 | 6.08 |
| 223 | 2 | 3.63 | 6.29 | 6.04 | 4.50 | 7.33 | 8.58 |
| 224 | 2 | 2.67 | 3.21 | 4.50 | 4.17 | 4.33 | 6.08 |
| MSQ1 | 2 | 2.17 | 2.79 | NS | 3.16 | 4.08 | NS |
| MSQ2 | 2 | 2.17 | 2.75 | NS | 3.33 | 3.50 | NS |
| BVR1 | 2 | 4.08 | 5.17 | NS | 5.42 | 5.42 | NS |
| BVR2 | 2 | 5.96 | 3.63 | NS | 7.17 | 5.33 | NS |
| BVR3 | 2 | 3.54 | 4.67 | NS | 4.75 | 6.25 | NS |
| OHC1 | 2 | 3.17 | 3.00 | NS | 4.00 | 4.33 | NS |
| OHC2 | 2 | 1.64 | 4.08 | NS | 2.55 | 5.58 | NS |
| SEN1 | 2 | 2.25 | 3.00 | NS | 3.75 | 4.08 | NS |
| CAR1 | 2 | 4.17 | 3.42 | NS | 5.67 | 4.42 | NS |
| CAR2 | 2 | 3.63 | 2.50 | NS | 5.33 | 3.83 | NS |
| CAR3 | 2 | 1.91 | NS | NS | 2.82 | NS | NS |
| **Subtotal** | **2** | **3.02** | | | **4.17** | | |
| 313 | 3 | 6.08 | 7.58 | 3.67 | 8.25 | 10.00 | 5.08 |
| 314 | 3 | 3.88 | 4.42 | 4.08 | 5.50 | 6.42 | 3.75 |
| 322 | 3 | 5.58 | 3.38 | 4.63 | 7.00 | 5.17 | 6.58 |
| 323 | 3 | 2.46 | 2.79 | 5.33 | 4.00 | 4.67 | 7.92 |
| 324 | 3 | 4.63 | 3.83 | 4.54 | 5.25 | 5.17 | 6.83 |
| BLH1 | 3 | 2.09 | 2.42 | NS | 3.36 | 3.25 | NS |
| BLH2 | 3 | 3.55 | NS | NS | 4.73 | NS | NS |
| HAL1 | 3 | 2.50 | 3.46 | NS | 3.92 | 5.58 | NS |
| HAL2 | 3 | 3.00 | 3.92 | NS | 3.58 | 5.17 | NS |
| HAL3 | 3 | 3.25 | 6.96 | NS | 4.67 | 7.67 | NS |
| IND1 | 3 | 2.83 | 4.13 | NS | 4.50 | 5.50 | NS |
| RUS1 | 3 | 5.79 | 5.83 | NS | 6.92 | 7.75 | NS |
| SOD1 | 3 | 3.92 | NS | NS | 5.75 | NS | NS |
| SOD2 | 3 | 2.75 | NS | NS | 4.17 | NS | NS |
| SOD3 | 3 | 0.63 | NS | NS | 1.17 | NS | NS |
| SPC1 | 3 | 3.13 | 3.29 | NS | 4.33 | 4.75 | NS |
| SPC2 | 3 | 2.21 | 4.25 | NS | 3.50 | 5.75 | NS |
| **Subtotal** | **3** | **3.43** | | | **4.74** | | |
| 413 | 4 | 4.83 | 2.83 | 5.83 | 6.33 | 2.58 | 7.83 |
| 414 | 4 | 4.75 | 4.38 | 6.79 | 6.08 | 6.50 | 8.58 |

| | | Abundance | | | Richness | | |
|---|---|---|---|---|---|---|---|
| **Transect** | **Unit** | **2004** | **2003** | **2002** | **2004** | **2003** | **2002** |
| 422 | 4 | 3.71 | 4.54 | 4.29 | 4.58 | 5.42 | 5.92 |
| 423 | 4 | 3.58 | 3.29 | 4.58 | 4.92 | 4.50 | 6.75 |
| 424 | 4 | 3.54 | 5.46 | 5.75 | 5.33 | 7.42 | 8.00 |
| MIF1 | 4 | 3.29 | 4.00 | NS | 4.25 | 5.50 | NS |
| MIF2 | 4 | 3.00 | 5.67 | NS | 4.25 | 7.42 | NS |
| MIF3 | 4 | 3.54 | 5.21 | NS | 4.50 | 6.17 | NS |
| D404 | 4 | 3.35 | 6.50 | 4.96 | 5.00 | 8.33 | 7.08 |
| D405 | 4 | 3.35 | 4.79 | 4.46 | 4.90 | 7.00 | 6.50 |
| LKF1 | 4 | 2.96 | NS | NS | 3.42 | NS | NS |
| LKF2 | 4 | 3.83 | NS | NS | 4.92 | NS | NS |
| LKF3 | 4 | 5.13 | NS | NS | 6.75 | NS | NS |
| MVY1 | 4 | 3.29 | 4.75 | NS | 4.33 | 6.92 | NS |
| MVY2 | 4 | 3.79 | 5.58 | NS | 5.17 | 7.08 | NS |
| PLC1 | 4 | 3.71 | NS | NS | 5.67 | NS | NS |
| SIL1 | 4 | 3.08 | 5.17 | NS | 4.42 | 6.67 | NS |
| SIL2 | 4 | 6.83 | 5.13 | NS | 7.08 | 7.17 | NS |
| SIL3 | 4 | 2.46 | 2.29 | NS | 3.17 | 3.75 | NS |
| SNK1 | 4 | 2.38 | 4.25 | NS | 3.75 | 5.50 | NS |
| SNK2 | 4 | 2.33 | 4.54 | NS | 3.33 | 6.33 | NS |
| SNK3 | 4 | 1.71 | NS | NS | 2.67 | NS | NS |
| **Subtotal** | **4** | **3.57** | | | **4.77** | | |
| 513 | 5 | 6.79 | 3.00 | 5.38 | 7.67 | 4.33 | 6.92 |
| 514 | 5 | 4.08 | 5.75 | 2.46 | 5.58 | 5.17 | 4.25 |
| 522 | 5 | 3.17 | 5.63 | 5.50 | 4.42 | 7.25 | 7.67 |
| 523 | 5 | 2.42 | 3.33 | 3.54 | 4.00 | 5.75 | 5.25 |
| 524 | 5 | 3.04 | 2.79 | 4.42 | 4.92 | 4.08 | 6.42 |
| BEG1 | 5 | 1.96 | 3.42 | NS | 3.25 | 4.42 | NS |
| CHG1 | 5 | 2.46 | 3.46 | NS | 3.58 | 5.08 | NS |
| CHG2 | 5 | 3.17 | 6.67 | NS | 4.33 | 8.25 | NS |
| CHG3 | 5 | 5.79 | 3.54 | NS | 7.25 | 5.17 | NS |
| FRC1 | 5 | 2.96 | 5.25 | NS | 4.67 | 7.08 | NS |
| GRZ1 | 5 | 2.58 | 3.92 | NS | 3.50 | 4.92 | NS |
| GRZ2 | 5 | 3.96 | 3.58 | NS | 5.75 | 5.67 | NS |
| GRZ3 | 5 | 3.38 | 4.71 | NS | 5.08 | 7.08 | NS |
| RED1 | 5 | 4.42 | 4.75 | NS | 5.67 | 5.92 | NS |
| RED2 | 5 | 3.38 | 3.00 | NS | 4.92 | 5.08 | NS |
| RED3 | 5 | 3.92 | 4.13 | NS | 5.83 | 6.25 | NS |
| D501 | 5 | 2.35 | 4.21 | NS | 3.40 | 5.75 | NS |
| HAV1 | 5 | 3.42 | 5.75 | NS | 4.92 | 7.67 | NS |
| HAV2 | 5 | 3.42 | 4.92 | NS | 5.08 | 7.25 | NS |
| **Subtotal** | **5** | **3.51** | **4.31** | | **4.94** | **5.90** | |
| **Extensive Total**[1] | **1-5** | **3.50** | **4.25** | | **4.77** | **5.73** | |
| **DFPZ** | | | | | | | |
| D102 | 1 | 2.42 | 3.54 | 5.29 | 2.75 | 5.00 | 5.92 |
| D107 | 1 | 3.63 | 3.50 | 4.25 | 5.50 | 5.25 | 6.17 |
| D108 | 1 | 6.09 | NS | 5.89 | 7.25 | NS | 4.67 |

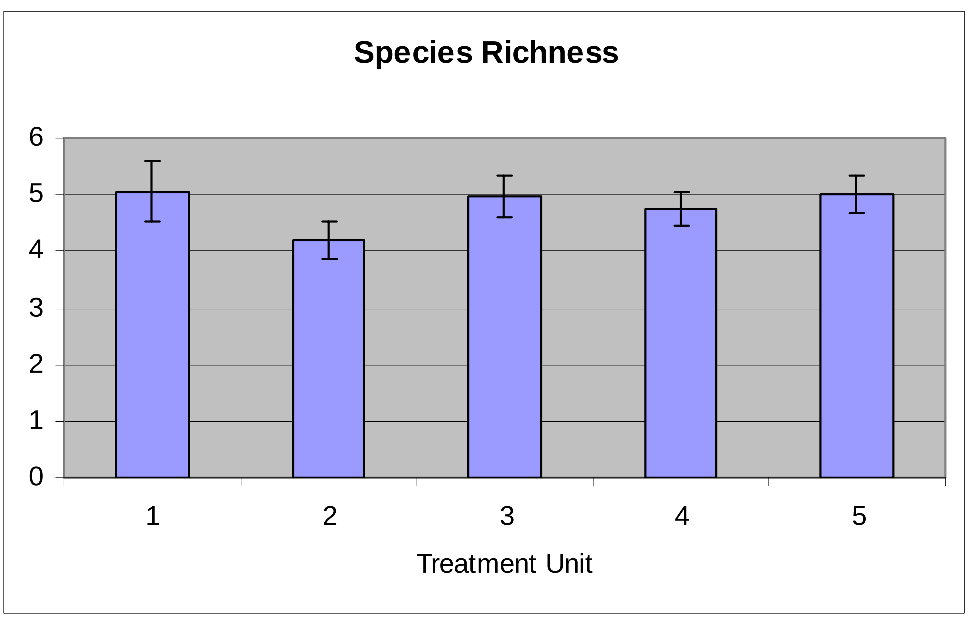
| Transect | Unit | Abundance 2004 | Abundance 2003 | Abundance 2002 | Richness 2004 | Richness 2003 | Richness 2002 |
|---|---|---|---|---|---|---|---|
| D109 | 1 | 6.08 | 5.71 | 6.13 | 7.25 | 7.08 | 8.67 |
| D110 | 1 | 2.79 | NS | NS | 4.08 | NS | NS |
| D111 | 1 | 3.42 | NS | NS | 5.33 | NS | NS |
| D112 | 1 | 5.46 | NS | NS | 7.08 | NS | NS |
| **Subtotal** | **1** | **4.27** | **4.58** | **5.17** | **5.61** | **6.29** | **6.90** |
| D401 | 4 | 2.30 | 4.21 | 6.79 | 3.33 | 5.00 | 8.75 |
| D402 | 4 | 3.05 | 4.13 | 4.71 | 4.50 | 5.58 | 6.75 |
| D403 | 4 | 1.85 | 3.79 | 3.71 | 2.45 | 5.58 | 5.42 |
| D407 | 4 | 3.00 | 3.46 | 4.42 | 4.83 | 5.33 | 6.33 |
| D408 | 4 | 3.70 | 5.88 | 4.50 | 5.08 | 7.58 | 6.75 |
| D409 | 4 | 2.00 | 1.92 | NS | 2.73 | 3.00 | NS |
| **Subtotal** | **4** | **2.65** | **3.90** | **4.83** | **3.82** | **5.35** | **6.80** |

**[1]Only calculated for transects surveyed in both 2003 and 2004.**

### Species Abundance and Richness by Treatment Unit

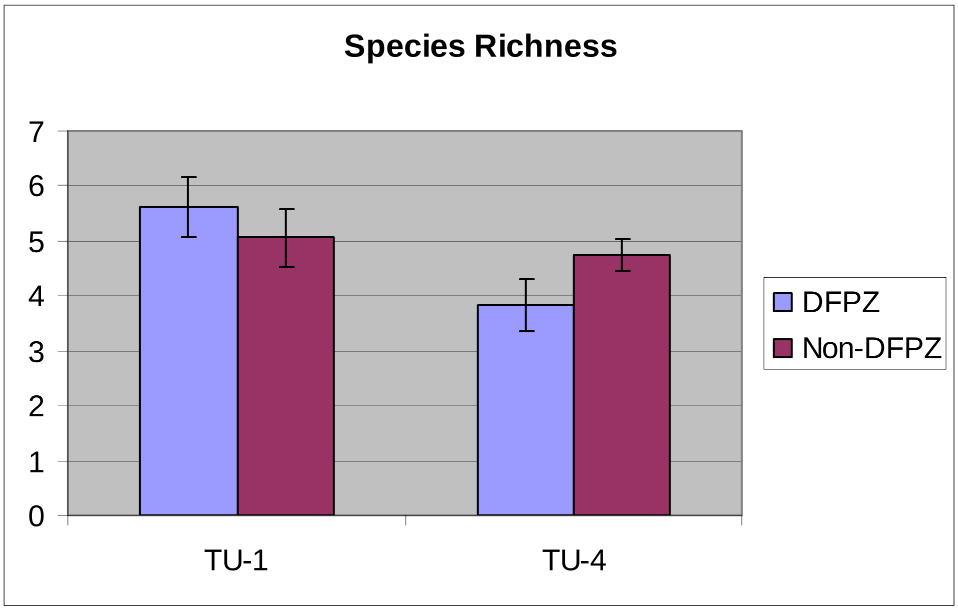
We compared the mean species richness for extensive transects (non-DFPZ) in each treatment unit in 2004 (Figure 1). Species richness ranged from a high of 5.05 in TU-1 to a low of 4.19 in TU-2. TU-2 mean richness per point was significantly ($p<0.05$) lower than TU-1, TU-3, and TU-5, with all other differences non-significant ($p>0.05$). Twenty-five percent (n=4) of transects in TU-2 averaged species richness below 3.00 (213, 214, OHC2, and CAR3), while only 12.5% (n=2) averaged per point richness over 5.50 (BVR 2 & CAR 1; Table 2). In contrast, 50% (n=3) of transects in TU-1, 29% (n=5) in TU-3, 23% (n=5) in TU-4, and 32% (n=6) in TU-5 averaged over 5.50 species per point. There were no transects in TU-1 and 5 that averaged below 3.00 species per point, and TUs 3 and 4 had one each (6% and 5% respectively).

**Figure 1. Avian species richness per point average by treatment unit in 2004 in the Plumas Lassen Study, with 95% confidence intervals**.



We compared species richness between pre-treatment DFPZ and extensive sites (non-DFPZ's) in TUs 1 and 4 (Figure 2). In TU-1 species richness was higher (non-significant p>0.05) in DFPZ's than at extensive sites (5.61 vs. 5.05), while in TU-4 DFPZ sites had significantly lower species richness than non-DFPZ sites (3.83 vs. 4.75; p<0.05). TU-4 DFPZ's were significantly lower than both TU-4 DFPZ and DFPZ and non-DFPZ sites in TU-1.

**Figure 2. Avian species richness per point average comparing all DFPZ and Extensive point count stations in Treatment Units 1 and 4 with 95% confidence intervals.**




We compared per point mean abundance of the ten most abundant species detected in TUs (2-5) from all extensive points surveyed in 2002 – 2004 (Table 3). We excluded TU-1 because most transects in that unit were only surveyed in 2004. A total of fourteen species comprised the ten most abundant species in the four units, though eight species were among the ten most abundant in each of the four units (Hermit Warbler, Audubon's Warbler, Oregon Junco, Mountain Chickadee, Western Tanager, Red-breasted Nuthatch, Dusky Flycatcher, and Fox Sparrow). TU-5 had the most unique species in its ten most abundant, with Hammond's Flycatcher and MacGillivray's Warbler not on any other units' most abundant species lists. TU-3 had one unique species, Cassin's Vireo, while units 2 and 4 did not have any unique species among their ten most abundant.

Hermit Warbler was the most abundant species in TUs 2, 3, and 4 (0.57, 0.45, and 0.62 respectively). In TU-4 where it was at its highest abundance per point, Hermit Warbler was nearly twice as abundant as Nashville Warbler (0.33), the next most abundant species. Audubon's Warbler was the most abundant species in TU-5 (0.41), followed closely by Oregon Junco (0.38), while Hermit Warbler was the fifth most abundant there with 0.28 detections per point.

**Table 3. Mean avian abundance[1] (within 50 meters) per point with 95% confidence interval for the 10 most abundant species (including ties) in each treatment unit (non DFPZ transects) for the PLAS study area for 2002 – 2004 combined.**

| Treatment Unit 2 Species | Mean Abundance | Treatment Unit 3 Species | Mean Abundance |
|---|---|---|---|
| Hermit Warbler | 0.57 ± 0.06 | Hermit Warbler | 0.45 ± 0.06 |
| Audubon's Warbler | 0.34 ± 0.04 | Nashville Warbler | 0.38 ± 0.06 |
| Oregon Junco | 0.32 ± 0.04 | Oregon Junco | 0.33 ± 0.04 |
| Mountain Chickadee | 0.29 ± 0.04 | Mountain Chickadee | 0.31 ± 0.04 |
| Nashville Warbler | 0.23 ± 0.04 | Audubon's Warbler | 0.22 ± 0.04 |
| Western Tanager | 0.19 ± 0.04 | Red-breasted Nuthatch | 0.21 ± 0.04 |
| Red-breasted Nuthatch | 0.18 ± 0.04 | Dusky Flycatcher | 0.21 ± 0.04 |
| Golden-crowned Kinglet | 0.17 ± 0.04 | Fox Sparrow | 0.19 ± 0.04 |
| Dusky Flycatcher | 0.15 ± 0.04 | Western Tanager | 0.18 ± 0.04 |
| Brown Creeper | 0.14 ± 0.02 | Cassin's Vireo | 0.13 ± 0.02 |
| Fox Sparrow | 0.14 ± 0.04 | | |
| **Treatment Unit 4 Species** | **Mean Abundance** | **Treatment Unit 5 Species** | **Mean Abundance** |
| Hermit Warbler | 0.62 ± 0.06 | Audubon's Warbler | 0.41 ± 0.04 |
| Nashville Warbler | 0.33 ± 0.04 | Oregon Junco | 0.38 ± 0.04 |
| Oregon Junco | 0.33 ± 0.04 | Mountain Chickadee | 0.34 ± 0.04 |
| Audubon's Warbler | 0.30 ± 0.04 | Golden-crowned Kinglet | 0.33 ± 0.04 |
| Dusky Flycatcher | 0.25 ± 0.04 | Hermit Warbler | 0.28 ± 0.04 |
| Mountain Chickadee | 0.25 ± 0.04 | Dusky Flycatcher | 0.22 ± 0.04 |
| Fox Sparrow | 0.23 ± 0.06 | Red-breasted Nuthatch | 0.21 ± 0.04 |
| Red-breasted Nuthatch | 0.21 ± 0.04 | Fox Sparrow | 0.17 ± 0.04 |
| Golden-crowned Kinglet | 0.22 ± 0.04 | MacGillivray's Warbler | 0.15 ± 0.02 |
| Western Tanager | 0.20 ± 0.04 | Western Tanager | 0.14 ± 0.02 |
| | | Hammond's Flycatcher | 0.14 ± 0.02 |
| | | Brown Creeper | 0.14 ± 0.02 |

**[1] Mean abundance is the average number of individuals per point, per visit.**

## DFPZ vs. Non-DFPZ Abundance and Species Richness

We compared the abundance of the ten most abundant species per point in 2004 in Treatment Units 1 and 4 at (non-DFPZ) and DFPZ (slated for treatment) point count locations (Table 4). In treatment unit 1, four species were significantly more abundant at points within proposed DFPZ treatments (Mountain Chickadee, Audubon's Warbler, Hermit Warbler, and Dusky Flycatcher), while no species were significantly more abundant in non-treated areas. In treatment unit 4, two species were significantly more abundant at points within proposed DFPZ's than at points outside of proposed treatment; those species were Dusky Flycatcher and Mountain Chickadee.

**Table 4. Mean abundance per point (within 50 meters) for the ten most abundant species in treatment units 1 and 4 at DFPZ and Non-DFPZ point count stations in 2004 with 95% confidence interval (* = significantly more abundant than Non-DFPZ transects in the same TU)**

| TU-1 DFPZ Species (n=72) | Mean Abundance & (CI) | TU-1 Non-DFPZ Species (n=59) | Mean Abundance & (CI) |
|---|---|---|---|
| Mountain Chickadee | 1.11 ± 0.28* | Mountain Chickadee | 0.41 ± 0.14 |
| Audubon's Warbler | 1.00 ± 0.24* | Audubon's Warbler | 0.58 ± 0.13 |
| Hermit Warbler | 0.78 ± 0.23* | Hermit Warbler | 0.34 ± 0.16 |
| Dusky Flycatcher | 0.74 ± 0.26* | Dusky Flycatcher | 0.31 ± 0.13 |
| Golden-crowned Kinglet | 0.58 ± 0.22 | Golden-crowned Kinglet | 0.40 ± 0.12 |
| Hammond's Flycatcher | 0.57 ± 0.19 | Hammond's Flycatcher | 0.30 ± 0.12 |
| Red-breasted Nuthatch | 0.51 ± 0.19 | Red-breasted Nuthatch | 0.32 ± 0.14 |
| Oregon Junco | 0.46 ± 0.15 | Oregon Junco | 0.23 ± 0.12 |
| Western Tanager | 0.44 ± 0.17* | Western Tanager | 0.19 ± 0.08 |
| Brown Creeper | 0.24 ± 0.13 | Brown Creeper | 0.15 ± 0.07 |

| TU-4 DFPZ Species (n=70) | Mean Abundance & (CI) | TU-4 Non-DFPZ Species (n=240) | Mean Abundance & (CI) |
|---|---|---|---|
| Hermit Warbler | 0.47 ± 0.17 | Hermit Warbler | 0.56 ± 0.08 |
| Nashville Warbler | 0.19 ± 0.11 | Nashville Warbler | 0.24 ± 0.05 |
| Oregon Junco | 0.50 ± 0.19 | Oregon Junco | 0.50 ± 0.19 |
| Audubon's Warbler | 0.24 ± 0.14 | Audubon's Warbler | 0.25 ± 0.06 |
| Dusky Flycatcher | 0.71 ± 0.24* | Dusky Flycatcher | 0.29 ± 0.07 |
| Mountain Chickadee | 0.46 ± 0.20* | Mountain Chickadee | 0.19 ± 0.04 |
| Fox Sparrow | 0.26 ± 0.14 | Fox Sparrow | 0.20 ± 0.05 |
| Red-breasted Nuthatch | 0.36 ± 0.18 | Red-breasted Nuthatch | 0.23 ± 0.04 |
| Golden-crowned Kinglet | 0.23 ± 0.14 | Golden-crowned Kinglet | 0.18 ± 0.05 |
| Western Tanager | 0.23 ± 0.12 | Western Tanager | 0.19 ± 0.04 |
| Hammond's Flycatcher | 0.26 ± 0.12 | Hammond's Flycatcher | 0.16 ± 0.04 |

[1]**Mean abundance is average number of individuals per point per visit.**

## Habitat Associations

*Landscape Statistics*

Landscape variables showed small to moderate variation (Table 5) and indicate that bird transects are located in areas with 64-99% forest cover (mean of 90.8%, where forest cover is based on GIS coverage indicating that hardwood or coniferous forest is present). On average the majority of the forested areas are conifers of size classes 3 and 4. The high degree of forest cover translates to relatively low levels of edge density, although this varies among transects. IJI approaches 0 when the distribution of adjacencies among seven unique patch types becomes increasingly uneven. IJI = 100 when all patch types are equally adjacent to all other patch types (i.e., maximum interspersion and juxtaposition; McGarigal et al. 2002). Our interspersion index results indicate a moderate IJI index with some variability. The contagion index shows more variability (relative to interspersion) with higher values in landscapes with a few large, contiguous patches. The Shannon's diversity index indicates the range in landscape diversity.

**Table 5. Descriptive statistics for landscape parameters for 32 point count transects (variable codes are described above in the Methods section under *Landscape Statistics*).**

| Variable | N | Mean | Std Dev | Minimum | Maximum |
|---|---|---|---|---|---|
| forPLAND | 32 | 90.8869281 | 7.6381994 | 63.9834000 | 99.1871000 |
| forED | 32 | 16.4710406 | 10.5643708 | 3.5360000 | 46.9302000 |
| IJI | 32 | 55.5290625 | 12.1933653 | 21.9600000 | 80.7500000 |
| CONTAG | 32 | 68.8243750 | 10.7759149 | 51.5500000 | 92.6900000 |
| SHDI | 32 | 0.9396875 | 0.3510674 | 0.1800000 | 1.4600000 |
| NONVEG(C1) | 32 | 3.2272235 | 3.8385896 | 0 | 16.4729025 |
| SHRUB(C2) | 32 | 5.3331657 | 6.8590950 | 0.2961719 | 37.7818053 |
| GRASS(C3) | 32 | 0.7166696 | 1.1529072 | 0 | 4.7365397 |
| HARDWD(C4) | 32 | 5.5687633 | 7.7700850 | 0 | 31.2991778 |
| CONIF(C12) | 32 | 2.3826364 | 2.5415887 | 0 | 7.6253205 |
| CONIF(C13) | 32 | 58.2231898 | 24.1011872 | 21.1674476 | 96.7774733 |
| CONIF(C14) | 32 | 24.5483517 | 21.1235108 | 0 | 65.9004509 |

*Local vs. Landscape Effects on Bird Abundance*

All of the 18 breeding bird species analyzed exhibited one or more significant correlations with landscape or vegetation variables in our stepwise multiple regression (Tables 6 - 8). However, only 10 of the species (56%; Golden-crowned Kinglet, Fox Sparrow, Nashville Warbler, Audubon’s Warbler, Black-headed Grosbeak, Dusky Flycatcher, Hammond’s Flycatcher, Hermit Warbler, MacGillivray’s Warbler, Mountain Chickadee) had results which explained greater than five percent of the variation in abundance.

The abundances for three species (17%; Golden-crowned Kinglet, Fox Sparrow, Nashville Warbler) were explained exclusively by vegetation variables or variables that were “local” to the transect (e.g. slope and elevation). The remaining seven species (39%; Audubon’s Warbler, Black-headed Grosbeak, Dusky Flycatcher, Hammond’s Flycatcher, Hermit Warbler, MacGillivray’s Warbler, Mountain Chickadee) were explained by a combination of local variables and landscape variables. For two of these species (Audubon’s Warbler and Dusky Flycatcher) a landscape variable was the first to enter the model and explained the greatest amount of variation. Hermit Warbler showed a negative relationship with the density of forest edge; Hermit Warbler, Hammond’s Flycatcher, and Dusky Flycatcher had relationships with the percent of hardwoods in the landscape; and Mountain Chickadee had a positive relationship with non-vegetated areas.

**Table 6. Multiple regression models for avian species sensitive to local vegetation features in the Plumas Lassen study area.**

**Golden-crowned Kinglet** ($F_{3,792}$ =63.37, P < 0.0001, $R^2$=0.1942)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | -0.07542 | 0.03993 | -1.89 | 0.0593 |
| abiconba | 1 | 0.02098 | 0.00206 | 10.19 | <.0001 |
| abimagba | 1 | 0.02355 | 0.00363 | 6.48 | <.0001 |
| maxtrdbh | 1 | 0.00192 | 0.00040 | 4.78 | <.0001 |

**Fox Sparrow** ($F_{3,793}$ =76.32, P < 0.0001, $R^2$=0.2247)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | -0.60810 | 0.10284 | -5.91 | <.0001 |
| realshrbco | 1 | 0.00858 | 0.00075 | 11.41 | <.0001 |
| elev | 1 | 0.00041 | 0.00007 | 5.76 | <.0001 |
| snags1030 | 1 | -0.00990 | 0.00243 | -4.08 | <.0001 |

**Nashville Warbler** ($F_{5,799}$ =54.21, P < 0.0001, $R^2$=0.2554)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | 0.77996 | 0.13113 | 5.95 | <.0001 |
| elev | 1 | -0.00041 | 0.00008 | -5.48 | <.0001 |
| quekelba | 1 | 0.08283 | 0.01412 | 5.87 | <.0001 |
| slope | 1 | 0.00948 | 0.00152 | 6.22 | <.0001 |
| basal | 1 | -0.01129 | 0.00209 | -5.40 | <.0001 |
| treshrbcov | 1 | 0.00545 | 0.00139 | 3.93 | <.0001 |

**Table 7. Multiple regression models for species sensitive to both local and landscape vegetation features in the Plumas Lassen Study Area.**

**Audubon's Warbler** ($F_{4,792}$ =46.37, P < 0.0001, $R^2$=0.1905)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | -0.01074 | 0.06923 | -0.16 | 0.8767 |
| C13 | 1 | 0.00663 | 0.00072 | 9.17 | <.0001 |
| ttlshrbcov | 1 | -0.00330 | 0.00089 | -3.71 | 0.0002 |
| cedar | 1 | -0.02011 | 0.00419 | -4.79 | <.0001 |
| maxtrdbh | 1 | 0.00172 | 0.00053 | 3.24 | 0.0012 |

**Mountain Chickadee** ($F_{3,792}$ =17.24 , P < 0.0001, $R^2$=0.0615)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | -0.39753 | 0.13019 | -3.05 | 0.0023 |
| maxtrdbh | 1 | 0.00225 | 0.00056 | 4.01 | <.0001 |
| elev | 1 | 0.00031 | 0.00009 | 3.52 | 0.0005 |
| C1 | 1 | 0.01548 | 0.00471 | 3.28 | 0.0011 |

**Hermit Warbler** ($F_{4,795}$ =32.94, P < 0.0001, $R^2$=.1428)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | 0.56232 | 0.06014 | 9.35 | <.0001 |
| basal | 1 | 0.01315 | 0.00356 | 3.70 | 0.0002 |

| | | | | | |
|---|---|---|---|---|---|
| forED | 1 | -0.01743 | 0.00230 | -7.59 | <.0001 |
| abicont1 | 1 | 0.00587 | 0.00141 | 4.15 | <.0001 |
| C4 | 1 | -0.01313 | 0.00294 | -4.47 | <.0001 |

**Dusky Flycatcher** ($F_{4,795}$ =41.98, P < 0.0001, $R^2$=0.1751)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | -0.03459 | 0.04185 | -0.83 | 0.4087 |
| C13 | 1 | 0.00279 | 0.00061 | 4.56 | <.0001 |
| realshrbco | 1 | 0.00451 | 0.00066 | 6.79 | <.0001 |
| pinjefba | 1 | 0.32171 | 0.06310 | 5.10 | <.0001 |
| C4 | 1 | -0.00835 | 0.00185 | -4.52 | <.0001 |

**Hammond's Flycatcher** ($F_{4,791}$ =24.17, P < 0.0001, $R^2$=0.1094)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | 0.11706 | 0.02616 | 4.47 | <.0001 |
| abicont1 | 1 | 0.00357 | 0.00059 | 6.02 | <.0001 |
| C4 | 1 | -0.00580 | 0.00134 | -4.32 | <.0001 |
| snagsg30 | 1 | 0.00584 | 0.00222 | 2.63 | 0.0088 |
| ttlshrbcov | 1 | -0.00134 | 0.00053 | -2.52 | 0.0121 |

**MacGillivray's Warbler** ($F_{2,783}$ =52.51, P < 0.0001, $R^2$=0.1185)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | -0.05770 | 0.02575 | -2.24 | 0.0253 |
| realshrbco | 1 | 0.00462 | 0.00049 | 9.43 | <.0001 |
| C13 | 1 | 0.00090 | 0.00041 | 2.21 | 0.0274 |

**Black-headed Grosbeak** ($F_{3,783}$ =30.86, P < 0.0001, $R^2$=0.1061)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | 0.23954 | 0.05194 | 4.61 | <.0001 |
| elev | 1 | -0.00015 | 0.00003 | -4.87 | <.0001 |
| C4 | 1 | 0.00403 | 0.00078 | 5.18 | <.0001 |
| slope | 1 | 0.00158 | 0.00063 | 2.50 | 0.0126 |

**Table 8. Multiple regression models for species with low explanatory power in the Plumas Lassen study area.**

**Oregon Junco** ($F_{2,795}$ =63.37, P < 0.0023, $R^2$=0.0152)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | 0.49506 | 0.07797 | 6.35 | <.0001 |
| quekelba | 1 | -0.04045 | 0.01745 | -2.32 | 0.0207 |
| IJI | 1 | -0.00280 | 0.00140 | -1.99 | 0.0466 |

**Hermit Thrush** ($F_{2,790}$ =5.87, P < 0.0006, $R^2$=0.0225)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | -0.15660 | 0.05207 | -3.01 | 0.0027 |
| C13 | 1 | 0.00218 | 0.00059 | 3.67 | 0.0003 |
| C14 | 1 | 0.00202 | 0.00068 | 2.96 | 0.0032 |
| hirsht | 1 | 0.01122 | 0.00550 | 2.04 | 0.0417 |

**Red-breasted Nuthatch** ($F_{3,792}$ =12.11, $P < 0.0001$, $R^2$=0.0440)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | 0.05823 | 0.05075 | 1.15 | 0.2516 |
| maxtrdbh | 1 | 0.00132 | 0.00047 | 2.82 | 0.0050 |
| pinlamt1 | 1 | 0.01103 | 0.00332 | 3.32 | 0.0009 |
| C4 | 1 | -0.00556 | 0.00197 | -2.82 | 0.0049 |

**Western Tanager** ($F_{3,779}$ =7.57, $P < 0.0001$, $R^2$=0.0284)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | 0.21324 | 0.02908 | 7.33 | <.0001 |
| pinlamt1 | 1 | 0.01182 | 0.00310 | 3.82 | 0.0001 |
| pinlamba | 1 | -0.02445 | 0.00793 | -3.08 | 0.0021 |
| hirsht | 1 | -0.02731 | 0.01056 | -2.59 | 0.0099 |

**Brown Creeper** ($F_{2,791}$ =11.18, $P < 0.0001$, $R^2$=0.0276)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | -0.03005 | 0.03794 | -0.79 | 0.4286 |
| hitreeht | 1 | 0.00387 | 0.00118 | 3.29 | 0.0010 |
| snagsg30 | 1 | 0.00612 | 0.00215 | 2.85 | 0.0044 |

**Cassin's Vireo** ($F_{4,795}$=24.17, $P < 0.0001$, $R^2$=0.0377)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | -0.30399 | 0.10271 | -2.96 | 0.0032 |
| psement1 | 1 | 0.00197 | 0.00081 | 2.45 | 0.0146 |
| forPLAND | 1 | 0.00298 | 0.00097 | 3.06 | 0.0023 |
| IJI | 1 | 0.00201 | 0.00064 | 3.16 | 0.0016 |
| pinpont1 | 1 | -0.00365 | 0.00143 | -2.54 | 0.0111 |

**Olive-sided Flycatcher** ($F_{3,783}$ =10.27, $P < 0.0001$, $R^2$=0.0375)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | -0.00409 | 0.00445 | -0.92 | 0.3589 |
| abimagba | 1 | 0.00364 | 0.00082 | 4.43 | <.0001 |
| C4 | 1 | 0.00137 | 0.00038 | 3.56 | 0.0004 |
| pinlamba | 1 | 0.00300 | 0.00164 | 1.83 | 0.0677 |

**Hairy Woodpecker** ($F_{2,790}$ =4.62, $P < 0.0101$, $R^2$=0.0116)

| Variable | DF | Parameter Estimate | Standard Error | t Value | Pr > \|t\| |
|---|---|---|---|---|---|
| Intercept | 1 | -0.01631 | 0.01916 | -0.85 | 0.3950 |
| mintrdbh | 1 | 0.00330 | 0.00146 | 2.27 | 0.0236 |
| snagsg30 | 1 | 0.00238 | 0.00124 | 1.92 | 0.0550 |

### GIS Project for Creating Species Maps

We created a GIS project incorporating all bird data collected in 2003 and 2004 (CD Supplement A). This tool can be used by land managers to generate distribution maps for all species breeding within the PLAS study area (see Appendices 10 and 11 for examples), identify birds species present at specific sites of management interest, present detection information for species of management interest, and present community indices (e.g., species richness) as determined by point count analysis. Appendix 12 outlines directions for creating additional maps for any species of interest or for bird community indices, and describes all aspects of this ArcView project and associated database tables. In future years we will update the bird data for this project to incorporate the most up to date information on the distribution and abundance of birds in the study area.

## DISCUSSION

### Annual Variation in Indices

Indices in 2004 were lower almost across the board when compared to the same transects in either 2003 or 2002. Though every effort is made to minimize it, some of this variation may be attributable to differences in observers across years which were not controlled for in this analysis. However, natural variability does occur between years and is part of the rationale to conduct longer term studies with multiple years of pre and post treatment data. In future analysis of trends and in analyzing changes following treatment we will model for the effects of observer variability.

### Abundance and Species Richness By Treatment Unit

The two highest elevation units, 1 and 5, had the highest species richness and abundance. We also found a significant positive relationship between avian diversity and elevation across the entire sampling area. We find this relationship interesting as we know that many of the higher elevation sites are fir dominated and often lack the hardwood component with which many of the species in the study area have a positive correlation. It may be that the lower elevation sites have been subjected to more intensive resource extraction and are thus in a more degraded state and elevation in and of itself is not influencing bird richness. The lowest richness and abundance indices were for TU-2, as it was the only unit that had significantly lower species richness per point. Interestingly, TU-2 also has the highest density of Spotted Owl territories in the study area (J. Keane pers. Comm.). It should be noted that the area we are sampling is limited to navigable terrain (slopes average <30%) within the study area. It may be that the owls are utilizing habitat in and on many of the steep canyons and hillsides within TU-2 where we are not able to sample. We intend to further investigate the relationship between Spotted Owl habitat the rest of the avian community by directly sampling within known owl territories starting in 2005.

Our analysis shows that Hermit Warbler is the most abundant breeding species in the navigable forested habitats (slope<30%) in the study area (our sampling area). We found this species associated with both basal area and white fir (*Abies concolor*), two forest attributes believed to have increased in the last century due to fire suppression and other management practices. Thus, this species may have benefited from the changes to forest conditions that current management is attempting to reverse. We hypothesize that Hermit Warbler might be one of the species negatively impacted by implementation of current forest management direction.

It should be noted that while we plan on using the most abundant species as tools for indicating changes in habitat conditions, some of the less common species are of greater management concern due to their scarcity (e.g., Olive-sided Flycatcher, Pileated Woodpecker). We are monitoring the entire bird community and it is our intention to determine the appropriate management actions that should be taken to prevent these species from becoming less common.

### DFPZ vs. Non-DFPZ Abundance and Species Richness

Ideally, planned forest thinning would occur on average in areas with lower habitat quality than the surrounding forests. Using species richness as a measure of habitat quality we found that the planned DFPZ's in TU-4 are in less species-rich avian habitat than the surrounding forest. Contrastingly, the proposed DFPZ's in the TU-1 (within the Almanor Ranger District's "Creeks" project) are in more species rich habitat than the surrounding forest. In fact, three of the DFPZ transects in TU-1 where among the most species rich transects surveyed in 2004. Though many factors go in to determining the placement of DFPZ's, we believe proposed forest treatments would have less negative and more positive effects on the avian community if results from our monitoring were incorporated into the final decision making process surrounding their placement. It is our aim to make available, in a timely and user friendly fashion, our data (species richness and the other measures of avian habitat quality) to forest service staff for incorporation into their planning process (see ArcView GIS CD supplement).

Of the ten most abundant species encountered, almost all were more abundant at DFPZ sites than at non-DFPZ sites in 2004, including all six of the significant differences found. The species we found significant differences with are among the most abundant species in each of these units (though this may be driven by the increased power associated with a larger sample). Several other less common species (e.g., Hammond's Flycatcher and Western Tanager) were marginally significantly more abundant at DFPZ sites in TU-1.

We expect the DFPZ treatments to have the largest immediate impact on the landscape due to their size and extensiveness, and thus a significant impact on the composition of the bird community within their footprint (and possibly beyond). If understory fuels are cleared, canopy significantly reduced, and most of the snags removed in these areas, we would expect a decrease in species richness and a decrease in the abundance of most of the current local breeding species at these sites. While short-term effects are relevant, more important are the long-term effects of these treatments on the avian community. In the longer time frame, we expect that species that are associated with closed canopy, basal area, and other shaded forest or heavily stocked conditions will remain below pre-treatment levels (e.g. Hammond's Flycatcher, Golden-crowned Kinglet, and Hermit Warbler). In contrast, we would expect species that favor open forest conditions, including not present pre-treatment, to increase following treatment, though this is highly dependent on the future management of the treated areas.

One would expect that the more open forest canopy conditions created should benefit shade intolerant plant species such as hardwoods and shrubs which are habitat for many bird species (see habitat associations above). As a result one would expect to observe an increase in the years following treatment of species such as Nashville Warbler, Black-headed Grosbeak, Fox Sparrow, Dusky Flycatcher, and MacGillivray's Warbler. However, if these areas are managed to discourage the development of many of the natural open forest habitat attributes (e.g. shrubs, herbaceous layer, and hardwoods), we predict these areas to have depressed avian species richness and total bird abundance when compared to the surrounding untreated forests over extended time periods.

## Habitat Associations

*Overview*

By considering both local and landscape habitat attributes to explain variation in bird abundance it is possible to better explain the factors driving observed differences as well as determine which have the larger influence on the distribution of species in the study area.

It is intriguing that none of the species we examined had relationships exclusively with landscape variables, and that only two species (Dusky Flycatcher and Audubon's Warbler) had a landscape variable enter the model first. Landscape effects have been shown to be strong correlates of bird abundance in other studies (Howell et al. 2000, Bolger et al. 1997), especially with numerous Neotropical migratory birds. Our analyses may be limited because there was not large variation in the landscape metrics that we considered. This is partly due to the fact that this area is fairly contiguous forest with a high degree of forest cover. However, there is also heterogeneity in the area (e.g., among different forest stand types); additional and more complex landscape metrics may be required to tease apart landscape differences. Alternatively, the relative homogeneity of these forests - when considered at a landscape scale - may increase our power to determine the impact of treatment at this scale, which is a key component of this study.

*Species Models*

The landscape variable with the most explanatory power for both Dusky Flycatcher and Audubon's Warbler was the amount of size class 3 forest within a 3km circle. Since it was the first variable to enter the model, it suggests these species are particularly sensitive to landscape attributes. Interestingly, both of these species tend to use different habitat, with Dusky Flycatcher rarely if ever found away from areas with substantial shrub cover (hence the associations with shrub cover; Table 7), and Audubon's Warbler is most abundant in coniferous forest with substantial canopy closure and has a negative association with shrub cover (Table 7). By further exploring these differences it will allow us to gain a greater understanding of the factors influencing the abundance and distribution of many of the species in the study area. This in turn will help focus our future analysis as well as provide insight into the potential effects of different forest treatment strategies.

The variables that occurred in the most models were shrub cover (mostly positive), maximum tree dbh (all positive), and the amount of hardwood habitat within 3 km (mostly negative). It is important to note that the variable measuring hardwood habitat used only habitat classified as hardwood and does not include coniferous habitats with hardwood components. The species with negative relationships with hardwood habitat (Hammond's Flycatcher and Hermit Warbler) are strictly found in coniferous habitats. At lower elevations closely related Pacific-slope Flycatcher is more abundant in hardwood habitats while Black-throated Gray become more abundant than Hermit Warbler (pers. Obs.). These interactions may partially explain the negative relationship between hardwoods and these two species.

Many of the associations found in our habitat modeling exercise were not surprising, based on our previous knowledge of the life history of these species. For example, shrub cover was positively correlated with Fox Sparrow, Dusky Flycatcher, and MacGillivray's Warbler, three species we know nest only in shrub habitats and appear to reach their greatest abundance in shrub dominated habitats (such as those on the flanks of Spanish Peak in TU-4). Additionally, we rarely if ever have found Nashville Warbler away from habitat with a Black Oak (*Quercus kellogii*) component. However, knowing this species is also negatively correlated with basal area, elevation, and positively correlated with tree cover less than 5 meters tall helps us gain a better understanding into the exact habitat conditions required to maximize its abundance. Additionally, we have gained insight into associations with other species that we did not consider before, such as Hammond's Flycatcher and large snags, Hermit Warbler and forest edge, and Dusky Flycatcher and the extent of size class 3 forest in the surrounding landscape. The information gained here will contribute to our body of knowledge of ecological requirements of the Northern Sierra bird community. Taking into consideration this knowledge we will be able to make more specific management recommendations and better able to evaluate the efficacy of future management decisions in achieving an ecologically sustainable forest bird community and ecosystem.

For the species where the regression model explained less than five percent of the variance (Brown Creeper, Cassin's Vireo, Hairy Woodpecker, Hermit Thrush, Oregon Junco, Olive-sided Flycatcher, Red-breasted Nuthatch, and Western Tanager) additional measures may be required to capture their landscape and vegetation preferences. Many of these species are detected in relatively small numbers in the study area (Olive-sided Flycatcher, Hermit Thrush, Brown Creeper, Cassin's Vireo, and Hairy Woodpecker) and are not ideal candidates for analyzing factors influencing abundance. We will explore other analysis techniques such as factors influencing the presence or absence of these species.

## CONCLUSION

Though no treatment has been implemented within the study area to date, the data collected in 2002 through 2004 is valuable for increasing our understanding of the habitat features many of the breeding species respond to, assessing pre-existing conditions at sites scheduled for treatment, honing our study design to ensure we will be able to properly evaluate the effects of forest management, and provide the knowledge necessary to make meaningful and timely management recommendations for maximizing the quality of coniferous forest habitats.

In order to determine the short term response of the avian community to forest treatments it appears it will be necessary to collect several years of post-treatment data in order to separate out the effects of annual variation from the treatment effects. In order to properly evaluate the impact of forest treatments it will be necessary to monitor the avian community over much longer time frames.

Our analysis of habitat associations illustrates the vast array of habitat types and attributes that the avian community in the Northern Sierra Nevada are associated with. It also illustrates that some species will likely decline as a result of these treatments. This is not to say that current management plans should not go forward just because they may cause declines in certain species. In fact we believe it would be impossible to change these forests in any significant way and not have a negative impact on one, and probably many species. The key to good management will be to ensure that negative the impacts to some species are met with positive ones for others so that a balance is struck where no one habitat type or conditions is disfavored to the extent that the species that depend on it are sent on a trajectory towards local extirpation. Determining an acceptable "balancing" point will be a difficult challenge. Long-term, landscape based ecological monitoring will be critical to determining when an acceptable balance has been struck. Avian monitoring is one of the only practical tools capable of providing the necessary feedback to make these complex and difficult decisions before the scale has been tipped too far and regulatory hurdles significantly limit management options. In recent years fire suppression and timber harvest practices (among others) have tipped the balance of these systems in favor of overstocked forests with small to medium sized trees. Here we present several management recommendations to increase habitat attributes that have been reduced as a result of forest management practices over the past century or more and ones we perceive might disfavored under new management direction.

## MANAGEMENT RECCOMENDATIONS

### Snags

Our analysis, as well as that of many others, has shown that snags are a critical component of forest ecosystems. A myriad of avian species in these forests are completely dependent upon snags. Retaining four snags per acre should be an absolute minimum guideline, we recommend maintaining as many snags as possible with priority given to the largest ones.

### Shrubs

Shrub habitats are a critical component of the forest ecosystem with many avian species fully dependent on them. Allowing group selection treatments and where appropriate DFPZ's to naturally regenerate would ensure this habitat type does not dramatically decline in the next 100 years. Additionally, shrub understory within forested habitats should be valued and managed as an important habitat attribute.

### Hardwoods

Thinning projects (both DFPZ and groups) can provide a duel benefit when incorporated into a Black Oak and Aspen enhancement projects (e.g. Almanor and Eagle Lake ranger Districts of the Lassen National Forest). Hardwoods in general have suffered from fire suppression resulting in a dramatic decrease in the amount of these habitat types/attributes. Hardwoods and other shade intolerant species will benefit from creating openings in the forest.

### Old Seral Forests

Many bird species are positively correlated with large tree habitat attributes in the study area. Undoubtedly this habitat has been drastically reduced here in the last century. With the

abundance of size class 3 and dearth of size class 4 and 5 forest currently on the landscape, every effort should be given to avoiding placement of groups or DFPZ's in size class 4 or 5 forests.
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PERSONNEL

This project is coordinated and supervised by PRBO staff biologist Ryan Burnett. Kim Maute is the field crew supervisor. Field work in 2004 was conducted by Ryan Burnett, Gabriel Cahalan, Jon Hall, Jennipher Karst, Kim Maute, Garr Owens, and Beth Peluso. Diana Humple was instrumental in preparing databases for analysis and helping develop the ArcView project that is used to generate species maps. Computer programs used to manage and summarize data were created by PRBO staff biologists Grant Ballard and Diana Humple. The study was carried out under the guidance of PRBO Terrestrial Program Director Geoffrey R. Geupel and PRBO Population Ecologist Nadav Nur.

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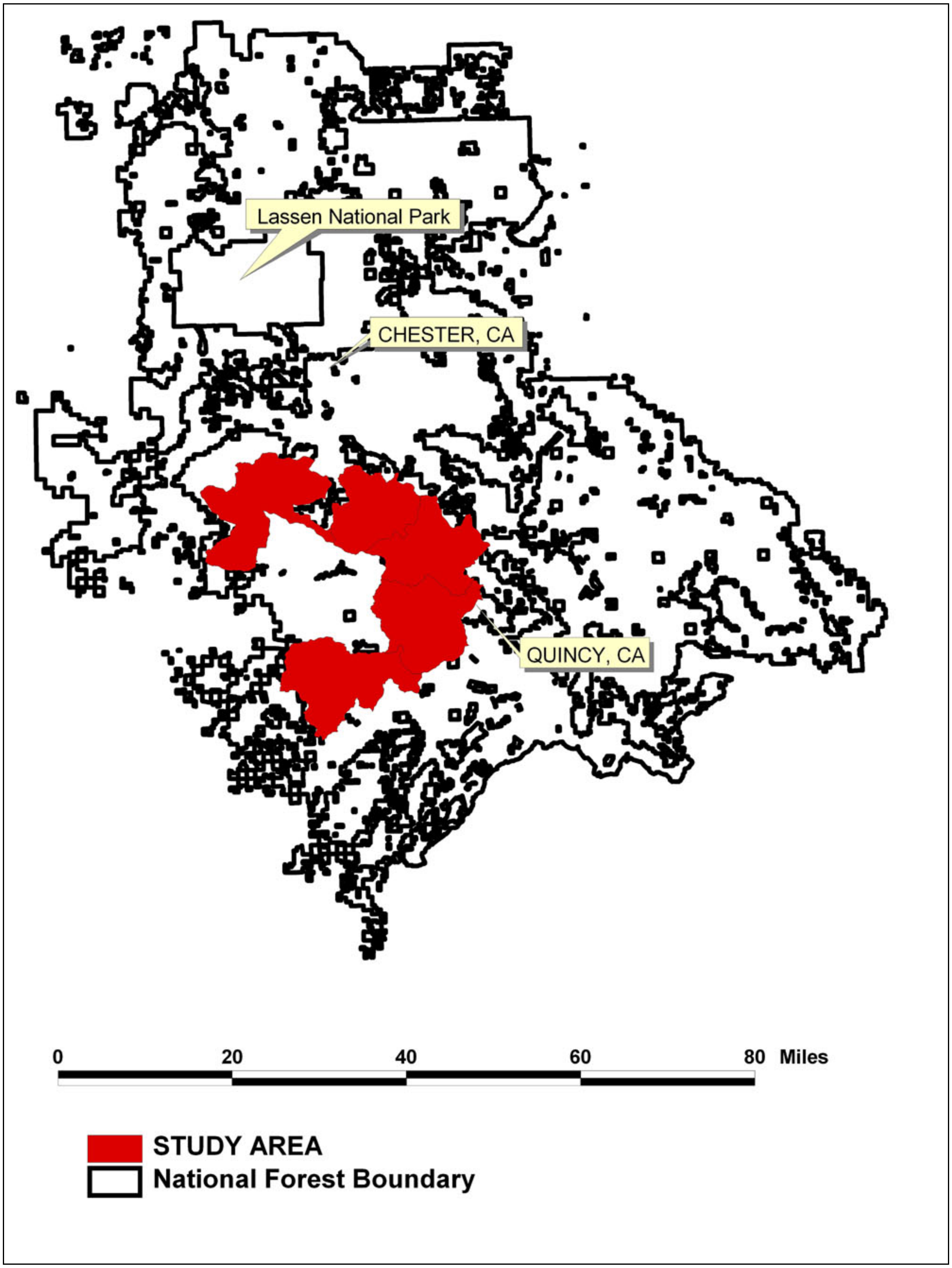
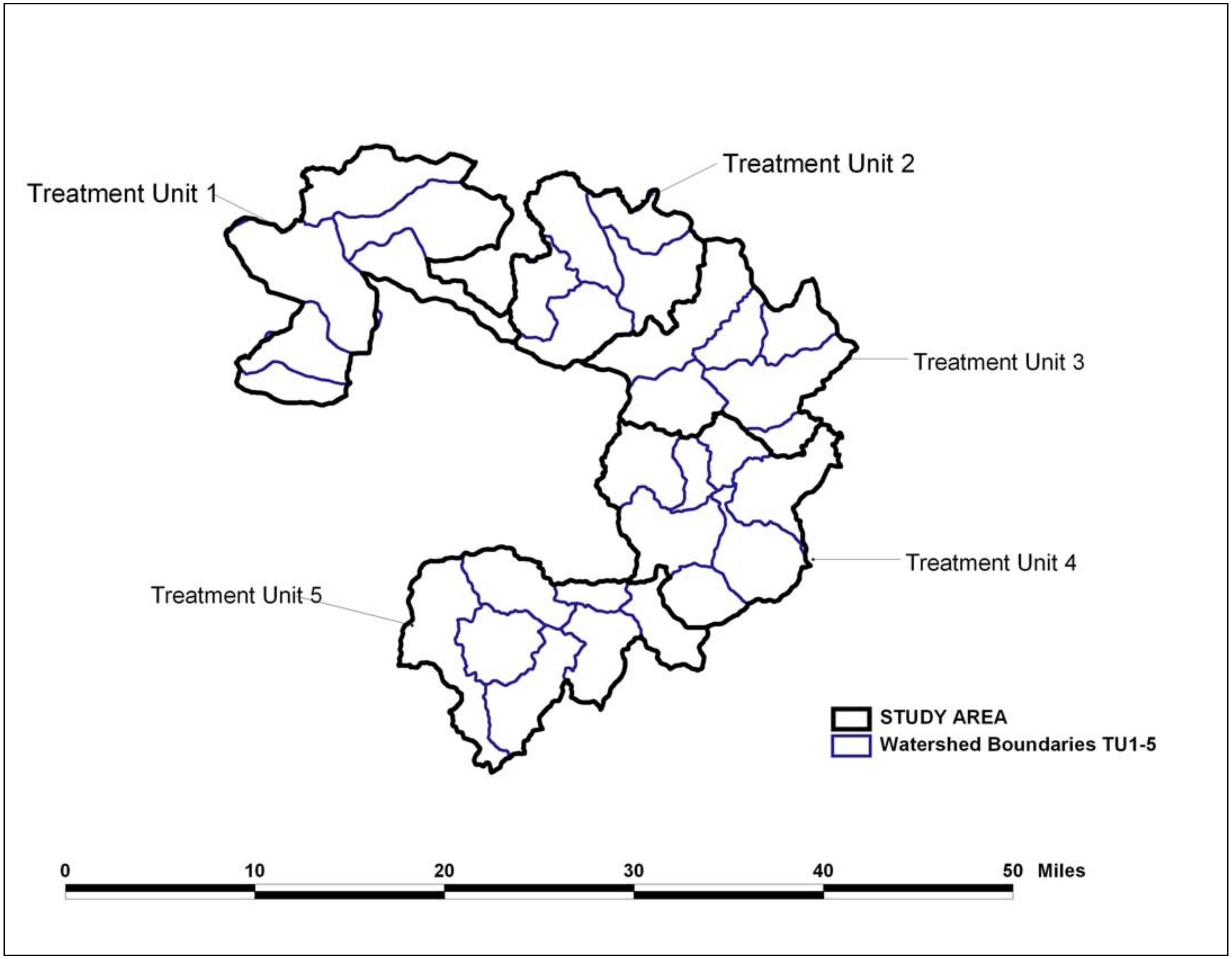
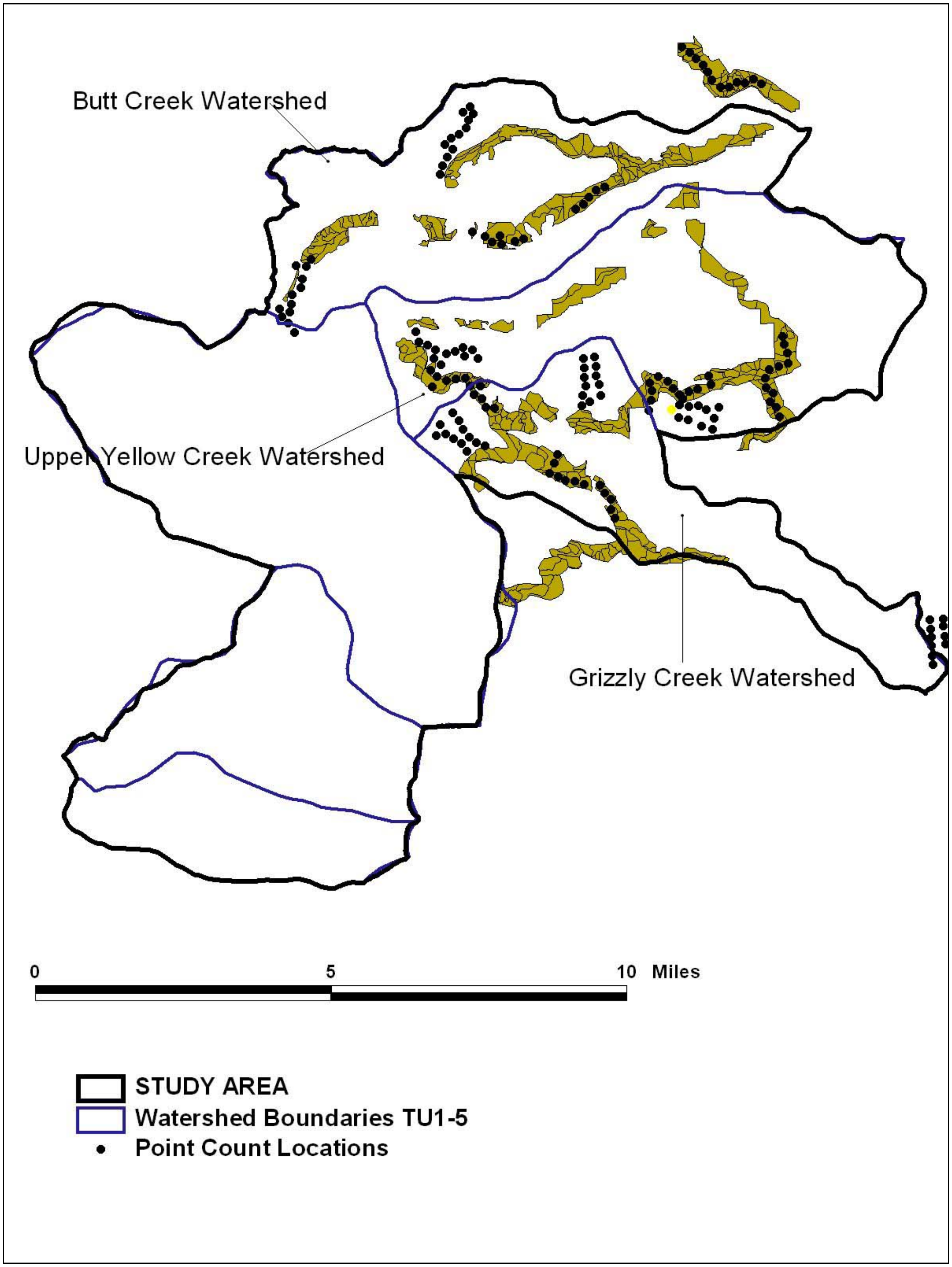
**Appendix 1. Study area overview map of the PRBO Plumas Lassen module of the Administrative Study.**



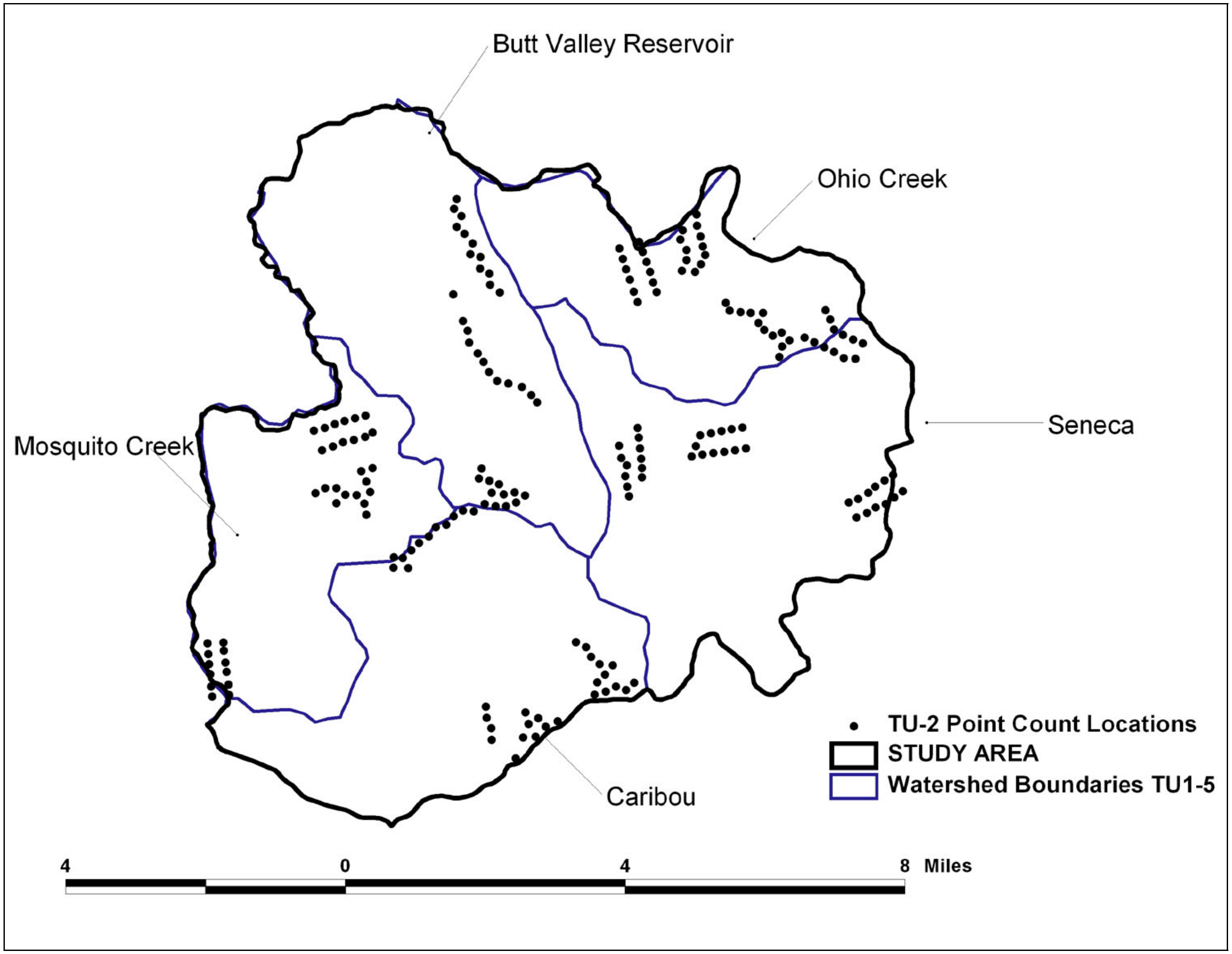
**Appendix 2. Treatment Units and Watershed boundaries of the PRBO Plumas Lassen Avian Study Area, 2004.**



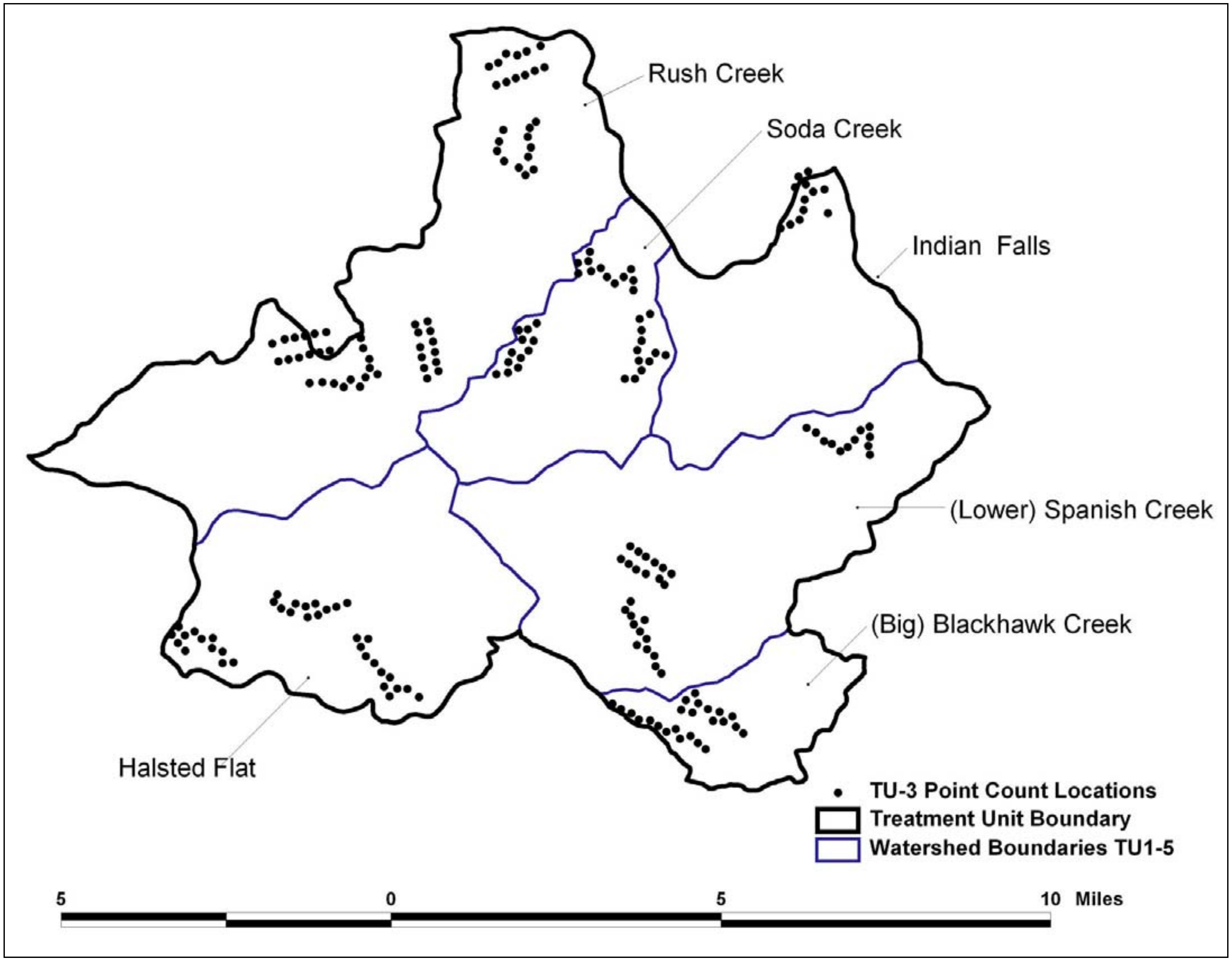
**Appendix 3. Treatment Unit 1 Map with watersheds, DFPZ outlines, and locations of point count transects surveyed in 2004 for the PRBO Plumas Lassen Administrative Study.**



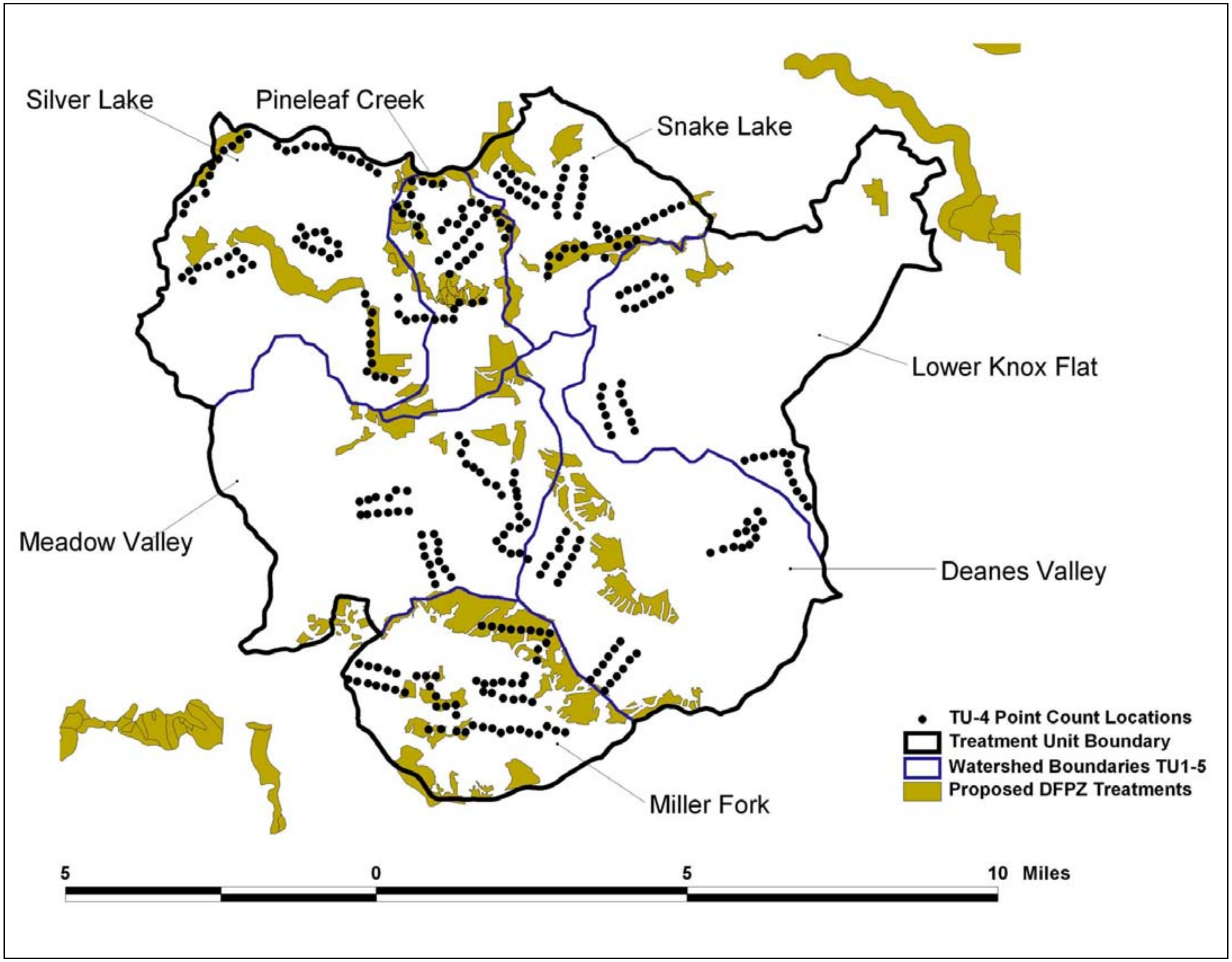
**Appendix 4. Treatment Unit 2 map with watersheds, DFPZ outlines, and locations of point count transects surveyed in 2004 for the PRBO Plumas Lassen Administrative Study.**



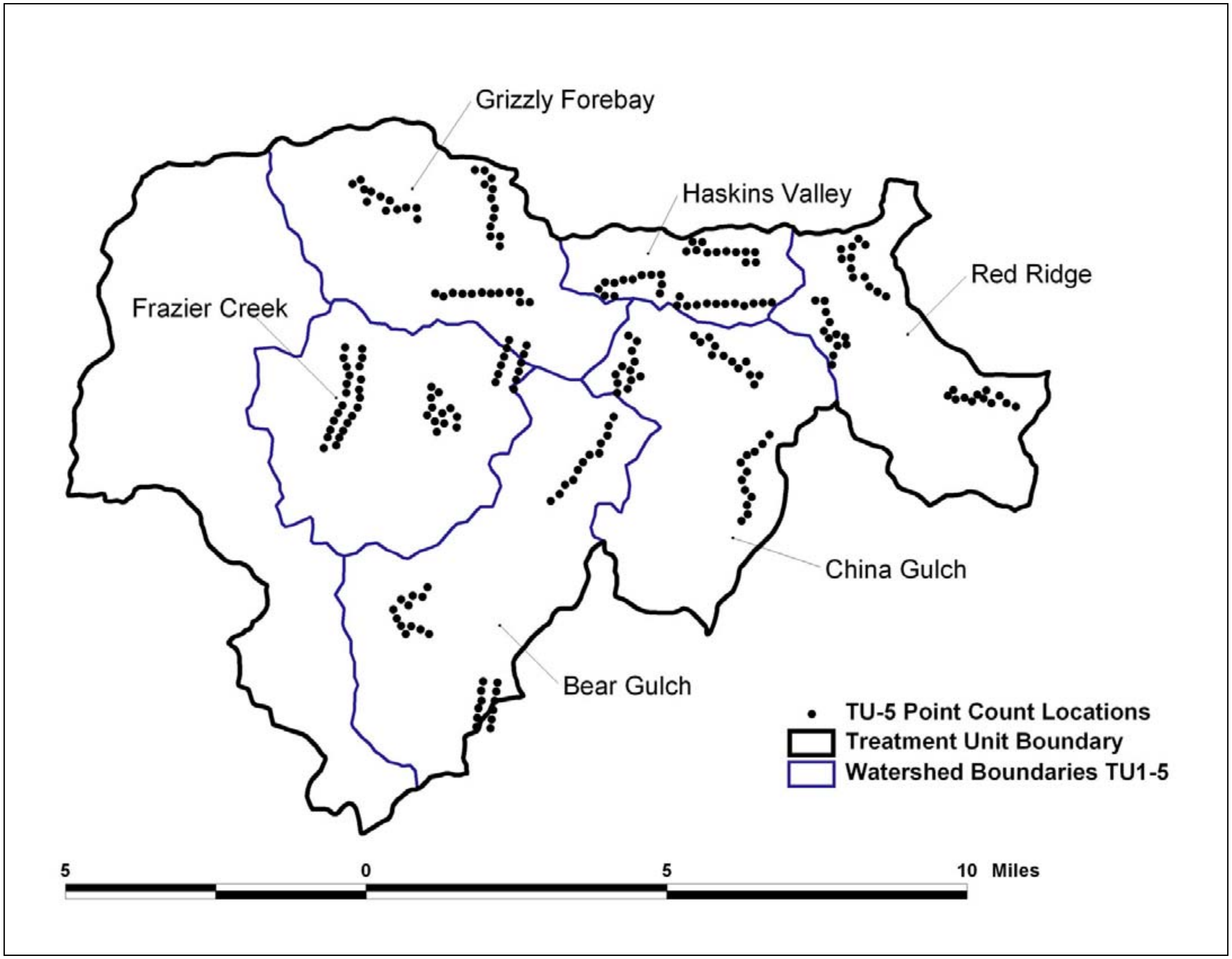
**Appendix 5. Treatment Unit 3 map with delineating watersheds and locations of point count transects surveyed in 2004 for the PRBO Plumas Lassen Administrative Study.**



**Appendix 6. Treatment Unit 4 map delineating watersheds, DFPZ outlines, and locations of point count transects surveyed in 2004 for the PRBO Plumas Lassen Administrative Study.**



**Appendix 7. Treatment Unit 5 map delineating watersheds and locations of point count transects surveyed in 2004 for the PRBO Plumas Lassen Administrative Study.**



**Appendix 8. Protocols for local point count vegetation data collection for variables used in habitat association analysis (landscape methods are described in methods above).**

All data is collected from a 50 meter radius circle using ocular estimates (accept basal area).

**Aspect** - the direction of the slope given in degrees (the direction a drop water would flow if poured onto the point). Collect magnetic direction.

**Slope** - the average slope of the plot with 90 degrees being vertical and 0 degrees being flat.

**Snags<10** - the total number of the snags in the plot less than 10cm DBH (this includes things that still have dead branches on it but it must be appear to be completely dead, leaning snags that are uprooted but not on the ground or almost on the ground count).

**Snags30>10** - the number of snags greater than 10 cm DBH but less than 30 cm DBH (see above for definition of a snag).

**Snags >30** - the total number of snags greater than 30 cm DBH in the plot.

**Cover Layers -** these are divided up into 5 layers (Tree, Tree Shrub, Real Shrub, Total Shrub, and Herbaceous)

Tree layer is defined by height category alone. Any plant species whose upper bounds (highest point) is greater than 5 meters tall is included in this category (a 6 m tall Manzanita would be included in this category, however a 4m tall White Fir would not be).

Tree Shrub is all tree species that are less than 5 meters tall regardless of height, this means a 25cm tall White Fir counts in this category. Tree species are the conifers, black oak, maple, white alder, canyon oak, etc.

Real Shrubs this is the true shrub species as well as a few shrubby trees that rarely get above 5 meters tall (e.g. Dogwood, Mountain Alder, ARCPAT, CEACOR, etc.), record the total cover of these species regardless of height.

Total Shrub – this is the total cover of all vegetation whose maximum height is between 0.5 and 5 meters. (the old releve way of doing it).

**High Heights**
Estimate to the nearest ½ meter the average height of the upper bounds of the vegetation layers (tree, tree shrub, real shrub). This is not the tallest outlier it is the average high of the tallest plants in that layer.

**Relative Covers –** the relative cover of the most dominant (make up at least 90% of the cover) in each of the cover layers [T1 (tree layer), TS (true shrub), and RS (real shrub), relative covers add to 100% regardless of the total cover recorded for the layer above (absolute cover will be calculated later for analysis by multiplying this number by the total cover for the layer).

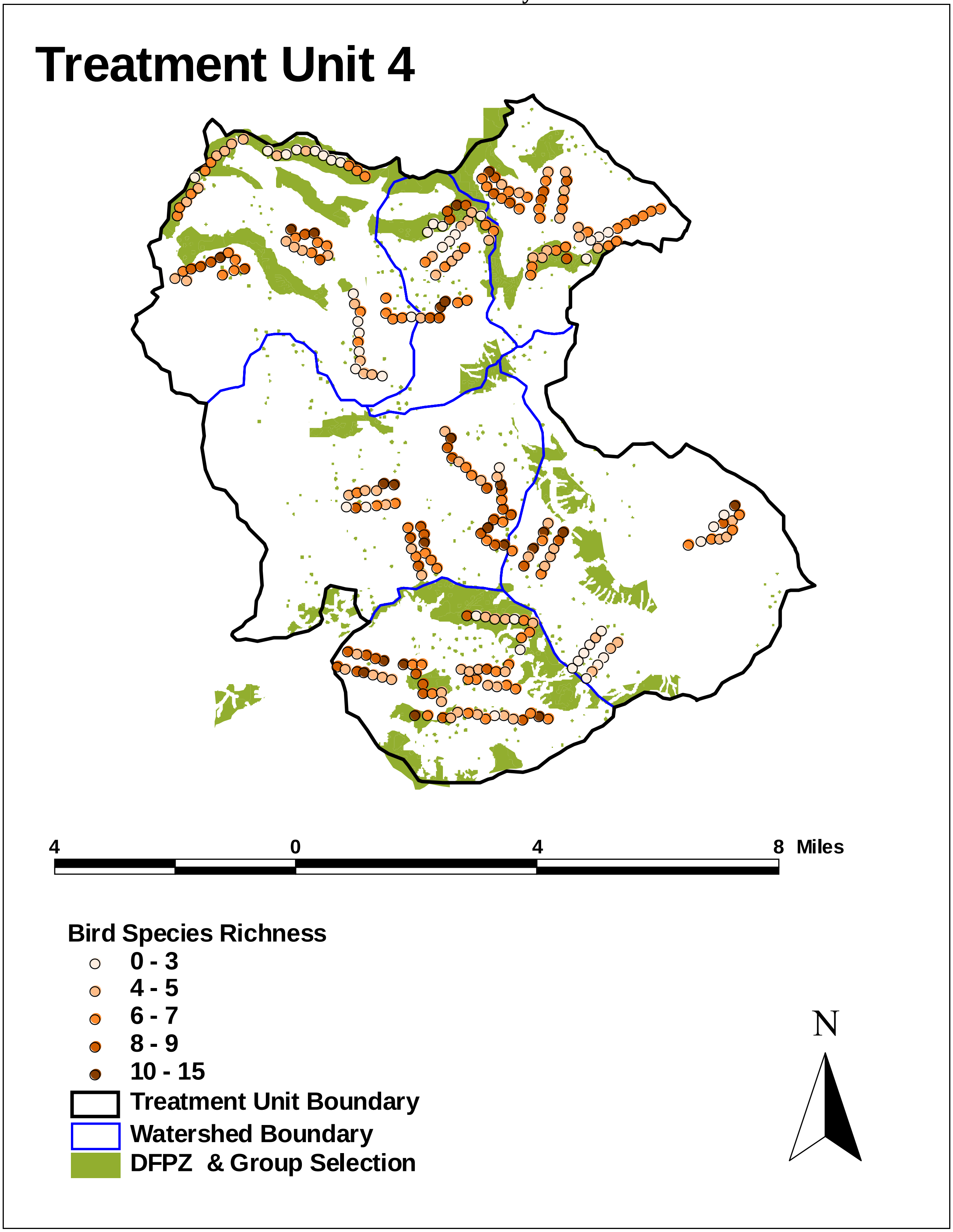
**Appendix 9. List of all bird species detected by PRBO on point count surveys (common, AOU code, scientific name) in the PLAS in 2002 - 2004.**

| Common Name | AOU Code | Scientific Name |
|---|---|---|
| Acorn Woodpecker | ACWO | *Melanerpes formicivorus* |
| American Crow | AMCR | *Corvus brachyrhynchos* |
| American Dipper | AMDI | *Cinclus mexicanus* |
| American Kestrel | AMKE | *Falco sparverius* |
| American Robin | AMRO | *Turdus migratorius* |
| Anna's Hummingbird | ANHU | *Calypte anna* |
| Audubon's Warbler | AUWA | *Dendroica coronata audubonii* |
| Bald Eagle | BAEA | *Haliaeetus leucocephalus* |
| Band-tailed Pigeon | BTPI | *Columba fasciata* |
| Belted Kingfisher | BEKI | *Ceryle alcyon* |
| Bewick's Wren | BEWR | *Thryomanes bewickii* |
| Black Phoebe | BLPH | *Sayornis nigricans* |
| Black-backed Woodpecker | BBWO | *Picoides arcticus* |
| Black-headed Grosbeak | BHGR | *Pheucticus melanocephalus* |
| Black-throated Gray Warbler | BTYW | *Dendroica nigrescens* |
| Blue Grouse | BGSE | *Dendragapus obscurus* |
| Blue-gray Gnatcatcher | BGGN | *Polioptila caerulea* |
| Brewer's Sparrow | BRSP | *Spizella breweri* |
| Brown Creeper | BRCR | *Certhia Americana* |
| Brown-headed Cowbird | BHCO | *Molothrus ater* |
| Bushtit | BUSH | *Psaltriparus minimus* |
| California Quail | CAQU | *Callipepla californica* |
| Calliope Hummingbird | CAHU | *Stellula calliope* |
| Canada Goose | CAGO | *Branta Canadensis* |
| Cassin's Finch | CAFI | *Carpodacus cassinii* |
| Cassin's Vireo | CAVI | *Vireo casinii* |
| Cedar Waxwing | CEDW | *Bombycilla cedrorum* |
| Chipping Sparrow | CHSP | *Spizella passerine* |
| Clark's Nutcracker | CLNU | *Nucifraga Columbiana* |
| Common Nighthawk | CONI | *Chordeiles minor* |
| Common Raven | CORA | *Corvus corax* |
| Cooper's Hawk | COHA | *Accipiter cooperii* |
| Downy Woodpecker | DOWO | *Picoides pubescens* |
| Dusky Flycatcher | DUFL | *Empidonax oberholseri* |
| European Starling | EUST | *Sturns vulgaris* |
| Evening Grosbeak | EVGR | *Coccothraustes vespertinus* |
| Fox Sparrow | FOSP | *Passerella iliaca* |
| Golden-crowned Kinglet | GCKI | *Regulus satrapa* |
| Gray Flycatcher | GRFL | *Empidonax wrightii* |
| Gray Jay | GRJA | *Perisoreus Canadensis* |
| Green Heron | GRHE | *Butorides virescens* |
| Green-tailed Towhee | GTTO | *Pipilo chlorurus* |
| Hairy Woodpecker | HAWO | *Picoides villosus* |

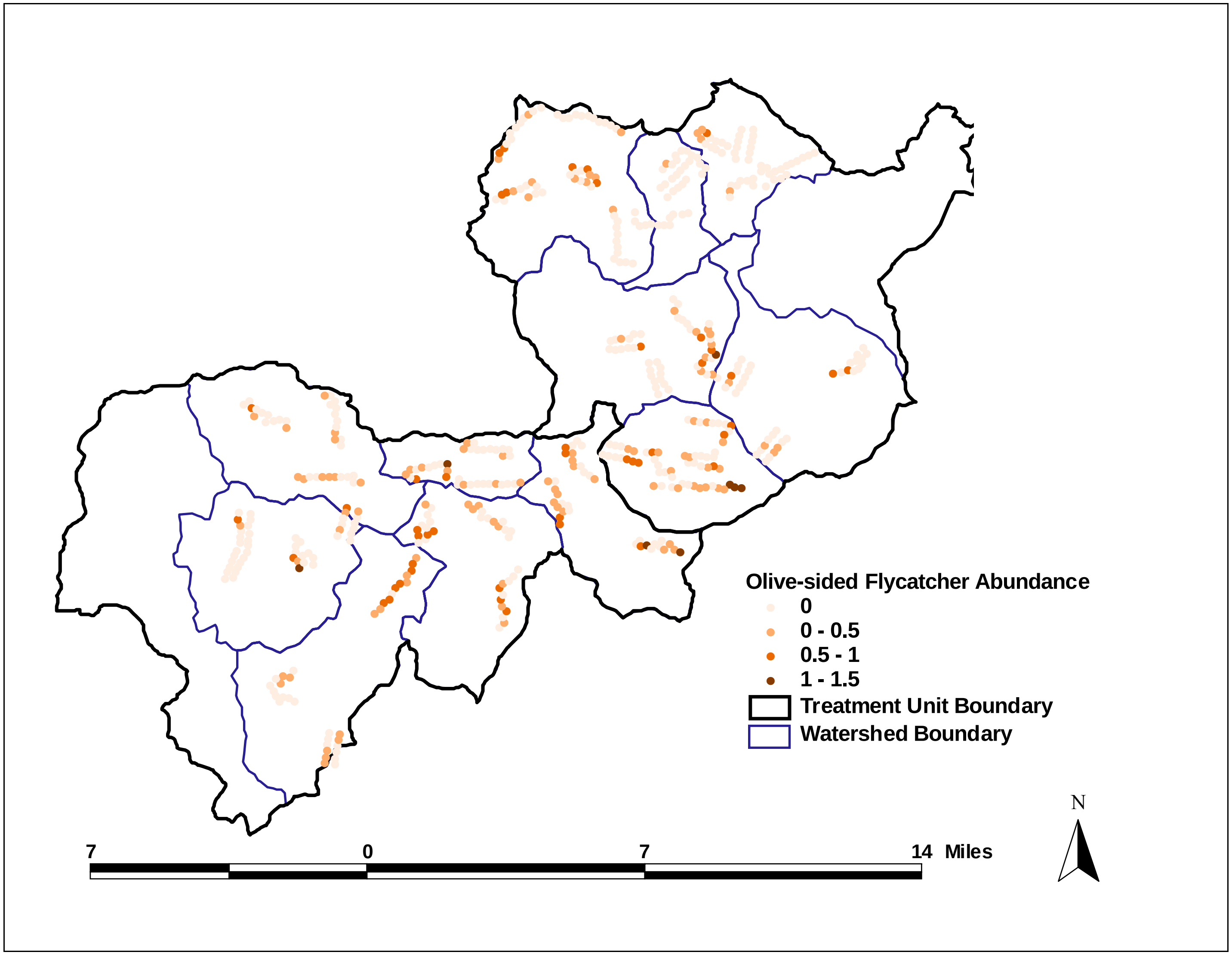
| Common Name | AOU Code | Scientific Name |
| --- | --- | --- |
| Hammond's Flycatcher | HAFL | *Empidonax hammondii* |
| Hermit Thrush | HETH | *Catharus guttatus* |
| Hermit Warbler | HEWA | *Dendroica occidentalis* |
| House Wren | HOWR | *Troglodytes aedon* |
| Huttons Vireo | HUVI | *Vireo huttoni* |
| Lazuli Bunting | LAZB | *Passerina amoena* |
| Lesser Goldfinch | LEGO | *Carduelis psaltria* |
| Lewis’s Woodpecker | LEWO | *Melanerpes lewis* |
| Lincoln’s Sparrow | LISP | *Melospiza lincolnii* |
| MacGillivray's Warbler | MGWA | *Oporornis tolmiei* |
| Mallard | MALL | *Anas platyrhynchos* |
| Mountain Bluebird | MOBL | *Sialia currucoides* |
| Mountain Chickadee | MOCH | *Poecile gambeli* |
| Mountain Quail | MOQU | *Oreotyx pictus* |
| Mourning Dove | MODO | *Zenaida macroura* |
| Nashville Warbler | NAWA | *Vermivora ruficapilla* |
| Northern Goshawk | NOGO | *Accipiter gentiles* |
| Northern Pygmy-Owl | NPOW | *Glaucidium gnoma* |
| Olive-sided Flycatcher | OSFL | *Contopus cooperi* |
| Orange-crowned Warbler | OCWA | *Vermivora celata* |
| Oregon Junco | ORJU | *Junco hyemalis* |
| Osprey | OSPR | *Pandion haliaetus* |
| Pacific-slope Flycatcher | PSFL | *Empidonax difficilis* |
| Pileated Woodpecker | PIWO | *Dryocopus pileatus* |
| Pine Siskin | PISI | *Carduelis pinus* |
| Purple Finch | PUFI | *Carpodacus purpureus* |
| Red Crossbill | RECR | *Loxia curvirostra* |
| Red-breasted Nuthatch | RBNU | *Sitta Canadensis* |
| Red-breasted Sapsucker | RBSA | *Sphyrapicus rubber* |
| Red-shafted Flicker | RSFL | *Colaptes auratus* |
| Red-tailed Hawk | RTHA | *Buteo jamaicensis* |
| Red-winged Blackbird | RWBL | *Agelaius phoeniceus* |
| Rock Wren | ROWR | *Salpinctes obloletus* |
| Rufous Hummingbird | RUHU | *Selasphorus rufus* |
| Sandhill Crane | SACR | *XXXX* |
| Sage Thrasher | SATH | *Oreoscoptes montanus* |
| Sharp-shinned Hawk | SSHA | *Accipiter striatus* |
| Song Sparrow | SOSP | *Melospiza melodia* |
| Spotted Owl | SPOW | *Strix occidentalis* |
| Spotted Towhee | SPTO | *Pipilo maculates* |
| Stellar's Jay | STJA | *Cyanocitta stelleri* |
| Swainson’s Thrush | SWTH | *Catharus ustulatus* |
| Townsend's Solitaire | TOSO | *Myadestes townsendi* |
| Tree Swallow | TRES | *Tachycineta bicolor* |
| Turkey Vulture | TUVU | *Cathartes aura* |

| Common Name | AOU Code | Scientific Name |
|---|---|---|
| Vaux’s Swift | VASW | *Chaetura vauxi* |
| Violet-green Swallow | VGSW | *Tachycineta thalassina* |
| Warbling Vireo | WAVI | *Vireo gilvus* |
| Western Bluebird | WEBL | *Sialia mexicana* |
| Western Scrub-Jay | WESJ | *Aphelocoma californica* |
| Western Tanager | WETA | *Piranga ludoviciana* |
| Western Wood-Pewee | WEWP | *Contopus sordidulus* |
| White-breasted Nuthatch | WBNU | *Sitta carolinensis* |
| White-headed Woodpecker | WHWO | *Picoides albolarvatus* |
| Williamson’s Sapsucker | WISA | *Sphyrapicus thyroideus* |
| Wilson's Warbler | WIWA | *Wilsonia pusilla* |
| Winter Wren | WIWR | *Troglodytes troglodytes* |
| Wrentit | WREN | *Chamea fasciata* |
| Yellow Warbler | YWAR | *Dendroica petechia* |

**Appendix 10. Sample map from GIS CD supplement of bird species richness in treatment unit 4 of the PLAS study area in 2003.**



**Appendix 11. Sample Map from GIS CD Supplement of Olive-sided Flycatcher Abundance (all detections) in Treatment Units 4 and 5 in the PLAS study area in 2003.**



# Appendix 12. Details on GIS CD Supplement Project for building species maps

### I. Summary

With this GIS project and these tables, additional maps can be generated (e.g., abundance maps for individual species showing where they are most and least common; maps showing differences in diversity, richness or overall abundance; and maps showing presence/absence of species of interest that are not well surveyed with this method, but encountered during point counts) for 2003 and 2004 data. Included in the ArcView project (see below for details) are examples of such maps: abundances of Hammond's Flycatchers within 50 meters of every point in 2003 and 2004; abundances of Band-tailed Pigeons detected at each of the points in 2004; abundances of Black-backed Woodpeckers at each of the points in 2004; and species richness at each of the points in 2003. The directions and metadata below will allow the user to create such maps for any species or index in either of the two years.

## II. PRIMARY ARCVIEW FILES

**PRBO_PSWreportsupplement04.apr** – ArcView project file. Double click this file to open the project.

**PLASabsum04_allGIS.dbf –** table which contains one line of data per point with all associated bird data from the 2004 point count season, including diversity, species richness, and abundance of all species combined, as well as abundance of individual species. Only includes data within 50m and for restricted species only (breeders in area and species well surveyed by the point count method; see *Methods*) This has been imported into an ArcView project file. It means "Point count abundance summary for birds less than 50 m from the observer in 2004".

**PLASabsum04_l50GIS.dbf –** table which contains one line of data per point with all associated bird data, includes ALL data (birds within 50m, birds greater than 50m, and flyovers, combined) and is for all species, including non-breeders as well as species not well surveyed with the point count method. Has been imported into ArcView project file. It means "Point count abundance summary for birds of all detections in 2004."

**PLASabsum03l50.dbf** – same as above (less than 50 m) but for 2003 point count data.

**PLASabsum03all** – same as above (for all data) but for 2003 point count data.

III. GIS DATABASE FIELDS EXPLAINED

**Below are the definitions for each field within the pcabsuml50.dbf and pcabsumall.dbf (see above) tables.**

YEAR **= year that data was collected**

STATION **= abbreviated point count transect name (4-letters)**

SITE **= point count station number within a given transect**

X_COORD **= latitude in UTMs for the point**

Y_COORD **= longitude in UTMs for the point**

VISITS **(2003 database) = number of total point count visits done per point; all sites were visited 2 times.**

SW **= bird diversity at that point (see *Methods: Statistical Analysis*)**

SPECRICH = **bird species richness at that point (see *Methods: Statistical Analysis*)**

ABUNDANCE = **average number of individuals detected at that point per visit (total individuals/number of visits; see *Methods: Statistical Analysis*)**

"SPEC"AB = **multiple fields, detailing number of individuals of each species at each point (averaged across visits). Uses AOU 4-letter codes for each bird species, combined with "AB" for abundance (e.g., Audubon's Warbler abundance is delineated as *AUWAAB*). See Appendix 2 for explanation of all 4-letter bird species codes. This is done for 61 species within 50 meters (PLASabsum03L50.dbf) and 92 species when including all detections (PLASabsum03all.dbf).**

## IV. HOW TO GENERATE ABUNDANCE MAPS BY SPECIES

1. Save all files on the CD onto hard drive
2. Open **PRBO_PSWreportsupplement04.apr** in ArcView
3. Since it has been moved, you will have to direct ArcView to each file location (all wherever you have saved them) for the first time, and then save the project so you won't need to do so again.
4. Open view 1.
5. Once inside view 1 click on VIEW on the pull down menu and choose "add event theme"
6. Choose table you want to take data from (PLASabsum03L50.dbf, PLASabsum03all.dbf, or 2004 tables); click OK.
7. Double click on the newly created event theme in left margin
8. Under legend subfolder inside the project folder choose ***speciesabundance.avl*** if you are going to create a map for individual species abundance; or **choose richdivab_legend.avl** if you are going to create a map of community indices. This way all the legends for all species are identical, and done to the same scale.
9. Then under *load legend: field* pick the species abundance you wish to map (i.e., choose *wiwrab* if making a map of Winter Wren abundance based on point count stations) and click OK.
10. Hit APPLY (and close legend window).
11. While that event theme is still selected, under *theme,* click on *properties.* You can then modify the theme name here (e.g., *Winter Wren <50 m*)
12. You will likely choose to make each species map a *layout* if you wish to print them out with a legend (View → layout)