



**Sierra Nevada National Forests Management Indicator Species Project  
2011 Annual Report**



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## Summary

2011 marked the third year of monitoring four USDA Forest Service Region 5 avian Management Indicator Species (MIS) across 10 National Forest units in the Sierra Nevada planning area. In 2011 a total of 2342 points on 472 transects in upland habitat were surveyed for Fox Sparrows, Hairy Woodpeckers, and Mountain Quail. An additional 402 points on 96 transects were surveyed in riparian habitats for Yellow Warblers. The three upland species were detected on over half of upland survey transects, and Yellow Warblers were detected at 30% of riparian transects. From 2010 to 2011, Fox Sparrow and Yellow Warbler detections were consistent, while Hairy Woodpecker and Mountain Quail detections declined slightly.

Analyses of field survey data from 2010 and 2011 show that Fox Sparrow is the most abundant of these four MIS across the study area. On average we detected 0.74 individuals per 100 m radius point count survey plot (approximately 7.8 acres, 3.1 hectares). Mountain Quail and Hairy Woodpeckers were distributed widely across the study area, but at much lower densities (approximately 0.08 Mountain Quail and 0.10 Hairy Woodpecker individuals per point). Fox Sparrows and Mountain Quail were detected more frequently on points with high shrub cover and low canopy cover, while Hairy Woodpeckers were more common on points with high snag numbers and low shrub cover. Both Fox Sparrows and Mountain Quail were more common at higher latitudes, but Hairy Woodpeckers showed no association with latitude. Fox Sparrows preferred higher elevations, while Hairy Woodpeckers and Mountain Quail showed no preference.

We detected 0.31 Yellow Warbler individuals per point on riparian transects in both years. Yellow Warblers were more common at points with low canopy cover, low tree basal area, high willow (*Salix* spp.) cover, and lower elevations. We also detected Yellow Warblers at upland survey points with high shrub cover, but at much lower densities than on riparian points.

Using playback surveys for Hairy Woodpeckers and Mountain Quail substantially increased detections of these two species. Fifty-four percent of Hairy Woodpecker and 53% of Mountain Quail detections came during playback surveys following point counts on which they were not detected. At the transect scale, including point count records from all five locations, the single playback survey accounted for 18% of the detections for Hairy Woodpecker and 13% of the Mountain Quail detections.

Vegetation surveys and habitat classifications were completed on over 90% of transects through 2011. The vast majority of upland survey locations were located in conifer forest types with much smaller proportions in pure chaparral, hardwood, and other non-forest habitats. Many forested points had variable or open canopy cover, were on edges of more than one distinct habitat type, or included openings and patches of shrubs. This was evident from vegetation surveys and bird survey data where shrub, edge, and open habitat associated species were present in areas classified as conifer forest.

The general interpretation of our monitoring results is that these four MIS and other species associated with their habitats are widely distributed with appropriate habitat common across the Sierra Nevada. The maintenance of appropriate habitat conditions into the future will rely on the widespread occurrence of natural and human disturbances that create a mosaic of shrub, early successional conifer forest, mature conifer, and greater densities of snags. Fire is the main process by which many of these conditions are generated, but timber harvest and other management practices have the potential to promote appropriate habitat conditions for these species. In riparian habitats the restoration of natural hydrologic function in meadows and reduction of disturbances from cattle grazing has great potential to increase riparian shrub presence thereby increasing available habitat for Yellow Warblers.

In this document we present a summary of field data collection and report selected results, updates to a web-based decision-support tool that provides access to project data and analyses, and the development of presentations, publications, and other products using these data. This report is intended as a companion document to PRBO's Sierra Nevada Avian Monitoring Information Network web portal where data from this project are stored and can be accessed for analyses or download. Numerous improvements to the original version of this online tool have been implemented in 2011, including linking this monitoring project to other PRBO projects in the Sierra so that all management-relevant monitoring data can be examined in a single location. A complete description of how to use this website is presented in the Appendix. The website can be found at: <http://data.prbo.org/apps/snamin>

## **Introduction**

In 1982, planning regulations for National Forests in the Sierra Nevada region guided the establishment of Management Indicator Species (MIS) that were chosen to reflect the diversity of plant and animal communities and their response to forest plan implementation [1982: 36 CFR 219.19(a)]. In 2007 the land management plans for each of the nine forests in the Sierra Nevada and the Lake Tahoe Basin Management Unit were amended to adopt a common suite of MIS (USDA Forest Service 2007). We developed a monitoring program to track trends in the distribution of four of these species at the bioregional scale (Roberts et al. 2011a). The four MIS targeted for monitoring with this project are Mountain Quail (*Oreortyx pictus*), Hairy Woodpecker (*Picoides villosus*), Yellow Warbler (*Dendroica petechia*), and Fox Sparrow (*Passerella iliaca*). Mountain Quail were chosen as the indicator for early and mid-seral conifer forest, Hairy Woodpeckers as the indicator for snags in unburned forest, Yellow Warblers as the indicator for riparian habitat, and Fox Sparrows for shrub and chaparral.

The National Forests in the Sierra Nevada region encompass approximately 12 million acres, and the habitats linked to the four species above represent about half of that area. The aim of this project is to track the occupancy of these four MIS at sites across the Sierra Nevada landscape and provide the Forest Service with data and analyses that will inform adaptive management (USDA Forest Service 2008). The primary source of access to these data is the Sierra Nevada Avian Monitoring Information (SNAMIN) website (<http://data.prbo.org/apps/snamin/>). This website allows users to quickly and easily generate summary, abundance, and species richness analyses for hundreds of point count transects across the Sierra Nevada bioregion for MIS species as well as all other species detected. Results can be generated at the scale of individual transects, ranger district, forest, or the entire bioregion. In addition to the analyses listed above, there are map tools for visualizing the spatial distribution of survey locations and presence/absence of species at those locations and a link to request raw data.

## **Methods**

### *Sampling Design*

We conducted surveys across nine National Forests and the Lake Tahoe Basin Management Unit in the Sierra Nevada Forest Planning area (USDA Forest Service 2004). This

area extends from Modoc National Forest near the Oregon border to Sequoia National Forest east of Bakersfield. Sample locations ranged in elevation from 1000 – 2700 m, were limited to areas within 1 km of accessible roads, slopes less than 35 degrees and green forest, shrub and riparian habitats. These stratifications reduced potential sampling locations to approximately 50% of the area within Sierra Nevada National Forest jurisdictional boundaries.

The sample consists of 250 upland and 50 riparian locations that were selected using a Generalized Random-Tessellation Stratified (GRTS) algorithm to generate a spatially balanced sample of species occurrences. At each of the upland locations we created two transects, each with five point count locations arranged such that four points are spaced at 250 m in the cardinal directions from a fifth point at the center. The adjacent upland transects are separated by 1 km between center points. A small number of transects vary slightly on this spatial arrangement due to logistical constraints at the site. At each riparian field location we established two transects composed of four points at 200-300 m intervals in roughly linear arrangements along stream corridors or in meadows near stream corridors. Field reconnaissance has led to the replacement of some points and transects over the first two years of data collection due to inadequacy of remotely sensed data in identifying riparian habitat.

### *Survey Methods*

At each point we conducted a standardized point count survey (Ralph et al. 1995) where a single observer estimated the distance to the location of each individual bird detected within a five minute time span from a fixed location. All observers underwent an intensive, three week training period focused on bird identification and distance estimation prior to conducting surveys. Counts began at local sunrise, were completed within four hours, and did not occur in inclement weather. Laser rangefinders were used to assist in distance estimation.

At the center point on upland transects we also performed a five-minute call-playback survey for Hairy Woodpeckers and Mountain Quail after conducting passive point count surveys at the outer points and directly following the fifth passive point count. Both species have large home ranges, and woodpeckers may vocalize infrequently, thus the probability of detecting them on a point count can be low. The goal of the playback survey was to increase the probability of detecting individuals that are available for sampling. Each season we returned to 60-75% of the sites a second time to conduct repeat surveys. For a more detailed account of sample design and survey methods see Roberts et al. (2011a).

### *Vegetation Surveys*

At each point count location we conducted vegetation surveys within a 50 m radius of the plot center using a modified relevé protocol outlined in Stine et al. (2004). We measured shrub cover, live tree cover, and herbaceous cover as well as the relative cover of each species in the shrub and tree layers through ocular estimation. We also measured basal area of live trees using a 10-factor basal area tool and counted snags in three diameter at breast height (dbh) categories. We used the California Wildlife Habitat Relationships (CWHR) system to classify habitat within several conifer, shrub, and riparian types (Mayer and Laudenslayer 1988).

### *Analyses*

To assess patterns across the study area and between years, we calculated total number of MIS individual detections, abundance (density) and occupancy estimates. Detection counts can be misleading if used solely to assess abundance or prevalence. Each MIS varies in how far afield observers can detect them and therefore the effective area sampled varies when the distance of detections is not standardized for analyses. In the extreme case of Mountain Quail, individuals were regularly recorded at estimated distances of over 300 m, and therefore potentially a sizable proportion of detections were from single individuals detected multiple times on adjacent points. We attempted to correct for these ‘double counts’ by limiting the detections included in abundance and occupancy analyses to only those within 100 m of the point count plot center. Using this distance cut-off should make it unlikely that we included double counts of the same individual on adjacent survey locations.

We calculated an index of abundance using the average number of individuals detected per point across multiple visits. While this metric is not adjusted for imperfect detection (i.e., individuals present but not heard or seen) it can be a useful metric to compare species distribution. To date we have not explored methods of correcting for imperfect detection in abundance analyses, but we plan to explore these methods in subsequent analyses and to implement them on the SNAMIN website in 2012.

We used occupancy models to analyze patterns of occurrence across the study area. Occupancy models estimate the probability of occurrence while simultaneously accounting for errors in the detection process (MacKenzie et al. 2006). These models can account for unequal effort (e.g., transects with different numbers of visits) and variation in the detection process due to species behavior, singing volume and rates, site conditions (e.g. vegetation cover), and visit-

specific factors (e.g. time of day). Occupancy methods incorporate the detection history over multiple visits to estimate detection probability. We used the online analysis tools from the Sierra Nevada Avian Monitoring Information Network website, Bioregional Monitoring page that utilizes the R program (R Development Core Team 2011) to estimate occupancy. These results were generated using standard single-season occupancy functions in the R package ‘unmarked’ (Fiske and Chandler 2011). We report occupancy estimates as point-scale values averaged over all transects. Covariates on occupancy or detection probability were not included in the models, but we plan to implement occupancy analyses including covariates on the SNAMIN website in 2012.

While designing this project we identified a set of five additional focal species associated with each habitat for which the MIS were chosen to indicate. Trend estimates for focal species can aid interpretation of potential trends in MIS populations. For example, factors outside of forest management, or even outside the Sierra Nevada, have the potential to affect occupancy or abundance for any species. By examining trends in focal species populations and comparing to those of MIS we can better evaluate whether management is likely to be driving the patterns (Chase and Geupel 2005). The focal species we selected for early-mid seral conifer forest are Western Tanager, Dark-eyed Junco, Golden-crowned Kinglet, Black-throated Gray Warbler and Chipping Sparrow. Chaparral focal species are Dusky Flycatcher, MacGillivray’s Warbler, Mountain Quail, Yellow Warbler and Green-tailed Towhee. Snag focal species are White-headed Woodpecker, Mountain Chickadee, Red-breasted Nuthatch, Olive-sided Flycatcher and Brown Creeper. Riparian focal species are Song Sparrow, Wilson’s Warbler, Warbling Vireo, Black-headed Grosbeak and MacGillivray’s Warbler. We present the cumulative index of abundance for these species alongside each of the corresponding MIS. The trends in occupancy and abundance of MIS habitat focal species and others can be produced on the SNAMIN web site.

To examine general habitat associations for the four MIS, we classified survey points into high and low suitability groups based on the detection history from all visits in 2010 and 2011. In this analysis only points that have been visited at least twice are included, resulting in a sample of 2408 points on 491 transects. All detections up to 100 m from the observer were included for Fox Sparrows, Yellow Warblers and Hairy Woodpeckers, and up to 200 m for Mountain Quail. If Yellow Warblers, Mountain Quail and Hairy Woodpeckers were detected on at least 33% of the point visits, or 50% for Fox Sparrows (since they were much more prevalent than the other

species), we classified the point as high suitability otherwise the point was included in the low suitability group. We then conducted a two-tailed T-test to assess statistical significance in the values of vegetation measurements between the high and low suitability groups.

## Results

### *Survey Effort*

In 2011 we surveyed 2744 point count stations on 568 transects (upland and riparian combined, Table 1). We were not able to survey 28 upland and 4 riparian transects due to a variety of logistical reasons. For example, 10 of the 28 transects could not be reached because of snow pack restricting access, even in early July. We conducted repeat surveys at 54% of transects for a total of 876 transect visits (compared to 890 in 2010 and 724 in 2009). We achieved a lower repeat survey rate than we had targeted due to the record-breaking late season snowpack and spring storms that impacted the region in May and June. We conducted two visits at all upland sites that were new for 2011 and the sites where only single visits had been performed in each of the first two field seasons to better establish the presence or absence of species for occupancy analyses. We conducted two visits at a higher proportion of riparian transects (92%) than upland transects (47%) because many of these sites were newly relocated into more appropriate riparian habitat and we wanted to establish the presence of Yellow Warblers at these locations with as much confidence as possible. A secondary reason for the riparian repeat surveys was to account for late phenological changes in part due to the unseasonable cold in May and June, as we were concerned that Yellow Warblers would delay breeding until deciduous riparian vegetation had leaved out.

**Table 1.** Survey effort by year. The target upland sample includes 500 transects. In 2009 we targeted 50 riparian transects and in 2010 and 2011 we increased the target number to 100.

		2009	2010	2011
<b>Transects Visited</b>	<i>upland</i>	415	464	472
	<i>riparian</i>	43	94	96
<b>Second visits</b>	<i>upland</i>	250	267	220
	<i>riparian</i>	16	65	88
<b>Second visit rate (%)</b>	<i>upland</i>	60.2	57.5	46.5
	<i>riparian</i>	37.2	69.1	91.7

### *Prevalence and Abundance*

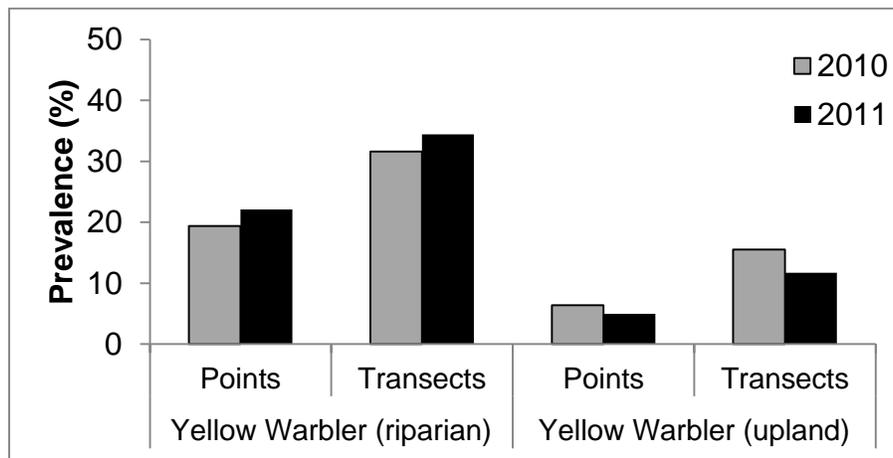
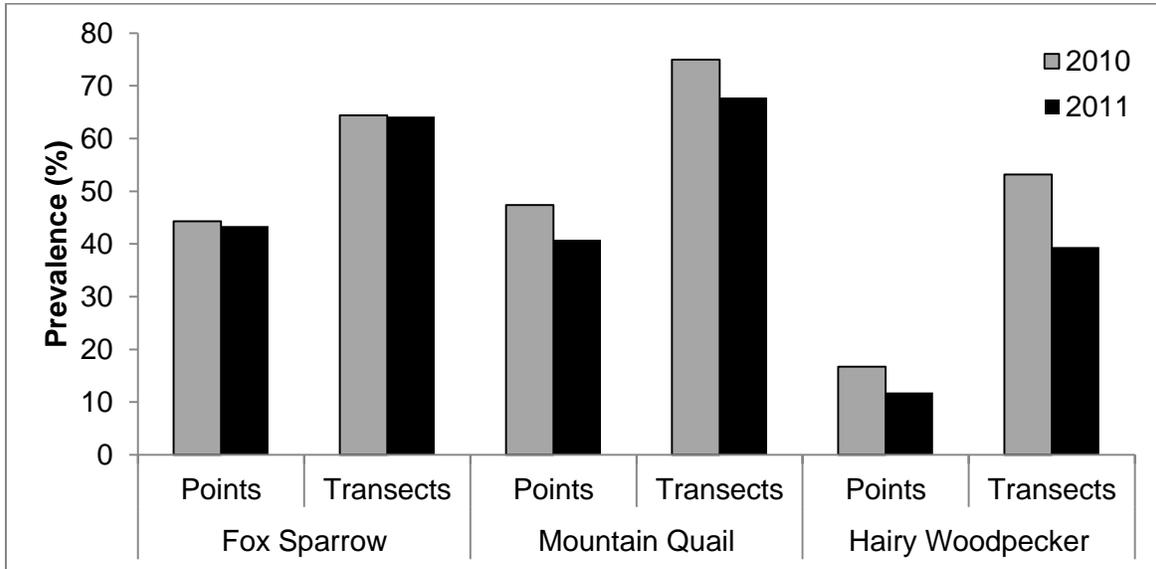
We compared naïve detections of the four MIS between 2010 and 2011 for the entire study area (Figure 1). Mountain Quail and Hairy Woodpecker transect prevalence declined by 7.2% and 13.8% respectively from 2010 to 2011. Fox Sparrow prevalence at both the point and transect scale was very similar between years. Yellow Warbler prevalence on riparian transects increased slightly between years, while prevalence on upland transects declined slightly.

MIS detections varied across forests (Figure 2). The three upland MIS have been detected on all forests but Yellow Warblers were not detected on Eldorado or Modoc riparian transects but were observed on upland transects in these forests. Fox Sparrows and Mountain Quail were more abundant in the central and southern Sierra forests with the highest abundance on the Tahoe, Eldorado, Stanislaus and Sequoia. Hairy Woodpeckers had variable abundance across forests with higher abundance on the Inyo. Yellow Warbler abundance was also variable, but highest on the three northern Sierra forests and the Inyo.

### *Occupancy*

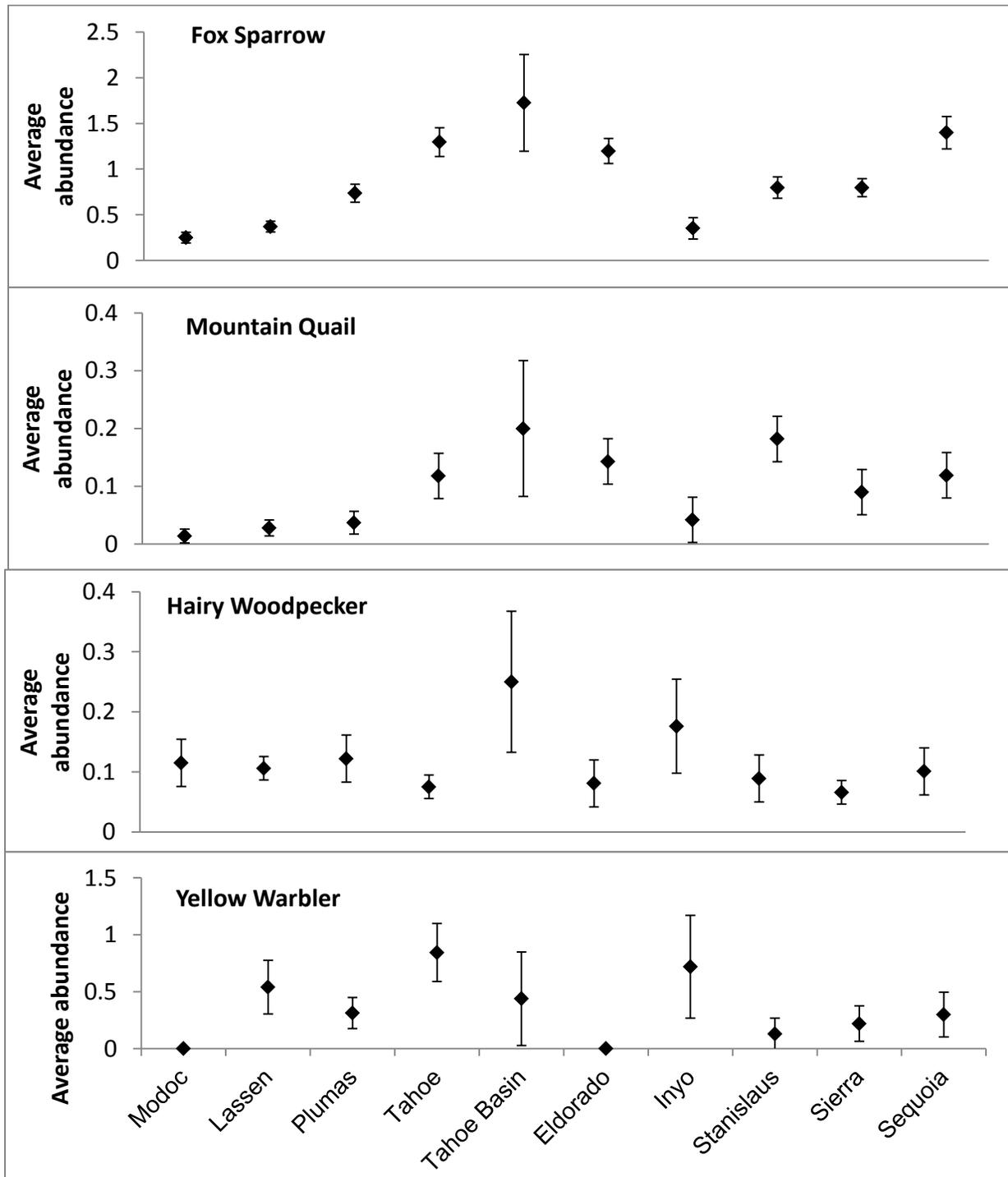
Occupancy estimates were relatively high for the three upland MIS species but considerably lower for Yellow Warbler in riparian habitats (Table 2). Due to very low probability of detection for Hairy Woodpecker and Mountain Quail using only detections within 100 m, occupancy estimates were high but confidence intervals were extremely wide and the index of abundance per point was very low. Fox Sparrow and Yellow Warbler detection probability within 100 m was much higher than for Hairy Woodpecker and Mountain Quail. Occupancy and abundance estimates were relatively consistent between years for both species as well. Fox Sparrow occupancy was 0.70 in 2010 and 0.65 in 2011 with confidence intervals largely overlapping between years and abundance estimates were similarly consistent. Yellow Warbler occupancy on riparian transect points was 0.23 in 2010 and 0.31 in 2011 with a small overlap in confidence intervals, and abundance estimates were very similar between years. Detection probability for Yellow Warbler declined from 0.63 in 2010 to 0.33 in 2011, possibly due to the bad weather conditions in 2011 and because shrubs leafed out far later compared to previous years (A. Fogg, R. Burnett, pers. obs.).

**Figure 1.** Prevalence of MIS in 2010 and 2011. Prevalence (% of points and transects where each species was present, not limited by distance and not including playback surveys) for four Management Indicator Species across Sierra Nevada National Forest units in 2010 and 2011.



The decline in riparian focal species abundance between years is similar in magnitude and direction to the corresponding estimates for Yellow Warbler (Table 2), although confidence intervals for the yearly estimates overlap so the trend may not be significant. Early-mid seral conifer species abundance increased slightly from 2010 to 2011, compared with no apparent change in Mountain Quail abundance. For Fox Sparrow and Hairy Woodpecker there was no apparent difference in abundance estimates between years, however there were apparently significant declines in chaparral and snag focal species abundance from 2010 to 2011.

**Figure 2.** Index of abundance of MIS by National Forest in the Sierra Nevada in 2011. Abundance was calculated as average number of detections <100 m per point count station. Playback surveys were not included. Only upland transects were used for Fox Sparrow, Mountain Quail, and Hairy Woodpecker. Only riparian transects were used for Yellow Warbler. Bars indicate 95% confidence intervals.



**Table 2.** Point-scale occupancy for MIS and abundance for MIS and habitat focal species. Estimated occupancy, detection probability, abundance (number of individuals detected per 100 m radius point count), and focal species abundance were calculated with the online tools available in SNAMIN. 95% confidence intervals are shown in parentheses under each estimate.

		Occupancy	Detection probability	Abundance	Focal species abundance
<i>Mountain Quail</i>	2010	0.63 (0.20,0.92)	0.04 (0.02,0.08)	0.06 (0.05,0.07)	1.81 (1.76,1.87)
	2011	0.99 (0.0,1.0)	0.03 (0.02,0.04)	0.07 (0.06,0.08)	1.91 (1.85,1.96)
<i>Fox Sparrow</i>	2010	0.70 (0.64,0.77)	0.23 (0.21,0.26)	0.66 (0.62,0.71)	1.16 (1.11,1.22)
	2011	0.65 (0.59,0.70)	0.27 (0.24,0.29)	0.69 (0.65,0.74)	0.99 (0.94,1.0)
<i>Hairy Woodpecker</i>	2010	0.99 (0.0,1.0)	0.04 (0.03,0.04)	0.08 (0.07,0.09)	1.96 (1.89,2.02)
	2011	0.75 (0.26,0.96)	0.05 (0.03,0.08)	0.09 (0.08,0.10)	1.76 (1.71,1.82)
<i>Yellow Warbler (riparian points)</i>	2010	0.23 (0.18,0.28)	0.65 (0.54,0.75)	0.29 (0.22,0.37)	1.59 (1.42,1.77)
	2011	0.31 (0.24,0.39)	0.33 (0.25,0.41)	0.24 (0.18,0.29)	1.34 (1.18,1.49)

### *Playback surveys*

We found that playback surveys for Mountain Quail and Hairy Woodpeckers resulted in a considerable increase in detection rates for these species. We found at the transect scale (five passive point counts followed by a playback survey), 17% of Hairy Woodpecker observations and 13% of Mountain Quail observations within 200 m from the observer were unique to the playback survey. When comparing only the single point count directly preceding the playback survey at the same location, both species responded strongly to playback; 53% of Hairy Woodpecker and Mountain Quail detections were unique to the playback survey. Our data also show that playbacks were effective at drawing individuals closer to the observers, thus resulting in a larger number of visual identifications for woodpecker species, which can be more difficult to identify by drumming or calls. Including the playback survey records (within 200 m of the

observer) also nearly doubled detection probability in comparison to point counts alone, and 95% confidence intervals for occupancy estimates were approximately half as wide (Fogg et al. in prep).

### *Vegetation Surveys*

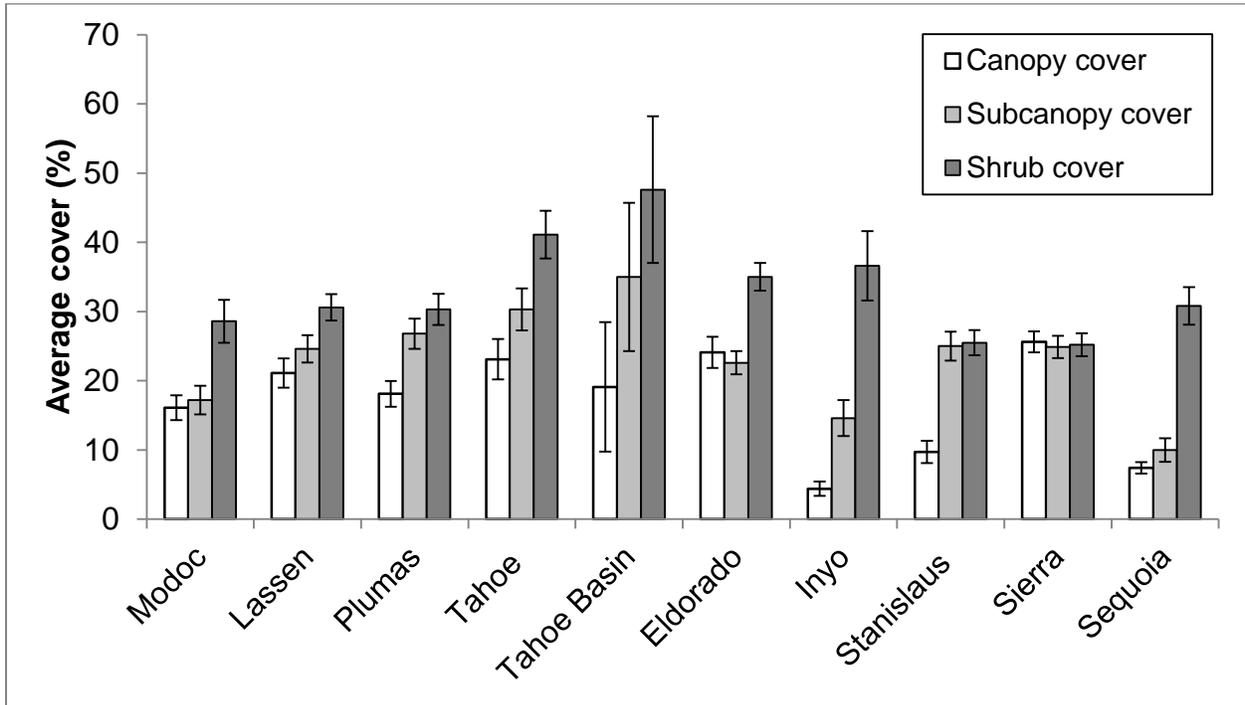
Conifer habitats made up over 89% of upland point count locations and were dominated by Sierra mixed conifer, white fir, red fir, and eastside pine (Table 3). Shrub habitats, including Montane Chaparral and Mixed Chaparral accounted for only 7.1% of count locations. There was considerable variation in canopy, sub-canopy, and shrub cover between forests (Figure 3). Canopy cover was fairly consistent amongst forests, except Inyo, Stanislaus and Sequoia had cover lower than other forests and for Inyo and Sequoia, subcanopy cover was also low. Shrub cover tended to be higher in the central Sierra forests (Tahoe, Tahoe Basin, Eldorado) and Inyo NF. The central forests (Plumas, Tahoe, Tahoe Basin, Eldorado) also generally had higher snags per acre (Figure 4) but the median per acre number for all forests was lower than the four recommended for retention in the Sierra Nevada Forest Plan Amendment (USDA Forest Service 2004).

Willow (*Salix* spp) and alder (*Alnus* spp) tended to be the most common shrubs at riparian point locations. Central Sierra forests generally had the highest proportion of alder shrub cover while willow shrub cover was distributed more evenly across the region (Figure 5). Approximately 60% of riparian transects were dominated by riparian vegetation types which included Wet Meadow (38%), Montane Riparian (19%) and Aspen (2%). The remaining 40% of transects were situated along creek corridors that were dominated by conifer habitat containing deciduous riparian vegetation in proportions too small to warrant classification as riparian habitat. Conifer habitat types primarily included Lodgepole Pine (12%), White Fir (8%) and Eastside Pine (6%).

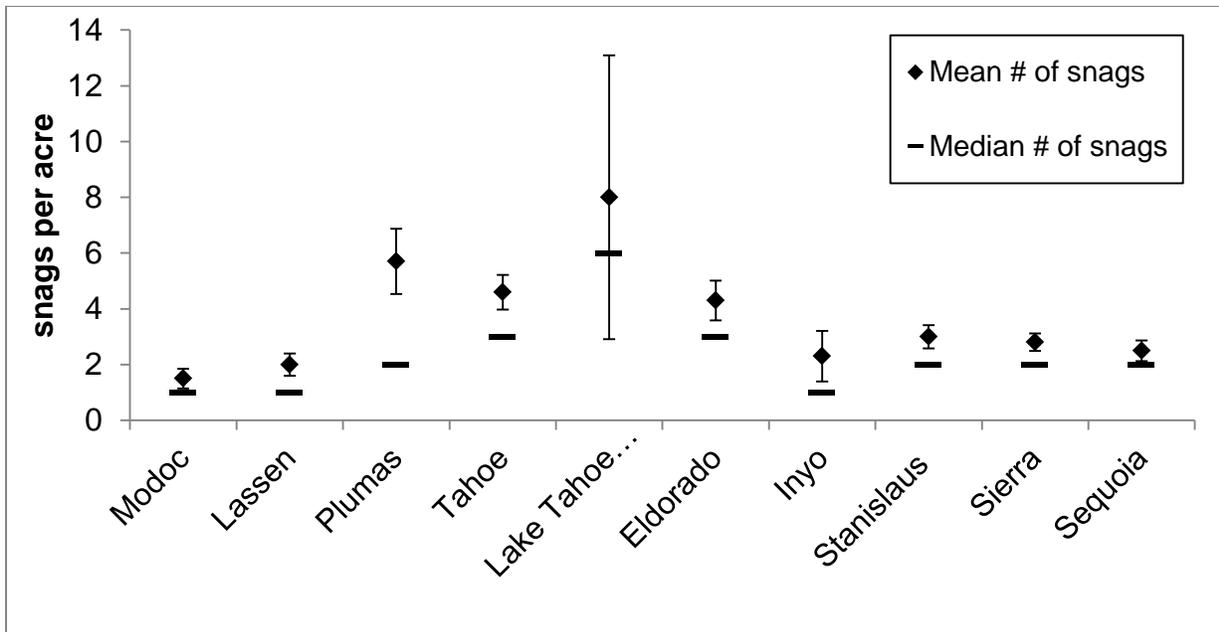
**Table 3.** The percentage of upland point count stations classified into California Wildlife Habitat Relationship (CWHR) types using data from field vegetation surveys. Numbers indicate averages within each National Forest and the entire Sierra Nevada study area. Listed from north to south: MNF: Modoc, LNF: Lassen, PNF: Plumas, TNF: Tahoe, LTBMU: Lake Tahoe Basin Management Unit, ENF: Eldorado, INF: Inyo, STF: Stanislaus, SNF: Sierra, and SQF: Sequoia.

<b>CWHR type</b>	<b>MNF</b>	<b>LNF</b>	<b>PNF</b>	<b>TNF</b>	<b>LTBMU</b>	<b>ENF</b>	<b>INF</b>	<b>STF</b>	<b>SNF</b>	<b>SQF</b>	<b>Entire Study Area</b>
<b>Aspen</b>	0.4	0.3	0	0	0	0	6.9	0	0	0	0.5
<b>Mixed Hardwood</b>	0	0	0	2.7	0	0	0	4.2	3.6	5.2	1.9
<b>Eastside Pine</b>	47.1	23.6	26.8	0.5	0	0	41.4	0	0	0	14.1
<b>Jeffery Pine</b>	0	8.3	3.5	13	17.6	10.2	3.4	10.3	9.2	24.3	9.5
<b>Ponderosa Pine</b>	4.6	1.5	2.8	7	0	8.4	0	16.4	21.4	6.4	8.2
<b>Lodgepole Pine</b>	5.9	3.2	2	5.9	23.5	6.5	20.7	6.5	3.9	1.2	4.8
<b>Chaparral</b>	10.5	7.8	6.3	8.6	0	4.2	1.7	7.5	3.3	12.2	7.1
<b>Red Fir</b>	0	12.1	12.2	19.5	35.3	8.8	11.2	13.1	18.4	19.1	13.3
<b>Sierra Mixed Conifer</b>	3.4	19.5	28.3	20	5.9	38.6	6.9	31.3	27.4	14.7	21.8
<b>White Fir</b>	21.8	19.2	10.2	19.5	17.6	21.4	6	10.7	12.8	15.9	15.9
<b>other types</b>	5	2.4	1.6	3.2	0	1.9	1.7	0	0	0.8	1.5

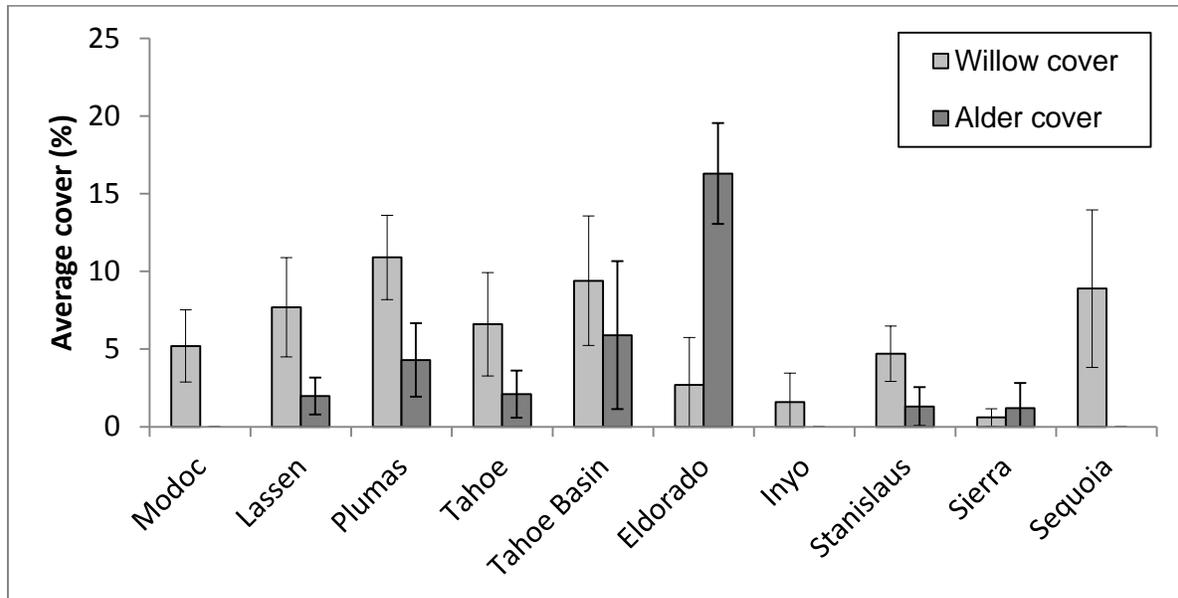
**Figure 3.** Measured vegetation cover. Average cover of green vegetation in three above-ground layers across Sierra Nevada National Forests. Error bars show 95% confidence intervals.



**Figure 4.** Mean and median number of snags per acre by forest. Mean with 95% confidence intervals and median number of snags greater than 30 cm (11.8 in) dbh per acre at PRBO Management Indicator Species point count stations on national forest units in the Sierra Nevada.



**Figure 5.** Average percent willow (*Salix* spp.) and alder (*Alnus* spp.) cover at riparian point locations (50 m radius plot) on vegetation surveys across Sierra Nevada National Forests. Bars indicate 95% confidence intervals.



### Habitat Associations

Each indicator species appeared to be associated with at least some of the habitat features for which they were chosen to indicate. An exception may be Mountain Quail, the indicator for early and mid-seral forest, which was negatively associated with canopy cover and basal area, had no association with subcanopy cover, and was positively associated with shrub cover. As such, Mountain Quail appear more closely aligned with chaparral habitat than mid-seral forest.

On upland transects all four species responded strongly to shrub cover presence; high suitability sites had significantly higher shrub cover for Fox Sparrows, Mountain Quail, and Yellow Warblers, and significantly lower shrub cover for Hairy Woodpeckers (Figures 6 and 7). Fox Sparrows and Mountain Quail were associated with lower canopy cover and Mountain Quail with low basal area. Hairy Woodpeckers were found on sites with higher snag density, as were Fox Sparrows which may have been related to higher shrub cover in areas that have been subject to recent disturbance (e.g. fire, insect outbreak) and less directly tied to the snags themselves. Fox Sparrows were also found on higher elevation sites, and both Fox Sparrows and Mountain Quail were more likely to be present at higher latitudes. At riparian sites, Yellow Warblers were

found on sites with high willow cover and at lower elevations (Figure 7). Yellow Warblers also were more likely to be present on sites with low canopy cover, low basal area, and few snags, indicating their preference for open habitats.

**Figure 6.** Average habitat measurements at high and low suitability upland points for MIS. We grouped field sites based on whether Mountain Quail and Hairy Woodpecker were detected within 100m on at least 33% of visits, or 50% for Fox Sparrow, and calculated average values of habitat measurements for each group. Error bars show 1 standard error. Asterisks indicate statistical significance at  $P < 0.01$  (two-tailed T-test with unequal variance between groups).

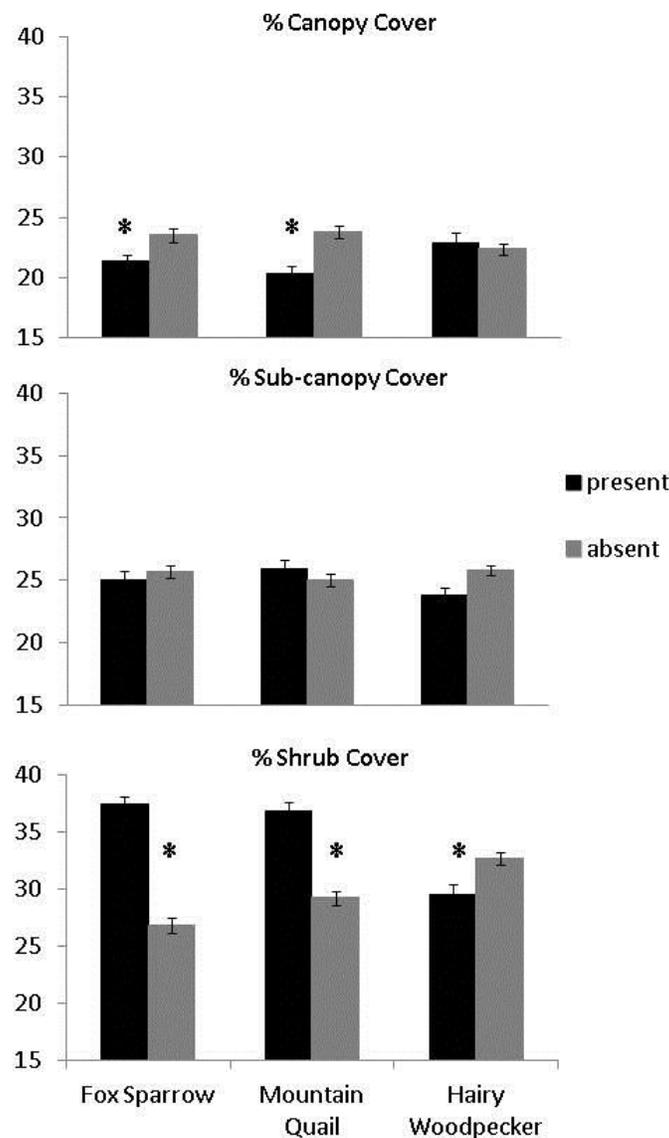
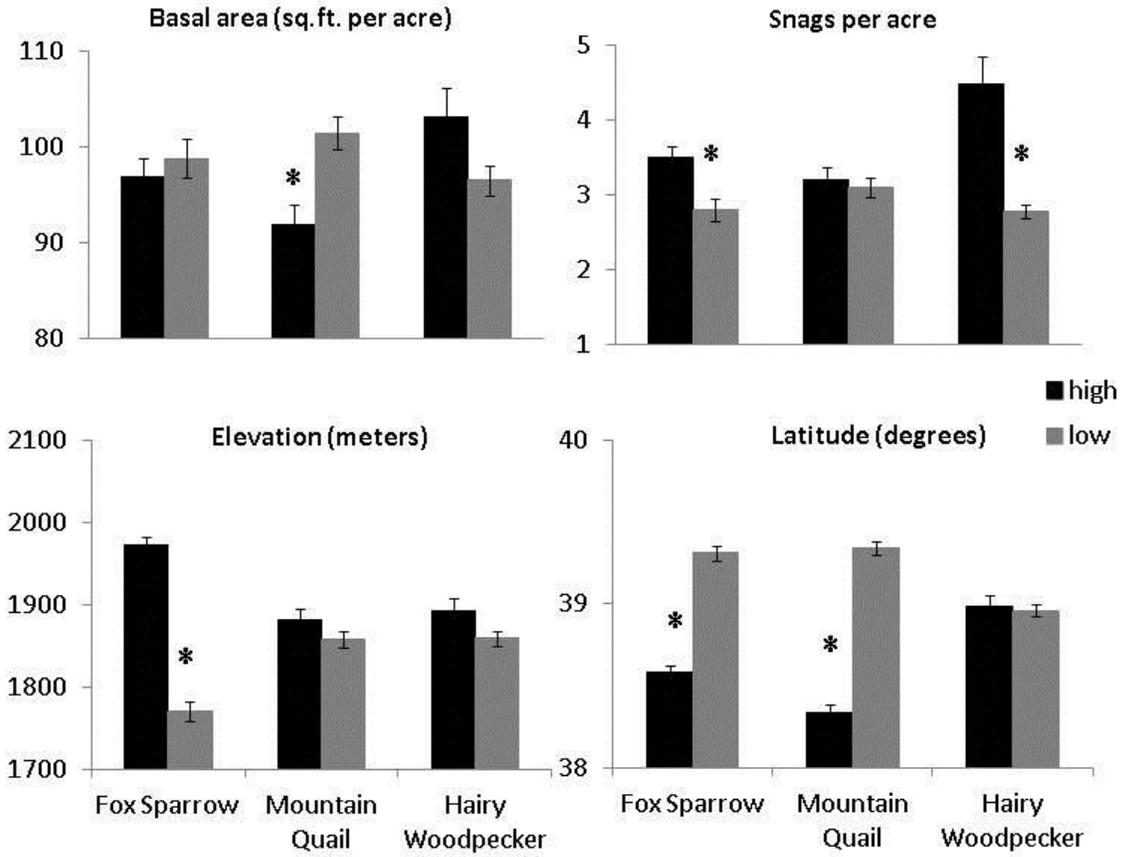


Figure 6, cont'd.



**Figure 7.** Average habitat measurements at high and low suitability points for Yellow Warbler at both upland and riparian survey locations in the Sierra Nevada. We grouped field sites based on whether Yellow Warbler was detected within 100m on at least 33% of visits and calculated average values of habitat measurements for each group. Error bars show 1 SE and asterisks indicate statistical significance at  $P < 0.01$ .

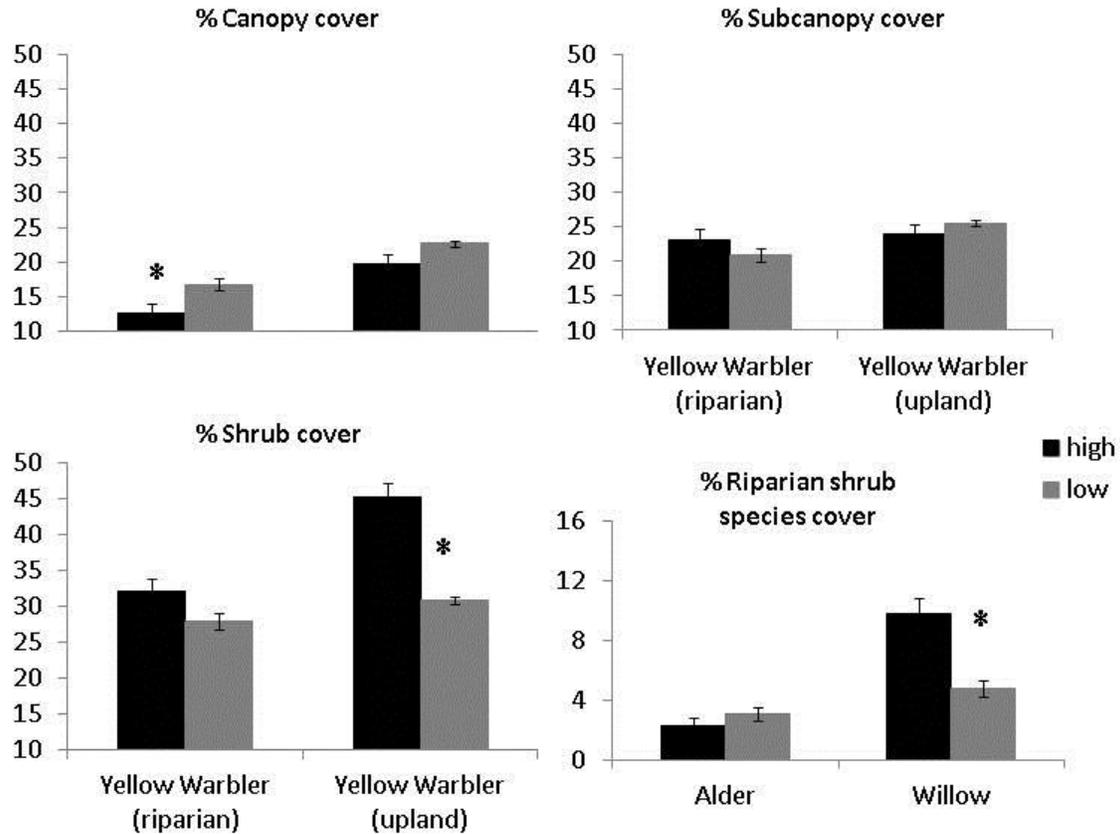
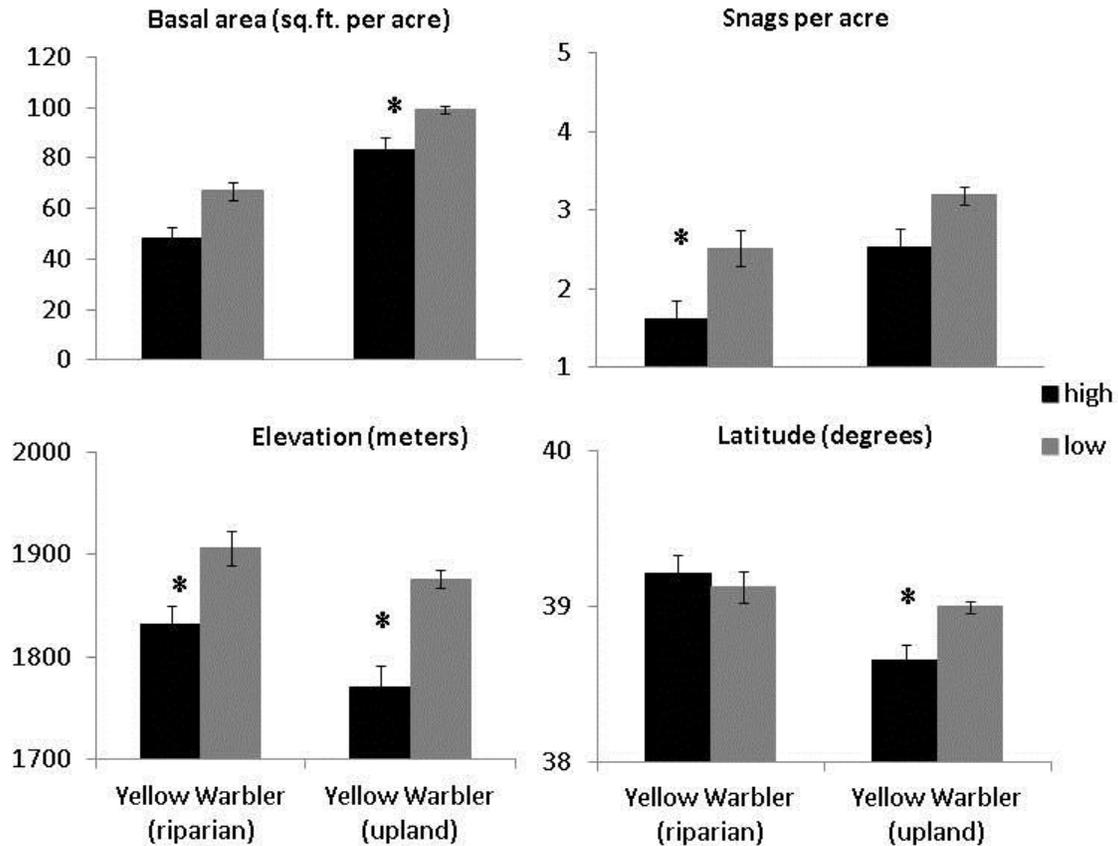


Figure 7, cont'd.



## Discussion

### Overview

Upon initial examination of our monitoring results, these four MIS appear to be distributed widely across the study area, have stable abundance and occupancy, and appear to generally be associated with the habitat attributes for which they were chosen to indicate. Our survey locations were widely distributed across the Sierra Nevada in a range of habitats and topographical conditions and we expect this sample to be well suited to detect changes in habitat availability and distribution on regional and individual National Forest scales. Because we have records of occurrence for a large suite of forest bird species, we are in an excellent position to provide ecological analyses for adaptive forest management questions now and throughout the USDA Forest Service planning horizon.

### *Fox Sparrow*

Despite the fact that chaparral makes up only 7.1% of the dominant habitat classes across field sites, Fox Sparrow was the most frequently encountered MIS on all three years of surveys. In the Sierra Nevada, Fox Sparrows are closely tied to montane chaparral and other habitats that support a dense shrub layer. We observed them in pure montane chaparral, early successional conifer stands (e.g. plantations and post-fire areas), and more mature forest with open canopies. Based on vegetation surveys, these conditions are common throughout the Sierra Nevada landscape and especially abundant in the central and southern forests. Fox Sparrows were detected at over 40% of points and 60% of transects each year. Detection probabilities were moderate, resulting in point-scale occupancy estimates of 0.70 in 2010 and 0.65 in 2011. Both abundance and occupancy confidence intervals overlapped across years indicating that a trend in population size or distribution is unlikely at this point. They were distributed across the entire region, but relatively uncommon on points in Inyo, Lassen, and Modoc National Forests, presumably due to the lack of suitable west slope montane shrub habitats.

Based on these monitoring results we believe that montane chaparral and other shrub and early successional habitats are well distributed across the Sierra Nevada and provide ample habitat for Fox Sparrows and other shrub associated species. However, the maintenance of widespread disturbance events that create these conditions (e.g. fire) is needed to sustain these conditions over time. Management actions that significantly reduce shrub cover, such as mastication, will have negative impacts on this species. Managing for shrub habitats in the Sierra will ensure this species, along with many others associated with these habitats, continue to persist.

### *Mountain Quail*

Mountain Quail were infrequently detected at distances less than 100 m, but when all distances were considered they were one of the most prevalent species. Their effective detection distance is extremely large, with over 35% of all detections from beyond 300 m, so the effective area sampled with each point count is much greater than for other species. As a result, we were more likely to record the same Mountain Quail individual on adjacent point counts than for other species. This presents a challenge for calculating indices of abundance and distribution, since density estimates using a cutoff distance appropriate for many other species (e.g. 100 m) will result in very low density numbers for Mountain Quail, which is a correct result but counter-

intuitive given the high frequency of detections. Mountain Quail can move across large areas during a survey season thus resulting in periods of non-availability for sampling on points that are actually within their territories.

Given the very high occupancy estimate values (despite the wide confidence interval) we believe this species is widespread on the landscape, but at very low density. We recorded Mountain Quail on a wide range of habitats across the Sierra Nevada, including all conifer types. They are distributed throughout the Sierra Nevada region but appear to be less common on the northern and eastern forests (Modoc, Lassen, Plumas and Inyo) compared to central and southern Sierra forests. They are likely tied to west-side early-seral forest and shrub habitats and may be less prevalent in mid-seral forest, compared to other focal species associated with conifer forest such as Western Tanager or Chipping Sparrow. But based on these monitoring results we believe that early and mid-seral conifer habitats are well distributed across the Sierra Nevada and provide ample habitat for Mountain Quail and other conifer associated species. The juxtaposition of different habitat types in close proximity may be a key spatial habitat component (Brennan et al. 1987, Rickers et al. 1995). The maintenance of disturbance events that create open conditions (fire) and management strategies that continue to create habitat mosaics at appropriate scales could be important for sustaining Mountain Quail habitat over time. In future years we will investigate the local and landscape scale factors that influence the distribution of this species in our study area.

### *Hairy Woodpecker*

Hairy Woodpeckers were the least frequently detected of the upland species, but still were present on about 50% of transects across a broad range of habitats. Woodpeckers vocalize less frequently than many other bird species and their drumming signals can be difficult to distinguish from each other. Like Mountain Quail, they can travel over a relatively wide home range area as part of daily activity. As a result, the probability of detecting a Hairy Woodpecker individual at any given point count location can be quite low.

There does not appear to be a geographical pattern to the distribution of Hairy Woodpeckers across Sierra Nevada national forests. They were detected (within 100 m of observers) at approximately 15% of upland transects in each of the three field seasons. However, point-scale occupancy estimates show them to be present on a large proportion (0.75-0.99) of

upland locations. Similar to Mountain Quail, their low detectability creates wide confidence intervals on the occupancy estimates.

Given these results it seems that Hairy Woodpeckers are distributed widely across the Sierra Nevada landscape, but like Mountain Quail they occur at very low density. They have been selected as the indicator for snags in unburned forest habitats, and our data show they are more likely to be detected in locations with high numbers of snags present. Current management guidelines require retaining the four largest snags per acre, but our vegetation survey data as well as other reports from fuels reduction projects in the northern Sierra Nevada indicate that those targets are not currently achieved on the landscape (Bigelow et al. In Press). However it is not known whether this target is sufficient to meet the forage and habitat needs of woodpeckers and other snag dependent species. Managing green forest to increase snag density and monitor the impact on wildlife should be a priority of land managers in the Sierra Nevada.

#### *Yellow Warbler*

Yellow Warblers were detected on a small proportion of upland sites but a higher proportion of riparian sites. Upland detections were largely from non-riparian shrub habitat at mid to low elevation transects. They are known to occur in these upland shrub habitats in the Sierra Nevada, but at a lower density in comparison to riparian habitat (Humble and Burnett 2010). When willows were present at mid or low elevation transects, Yellow Warblers were very likely to be present. Some of the riparian transects were located in areas where these shrubs were not present, but could someday establish given a change in management. Large scale eradication of riparian deciduous vegetation to improve range conditions for grazing over the past century has likely significantly reduced the suitable habitat for this and other meadow dependent species in the Sierra Nevada.

We recorded the same number of individuals on riparian transects in 2011 as compared to 2010, and they were present on a slightly higher proportion of locations. The geographical distribution of Yellow Warblers is highly variable. They are more common on Inyo, Lassen, Plumas, and Tahoe National Forest surveys than elsewhere, and notably absent from Modoc and Eldorado National Forests. Absence on the Eldorado is likely due to more high elevation sampling locations compared to other forests and most transects are located along fast-moving stream corridors with alder shrubs present, but few willows. On the Modoc, several sites are located in the Warner Mountains at high elevation, where Yellow Warblers are far less likely to

occur. At the lower elevation sites where Yellow Warblers would be expected to occur, habitat has likely been degraded by grazing to the extent that deciduous shrub cover and structure is not present in sufficient quality and quantity to provide suitable breeding habitat for this species.

Willow cover appeared to be one of the primary factors driving the distribution pattern of Yellow Warblers in the Sierra Nevada. Given that Yellow Warblers are only present on approximately 30% of riparian transects, we feel there are ample opportunities for management to create more appropriate habitat for this species and its riparian associates (e.g. Willow Flycatcher). The restoration of floodplain function and more compatible grazing prescriptions for meadows could have a largely positive effect on the development of riparian shrubs and conditions appropriate for Yellow Warblers and a host of other riparian dependent bird species. Restoration of montane riparian habitats that have stream channel incision, lowered water tables and conifer encroachment as a result of overgrazing, road building and fire suppression, amongst other factors, would increase habitat for Yellow Warblers and many other species. Since riparian habitat represents a tiny fraction of total land base in the Sierra Nevada and harbors some of the highest biodiversity it should be among the highest priorities of land managers here.

## **Conclusions**

The four MIS appeared to be closely associated with the habitat attributes they were chosen to indicate, with the possible exception of Mountain Quail which is closely tied to shrub habitats in addition to conifer forest. As such they may be useful as indicators for land management in the Sierra Nevada region but we suggest that a focal species approach incorporating a suite of species that represent a range of conditions within the selected habitat would be a more powerful tool for guiding and evaluating land management.

It will be essential to continue to monitor multiple species in a standardized and consistent way (such as this project) in order to establish trends in comparison to other species that share habitat needs but are sensitive to a variety of other influences on population change. Collecting data on all bird species also provides a unique opportunity to contribute to other research questions in the Sierra Nevada region. Statistically rigorous landscape-scale monitoring programs are rare in the western United States. There is a general consensus in the scientific and management community that more monitoring is needed to track wildlife response to climate change, forest management and habitat alteration and destruction. Three years of PRBO

bioregional monitoring across the Sierra Nevada and southern Cascades range has resulted in nearly 160,000 observations of over 190 bird species. As the Sierra Nevada national forests move forward with forest planning, bioregional monitoring will play an important role in helping forest staff make regional, forest, and project-level decisions within an adaptive management framework.

Heavy snowpack in 2011, late snowmelt and frequent spring storms may have resulted in slightly lower prevalence and abundance for some MIS in comparison to 2010. However, annual fluctuations are expected and future analyses using occupancy methods will account for variations such as weather and a variety of other factors. In 2012, we plan to have 13 field biologists across the Sierra Nevada in order to achieve a 75% resample rate for upland sites in 2012 as described in the study plan (Roberts et al. 2011).

We will also continue playback surveys for Hairy Woodpeckers and Mountain Quail. Playback methods for surveying species with low detectability such as Mountain Quail and Hairy Woodpecker also appeared to be warranted and allowed us to estimate occupancy with much greater confidence. Occupancy and abundance are both useful parameters that reflect different aspects of population distribution and we will continue to provide both parameters when appropriate.

We have completed vegetation surveys at over 90% of point locations, and will complete the remainder in 2012 as well as revisit sites where conditions have significantly changed due to management, succession, or natural disturbance.

## **Acknowledgements**

We'd like to thank Diana Craig, USDA Forest Service Region 5 Wildlife Ecologist for all of her leadership and assistance in making this project happen every year. We are also especially thankful to all the staff on the forests and ranger districts throughout the Sierra Nevada that have been invaluable to the success of this project. Of particular note are Peggy O'Connell, Claudia Funari, Dawn Lipton and Diana Cole of Eldorado National Forest; Coye Burnett, Jennifer Hensel, and Mark Williams of Lassen National Forest; Marty Yamagiwa of Modoc National Forest; Tina Mark and Marilyn Tierney of Tahoe National Forest; Crispin Holland of Stanislaus National Forest; Greg Schroer, Anae Otto and Kim Sorini of Sierra National Forest and Emilie Lang, Jeff Cordes, Steve Anderson and Robin Galloway of Sequoia National Forest. We

especially thank the 2011 field crew for their dedication and hard work under very challenging conditions: PRBO staff members Brent Campos, Ken Etzel, Kristin Sesser, Jim Tietz and seasonal field biologists Mary Clapp, Lidia D'Amico, Patrick Furtado, Dan Lipp, Michelle McGee, Jeff Moker, Lauren Morgan-Outhisack, Julia Polasik, Josh Stagner and Nate Turner. Cover photos: Mountain Quail photo © Peter LaTourrette, Fox Sparrow and Yellow Warbler photos courtesy of Ryan Burnett, Hairy Woodpecker photo courtesy of Alan D. Wilson.

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## Appendix 1. Presentations and other outreach activities

### *Presentations completed:*

USFS Region 5 District Biologists Training Meetings (February 2, 2010 – Susanville, CA; February 23, 2010 – Sonora, CA; March 16, 2010 – Redding, CA; April 20, 2010 – South Lake Tahoe, CA)

Authors: L. Jay Roberts, Ryan Burnett, Geoff Geupel, Alissa Fogg, Diana Craig. Presentation Title: PRBO Sierra Nevada Program – Sierra Nevada Avian Monitoring Information Network – Online Tools

American Ornithologists Union/Cooper Ornithological Society 2010 Annual Meeting. February 11, 2010, San Diego, California.

Authors: Alissa Fogg, L. Jay Roberts. Presentation title: Is Call-Playback Necessary to Monitor Hairy Woodpecker and Mountain Quail in the Sierra Nevada?

Black-backed Woodpecker Conservation Symposium, November 18, 2010 – Sacramento, CA

Authors: Ryan Burnett, L. Jay Roberts, Nathaniel Seavy. Presentation Title: It's Not Easy Being Green: Black-backed Woodpeckers in Unburned Forest of the Sierra Nevada

The Wildlife Society-Western Section Annual Meeting, February 11, 2010 – Riverside, CA

Author: L. Jay Roberts. Abstract title: Influence of avian species ecological characteristics on interpretation of occupancy estimates from point count data

International Association for Landscape Ecology Annual Meeting, April 6, 2011 – Portland, OR

Author: L. Jay Roberts. Abstract title: Influence of avian species ecological characteristics on interpretation of occupancy estimates from point count data

The Wildlife Society-Western Section Annual Meeting, February 1-3, 2012 – Sacramento, CA.

Authors: Alissa Fogg, L. Jay Roberts. Presentation Title: Comparison of Call-playback and Passive Detection Methods to Monitor Avian Management Indicator Species in the Sierra Nevada

### *Other outreach activities:*

In 2011, we collaborated with CA Department of Fish & Game (CDFG) Northern and North Central regions to deploy audio recording devices at MIS point count stations concurrent with field surveys. CDFG uses audio recorders to monitor vertebrate biodiversity (primarily birds) in the Sierra/Cascades region. The overall intent of using digital recording devices for bird point counts is to use the recordings as a surrogate for human-observer data while reducing human observer variability and staff requirements. PRBO intends to use the recordings to study observer-dependent bias in detection probabilities, detection distance for the recorders and compare species richness values between observer data and recorder data. During the 2011 field season, we collected 367 recordings from 11 different observers.

## Appendix 2. PRBO Sierra Nevada Avian Monitoring Information Network Website



In 2011 we implemented a set of upgrades to the Sierra Nevada Avian Monitoring Information website. These include adding occupancy analyses, a new mapping engine and additional spatial data layers, and including clickable points to reveal species records for all visits. We also incorporated four other sets of PRBO monitoring projects in the Sierras in order to create a single portal for all management-relevant avian inventory data in the region. The PRBO MIS project survey data are located in a node that we have titled “Bioregional Monitoring”, and other PRBO monitoring data are assembled in nodes including: Aspen Enhancement, Fuels Treatments, Post-fire Habitat, and Mountain Meadows. Each node contains background and sampling design information, as well as a set of mapping and data analysis tools for examining survey results including trends over time. Clicking on the Bioregional Monitoring tab will bring you to the page shown below:

Sierra Nevada Avian Monitoring Information Network

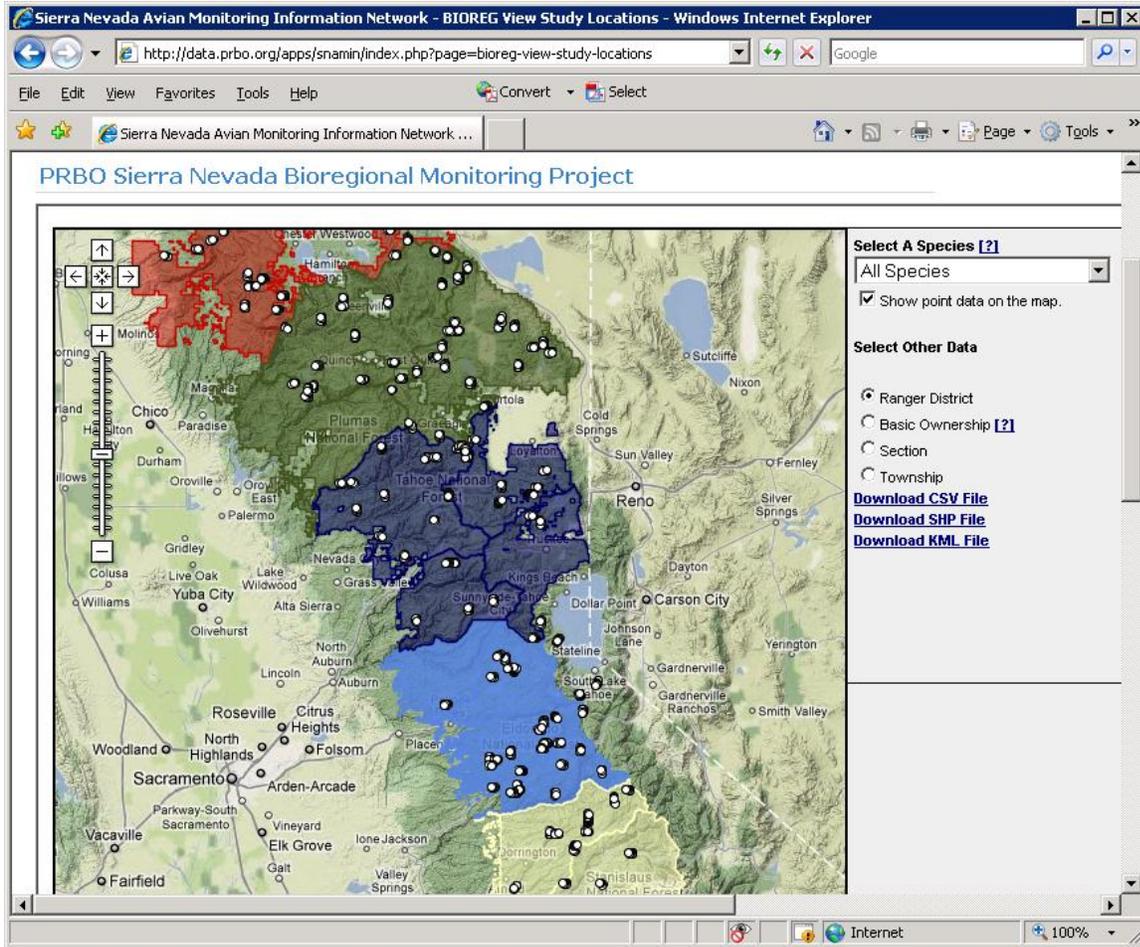
SNAMIN Home Project Background Sample Design View Study Locations Explore Project Results

### PRBO Sierra Nevada Bioregional Monitoring Project

This website, hosted by the California Avian Data Center (CADC) at PRBO Conservation Science, will give users quick and easy access to data generated by the Sierra Nevada Management Indicator Species (SNMIS) project currently being implemented by PRBO. We have provided links to download our field survey locations and raw data, plus analyses that provide tables, graphs, and maps of data from over 100,000 species occurrence records from over 2,000 point count locations across conifer, chaparral, and riparian habitats in the Sierra Nevada region.

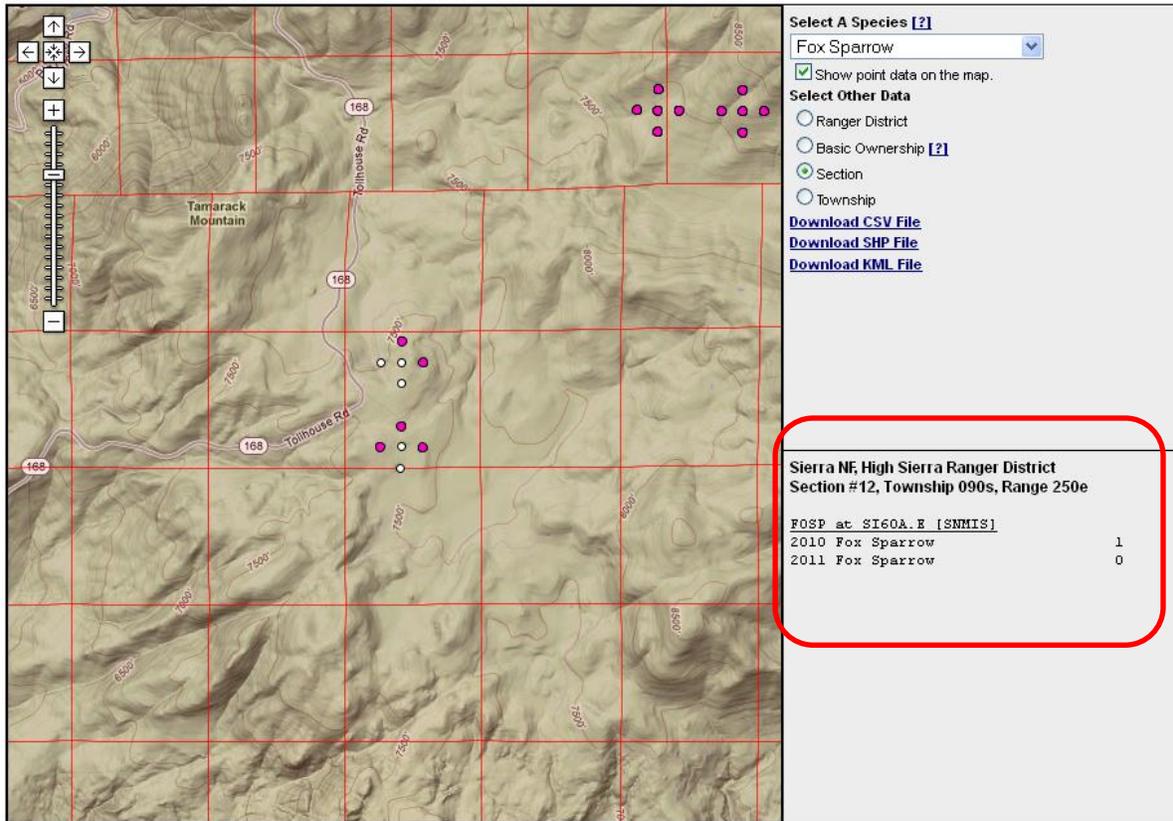
Data from the most recent field season are incorporated into this site within several months of it being collected. The analyses and output that are available include: locations viewable on a [map](#) or in raw formats, [effort and sample summaries](#), [density estimates](#), [species richness](#), and [occupancy](#). These analyses can be generated at targeted study areas of interest from the entire Sierra Nevada bioregion down to the Forest District level. To get started, please select either the [Explore Project Results](#) or [View Study Locations](#) tabs above and follow the step-by-step instructions.

The tabs across the top of this page include project background and study design information, plus two tabs that will let you explore project data and analyses. The first set of analyses that can be used is the mapping tool, which can be accessed by clicking on “View Study Locations” in the menu bar at the top of the webpage. Clicking this link will bring you to an interactive map interface driven by Google technology (below).

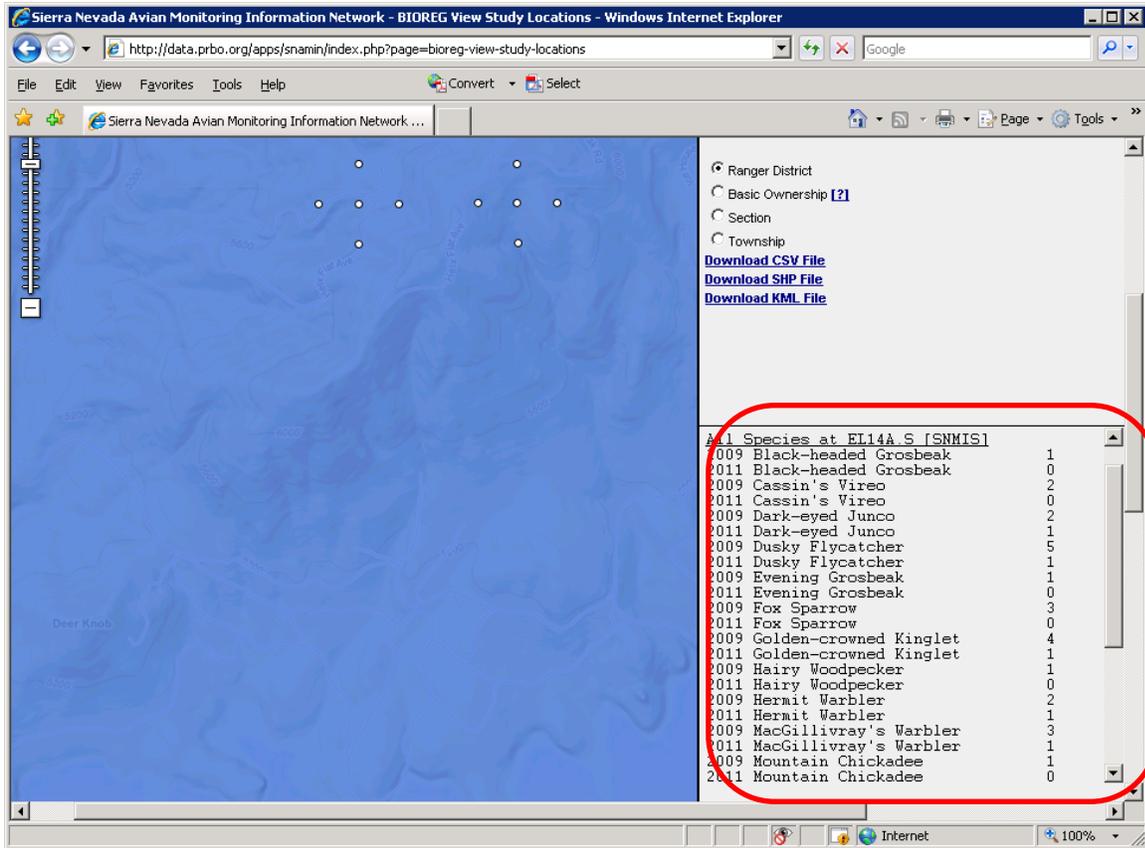


Multiple base layers are available including: Ranger district boundaries, ownership, sections and townships. Raw location and detection data are also available by clicking on the “Download” links underneath the display selections, in three formats (.csv flat tables, ArcGIS shapefiles, or GoogleEarth .kml files).

PRBO Sierra Nevada Bioregional Monitoring Project



You can select a species of interest to examine the locations where it is present (colored dots) or absent (white dots). In addition, clicking on any single point will show the list (bottom-right corner of the page) of years on which that species was detected.

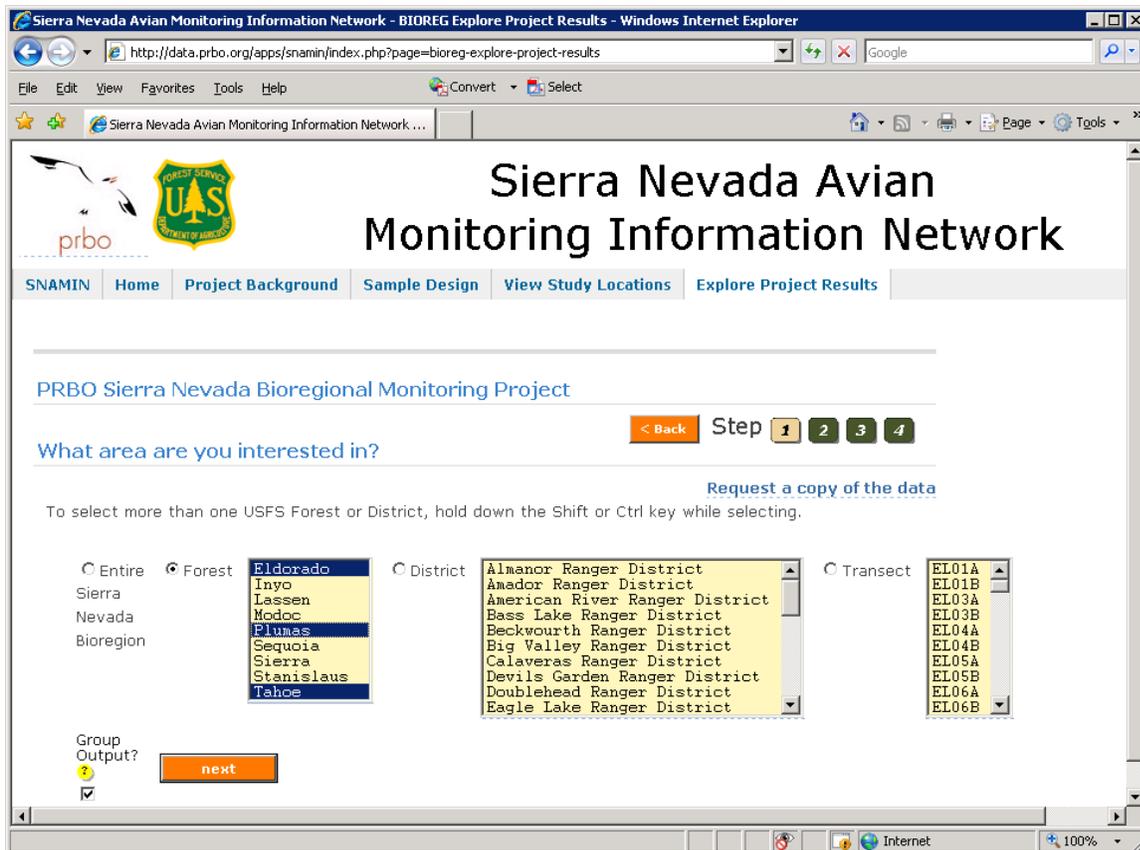


If “All Species” is selected from the dropdown list, then the complete detection history of all species at that point is shown in the table.

A wide variety of additional visualizations and data exploration functions are available and we encourage you to investigate these at your convenience.

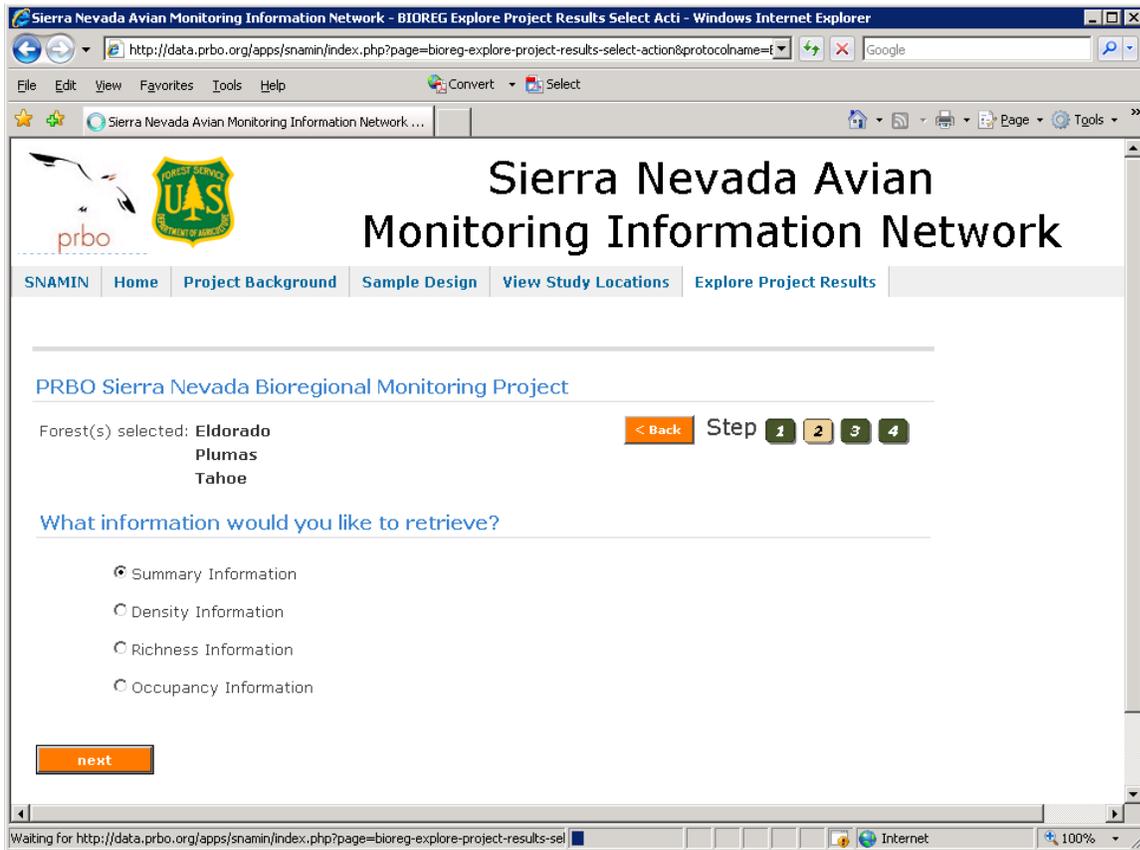
Clicking on “Explore Project Results” will bring you to a four-step process for creating custom analyses and summary tables. At the end of this appendix we give an outline of the steps we used to generate estimated occupancy and abundance numbers from the species summaries in the Monitoring Results section above.

The first step is to select an area of interest. Options include the entire Sierra Nevada Bioregion in a single set of results, individual forests, individual ranger districts, or individual transects.

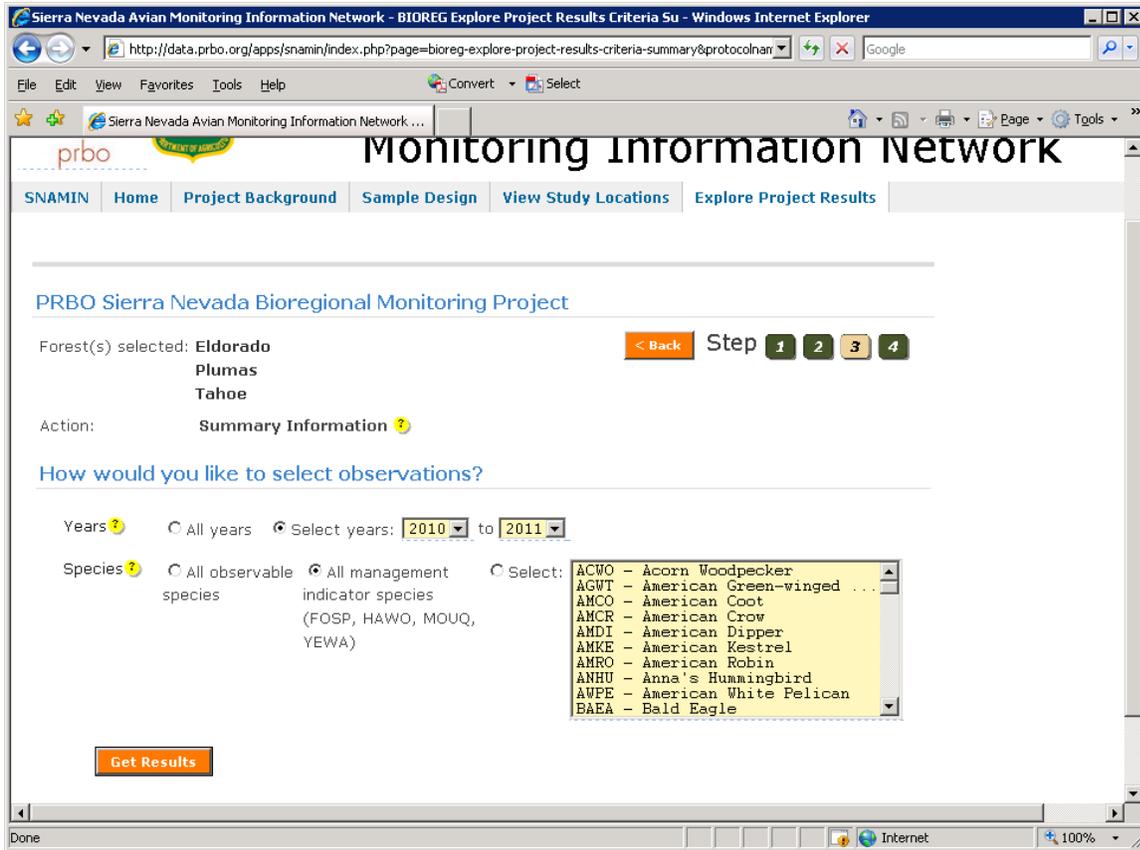


As an artifact of our current graphing tools, a maximum of nine distinct areas can be analyzed and displayed in the results. If more than nine geographic areas or transects are desired then you must select the “Group Output?” button to create a single set of results for all areas of interest. Note also that Lake Tahoe Basin Management Unit is lumped with Tahoe National Forest in the Forest-level analyses, but it is also a distinct unit in the “District” level so results can be created using that criteria, or by selecting all LTBMU transects (those with ID’s that start with “TB”) from the Transect menu.

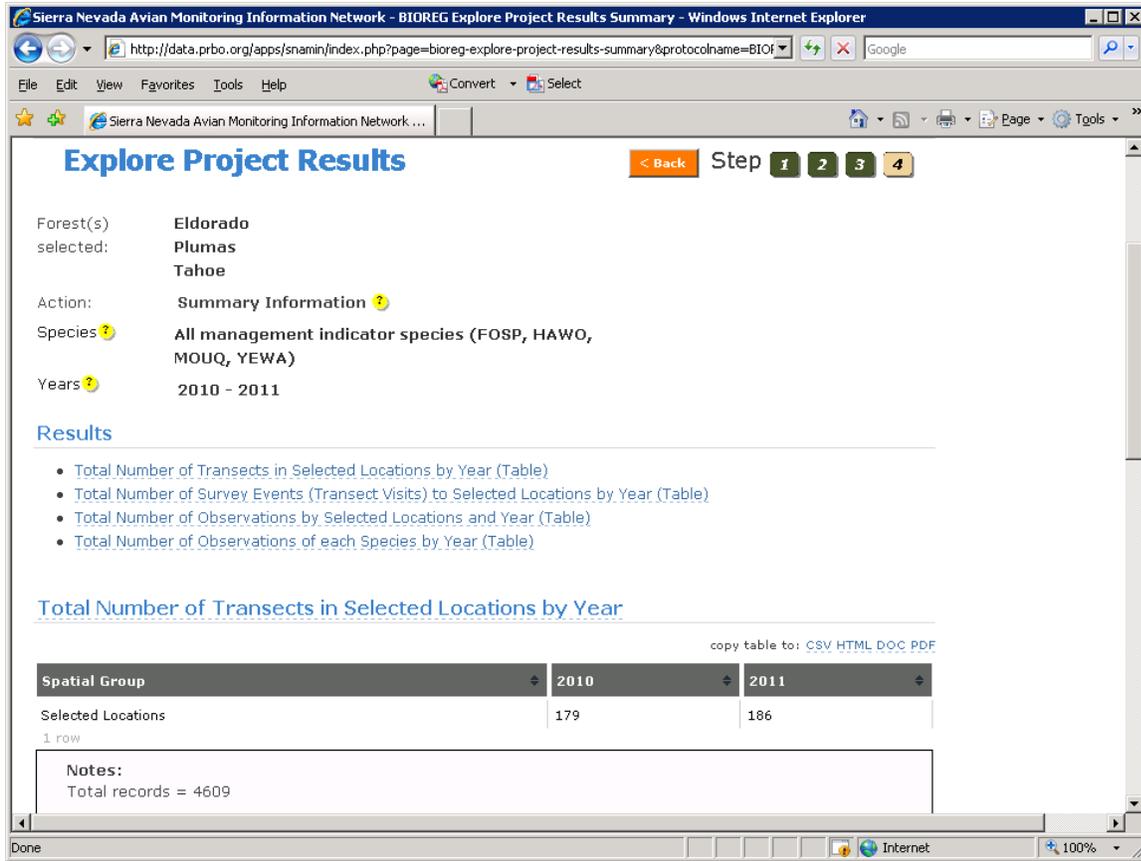
Also note that by default the Bioregion and Forest lists include both upland and riparian transects. If only upland transects are of interest then you can use the District menu to select all districts EXCEPT the one labeled “Riparian” or vice-versa you can select only riparian transects using “Riparian” from the District list. Individual riparian transects can also be selected by choosing transect IDs that start include an “R” in the first three characters (e.g. “ELR01”).



Step 2 in the process allows you to select the type of analysis you are interested in. Currently we show summary, abundance (density), species richness, and occupancy analyses.



Step 3 allows you to select the years of interest, and the species or group of species for which you would like to conduct analyses. For information on what the analyses do you may click on the yellow “?” buttons. You may select multiple species by holding “shift” or “control” to select and deselect multiple options from the dropdown list. The “All observable species” button is available for summary analyses, but not for Density or Occupancy. All observable species is the default for species richness analyses.



Example of Summary Information output, in this case for all four target MIS, includes tables showing the number of transects visited by year (above), total number of visits by year (below), and number of observations by species and year (below).

Sierra Nevada Avian Monitoring Information Network - BIOREG Explore Project Results Summary - Windows Internet Explorer

http://data.prbo.org/apps/snamin/index.php?page=bioreg-explore-project-results-summary&protocolname=

File Edit View Favorites Tools Help Convert Select

Sierra Nevada Avian Monitoring Information Network ...

### Total Number of Survey Events (Transect Visits) to Selected Locations by Year

copy table to: [CSV](#) [HTML](#) [DOC](#) [PDF](#)

Spatial Group	Year Collected	No. Survey Events
Selected Locations	2010	273
Selected Locations	2011	300

2 rows

**Notes:**  
Number of visits to transects that spanned more than 1 day: 1

### Total Number of Observations by Selected Locations and Year

copy table to: [CSV](#) [HTML](#) [DOC](#) [PDF](#)

Spatial Group	2010	2011
Selected Locations	1297	1887

1 row

**Notes:**  
Total records = 4609; sampling events with no ObservationCount = 1443

Done Internet 100%

Sierra Nevada Avian Monitoring Information Network - BIOREG Explore Project Results Summary - Windows Internet Explorer

http://data.prbo.org/apps/snamin/index.php?page=bioreg-explore-project-results-summary&protocolname=

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Sierra Nevada Avian Monitoring Information Network ...

### Total Number of Observations of each Species by Year

copy table to: [CSV](#) [HTML](#) [DOC](#) [PDF](#)

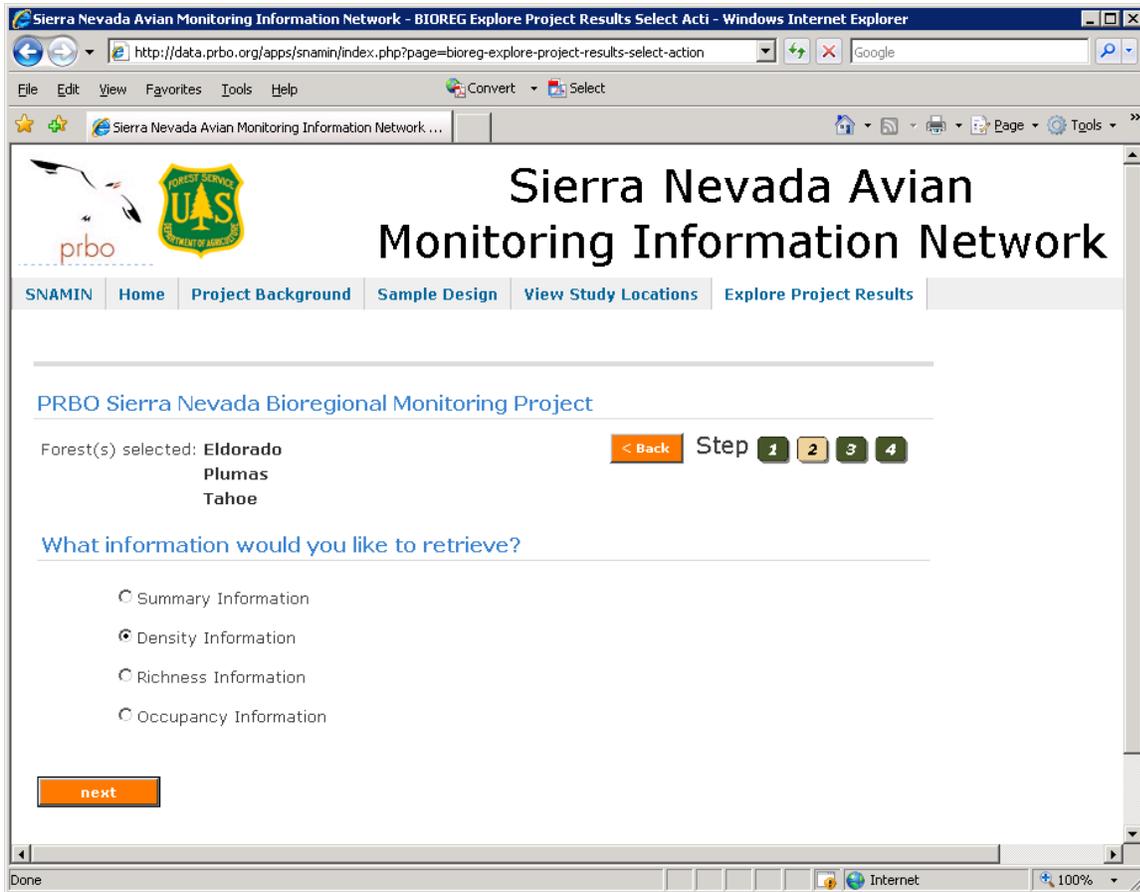
Common Name	2010	2011
Fox Sparrow	883	1410
Hairy Woodpecker	102	161
Mountain Quail	57	97
Yellow Warbler	255	219

4 rows

**Notes:**  
Total records = 4609; sampling events with no CommonName = 1443; sampling events with no ObservationCount = 1443

Done Internet 100%

If analyses other than Summary Information are desired, then return to Step 2 and choose another option, in this case we will examine Density. Density numbers are calculated as abundance estimates for a 100m radius circle (approximately 7.8 acres or 3.1 hectares).



Example density output, in this case for all four target MIS, includes tables showing the estimated number of individuals within selected locations by year in table and graph format. Density calculations produce the number of individuals detected within 100m as an average of per-point values on each transect, as well as variance and confidence intervals, and graphs over time.

Forest(s) selected: **Eldorado**  
**Plumas**  
**Tahoe**

Action: **Density Information**

Species: **All management indicator species (FOSP, HAWO, MOUQ, YEWA)**

Years: **2010 - 2011**

**Results**

- Point-level Estimates of Abundance (Individuals Detected Within 100m) by Selected Locations and Year (Table)
- Point-level Estimates of Abundance (Individuals Detected Within 100m) by Selected Locations and Year (Graph)
- Simple linear trend estimate of Abundance by year for Indicator species. (Table)
- Simple linear trend estimate of Abundance by year for Indicator species. (Graph)

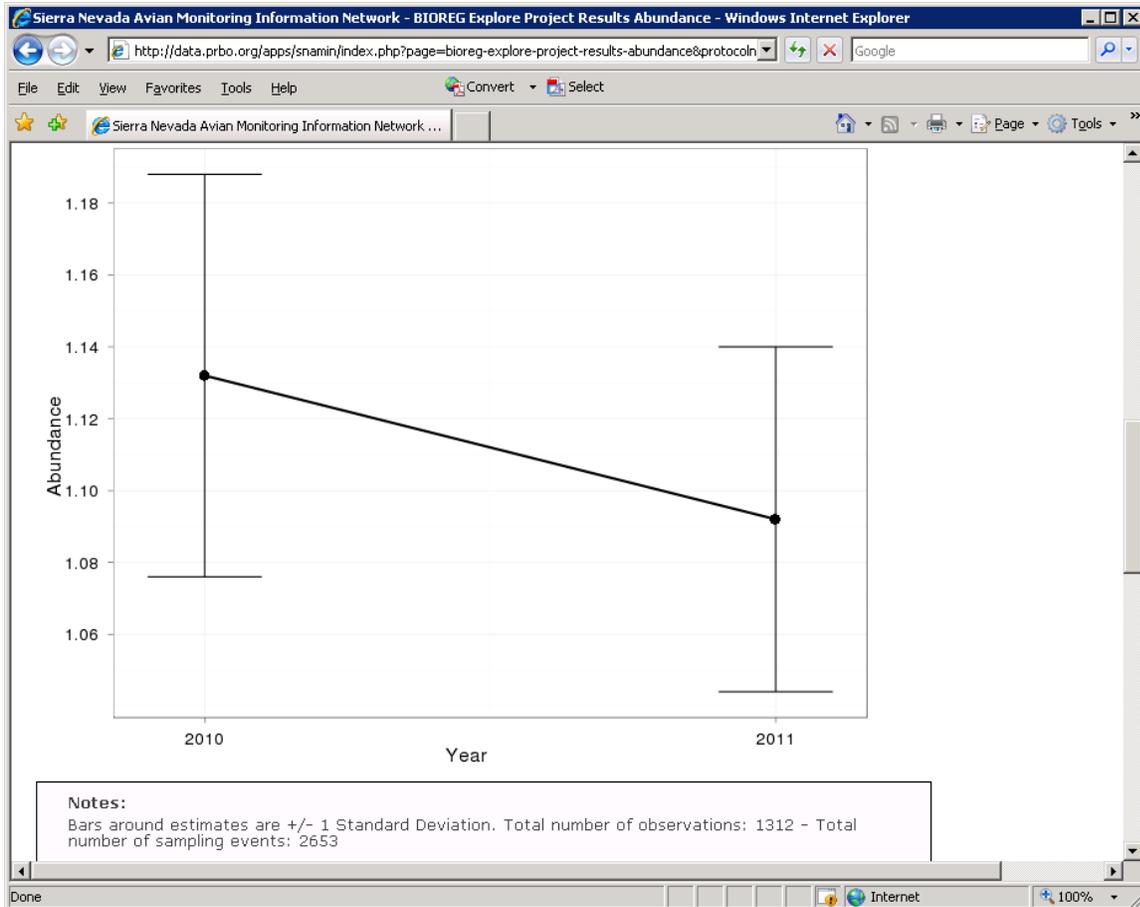
**Point-level Estimates of Abundance (Individuals Detected Within 100m) by Selected Locations and Year**

copy table to: [CSV](#) [HTML](#) [DOC](#) [PDF](#)

Year	Selected Locations	Indicator species	Abundance	Standard Error	ConfidenceInterval	Sample Size
2010	Selected Locations	Indicator species	1.132	0.056	(1.021,1.242)	844
2011	Selected Locations	Indicator species	1.092	0.048	(0.997,1.187)	890

2 rows

**Notes:**  
 Species: FOSP, HAWO, MOUQ, YEWA. Total number of observations: 1312 - Total number of sampling events: 2653

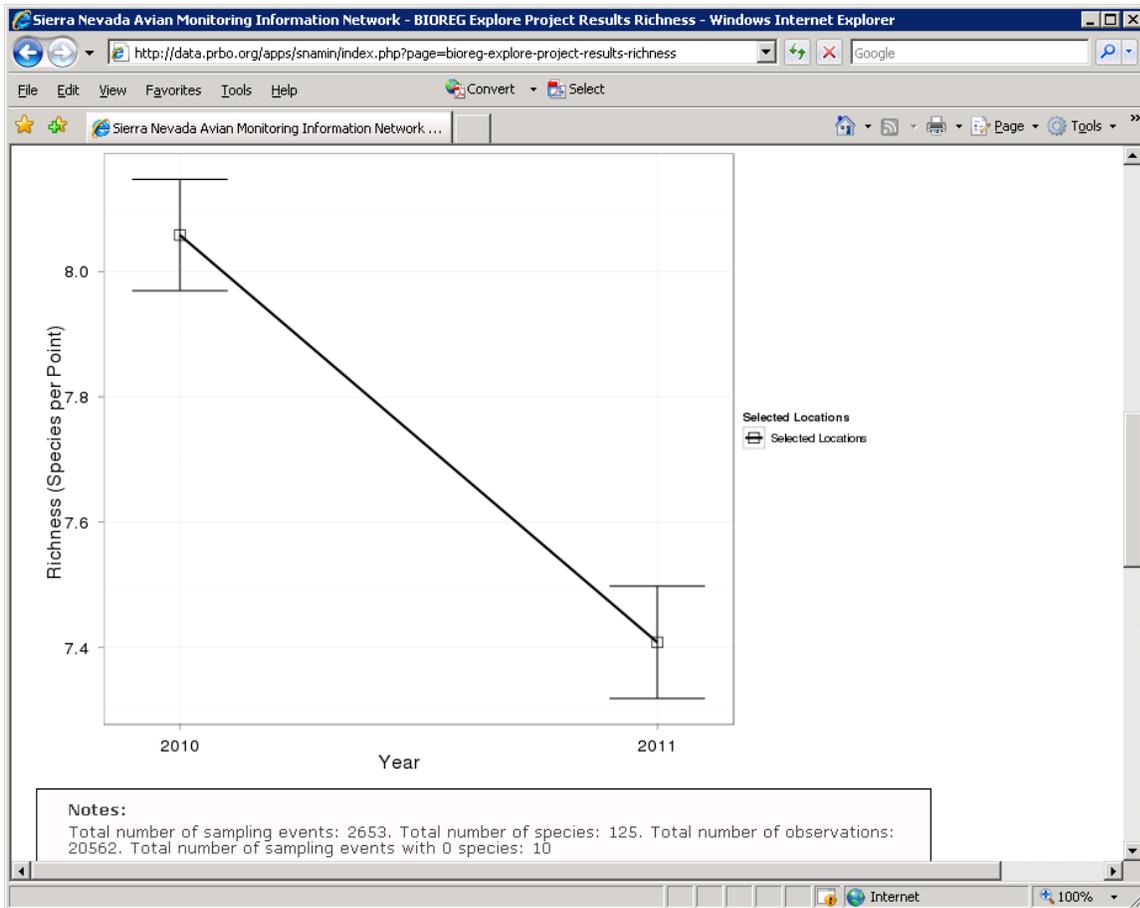


If species richness is selected in Step 2, the number of species detected per point (100m radius circle) averaged over each transect is calculated, as well as variance, confidence intervals and trend over time.

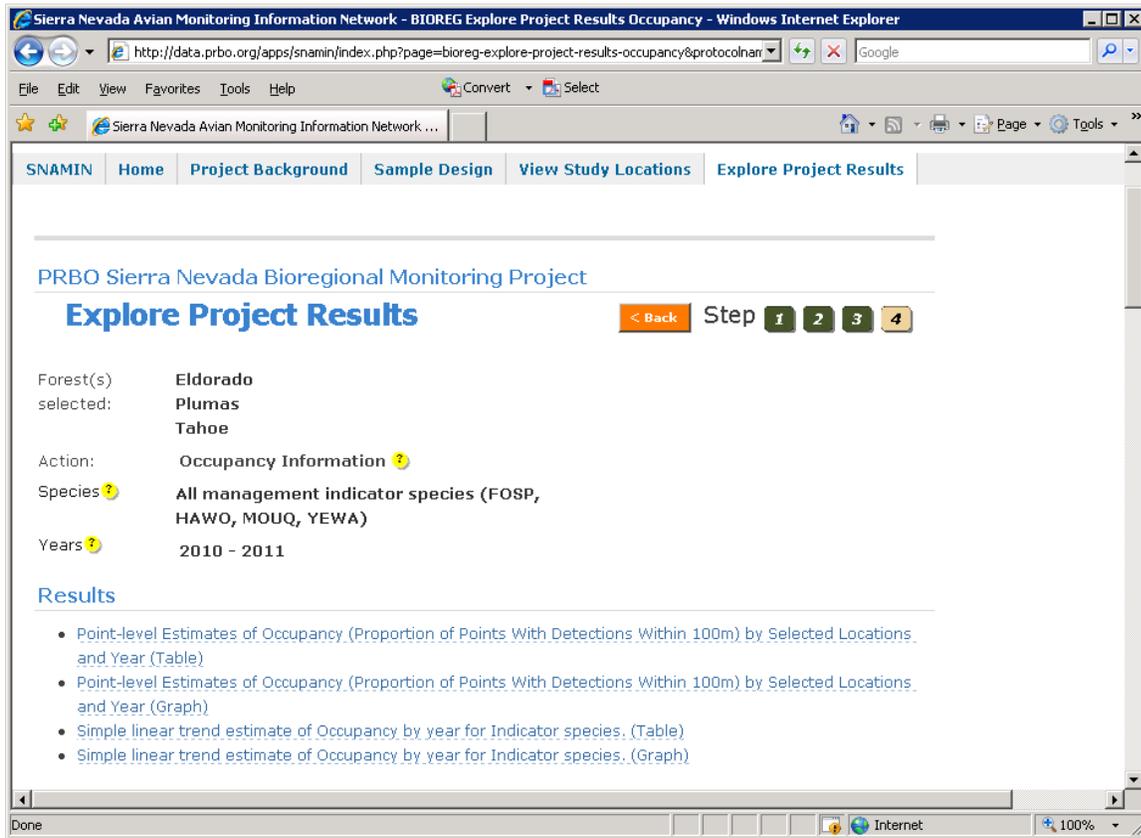
The screenshot shows a web browser window titled "Sierra Nevada Avian Monitoring Information Network - BIREG Explore Project Results Richness - Windows Internet Explorer". The address bar shows the URL: <http://data.prbo.org/apps/snamin/index.php?page=bioreg-explore-project-results-richness>. The page content includes:

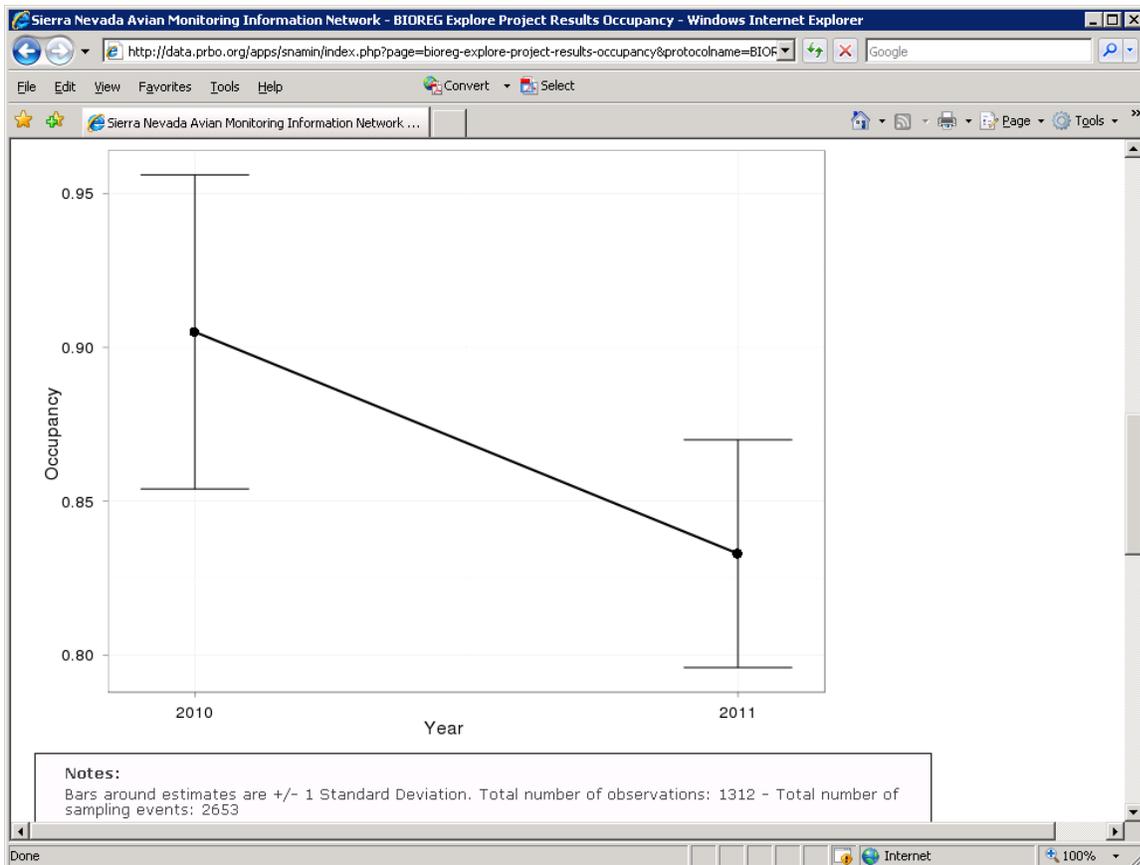
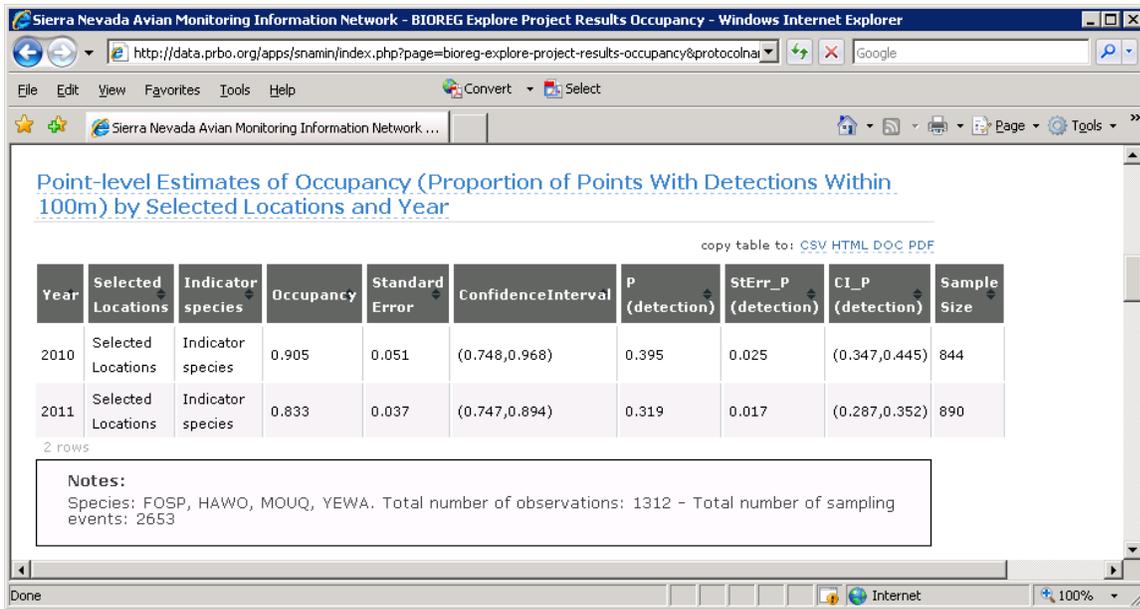
- Explore Project Results** header with a "Back" button and step indicators (1, 2, 3, 4).
- Forest(s) selected: **Eldorado**, **Plumas**, **Tahoe**
- Action: **Richness Information**
- Years: **2010 - 2011**
- Results** section with a list of links:
  - Mean Species Richness (Number of Species per Point) Summarized by Selected Locations (Table)
  - Mean Species Richness (Number of Species per Point) Summarized by Selected Locations (Graph)
  - Simple linear trend estimate of Richness (Species per Point) by Year (Table)
  - Simple linear trend estimate of Richness (Species per Point) by Year (Graph)
- Mean Species Richness (Number of Species per Point) Summarized by Selected Locations** section with a "copy table to: CSV HTML DOC PDF" link.
- A data table with the following content:
 

Selected Locations	Year	Richness	Variance	Standard Error	Sample Size
Selected Locations	2010	8.06	6.67	0.09	844
Selected Locations	2011	7.41	7.14	0.09	890
- Notes:** Only birds detected within 100m are included. Total number of sampling events: 2653. Total number of species: 125. Total number of observations: 20562. Total number of sampling events with 0 species: 10.



And finally, if Occupancy Information is selected in Step 2, in this case for all four target MIS, the output will include tables showing the estimated occupancy within selected locations by year in table and graph format. Occupancy calculations produce the probability of occupancy of selected species at all points in the selected locations, detection probability (“P”), as well as standard errors and confidence intervals, and a graph of occupancy probability over time.





Outline of steps used to produce species summary data in Monitoring Results section:

Find the Explore Project Results page in the Bioregional Monitoring project tab on SNAMIN (<http://data.prbo.org/apps/snamin/>).

Step 1: Select all upland transects by clicking on the “District” button, hold the “shift” key and click on all districts in the drop-down menu, then hold the “control” button to deselect the “riparian” District type. Click the “Group Output?” button at bottom left of screen. Click “Next”.

Step 2: Select the desired type of information, in this case we will choose “Density” by clicking on the adjacent button. (Occupancy information could be chosen as an alternative, the following steps will apply.) Click “Next”.

Step 3: Select “All years” by clicking on the adjacent button. Click to highlight the desired species from the dropdown menu at the right. In this case we will select “FOSP – Fox Sparrow”.

Step 4: Examine the results. In this case the estimated density at all upland sites (not including riparian locations) is 0.585 in 2009, 0.662 in 2010, and 0.699 in 2011 (we reported the value 0.65-0.70 in the text above). The large change in number of points surveyed from 2009 to subsequent years led us to discount the value and we would not consider this an indication of population increase without more years of monitoring data. In addition, the linear trend estimate with 95% confidence envelope includes negative slopes.

The steps needed to calculate densities and occupancy for other species in this report is largely the same.