EASTERN SIERRA RIPARIAN SONGBIRD CONSERVATION

1998-2000 FINAL REPORT
&
MONO BASIN 2000 PROGRESS REPORT

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CONSERVATION THROUGH SCIENCE

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TABLE OF CONTENTS

TABLE OF CONTENTS – CONTINUED

SUMMARY

The third season of fieldwork for the Eastern Sierra Riparian Songbird Conservation project was completed in 2000. The program emphasized coverage of riparian habitats on Bureau of Land Management Bishop Field Office, Inyo National Forest, Los Angeles Department of Water and Power, Mono Lake Tufa State Reserve, Mono County, and California Department of Fish and Game lands along a 232-kilometer stretch of the eastern Sierra Nevada. The initial phase of the project, which was initiated in 1998 and emphasized Owens Valley alluvial fan habitats, was completed in 2000 (Part I). The second phase, which was initiated in 2000 and emphasized Mono Basin habitats, is proposed to continue through at least 2002 (Part II). In total, we implemented and monitored 505 individual point count stations, 10 nest search plots, 8 mist netting stations and 6 area search plots.

We have collaborated with several federal, state and county agencies, non-profit conservation groups, consulting firms, other researchers, and private landowners. We contributed songbird data to several national databases, California Partners in Flight Bird Conservation Plans, Bureau of Land Management planning documents, and local land use decision-making forums. We also presented data at regional habitat and wildlife conferences and statewide Partners in Flight meetings and workshops. Provided herein as an appendix to this report, is the draft manuscript submitted for inclusion in the Riparian Habitats and Floodplains Conference proceedings.

Here, we present several results on primary and secondary songbird population parameters including species richness, diversity, abundance, and nest success. We present descriptive nest site and habitat characteristics of several avian breeding species. We further address factors influencing songbird occurrence, breeding diversity, and nest success by investigating the effects of vegetation and habitat features. We present rates of predation and Brown-headed Cowbird parasitism, and investigate factors influencing cowbird presence. We also discuss the importance of these riparian areas for migrants and sagebrush nesting species. Lastly, we present fourteen habitat and management recommendations derived from the 1998-2000 results.

BACKGROUND AND INTRODUCTION

Declines in populations of North American landbirds, specifically Neotropical migrants, have been and continue to be well documented (Finch and Stangel 1993, Askins 2000). Riparian has been identified as critical habitat for the majority of the declining landbird species in western North America (Miller 1951, Gaines 1974, Knopff et al. 1988, Manley and Davidson 1993, Ohmart 1994, RHJV 2000) and the loss and degradation of this habitat has been implicated as the most important cause of landbird population declines in western North America (DeSante and George 1994). Accordingly, land management agencies are charged with the task of understanding and managing for healthy and functioning riparian ecosystems and for the bird populations that utilize such systems.

In response to California's diminishing riparian habitat and the associated songbird communities, the Riparian Habitat Joint Venture (RHJV) of California Partners in Flight (CPIF) was established as a cooperative agreement between eighteen federal, state, and private organizations. RHJV is guided by the mission to promote conservation and restoration of riparian habitat sufficient to support long-term viability and recovery of native bird populations and associated non-bird species. The Riparian Bird Conservation Plan, a project of the RHJV, has been developed to guide conservation policy and action on behalf of riparian habitats and California's landbirds (RHJV 2000).

Conservation of landbird populations requires an understanding of the habitat needs and demographic mechanisms necessary for population sustainability (Martin 1992, Nur and Geupel 1993). The identification of these requirements and processes has become the focus of bird conservation and research over the last decade (see Askins 2000 for review).

Guided by Riparian Bird Conservation Plan recommendations and the cooperative spirit of the RHJV, the Point Reyes Bird Observatory (PRBO), in collaboration with Bureau of Land Management - Bishop Field Office (BLM), United States Forest Service - Inyo National Forest (USFS), California Department of Fish and Game (CDFG), Eastern Sierra Institute for Collaborative Education (ESICE), Eastern Sierra Audubon Society (ESAS) and Mono Lake Committee (MLC) began an assessment of songbirds in riparian habitats of the eastern Sierra Nevada foothill/western Great Basin region in the spring of 1998. The effort continued through 2000, with additional partners including Los Angeles Department of Water and Power (LADWP), the Mono Lake Tufa State Reserve (MLTSR), Mono County, consulting firms, other researchers, and educators in the region.

The principle objectives of this project were to:

1.) Implement a monitoring program utilizing standardized Partners in Flight (PIF) protocol to determine abundance, richness, diversity and breeding status of songbirds in riparian habitats across 3 main watersheds of the eastern Sierra Nevada/western Great Basin region, including BLM, USFS, CDFG, MLTSR and private lands, targeting but not limiting examination to riparian focal species (Appendix 1).
2.) Implement a monitoring program utilizing standardized Partners in Flight (PIF) protocol to estimate survival, productivity and parasitism rates of songbirds in riparian habitats on BLM,

USFS, LADWP and Mono County lands in the Owens Valley foothill zone and the Mono Basin.
3.) Train regional BLM, USFS, CDFG, MLTSR and ESICE biologists, MLC and ESAS members, and local experts in standardized monitoring methods, insuring monitoring beyond the life of the project.
4.) Determine effects of current BLM, USFS and CDFG management practices on riparian breeding songbirds in the region, and make recommendations to enhance bird populations through adaptive management.
5.) Assess the relationship of riparian songbird abundance, richness, diversity, and productivity to regional habitat and landscape characteristics
6.) Contribute to national, state, and regional conservation efforts by providing information to, for example: Riparian Bird Conservation Plan, Breeding Biology Research and Monitoring Database (BBIRD), Monitoring Avian Productivity and Survival (MAPS) database, decisions regarding proposed changes in water allocation in the Mono Basin, and land management planning processes (refer to Martin et al 1997, DeSante 1991, SWRCB 1998, BRMP 1993, USFS 1996).

SITE DESCRIPTION AND METHODS

Site Description

The study site encompasses riparian corridors along a 232 km stretch of the eastern Sierra Nevada foothill/western Great Basin region, principally the alluvial fan and foothill tributaries of the Mono Basin and Owens River watersheds (Figure 1). Twenty-nine separate tributaries comprise approximately 105 km of riparian habitat surveyed.

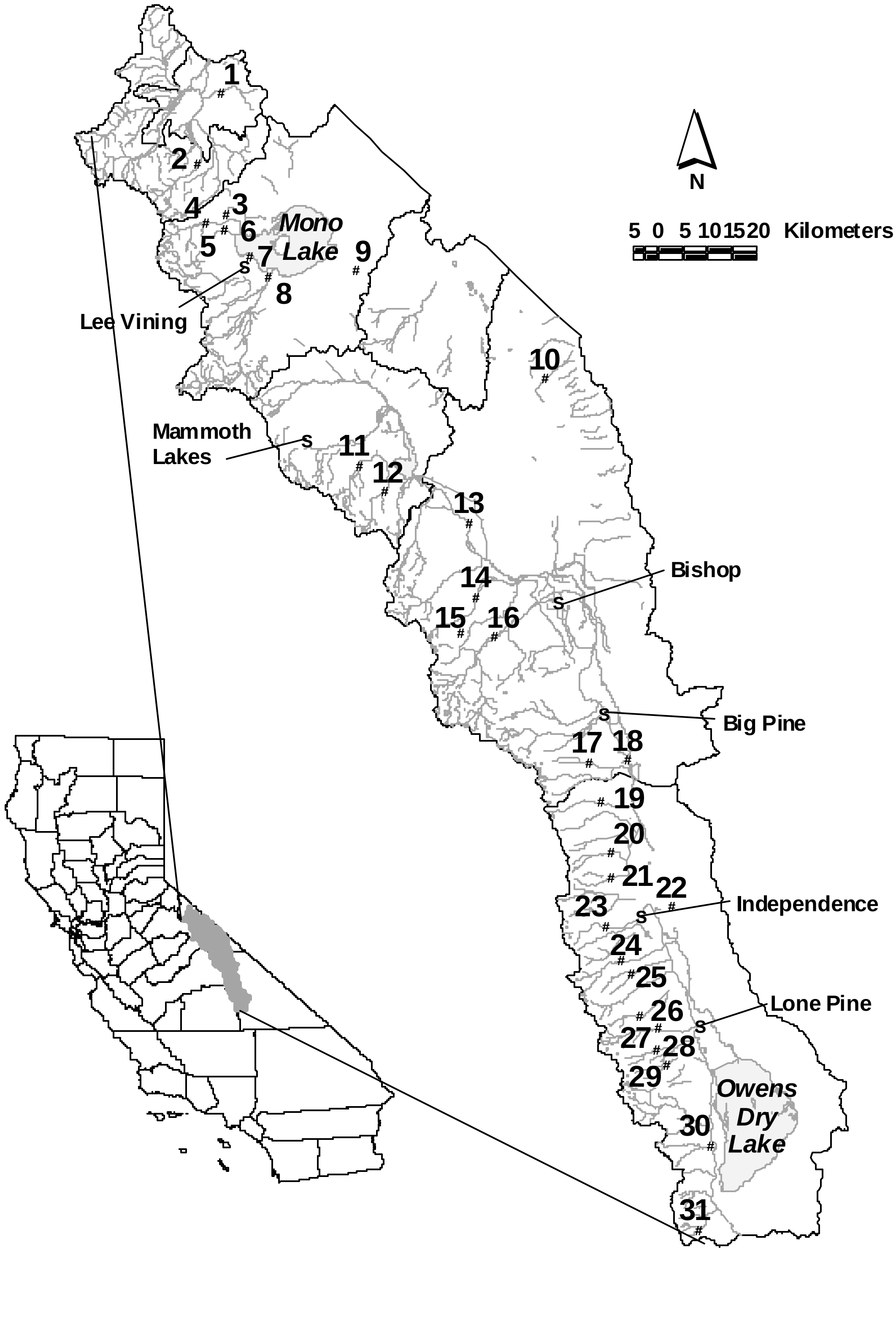
The mosaic of land ownership in this region is such that up to 5 different managers/owners may occur within one riparian corridor. Nearly all of the Owens Valley floor riparian habitats are owned and managed by LADWP, as are the lower reaches of their tributaries. The upper reaches of the tributaries in the alluvial fan/foothill zone are managed by the BLM, USFS, CDFG, and in some cases where wider, spring-fed corridors exist, the LADWP. Similarly in the Mono Basin, the LADWP owns and manages most of the lower reaches of most of the Mono Lake feeder streams, while the upper reaches are managed by the USFS, BLM, and Mono County. Lands that have emerged due to Mono Lake's dropping (but currently rising) water levels are owned by the state of California and are managed by the MLTSR.

Owens River Watershed

Study site locations in the Owens River watershed occur along tributary creeks and the Owens River. Tributary sites are comprised of narrow (5m - 50m) riparian drainages along the alluvial fan and foothill zone of the eastern Sierra Nevada, flowing into the Owens, Long, and Round valleys. Owens River sites are comprised of riparian and dry riverbed located up and downstream from the river's diversion (see Brothers 1984 for review).

Tributary sites are generally characterized by extremely dense groves of low trees or tall shrubs to areas with medium-size trees. The dominant canopy species include water birch (*Betula*

Figure 1. Eastern Sierra Riparian Songbird Conservation Project study area, 1998-2000. Numbered sites correspond with Table 1.



occidentalis), willow (primarily *Salix lasiolepis and S. exigua*) and black cottonwood (*Populus trichocarpa*). The shrub layer is comprised of smaller individuals of canopy species and wild rose (*Rosa woodsii*). A few streams are comprised of black or canyon live oak (*Quercus kelloggii* and *Q. wislizenii*).

Higher elevation tributary sites in this region generally contain relatively open canopies comprised of medium to tall trees including species such as black cottonwood, water birch, willow, aspen (*Populus tremuloides*), and Jeffrey pine (*Pinus jeffreyi*). Wild rose, and smaller individuals of the canopy species make up the shrub layer.

Owens River sites are comprised of a canopy of black willow (*Salix goodingii*) and Russian olive (*Elaeagnus angustifolia*) and a shrub layer of Russian olive, willow, tamarisk (*Tamarix* sp.), wild rose, tule (*Scirpus* sp.) and cattail (*Typha* sp.).

Mono Basin Watershed
Study site locations in the Mono Basin watershed consist of riparian tributaries descending from the eastern slope of the Sierra Nevada into Mono Lake and one spring in the eastern Mono Basin.

The upper reaches of Mono Basin tributaries are generally comprised of aspen, black cottonwood, willow, and lodgepole pine (*Pinus contorta*). Shrub layers include snowberry (*Symphoricarpos* sp.), wild rose, and smaller individuals of the canopy species.

Lower reaches of the same tributaries are either in the stage of rehabilitation and re-watering after years of streamflow diversions (as is the case for Lee Vining and Rush Creek), are currently experiencing partial diversion (as is the case for Mill Creek), or are areas where (due to water diversions) riparian habitat has established where it had not previously existed (as is the case for Wilson Creek). These lower reaches are comprised of shrub-sized willow (primarily *S. lutea*, *S. lucida* and *S. exigua*), wild rose, cottonwood saplings and decadent cottonwood.

Other Locations
Two tributaries of the West Walker River watershed (Clark Canyon and Green Creek) are similar to creeks found in the Mono Basin watershed, and Marble Creek in the Hammil Valley is comparable to Owens Valley alluvial fan sites.

Methods

Project Time Scale
The project was initiated in May of 1998. From that time until August of 2000, extensive songbird monitoring methods (e.g. point counts and vegetation assessments) were conducted at all study sites, and the most intensive methods (e.g. nest searching, nest vegetation assessments, spot mapping and mist netting) were conducted in the alluvial fan region of the Owens Valley. Results of these efforts are presented in Part I. In 2000, intensive methods were implemented at the Mono Basin sites and are proposed to continue through at least 2002. The intention is to continue work at the Mono Basin intensive sites, in addition to a subset of the original 1998 study area, as a part of a long term monitoring program for the eastern Sierra bioregion. Results of the Mono Basin 2000 nest searching and mist netting efforts are presented in Part II.

Description of Methods

In order to meet project objectives, PRBO implemented the following methodologies:

1) Fixed radius point count censuses (objectives 1, 3, 4, 5, 6)
2) Nest monitoring (objectives 2, 3, 4, 5, 6)
3) Spot mapping (objectives 2, 3, 4, 6)
4) Constant-effort mist netting (objectives 2, 3, 4, 6)
5) Area Searches (objectives 1, 3, 4, 6)
6) Habitat and vegetation assessment (objectives 3, 4, 5, 6)

Census techniques are indicated by drainage in Table 1.

Table 1. Songbird census techniques conducted at each study site, eastern Sierra Nevada, 1998 - 2000. Sites listed from north to south and key numbers correspond with numbered dots in Figure 1. Underlined methods are those initiated in 2000.

		CENSUS TECHNIQUES					
STUDY SITE	**Key to Fig. 1**	point count	area search	nest monitor	spot map	mist net	habitat & vegetation assessments
Clark Canyon	1	X					X
Green Creek	2	X					X
Wilson Creek	3	X	X	X	X	X	X
Mill Creek	4	X	X	X	X	X	X
Dechambeau Creek	5	X					X
Thompson Ranch	6		X				X
Lee Vining Creek	7	X	X	X	X	X	X
Rush Creek	8	X	X	X	X	X	X
Indian Spring	9	X					X
Marble Creek	10	X					X
Convict Creek	11	X					X
McGee Creek	12	X					X
Rock Creek – Lower	13	X					X
Horton Creek	14	X					X
Buttermilk Country	15	X	X				X
Bishop Creek	16	X					X
Birch Creek	17	X		X	X		X
Owens River – North	18	X					X
Taboose Creek	19	X		X	X	X	X
Sawmill Creek	20	X					X
Thibaut Creek	21	X					X
Owens River – South	22	X					X
Independence Creek	23	X		X	X	X	X
Shepherd Creek	24	X					X
Bairs Creek – S. Fork	25	X		X	X	X	X
Hogback Creek	26	X					X
Lone Pine Creek	27	X		X	X		X
Tuttle Creek	28	X		X	X	X	X
Lubken Creek – N. Fork	29	X					X
Ash Creek	30	X					X
Walker Creek	31	X					X

Breeding Status
Breeding status was determined for all species encountered using all data collected during the 1998 - 2000 field seasons. Species were ranked by site, using the following four criteria of the Riparian Habitat Joint Venture breeding scale, modified from breeding bird atlas criteria (e.g. Shuford 1993), (see http://www.prbo.org/CPIF/coplbkgr.html.)

0 No evidence of breeding: Species not detected during breeding season, or captured only on migration (with high fat scores).
2 Possible breeding: Species encountered singing or acting territorial only once during the breeding season (in suitable habitat).
3 Probable breeding: Singing individual encountered on 2 or more different days of standardized censuses (at least one week apart); territorial behavior noted more than once at the same location; pair observed in courtship behavior; female with brood patch (males with cloacal protuberances not used as evidence of breeding locally).
1 Confirmed breeding: distraction display; nest building (except woodpeckers and wrens); nesting material or fecal sack being carried by adult; captured female with eggs in oviduct; dependent juveniles with adults; juvenile with no skull ossification before 1 August; active territory observed on at least three days of spot mapping (at least one week apart); active nest observed.

Point Count Censuses
We established thirty-seven transects, totaling 505 independent stations. 433 stations were established in 1998 and censused 1998-2000. An additional 72 stations were established in 1999 and censused 1999-2000. We conducted 5 minute 50 m fixed radius point counts following standards recommended by Ralph et al. (1993, 1995). We conducted all counts during the peak breeding season, May 15 to July 10, 1998-2000.

We established transects on most streams in the general study area. Where width of riparian vegetation allowed, the 50 m census radius was placed entirely within riparian vegetation. In many cases, we established points on the edges of narrow riparian strips, therefore including adjacent sagebrush, pasture and conifer habitats. We placed stations 250 m apart regardless of riparian habitat type, generally with 15 to 20 points on each creek, depending on creek length. In most cases we covered most of the riparian habitat on public lands along these creeks.

All stations were censused three times each season by field biologists familiar with the songs and calls of the birds in the area, and trained in distance estimation. Censuses were conducted from within 30 minutes after local sunrise until approximately 3 hours later, and were not conducted in excessively windy or rainy conditions. All birds detected within a 50 m radius of the census station were recorded separately from those greater than 50 m and we noted whether detections were inside or outside of the riparian vegetation. Detections were categorized as song, call or visual. We recorded all breeding observations.

In conditions where the creek was too loud for bird detections, observers stepped slightly away from the creek, but continued to census the 50 m radius circle with the original point as center. In 2000, we recorded all mammalian and reptilian predator species detected during the 5 minute counts. When possible, we avoided double counting Brown-headed Cowbirds within transect, noting when individuals flew across several points in one flight. Transects, four-letter transect codes, number of points per transect, dates of censuses. GPS coordinates for each point, and route maps are presented in Appendix 2. Transect narratives are available, organized by 4-letter transect code, at www.prbo.org.

Area Searches

Area searches are similar to point counts in that they are quantitative and repeatable, giving insight into abundance, species richness, and diversity within a given census area and time. Because it mimics the method a birder would use while searching for birds, it is appealing to volunteers. The primary objective of area searches for this project were to 1) confirm breeding status at key sites 2) train personnel in bird census methods and 3) gain more thorough coverage of sites intended for more intensive efforts, but that were only visited 3 times per season by point counts in 1998 and 1999. Staff and biologists from the MLC, CDFG, MLTSR and USFS conducted all censuses.

Three area search plots were established at each of 6 sites. Each was censused 3 times throughout the breeding season in the year it was censused (see Appendix 3 for plot numbers, sizes and census dates). In summary, each plot was censused for 20 minutes during the morning hours, and all birds detected within the plot and type of detection (song, visual, or call) was recorded. Breeding behaviors were also recorded (see Ambrose 1989, Ralph et al. 1993).

Nest Monitoring

Owens Valley alluvial fan nest monitoring plots were established on Taboose Creek, Independence Creek and Birch Creek in 1998 and monitored through 2000. Nest searching began in early May and lasted until breeding activity declined in late July or early August of each year. Three other plots (Bairs Creek, Tuttle Creek and Lone Pine Creek) were initiated and censused in 1998, but discontinued in following years because they had insufficient breeding densities to justify the intensive nest monitoring effort. Nest searching plots at Mono Basin sites (Lee Vining Creek, Rush Creek, Wilson Creek and Mill Creek) were established and monitored in 2000. See Appendix 4 for plot sizes and effort summaries and Appendix 5 for general site locations.

PRBO biologists conducted all nest monitoring, following specific guidelines in Martin and Geupel (1993) and BBIRD protocol (Martin et al. 1997). Special care was taken to minimize human induced predation probability and disturbance to the adults and nest site. Nests of all species were located at all stages (construction, egg laying, incubation, and nestling). Nest outcomes were determined by checking nests every 1 - 4 days until completion. Parasitism by the Brown-headed Cowbird and types of nest predators were determined when possible. Mirror poles were used to check the contents of high nests when possible. Nests of species such as Warbling Vireo and Western -wood Pewee often remained unreachable, therefore parental, nestling or fledgling behavior or disturbance to nest were used to determine nest status and outcomes.

All data from nest monitoring was recorded and entered in a format compatible with the BBIRD program of the Fish and Wildlife Service Cooperative Unit at the University of Montana (Martin et al. 1997). Basic measurements of the nest and nest substrate were also recorded after outcome was determined. See Martin et al. (1997) for a complete list of data variables.

Spot Mapping

PRBO biologists conducted spot mapping at each nest plot. The same biologist mapped all territorial individuals during each visit to her/his nest plot, following guidelines discussed in Ralph et al. (1993) and International Bird Census Committee recommendations (IBCC 1970). At the end of the field season, daily spot maps were combined into single territory maps for each breeding species at each nest plot. Locations of transient species were noted to document their presence on the plots. All predator sightings were also mapped.

Constant Effort Mist Netting

Owens Valley alluvial fan mist netting stations were established at Bair's Creek, Tuttle Creek, Independence Creek and Taboose Creek in 1998 and were run through 2000. Mono Basin mist netting stations were established in 2000 at Rush Creek, Lee Vining Creek, Mill Creek and Wilson Creek.

Netting procedures conformed to the guidelines described in Ralph et al. (1993). In summary, 10 mist nets were operated at each station once every ten day period, 11 times between May 1 and August 15. Nets were unfurled 15 minutes after local sunrise, checked every 30 to 45 minutes (more often in hot or windy weather) and were operated for five hours. Birds captured were removed from the net and processed nearby. Each bird captured (except hummingbirds in 1998, and game birds all years) received a USFWS band for permanent identification. Age, sex, wing length, breeding condition, weight, skull ossification, flight feather wear, molt, and fat score of each bird were recorded as described by Pyle (1997) prior to releasing the bird. Nets and poles were taken down immediately after netting concluded. PRBO permitted biologists conducted all banding. See Appendix 6 for census dates, and Appendix 5 for general site locations.

All mist netting data was submitted to the MAPS program of the Institute for Bird Populations in Point Reyes Station, CA.

Point Count Vegetation Assessment

ESICE, PRBO, and BLM biologists conducted vegetation assessments at each of the 505 point count stations once during 1998-2000. Most assessments were conducted the year of station establishment. Following a slightly modified version of the Relevé method described by Ralph et al. (1993), we estimated percent cover by height category for every species of plant located within 50 m of point count stations. Height categories were "herb" (0 - .5 m), "shrub" (.5 - 5 m) and "tree" (> 5 m, > 8 cm DBH). We also estimated the width of the riparian zone at the point (riparian width) and the percent of the 50 m radius census area that consisted of riparian plants (percent riparian). We determined elevations at each point using 7.5' USGS topographical maps. Our efforts yielded 170 potential vegetation and habitat variables. We used our vegetation measurements and guidance provided by Sawyer and Keeler-Wolf (1995) to assign dominant habitat series (habitat types) to each point.

Nest Vegetation Assessment

PRBO biologists conducted nest vegetation assessments at all nest locations in all years. Soon after the nesting attempt terminated, we measured the nest substrate and surrounding vegetation patch of each nest. A slightly modified version of the BBIRD method for vegetation measurements was used (Martin et al. 1997), which included a section for forb cover and average forb height by species. The basic units for vegetation sampling were a 5-meter radius plot (for shrubs, forbs and ground cover) and an 11.3-meter radius plot (for trees) centered on the nest. For a detailed description of measurements and estimations used see Martin et al. (1997).

Nest Plot Vegetation Assessment
Random vegetation assessments at non-nest sites within a nest plot serve as a means to characterize the nest plot and to randomly characterize the vegetation that birds are "not choosing" for nest locations.

PRBO biologists completed all assessments for the Owens Valley alluvial fan sites in 1998 and 1999. Assessments for Mono Basin nest plots were begun in 2000. Point count stations located within nest plots were used as reference points for the vegetation assessments. At each station, 4 independent vegetation assessments were conducted within the riparian vegetation. Due to the narrow width and long length of the and to compensate for the fact that stations were generally on the edge of the riparian vegetation, a slightly modified method of Martin et al. (1997) was used for placement of the vegetation plots at Owens Valley alluvial fan sites. In summary, 1 sub point (a) was placed within the riparian vegetation directly in line with the point count station and perpendicular to the line of the creek. The other 3 sub points (b, c, and d) were placed 30 meters either upstream or downstream from sub point a and each other. To insure that the sub points were placed at different distances from the edges of the riparian, each sub point was located either 5 meters or 10 meters from the edge or in exact center of the riparian strip. The 3 choices were determined randomly. Degrees and distances from the previous sub point or reference point were recorded. Vegetation assessments identical to those done at nest sites were done at each sub point. We used a non-modified version of the method described in Martin et al (1997) for placement of the vegetation plots at Mono Basin sites.

"Non-use" vegetation assessments were also done in the adjacent upland sagebrush habitat at the Owens Valley alluvial fan sites. One "shrub non-use" was done for each nest found in shrub habitat for each plot. These assessment locations were also placed using the point count stations as reference points, using a modified version described in Martin et al. (1997). For these locations, sub point e, f, g, or h was placed 30m (at a randomly chosen direction) from the point count station. If 5 shrub nests were found and there were 5 point count stations within the nest plot, one "shrub non-use" vegetation plot was set up from each point count station. If 10 nests were found, two would be done at each point count station etc. Direction and distance from the reference point was recorded.

At each sub point, riparian or shrub, a point-centered quarter method (Mueller-Dombois and Ellenberg 1974), as described by Martin et al. (1997) was also conducted.

Weather Data
Weather data including wind speed and direction, temperature, cloud cover and type and rain was recorded three times during each banding session during all years. Hi and low temperatures, and time interval between temperature readings were recorded at each nest plot site in 1999 and 2000.

Geographic Data
Location information was collected at all point count stations, nest plot boundaries and nests monitored using a Garmin Global Positioning System (GPS II+) receiver. All point count station location information was re-collected after May 1, 2000 when the US Interagency GPS Executive Board turned off 'selective availability', resulting in increased accuracy of GPS receivers. Positions were recorded in Decimal Degrees, NAD83 datum. All coordinates and estimated accuracy (figure of merit (FOM)) were recorded. FOM of these points ranges from 0 to 10 meters. Point count locations and associated vegetation and bird data have been converted to Geographic Information System (GIS) coverages in ArcView 3.2 (ESRI 2000) for use in some of the analyses presented below. All maps are represented in UTM (Universal Transverse Mercator) coordinates, Zone 11, NAD83 datum.

Statistical Analysis and Definitions
Indices of richness, diversity and abundance: We only used species for which we confirmed breeding, by site, on our study area. We excluded all non-breeding migrant species. We further limited the species to those that we felt were best counted with the point count protocol. Thus we removed non-territorial species, and species whose territories are typically so large that we could not assure independence of individual observations among points. Nocturnal species were also excluded.

We summarized data by point and by transect, averaging indices over the 3 annual visits. Transect indices were divided by the number of points within transect, resulting in a by point mean, by transect. We looked for annual variation in breeding bird diversity using the Kruskall-Wallis equality of populations rank test (variances on the mean diversity indices were similar). Finding that annual variation was not significant ($\chi^2 = 2.46$, $P = 0.3$), we calculated a mean of annual means for each index. We tested differences between transects using the Kruskall-Wallis test.

> *Species richness*: Total number of species detected within 50m, by point and by transect.
> *Species diversity*: We calculated breeding bird diversity for each point count station and each transect using the transformed Shannon-Wiener index of biological diversity (MacArthur 1965, Krebs 1989). This index of diversity is usually highly correlated with bird species richness, but also takes the number of individuals of each species into account. Higher scores on the Shannon-Wiener index indicate higher species richness and more balanced numbers of individuals of each species added.
> *Abundance*: Total number of individuals detected within 50m, by point and by transect. We calculated abundance for all species combined, and for the 14 riparian focal species individually.

Investigations of the relationship between Brown-headed Cowbird abundance and host species abundance: We calculated Brown-headed Cowbird abundance by transect using all detections (<50m & >50m). We averaged abundance over 3 annual visits, and then calculated the mean of annual means. We calculated host species abundance by point by transect for species with confirmed incidence of Brown-headed Cowbird parasitism within our study site. We used all detections (breeders and migrants) detected within 50m. We averaged abundance over 3 annual visits, and then calculated the mean of annual means. We used stepwise elimination linear regression to model the relationship between Brown-headed Cowbird abundance and host abundance.

Investigations of the relationship between breeding bird diversity, species occurrence, and habitat features: Detailed description of analysis used for this investigation is presented in Appendix 8 (Heath and Ballard 2001).

Brown-headed Cowbird abundance in relation to habitat features: We used stepwise elimination linear regression to model the relationship between mean of annual mean Brown-headed Cowbird abundance by point and select habitat features and by-point host abundance (see above).

Estimates of nest success: Nest calculations were limited to nests with known outcome, which were observed with at least one egg or young. Nest success was calculated using two methods: Mayfield (1975), as recommended by Johnson (1979), and Proportion Successful (Martin 1992). The Mayfield method calculates the probability of nest success based on the daily survival rate of the given sample of nests. The method corrects for the fact that nests in any sample are likely to be found at various stages in the nest cycle. The recommended number of nests for use of the Mayfield method is 75 per species, however 20 nests is considered the absolute minimum sample size (Nur et al. 1999). Proportion Successful is the percentage of successful nests out of all nests for that species. A successful nest is defined as a nest that fledges at least one host young. We tested for annual variation in nest success by species using the program CONTRAST (Hines and Sauer 1989), found no variation (P = 0.08-0.91), and thus grouped nests from all years for further calculations. We tested for between-plot variation in nest success using logistic regression.

Investigations of the effects of vegetation and other habitat characteristics on nest success: We used nest outcome as the dependent variable in a series of pairwise correlations with vegetation measurements and human disturbance ratings for nine species with sample sizes over 20. We then tested all significant correlates independently using simple logistic regression. We used stepwise elimination multiple logistic regression with the remaining significant variables to build the most parsimonious model for nest success for each of the nine species.

Except where noted (above) statistical calculations were performed using Stata (Stata Corp. 1999). Significance was assumed at $P = 0.05$, after Bonferroni adjustment when necessary. Residuals from linear regression models passed Skewness/Kurtosis tests for normality ($P>0.05$) and Cook-Weisenberg tests for heteroscedasticity ($P>0.05$). Logistic regression models passed goodness of fit χ^2 tests ($P > 0.2$).

Project Journal

A project journal was kept on a daily basis. Daily activity of all personnel was recorded in addition to a list of all birds detected at both on and off site locations.

Personnel

PRBO: All aspects of fieldwork, project design and set-up, and data analysis were conducted by staff biologist and project director Sacha Heath and staff biologists Grant Ballard, with guidance from Terrestrial Program Director, Geoffrey Geupel and Population Ecologist, Nadav Nur. Fieldwork was conducted by staff biologists Sue Guers, Will Richardson, Tom Gardali and Geoff Geupel, and field biologists Keith Barnes, Dan Calvert, Carina Gjerdrum, Mark Gregory, Veera Harnal, Gretchen Jehle, Keith Barnes, Chris McCreedy, Kristie Nelson, Zach Smith, Mindy Spiegel, Andrew Stempel, Charmian Traynor, Crow White and Gregor Yanega. Emilie Strauss was contracted by PRBO to assist with point counts in 1998. Computer programs for data analyses were developed by Grant Ballard, and staff biologist Aaron Holmes assisted with statistical analysis throughout.

BLM: Wildlife Biologist Joy Fatooh assisted in selecting study sites and conducting point counts and vegetation assessments.

USFS: Inyo National Forest Biologist Gary Milano assisted in selecting study sites and conducted area search censuses. Wildlife Biologist Joel Ellis conducted point counts.

CDFG: Wildlife Biologist Denyse Racine assisted in selecting study sites and conducted area search censuses.

ESAS: Debby Parker and Jim Parker conducted point counts.

MLC: Staff members Romona Clark, Heidi Hopkins, and Bartsche Miller conducted area seach censuses.

MLTSR: Staff member Dave Marquart conducted area searches.

ESICE: Biologists Annabel Bradford and Jake Giessman conducted point count vegetation assessments. Christine Hancock and Sarah Brown supervised ESICE crews and conducted nest plot vegetation assessments. Jenna Beck, Cooper French, Kat Jankaew, Dirk Kinsey, Andy McKeon, Mike Steinwand and Carrie Tracy conducted nest plot vegetation assessments.

Local Volunteers: Robert Hudson, Jeannie Sassin, Bob Toth, Barbara Toth and Judy Wickman conducted point counts. Paul Clark and Colleen Yancey conducted area search censuses.

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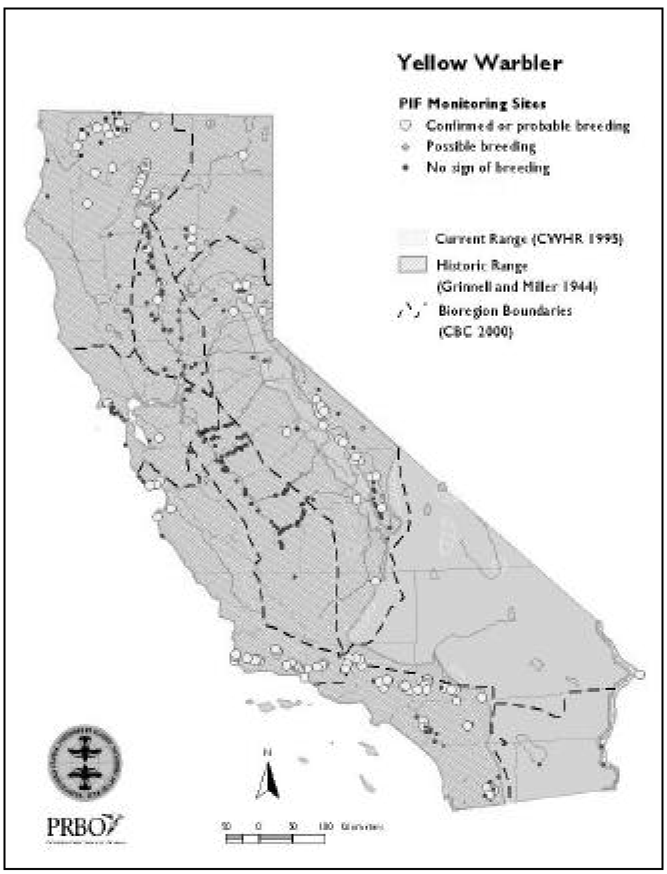
Part I: 1998-2000 RESULTS AND DISCUSSION

Bird species composition, distribution and breeding status

One hundred and seventy nine species among Owens and Hammill Valley watershed sites and 172 species among Mono Basin and east Walker River watershed sites were detected by all methods and observations, 1998-2000. We determined breeding status for all species encountered at 38 locations over the entire study area and ranked using the RHJV breeding scale (Appendix 7).

Breeding status of the 14 riparian focal species was incorporated into the California Partners in Flight (CPIF) statewide database and Version 1.0 of the Riparian Bird Conservation Plan (RHJV 2000) to assist in documenting the most current California breeding distribution for these species. The current breeding distribution for the Yellow Warbler, for example, includes data provided by this project (Figure 2). Breeding status of focal species for the Coniferous Forest and Oak Woodland Bird Conservation Plans was also determined where these habitat types occurred at our sites. See http://www.prbo.org/CPIF/Consplan.html for the most current California distribution maps for all CPIF riparian, coniferous forest and oak woodland focal species.

Figure 2. California Partners in Flight current and historic breeding distribution for Yellow Warbler, 2000.



Breeding species diversity, richness and abundance

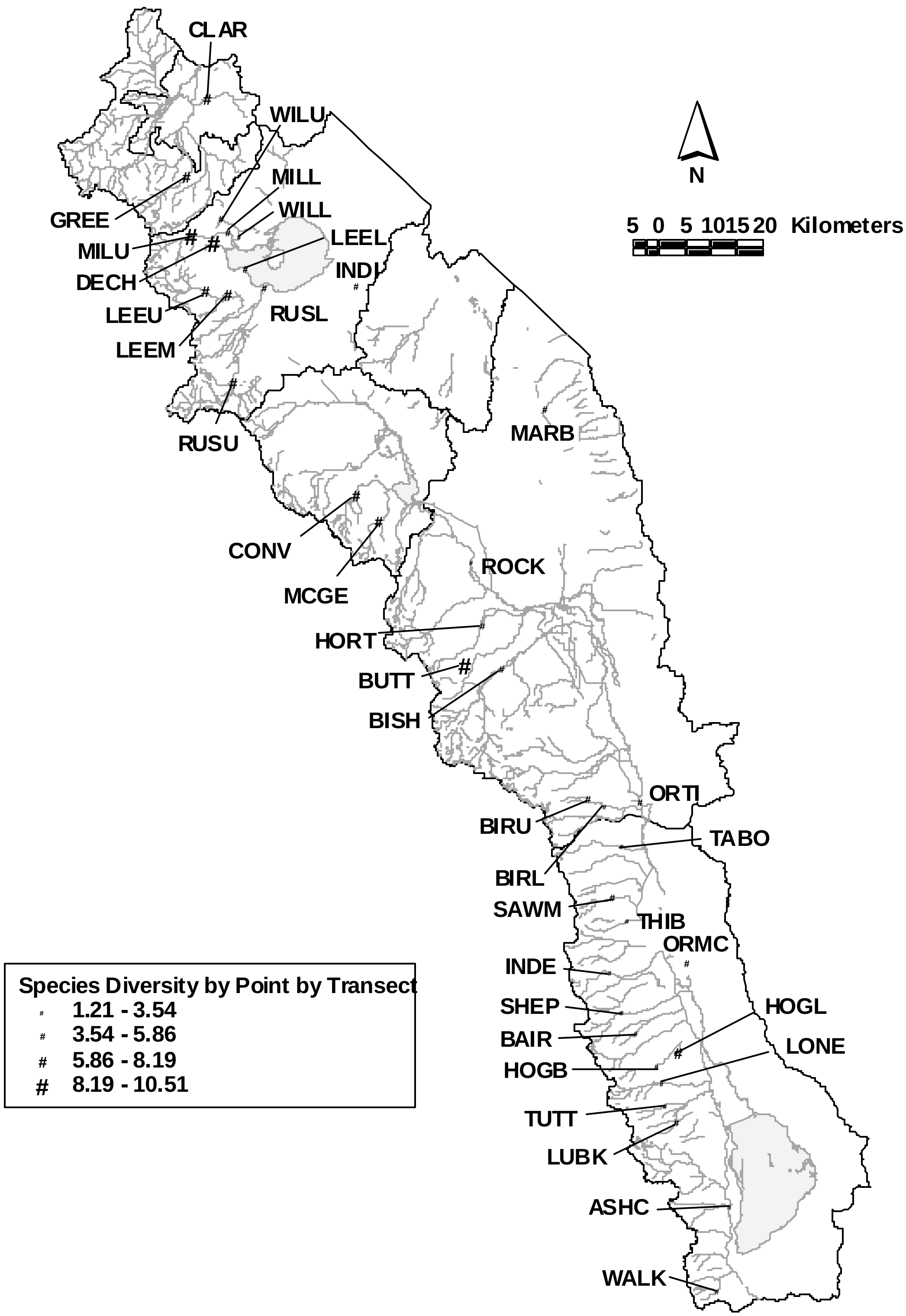
Year to year variation in breeding species diversity by point was not significantly different between years 1998-2000 (Appendix 8 - Heath and Ballard 2001). A by point summary of breeding species diversity, richness and total individuals, averaged over three years, is in Appendix 9.

Mean species diversity was generally highest at Mono Basin sites and at high elevation sites in the Owens Valley watershed (Figure 3). Representative of these are Dechambeau, Upper Mill and Upper Lee Vining Creeks in the Mono Basin; and Buttermilk Country, Convict, McGee, and Lower Hogback Creeks for the Owens Valley watershed (Table 2).

Table 2. Mean total individuals, Shannon-Weiner index of species diversity and species richness per point by transect for breeding species detected within 50m during fixed-radius point counts. Mean of annual means and range of all years, 1998-2000.

Station	Total Abundance		Species Richness		Species Diversity	
	mean	range	mean	range	mean	range
Ash Creek	1.48	1.37-1.63	2.89	2.78-3.11	2.68	2.45-2.89
Bairs Creek	1.95	1.78-2.18	2.98	2.40-3.67	2.65	2.07–3.27
Birch Creek - Lower	2.06	1.78-2.59	3.59	2.89-4.67	3.23	2.66-4.17
Birch Creek - Upper	2.41	1.63-3.27	4.20	2.50-6.00	3.85	2.36-5.43
Bishop Creek	3.48	2.74-4.23	6.13	5.69-6.54	5.48	5.11-5.93
Buttermilk Country	7.64	7.54-7.71	12.21	11.38-12.88	10.51	9.65-11.04
Clark Canyon	5.20	4.47-6.27	7.43	5.80-9.30	6.91	4.68-7.93
Convict Creek	6.17	5.64-7.08	8.78	8.08-9.17	7.35	6.73-7.73
Dechambeau Creek	6.93	5.20-8.07	10.27	8.80-11.20	8.61	7.46-9.27
Green Creek	5.92	5.64-6.27	8.20	7.91-8.60	6.86	6.51-7.09
Hogback Creek	1.91	1.44-2.22	2.89	2.33-3.20	2.55	2.05-2.88
Hogback Creek - Lower	5.61	5.36-5.87	7.43	7.20-7.67	6.12	5.89-6.35
Horton Creek	2.74	2.60-2.84	4.33	3.67-4.67	3.76	3.11-4.09
Independence Creek	1.93	1.20-3.11	3.76	2.80-5.20	3.49	2.69-4.74
Indian Springs	4.49	3.50-5.21	5.88	4.63-6.63	5.16	4.08-5.90
Lee Vining Creek - Lower	4.21	3.96-4.47	6.10	5.80-6.40	5.34	5.08-5.60
Lee Vining Creek - Middle	4.29	3.30-5.18	6.85	5.91-7.64	5.92	5.27-6.38
Lee Vining Creek - Upper	5.74	5.51-6.00	8.23	7.54-8.92	7.08	6.43-7.74
Lone Pine Creek	1.33	1.00-1.76	2.61	2.00-3.36	2.42	1.87-3.02
Lubken Creek	2.59	2.22-2.89	4.37	4.33-4.44	3.98	3.91-4.06
Marble Creek	2.95	2.30-3.73	4.52	3.81-5.90	3.93	3.31-5.00
McGee Creek	4.51	4.29-4.62	7.14	6.79-7.47	6.16	5.86-6.46
Mill Creek - Lower	3.72	3.41-3.89	5.70	5.48-6.00	4.88	4.60-5.16
Mill Creek - Upper	5.41	4.78-6.49	9.30	8.87-10.15	8.21	7.91-8.66
Owens River - Mazourka Cyn.	4.01	3.47-4.56	6.10	5.47-6.73	5.25	4.82-5.69
Owens River - Tinemaha Res.	6.00	5.92-6.08	6.81	6.50-7.13	5.52	5.27-5.78
Rock Creek	0.61	0.42-0.82	1.27	1.05-1.55	1.21	1.02-1.46
Rush Creek - Lower	5.00	4.42-6.89	5.23	4.93-5.53	4.21	3.89-4.56
Rush Creek - Upper	4.91	4.41-5.90	7.29	6.65-8.53	6.25	5.59-7.39
Sawmill Creek	2.23	2.03-2.42	4.19	3.25-5.00	3.82	2.92-4.59
Shepherd Creek	1.47	1.29-1.71	2.38	2.27-2.40	2.18	2.07-2.26
Taboose Creek	1.43	1.33-1.53	2.58	2.37-2.95	2.39	2.15-2.74
Thibaut Creek	2.17	2.07-2.33	3.48	3.00-4.14	3.15	2.72-3.77
Tuttle Creek	1.41	1.13-1.58	2.76	1.73-3.40	2.59	1.63-3.22
Walker Creek	1.77	1.11-2.19	3.37	2.22-4.22	3.12	2.06-3.91
Wilson Creek - Lower	1.96	1.48-2.63	3.19	2.61-4.06	2.85	2.45-3.50
Wilson Creek - Upper	3.90	3.50-4.39	5.69	5.39-6.06	4.96	4.65-5.43

Figure 3. Mean breeding bird diversity (all detections within 50m radius point count), by point by transect, mean of annual means, 1998-2000.



Mean species diversity at Buttermilk Country was significantly higher than the mean for all other transects (χ^2 =19.507, $P < 0.001$(compared with next highest mean)). Mean species diversity, species richness and total individuals were lowest among the Owens Valley alluvial fan sites. Among these were Rock, Ash, Lone Pine, Shepherd, Taboose, Tuttle and Hogback Creeks.

Species abundance and richness of 14 riparian focal species

Yellow Warbler abundance was highest along lower Rush and Convict Creeks (Table 3 and Figure 4) and is the highest among all CPIF study sites statewide (RHJV 2000). The highest concentrations of Warbling Vireos were along upper Mill, upper Rush, Green and Dechambeau Creeks (Table 3 and Figure 5). Owens River North of Tinemaha Reservoir supported a Song Sparrow abundance that was over twice as high as that of any other site in the study area.

Table 3. Mean number of individuals detected for 6 breeding riparian focal species, at all eastern Sierra riparian sites. Based on mean number of individuals detected within 50m during fixed-radius point counts, per point by transect, mean of annual means, 1998-2000.

Station	Yellow Warbler	Song Sparrow	Blue Grosbeak	Common Yellow-throat	Warbling Vireo	Yellow-breasted Chat
Ash Creek	--	--	--	--	--	--
Bairs Creek	--	--	--	--	--	--
Birch Creek - Lower	0.07	0.01	0.01	--	--	--
Birch Creek - Upper	0.06	0.12	--	--	0.11	--
Bishop Creek	0.05	0.01	--	--	0.24	--
Buttermilk Country	0.85	0.72	0.03	--	0.17	--
Clark Canyon	--	0.64	--	--	0.09	--
Convict Creek	1.26	0.44	--	--	0.42	--
Dechambeau Creek	0.44	0.36	--	--	0.49	--
Green Creek	0.73	0.14	--	--	0.50	--
Hogback Creek	--	--	--	--	--	--
Hogback Creek - Lower	0.09	0.44	0.08	--	0.01	0.23
Horton Creek	0.10	0.04	0.01	--	0.07	--
Independence Creek	--	0.03	--	--	0.16	--
Indian Springs	--	0.63	--	--	--	--
Lee Vining -Lower	0.88	0.64	--	--	0.12	--
Lee Vining - Middle	0.02	0.11	--	--	0.24	--
Lee Vining - Upper	0.46	0.39	--	--	0.28	--
Lone Pine Creek	--	--	--	--	--	--
Lubken Creek	--	--	--	--	0.32	--
Marble Creek	0.02	0.04	0.03	--	0.02	--
McGee Creek	0.92	0.39	--	--	0.27	--
Mill Creek - Lower	0.30	0.20	--	--	0.04	--
Mill Creek - Upper	0.50	0.42	--	--	0.56	--
Owen's River - Mazourka Cyn.	0.06	0.31	0.12	0.12	0.01	--
Owen's River - Tinemaha Res.	0.31	1.98	0.06	0.69	0.02	0.02
Rock Creek	--	--	--	--	--	--
Rush Creek - Lower	1.59	0.72	--	--	--	--
Rush Creek - Upper	0.60	0.43	--	--	0.46	--
Sawmill Creek	--	0.01	0.06	--	--	--
Shephard Creek	--	--	0.01	--	--	--
Taboose Creek	--	0.01	--	--	--	--
Thibaut Creek	--	--	0.07	--	--	--
Tuttle Creek	--	0.01	--	--	0.04	--
Walker Creek	--	--	--	--	0.10	--
Wilson Creek - Lower	0.03	0.41	--	0.01	--	--
Wilson Creek - Upper	0.43	0.74	--	--	0.01	--

Figure 4. Yellow Warbler abundance (all detections within 50m radius point count), by point by transect, mean of annual means, 1998-2000.

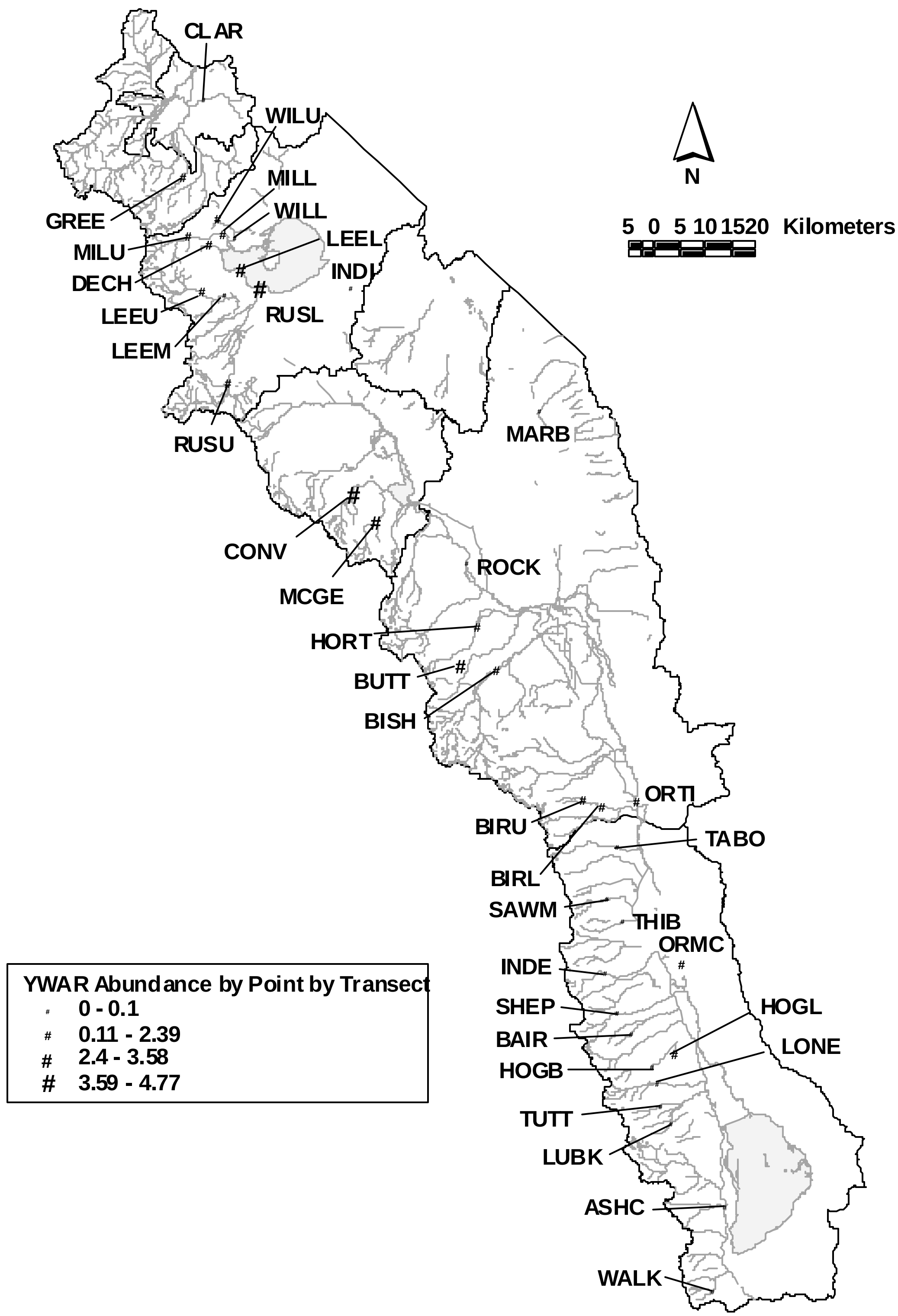


Figure 5. Warbling Vireo abundance (all detections within 50m radius point count), by point by transect, mean of annual means, 1998-2000.

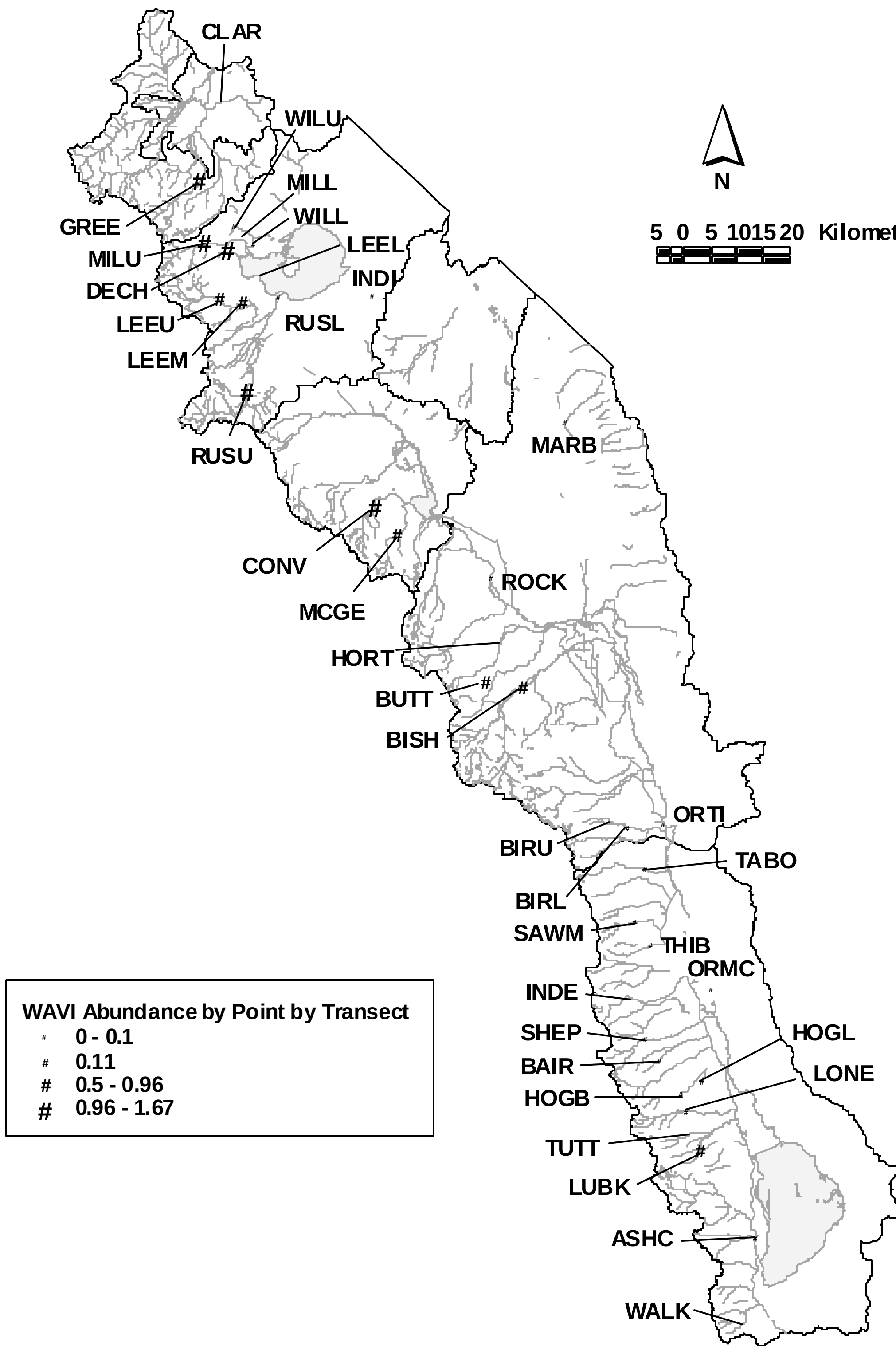
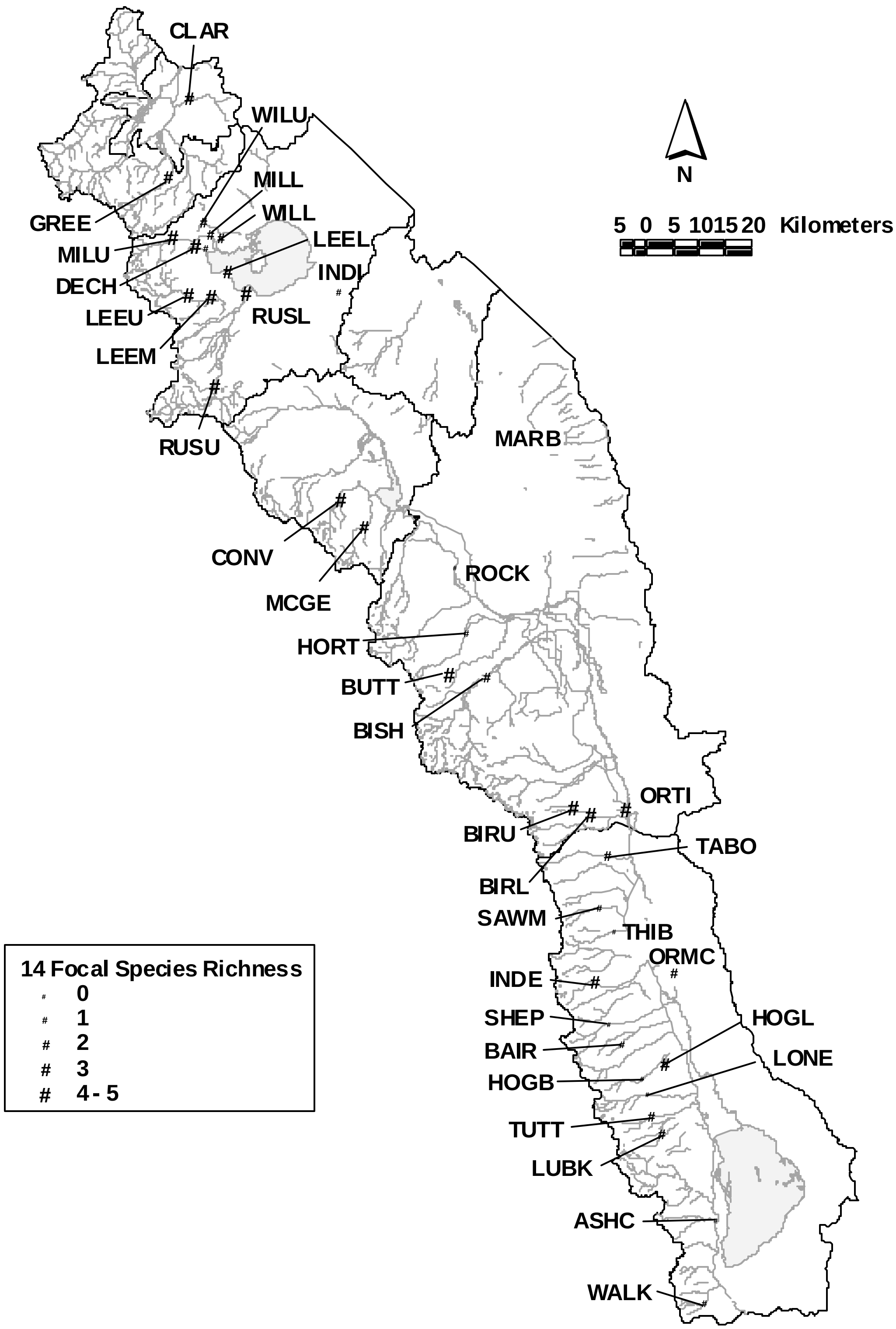


Figure 6: Number of 14 CPIF riparian focal species detected as breeders at each site, based on all methods and observations, 1998-2000.



Common Yellowthroats bred only on Owens River sites and at Wilson Creek. Blue Grosbeaks were not confirmed to breed at Shepherd or Thibaut Creek, but likely bred there, so we presented their abundance. It was difficult to discern migrant from breeding Black-headed Grosbeaks at some sites, so their abundance was not presented (Table 3).

Owens River North of Tinemaha Resevoir, Buttermilk Country, upper and lower Rush, upper and middle Lee Vining, upper Mill, upper and lower Birch, Dechambeau, and Convict Creeks all had 4-5 probable or confirmed breeding riparian focal species on site. Several sites in the Owens Valley alluvial fan had one or no breeding riparian focal species (Figure 6).

Brown-headed Cowbird abundance in riparian breeding areas, and the relationship with host species abundance

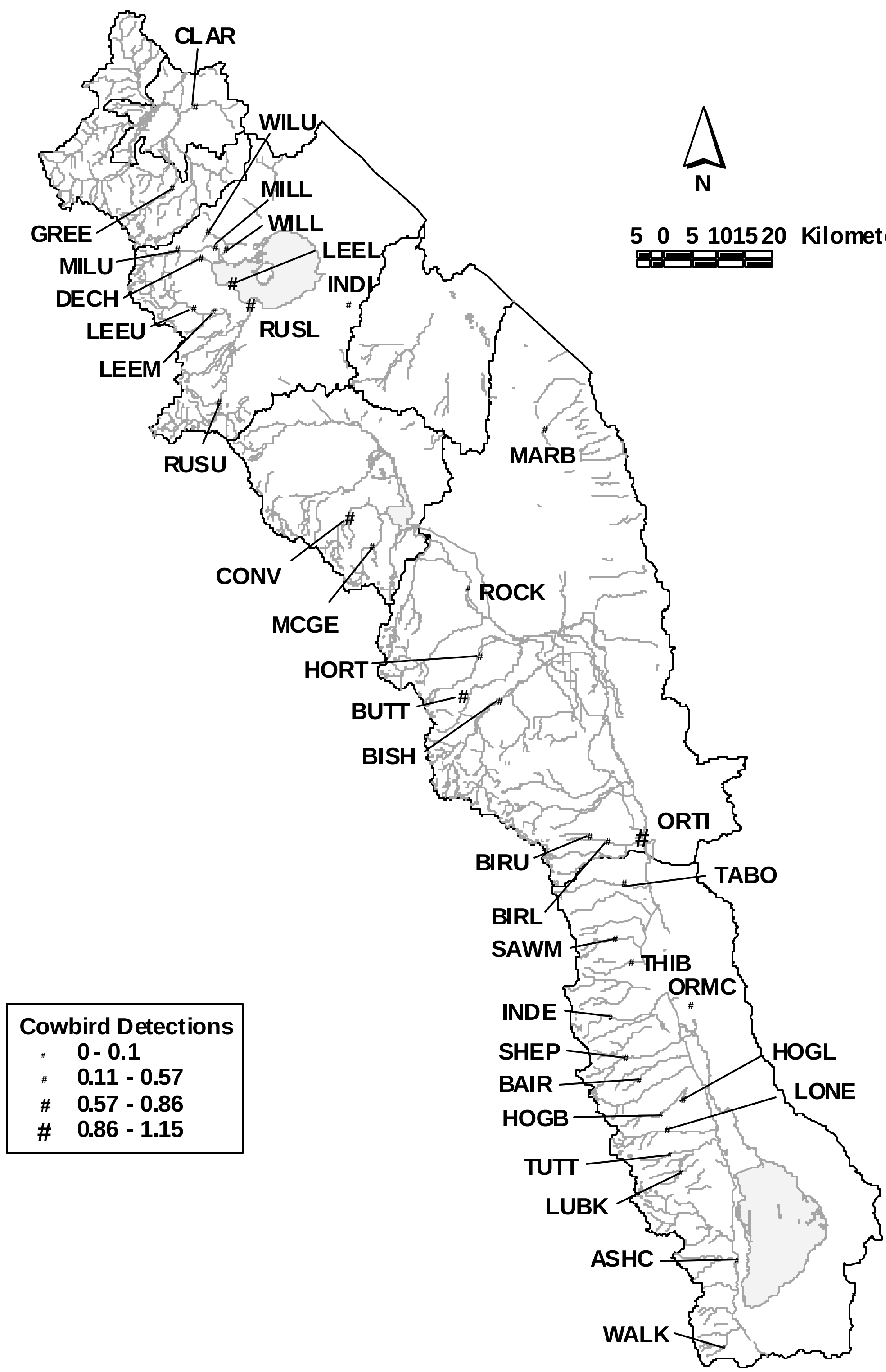
Sites with high detections of Brown-headed Cowbirds included Owens River North of Tinemaha Reservoir, lower Rush Creek, lower Lee Vining Creek, Buttermilk Country and lower Hogback Creek. Sites with very few cowbird detections included Rock, Walker, Lubken, Tuttle and Independence Creeks (Figure 7).

Among all study sites, Brown-headed Cowbird detections were strongly correlated with those of host species, especially Yellow Warblers and Blue-gray Gnatcatchers. For Owens Valley and Owens River alluvial fan transects (including Marble Creek), detections of Yellow Warblers and Song Sparrows were the best predictors of Brown-headed Cowbirds. Similarly, among the 17 Mono Basin, upper Owens River watershed and east Walker River transects, high numbers of Yellow Warbler detections were strongly correlated with high numbers of cowbird detections (Table 4). Several other studies have suggested that the distribution and abundance of cowbirds should be largely determined by the density and abundance of hosts (Verner and Ritter 1983, Barber and Martin 1996, Tewksbury et al 1998, Tewksbury et al 1999).

Table 4. Relationship between mean Brown-headed Cowbird abundance (mean of all detections < & > 50m, by transect, all years) and mean abundance of most predictive host species (mean of all detections < 50m migrants included, by point, by transect, all years) at point count locations, results from stepwise elimination linear regression modeling.

Location	Host species	N (transects)	ß (host)	SE (host)	*P* (model)	Adj. R^2 (model)
Owens Valley and alluvial fan	Song Sparrow	20	0.46	0.02	<0.001	0.78
	Yellow Warbler		0.30	0.11		
Mono Basin and upper Owens River watershed	Yellow Warbler	17	0.05	0.01	<0.001	0.58
Entire Study area	Blue-Gray Gnatcatcher	37	0.30	0.05	<0.001	0.67
	Yellow Warbler		0.05	0.01		

Figure 7. Brown-headed Cowbird abundance (all detections within and outside of 50m radius point count), by transect, mean of annual means, 1998-2000.



Relationships between breeding bird diversity, species occurrence, and habitat features

Breeding bird diversity and the occurrence of selected species was related to several vegetation and habitat features at different scales ranging from the entire study area to specific habitat types within climate zones. Appendix 8 of this report is a manuscript presenting the details of these results and was presented at the Riparian Habitat and Floodplains Conference (March 12-15 2001 Sacramento, California) and submitted for inclusion in the conference proceedings.

Brown-headed Cowbird abundance in relation to habitat and landscape features
While transect-level host abundance explained much of the variation in mean cowbird detections (R^2 values ranged from 58% to 78%, Table 4), by-point investigations of cowbird abundance in relation to by-point host abundance and selected habitat features resulted in no correlations (Appendix 10).

Transect-level investigations of cowbird detections are probably more appropriate, however, because cowbirds are known to travel several kilometers from feeding sites to breeding locations in the eastern Sierra (Rothstein et al. 1984). When possible, we avoided double counting cowbirds within transect, noting when individuals flew across several points in one flight. Future efforts will include the investigation of landscape-scale features that may further contribute to predictive models of transect-level cowbird abundance, including distances to feeding sources such as pack stations, campgrounds and concentrations of bird feeders, as suggested by previous eastern Sierra studies (Rothstein et al. 1980, Rothstein et al. 1984).

Nest success in the Owens Valley alluvial fan

Mayfield estimates of nest success
Mayfield nest success was determined for nine species and 299 nests, at all sites combined (Table 5). There was no annual variation in nest success between years for any species (P = 0.08-0.91) so nests from all three years were pooled.

Table 5. Mayfield estimates of nest success for study species for which we found more than 20 nests at the Owens Valley alluvial fan study sites (Bairs, Birch, Independence, Lone Pine, Taboose, and Tuttle Creeks), 1998-2000. Proportional success is provided for comparison, but is generally an overestimate of true success.

Species	Number of Nests	Daily nest survival	SE	Total Nest survival	Proportional Nest Success
American Robin	29	0.98	0.01	0.49	0.62
Black Headed Grosbeak	24	0.98	0.01	0.57	0.67
Western Wood-Pewee	27	0.98	0.00	0.63	0.63
Warbling Vireo	22	0.93	0.01	0.12	0.09
Black-chinned Hummingbird	37	0.97	0.01	0.39	0.50
Calliope Hummingbird	32	0.97	0.01	0.32	0.50
Costa's Hummingbird	30	0.97	0.01	0.33	0.45
Spotted Towhee	52	0.95	0.01	0.24	0.60
Bushtit	46	0.97	0.01	0.44	0.63

Western Wood-Pewees, Black-headed Grosbeaks, American Robins and Bushtits all had high total nest survival (standard nest success defined here as 0.30). The three hummingbird species had slightly better than average nest survival. Nest success for Spotted Towhees was low. Nest success for the Warbling Vireo was extremely poor: only 2 out of 22 nests fledged young.

Several other riparian songbird monitoring projects in California provided Mayfield nest survival estimates for comparison (Table 6).

Table 6. Mayfield estimates of nest success for select species among other PRBO riparian songbird monitoring sites in California, using same data collection and analysis methods, for comparison with Owens Valley alluvial fan sites.

Location	Year	# nests	Mayfield estimate	Citation
American Robin				
Golden Gate NRA	1999	26	0.21	Gardali et al. 1999
Black-headed Grosbeak				
Golden Gate NRA	1998	15	0.27	Gardali et al. 1999
Clear Creek	2000	15	0.33	Wood et al. 2000
Sacramento River	1998	13	0.27	Small et al. 1999
Western Wood-Pewee				
Cosumnes River	2000	9	0.64	Haff et al. 2001
Lassen NF & NP	1997-1999	10	0.17	King et al. 2001
Warbling Vireo				
Golden Gate NRA	1998	12	0.06	Gardali et al. 1999
Black-chinned Hummingbird				
Sacramento River	1998	7	0.44	Small et al. 1999
Spotted Towhee				
Cosumnes River	2000	24	0.43	Haff et al. 2001
Clear Creek	2000	12	0.05	Wood et al. 2001
Sacramento River	1998	12	0.28	Small et al. 1999
Bushtit				
Cosumnes River	2000	23	0.44	Haff et al. 2001

Mayfield estimates of nest success were, on average, 15% lower than proportional estimates (Table 5), corroborating other investigators' reports that the proportional method overestimates success (Johnson 1979, Martin 1992). Spotted Towhee proportional estimates were especially inflated because most nests were found during the nestling stage, meaning that nests that failed during incubation could not be included. Western Wood-Pewee estimates were the same using both methods, primarily because almost all were observed from building to final outcome.

Proportional nest success by nest category and site

Outcomes were determined for 440 nests observed with at least one egg or young, and were used for calculations of proportional nest success (Table 7).

Proportional nest success of open cup nesters for resident and neotropical migrant species was 53% at Independence Creek, 44% at Birch Creek and 57% at Taboose Creek (difference among

Table 7. Total number of nests observed with at least one egg or young and known outcome, and proportion successful at all Owens Valley Alluvial Fan sites: Independence Creek, Birch Creek, Taboose Creek, Bairs Creek, Tuttle Creek, and Lone Pine Creek, 1998-2000.

Species	Nest Type[1]	Independence (1998-2000)		Birch Creek (1998-2000)		Taboose Creek (1998-2000)		Bairs Creek 1998		Tuttle Creek 1998		Lone Pine Creek 1998		All Sites All Years Combined	
		# nests	prop. succ	# nests	prop. succ.	# nests	prop . succ.	# nests	prop. succ.	# nests	prop. succ.	# nests	prop. succ.	# nests	prop. succ.
American Dipper	B	2	0.50	--	--	--	--	--	--	--	--	--	--	2	0.50
American Robin	A	26	0.62	2	0.50	--	--	1	1.00	--	--	--	--	29	0.62
Bewick's Wren	B	5	1.00	2	1.00	2	0.50	1	1.00	--	--	--	--	10	0.90
Black-chinned Hummingbird	A	10	0.60	17	0.41	10	0.60	1	0.00	--	--	--	--	38	0.50
Black-headed Grosbeak	A	15	0.73	2	0.00	6	0.66	--	--	1	1.00	--	--	24	0.67
Black-throated Sparrow	A	--	--	4	0.25	3	0.33	--	--	--	--	--	--	7	0.29
Blue-gray Gnatcatcher	A	7	0.14	--	--	3	0.33	1	0.00	--	--	--	--	11	0.18
Blue Grosbeak	A	--	--	1	1.00	1	1.00	--	--	--	--	--	--	2	1.00
Bullock's Oriole	C	2	0.50	1	1.00	--	--	--	--	--	--	--	--	3	0.67
Bushtit	C	10	0.40	16	0.63	14	0.64	5	1.00	1	1.00	--	--	46	0.63
Calliope Hummingbird	A	7	0.57	20	0.50	4	0.50	1	0.00	--	--	--	--	32	0.50
Chipping Sparrow	A	--	--	--	--	--	--	2	0.50	--	--	--	--	2	0.50
Common Raven	A	2	0.50	--	--	--	--	--	--	--	--	--	--	2	0.50
Costa's Hummingbird	A	--	--	6	0.17	20	0.60	1	0.00	--	--	4	0.25	31	0.45
European Starling	B	--	--	2	1.00	--	--	--	--	--	--	--	--	2	1.00
Hairy Woodpecker	B	1	1.00	--	--	--	--	--	--	--	--	--	--	1	1.00
House Wren	B	10	1.00	--	--	--	--	--	--	--	--	--	--	10	1.00
Indigo Bunting	A	--	--	1	0.00	--	--	--	--	--	--	--	--	1	0.00
Lazuli Bunting	A	1	1.00	5	0.40	5	0.20	3	1.00	--	--	--	--	14	0.50
Lesser Goldfinch	A	--	--	4	0.25	3	1.00	--	--	--	--	--	--	7	0.57
Mourning Dove	A	--	--	--	--	--	--	1	0.00	--	--	--	--	1	0.00
Orange-crowned Warbler	A	5	0.40	1	0.00	--	--	1	1.00	--	--	--	--	7	0.43
Red-shafted Flicker	B	5	1.00	2	1.00	--	--	--	--	--	--	1	1.00	8	1.00
Red-tailed Hawk	A	--	--	3	0.67	--	--	--	--	--	--	--	--	3	0.67
Rock Wren	B	--	--	1	1.00	--	--	--	--	--	--	--	--	1	1.00
Sage Sparrow	A	--	--	4	0.50	3	0.67	--	--	--	--	--	--	7	0.57
Song Sparrow	A	4	0.25	9	0.78	--	--	--	--	--	--	--	--	13	0.62
Spotted Towhee	A	13	0.69	8	0.63	24	0.58	4	0.50	3	0.33	1	1.00	53	0.60
Steller's Jay	A	1	1.00	--	--	--	--	--	--	1	0.00	--	--	2	0.50
Warbling Vireo	A	20	0.10	2	0.00	--	--	--	--	--	--	--	--	22	0.09
Western Bluebird	B	3	0.67	--	--	--	--	--	--	--	--	--	--	3	0.67
Western Kingbird	A	--	--	1	1.00	--	--	--	--	--	--	--	--	1	1.00
Western Scrub-jay	A	4	0.50	--	--	--	--	--	--	--	--	--	--	4	0.50
Western Tanager	A	10	0.70	--	--	--	--	1	0.00	--	--	--	--	11	0.64
Western Wood-Pewee	A	27	0.59	--	--	--	--	--	--	--	--	--	--	27	0.63
Yellow Warbler	A	--	--	3	0.00	--	--	--	--	--	--	--	--	3	0.00
TOTAL TYPE A NESTS		152	0.53	93	0.44	82	0.57	17	0.47	5	0.40	5	0.40	354	0.51
TOTAL TYPE B NESTS		26	0.92	7	1.00	2	0.50	1	1.00	0	0.00	1	1.00	37	0.92
TOTAL TYPE C NESTS		12	0.42	17	0.65	14	0.64	5	1.00	1	1.00	0	0.00	49	0.63
TOTAL ALL NESTS		190	0.58	117	0.50	98	0.58	23	0.61	6	0.50	6	0.50	440	0.56

[1] Nest Types: A = open cup, scrape, saucer or platform; B = cavity, crevice or burrow; C = pendulum or sphere

plots was not significant, $P = 0.29$). Proportional nest success of open cup nesters for all sites combined was 51%. Martin (1992) presented 44% as the mean proportional nest success of 32 open cup nesting neotropical migrant species, derived from several studies in North America.

Cavity and crevice nesters fared extremely well among all creeks, with 92% nest success at Independence Creek, 100% nest success at Birch Creek, and 92% overall. Pendulum nesters were also successful, with generally high nest success among all creeks: Independence (42%), Birch (65%), and Taboose (64%); and 63% overall.

Mid to high canopy nesting neotropical migrant species bred primarily at Independence Creek, where Black Oaks and Jeffrey Pines provided nesting substrate. Among these, Western Tanagers, Western-wood Pewees and American Robins had high proportional nest success of 70%, 59% and 62% respectively. Warbling Vireos and Blue-gray Gnatcatchers fared extremely poorly, however, with 10% and 14% proportional nest success, respectively. Black-headed Grosbeaks bred primarily at Independence and Taboose Creek, and proportional nest success for this species at these creeks (73% and 66% respectively) was high.

Proportional nest success for Black-chinned Hummingbirds was high at Independence and Taboose Creek (60% each), and lower at Birch Creek (41%). Calliope Hummingbirds had fairly high nest success at these creeks as well, at 57%, 50% and 50% respectively. Costa's Hummingbirds had high nest success at Taboose Creek (60%), but very low nest success Birch Creek (17%).

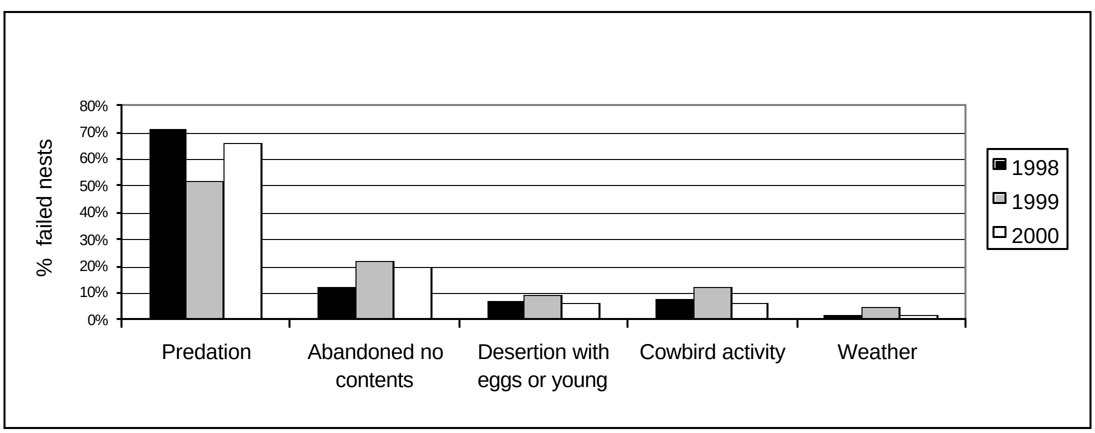
Spotted Towhees had similar proportional nest success at Independence (69%), Birch Creek (63%) and Taboose Creek (58%). Bushtits had good nest success at Birch (60%) and Taboose Creeks (64%), and lower success at Independence Creek (40%).

Factors Influencing Nest Success

Nest mortality

Predation accounted for between 52% and 72% of all nest failure annually (Figure 8). Potential nest predators and a few predation events were observed at all sites (Appendix 11).

Figure 8. Mortality factors of 237 failed open cup nests at Owens Valley alluvial fan sites 1998-2000.

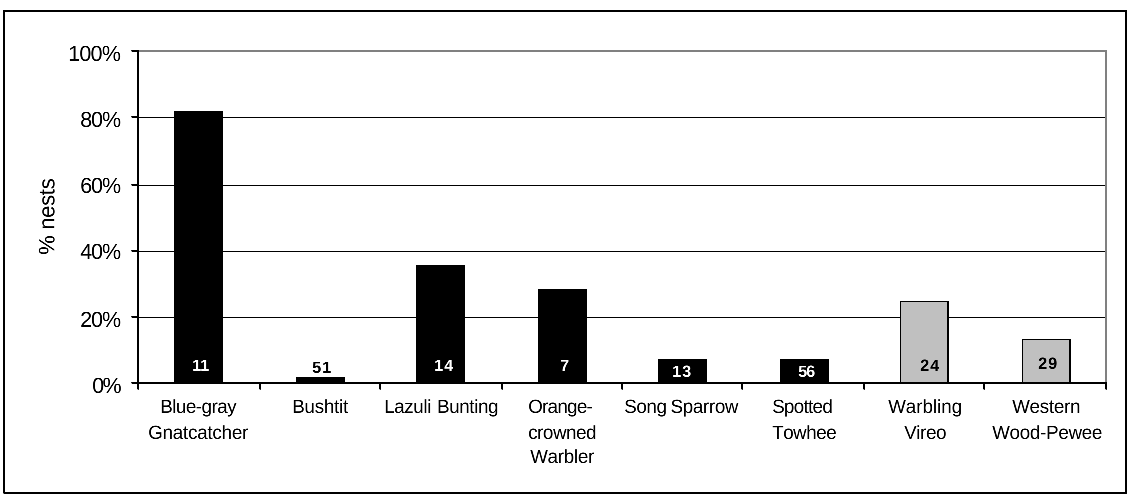


Abandonment of nests prior to egg laying accounted for between 12% and 22% of all nest failure. 24% of all American Robin, 22% Warbling Vireo, 15% Calliope Hummingbird, 10% Bushtit, and 9% Bewick's Wren nests failed before egg laying. The dismantling of a nest prior to egg laying is fairly common for Warbling Vireos, and does not necessarily imply undo predation pressure (Gardali and Ballard 2000). In 1999, 35% of the American Robin and 38% of the Bushtit nests located in or near occupied campsites at Independence Creek were abandoned while building (Heath and Ballard 1999b).

Desertion with eggs or young accounted for between 6% and 9% of all nest failure. Nineteen percent of Black-chinned Hummingbird and 21% of Calliope Hummingbird nests were abandoned with eggs or young. Two hummingbird nests were, by chance, found with dead young, suggesting that abandonment was caused by factors other than human disturbance related to nest monitoring.

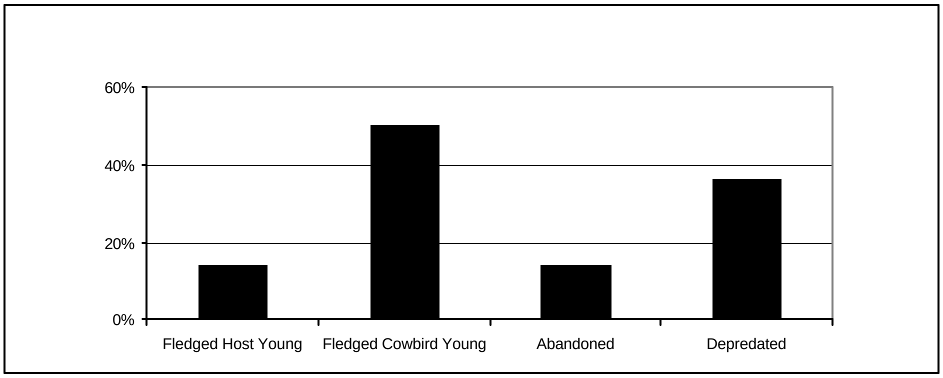
Brown-headed Cowbird parasitism
Brown-headed Cowbird parasitism accounted for 6% to 12% of all nest failure (Figure 8). Seventeen percent of all open cup nests observed with at least one egg or young were parasitized, all years combined. Ten species were confirmed hosts: those shown in Figure 9, and Indigo Buntings and Yellow Warblers (which had very small sample sizes). Parasitism rates were relatively low for Lazuli Bunting (36%), a species with high incidence of parasitism in other regions (86.7%, Gardali et al. 1998). Blue-gray Gnatcatchers suffered very high incidence of parasitism at 82%. Bushtits were a surprising, but seemingly very rare cowbird host (1 nest). Spotted Towhees were also a rare host. Parasitism rates for Warbling Vireos and Western Wood-Peewees were difficult to discern due to high nest locations: rates presented here are probably underestimates.

Figure 9. Percent nests parasitized of host species' nests observed with at least one egg or young, and with at least 5 nesting attempts, all sites and years combined (1998-2000). Nest numbers shown on bars. Gray bars represent only *known* parasitism rates for species with high and sometimes un-observable nests.



Brown-headed Cowbirds successfully fledged from 44% of the parasitism attempts (Figure 10). Parasitized nests failed due to depredation 32%, and abandonment 12% of the time. Twelve percent of the parasitized nests successfully fledged host young.

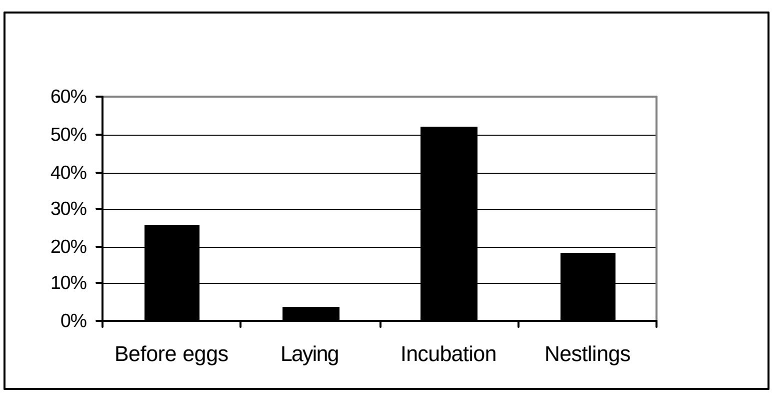
Figure 10. Outcome of 36 parasitized nests. Parasitized nests of all sites and all years combined, 1998-2000.



Time of failure - a closer look at Warbling Vireos

Warbling Vireos suffered the poorest nest success of all species on all plots and all years. Recent documentation of Warbling Vireo declines suggests that this species may be most sensitive to breeding ground disturbances (Gardali et al. 2000). Our estimate of 24% parasitism for this species may be low, because it is often difficult to determine parasitism for high nests. There is debate as to whether parasitism increases or decreases the likelihood of predation (McLaren and Sealy 2000). Most Warbling Vireo nests at our sites failed during the incubation stage (Figure 11), suggesting: 1) predation (regardless of parasitism) may be the most limiting factor for Warbling Vireos at our sites, or 2) parasitism affected parental behavior during incubation, making the nests more susceptible to depredation.

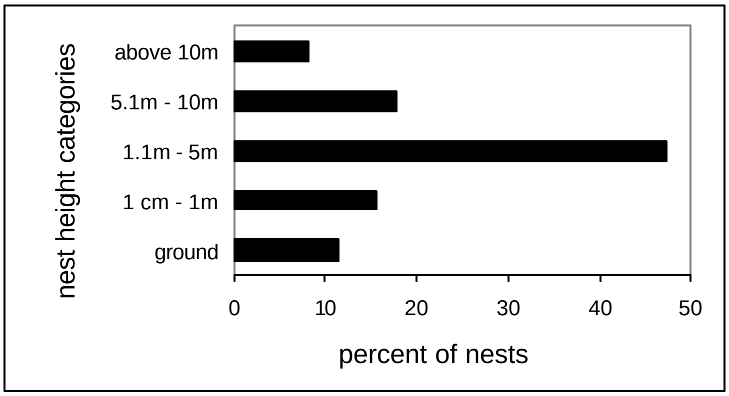
Figure 11. Time of failure for 27 failed Warbling Vireo nests, all sites combined 1998-2000.



Nest site selection

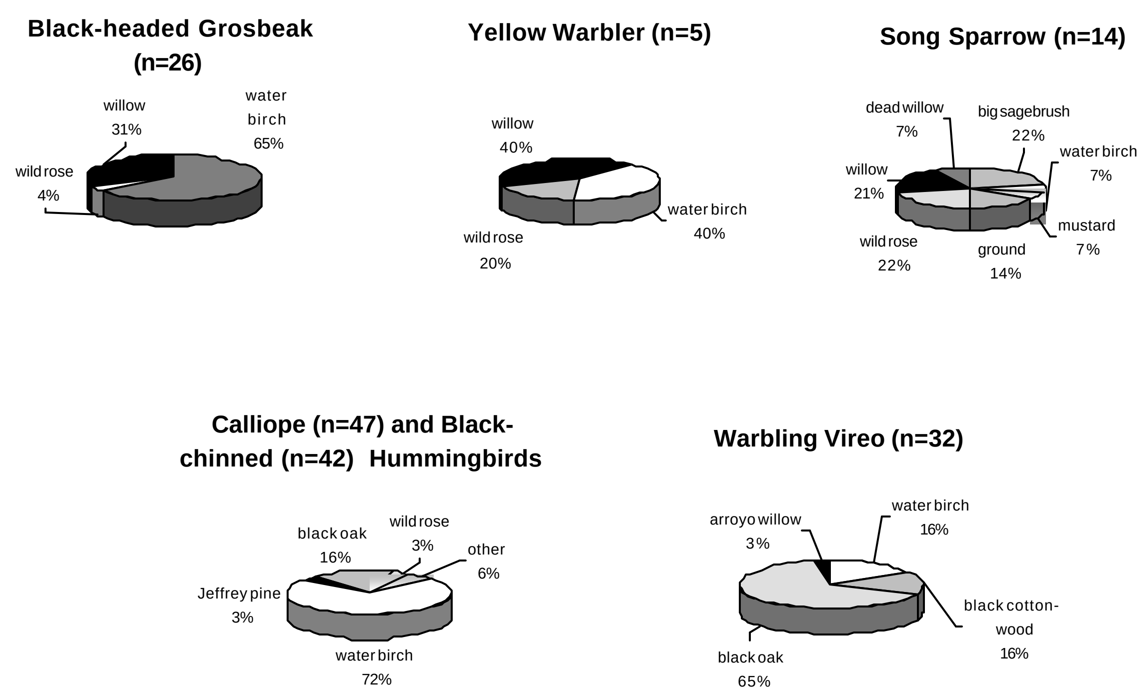
Almost 50% of 548 nests found were located between 1m and 5m from the ground (Figure 12), demonstrating the importance of shrub layer vegetation to breeding birds at our study sites. The remaining nests were located on the ground (11.5%), under 1m (15.5%), 5m to 10m (17.7%) and above 10m (8%), demonstrating also, the importance of multiple vegetation layers.

Figure 12. Percent of 548 nests located within 5 height categories, all nests, sites and years combined, 1998-2000.



Riparian nesting birds selected several species of forbs, shrubs and trees for their nest sites (Figure 13). A heterogeneous riparian plant community provides nesting substrate for a diverse breeding bird community. Black oak is an anomalous vegetation type among eastern Sierra

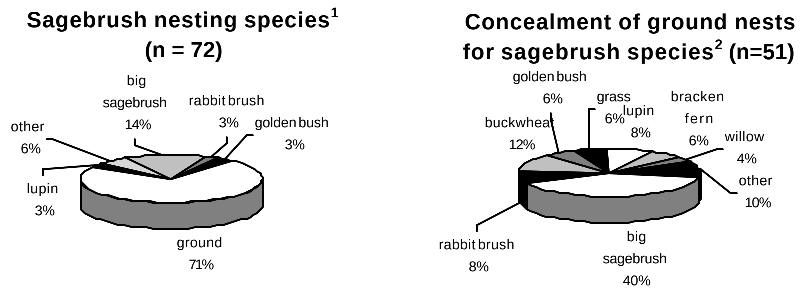
Figure 13. Nest substrate used by Yellow Warblers, Black-headed Grosbeaks, Song Sparrows, Black-chinned and Calliope Hummingbirds, and Warbling Vireos, all nests, sites and years combined, 1998-2000.



riparian (Taylor 1982), but is apparently important to Warbling Vireos as it is their most predominantly chosen nest substrate. Black-headed Grosbeaks primarily chose to nest in water birch. Song Sparrows utilized a variety of nesting substrates, but chose herbaceous and shrub layer species exclusively. Yellow Warblers, which only bred in 1998 at Birch Creek, nested in willow, water birch and wild rose. Calliope and Black-chinned Hummingbirds selected water birch for 72% of their nests.

Sagebrush nesting species Spotted Towhee, Black-throated Sparrow and Sage Sparrow primarily used the ground as nesting substrate (71%), but several forb and shrub species provided concealment (Figure 14).

Figure 14. Nest substrate and concealment used by Spotted Towhees, Black-throated Sparrows and Sage Sparrows, all nests, sites and years combined, 1998-2000.



[1] Spotted Towhees, Sage Sparrows and Black-throated Sparrows.
[2] Ground nests of Spotted Towhees, Sage Sparrows and Black-throated Sparrows were concealed by the following plants.

Effects of vegetation and other habitat characteristics on nest success

A total of 215 variables representing the structural and floristic environment of nest sites were collected at all nests in all years (Appendix 12). None of the habitat features that we investigated influenced nest success of Spotted Towhees, Costa's Hummingbirds or Warbling Vireos. This suggests that other factors, such as predator abundance, may more strongly influence nest success for these species. Results for American Robin, Bushtit, Black-chinned hummingbird, Calliope Hummingbird, Western Wood-pewee, and Black-headed Grosbeak, are presented in the following section.

American Robin

Nest height and true canopy cover most accurately predicted American Robin nest success (Table 8). Successful American Robin nests were on average, 6.4 m from the ground, while mean height of unsuccessful nests was 2.3 m. All but 3 American Robin nests were located at Independence Creek, and of these, 71% were located in the USFS Grays Meadows campground. It is possible that low nests were more susceptible to human-induced disturbances associated with the active campground. The mean percent of canopy cover within 11.3 m was 79% for successful nests and 47% for unsuccessful nests. High canopy cover may be beneficial because cover from above conceals nests from avian predators such as corvids and hawks, and from tree dwelling mammalian predators such as squirrels. All of these potential predators were present at Independence Creek.

Table 8. Factors affecting American Robin nest success, Owens Valley alluvial fan study sites 1998-2000, results of logistic regression analyses (29 nests, LRS = 23.89, $P < 0.001$, Pseudo R^2 = 0.62).

Habitat feature	Coefficient	Standard Error	*P*
nest height from ground	0.02	0.01	0.001
true canopy cover	0.06	0.03	0.007

Black-chinned Hummingbird

Percent willow cover within 5m of Black-chinned Hummingbird nests positively influenced their success (Table 9). Successful nests had averaged 16% willow cover while unsuccessful nests had a mean of 6%. Surprisingly, Black-chinned Hummingbirds did not use willow as a nesting substrate, and 73% of their nests were located in water birch. Hummingbirds utilized the cottony catkins of willow to construct and maintain their nests. It is possible that the female more closely attended nests that were closer to nesting material. It is also possible that the presence of willow provided a more structurally diverse patch of vegetation surrounding the nest, providing better cover against predators. Arroyo willow (*Salix lasiolepsis*) is co-dominant with and slightly out-competed by water birch in the Owens Valley alluvial fan region (Taylor 1982).

Table 9. Factors affecting Black-chinned hummingbird nest success, Owens Valley alluvial fan study sites 1998-2000, results of logistic regression analyses (38 nests, LRS = 5.76, $P = 0.02$, Pseudo $R^2 = 0.11$).

Habitat feature	Coefficient	Standard Error	*P*
willow shrub cover	0.07	0.03	0.03

Calliope Hummingbird

Calliope nest success was positively influenced by the number of black cottonwood trees within 11.3 m of the nest and the percent of forb ground cover (defined here as all forb species below 50 cm) within 5m of the nests (Table 10). Nests in proximity to, on average, 2 black cottonwood trees, were more likely to succeed than nests that without black cottonwood trees nearby. Nest sites with mean forb ground cover of 12% were more likely to succeed than those with a low (3% mean) forb cover. Calliope Hummingbirds did not use black cottonwood trees or any forb species as nesting substrate, but constructed their nests primarily in water birch (68%) and black oak (23%). Hummingbirds used black cottonwood catkins to construct and maintain their nests. It is possible that the female more closely attended nests that were closer to nesting material. The presence of black cottonwoods gave structural complexity to nearly continuous stands of water birch and willow and to a relatively open mid-canopy among black oak stands, and therefore may have provided a more complex cover for nests.

Areas with black cottonwoods are typically found along streams with higher flow rates and at higher elevations in the Owens Valley alluvial fan region, and relatively high forb ground cover is associated with black cottonwoods (Taylor 1982). Calliope Hummingbirds are predominantly a high altitude nesting species (Bent 1940), and may have faired better (at the lower altitudinal end of their range) among habitats that more closely mimicked their traditional nesting areas (see page 37 of this report). It is possible that black cottonwoods and forb cover maintain a cooler microclimate for nestlings in the hot and arid Owens Valley.

Table 10. Factors affecting Calliope Hummingbird nest success, Owens Valley alluvial fan study sites 1998-2000, results of logistic regression analyses (32 nests, LRS = 14.11, $P < 0.001$, Pseudo $R^2 = 0.32$).

Habitat feature	Coefficient	Standard Error	*P*
number Black Cottonwood trees within 11.3m	0.69	0.66	0.02
forb ground cover	0.15	0.09	0.01

Western Wood-pewee

Western Wood-pewee nest success was positively correlated with the date that the first egg was laid (Table 11), meaning that later nests were more likely to succeed than earlier ones. June 30 was the mean date of first egg laid for successful Western Wood-Pewee nests, while June 18 was the mean date for unsuccessful nests. A possible explanation for this result may be the timing of higher or lower predator abundance, or timing of predator behaviors. For example, we observed that Western Scrub-Jays were less active around other songbird nests during the later course of the breeding season, possibly because their own young had fledged and were seeking out other food sources than what they were fed as nestlings. We also observed that Western Scrub-Jays focused their later season food gathering efforts on the collection and storage of black oak acorns.

Table 11. Factors affecting Western Wood-Pewee nest success, Owens Valley alluvial fan study sites 1998-2000, results of logistic regression analyses (27 nests, LRS = 6.40, $P = 0.01$, Pseudo $R^2 = 0.18$).

Habitat feature	Coefficient	Standard Error	*P*
date of first egg laid	0.10	0.05	0.04

Black-headed Grosbeak and Bushtit

Black-headed Grosbeak and Bushtit nest success was negatively correlated with number of wild rose stems within 5m of the nest and herbaceous cover, respectively (Table 12). These results are difficult to interpret but warrant further investigation. It is possible that the measured vegetation variables are serving as a proxy for other, unmeasured variables.

Table 12. Factors affecting Black-headed Grosbeak and Bushtit nest success, results of logistic regression analyses (24 Black-headed Grosbeak nests, LRS = 7.08, $P = 0.01$, Pseudo $R^2 = 0.23$ & 45 Bushtit nests, LRS = 5.21, $P = 0.02$, Pseudo $R^2 = 0.09$), Owens Valley alluvial fan study sites 1998-2000.

Species	Habitat feature	Coefficient	Standard Error	*P*
Black-headed Grosbeak	number wild Rose stems within 5m	-0.12	0.05	0.04
Bushtit	herbaceous cover	-0.05	0.02	0.03

Nest timing

The breeding season for birds begins prior to the laying of an egg, when pair bonding, nest location choices and nest building takes place. After the first egg is laid, at least a month is required for the pair to raise and successfully fledge a brood of young. Additionally, the young of some species will remain dependent on their parents for up to a month after fledgling.

The earliest egg laid in all years was by a Red-tailed Hawk at Birch Creek, on March 24 1999 (Table 13). Other early nesters included resident species American Dipper, Western Scrub-Jay, Bewick's Wren, Spotted Towhee, Bushtit, Common Raven and Song Sparrow, and all species of

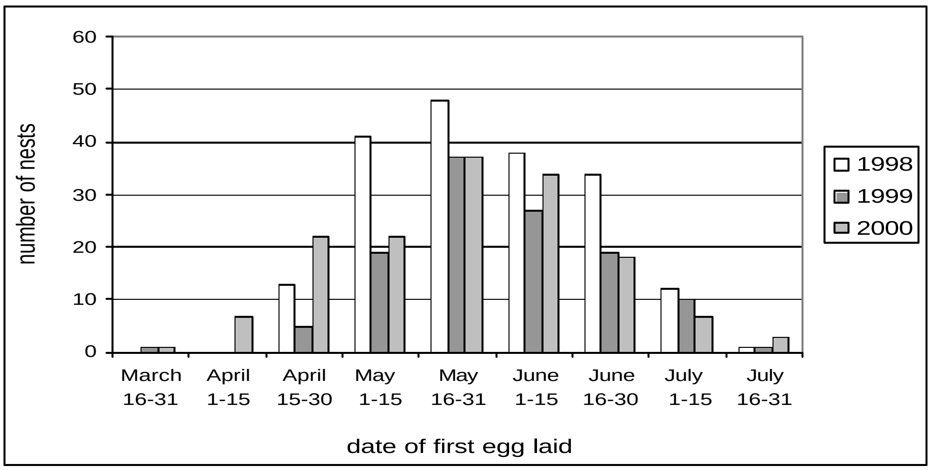
Table 13. Timing of nest initiation, based on date of first egg laid for 36 species at all Owens Valley alluvial fan sites, 1998-2000.

Species	Number of nests	Mean date of first egg	Earliest first egg	Latest first egg
Red-tailed Hawk	2	March 29	24-Mar-99	3-Apr-00
American Dipper	2	April 20	3-Apr-00	7-May-98
Common Raven	2	April 30	16-Apr-00	15-May-99
Rock Wren	1	May 3	3-May-00	3-May-00
Western Scrub-Jay	4	May 3	9-Apr-00	9-Jun-00
Hairy Woodpecker	1	May 10	10-May-99	10-May-99
Bewick's Wren	12	May 11	11-Apr-00	27-Jun-00
Bushtit	48	May 17	20-Apr-00	4-Jul-98
Red-shafted Flicker	9	May 18	3-May-98	12-Jun-99
Mourning Dove	1	May 21	21-May-98	21-May-98
Orange-crowned Warbler	7	May 22	5-May-00	16-Jun-98
Calliope Hummingbird	36	May 24	19-Apr-00	23-Jun-98
Costa's Hummingbird	33	May 24	30-Apr-00	17-Jun-98
Spotted Towhee	55	May 25	14-Apr-00	8-Jul-99
Sage Sparrow	6	May 26	15-May-00	6-Jun-00
American Robin	32	May 27	1-May-00	1-Jul-98
House Wren	11	May 31	8-May-00	22-Jun-99
European Starling	3	May 9	7-May-98	11-May-98
Song Sparrow	13	June 2	22-Apr-00	7-Jul-99
Black-chinned Hummingbird	38	June 3	23-Apr-00	15-Jul-98
Lesser Goldfinch	7	June 4	19-May-98	18-Jun-98
Black-headed Grosbeak	22	June 9	19-May-98	29-Jun-98
Black-throated Sparrow	7	June 10	23-May-00	6-Jul-00
Western Kingbird	1	June 10	10-Jun-00	10-Jun-00
Bullock's Oriole	3	June 12	26-May-98	25-Jun-99
Chipping Sparrow	2	June 12	12-Jun-98	13-Jun-98
Western Bluebird	2	June 14	12-Jun-00	15-Jun-00
Western Tanager	12	June 19	3-Jun-00	16-Jul-98
Warbling Vireo	22	June 20	29-May-00	19-Jul-98
Yellow Warbler	3	June 21	13-Jun-98	29-Jun-98
Blue-gray Gnatcatcher	10	June 22	1-Jun-98	15-Jul-99
Lazuli Bunting	15	June 24	1-Jun-98	20-Jul-99
Steller's Jay	3	June 25	28-May-98	17-Aug-98
Western Wood-pewee	30	June 26	3-Jun-00	21-Jul-00
Blue Grosbeak	2	June 28	23-Jun-00	3-Jul-00
Indigo Bunting	1	June 30	30-Jun-98	30-Jun-98

hummingbirds. Species that did not initiate nests until late May and early June included Warbling Vireos, Western Wood-Pewees, Yellow Warblers, Blue-gray Gnatcatchers and Lazuli Buntings. First egg dates in the second half of June and in July were, with the exception of the Indigo Bunting and Blue Grosbeaks, comprised of additional nesting or multiple brood attempts.

The range of date of first egg laid among all species was the third week of March through the last week of July in each year, with most first eggs laid in May and June (Figure 15).

Figure 15. Date of first egg for nests of all species at Owens Valley alluvial fan study sites. First egg dates sometimes calculated by subtracting the age of nestlings and known incubation periods for nests found after the first egg was laid.



Site fidelity and breeding density variation among select species

Forty-two individuals of 11 species were recaptured in mist nets in years following their original capture (Table 14). All recaptured individuals were breeders. Fourteen percent of the recaptures

Table 14. Total individuals recaught in multiple years by location and species. All were recaught at creek of original banding. Results of constant effort mist netting at Owens Valley alluvial fan study sites 1998-2000.

Species	Bairs Creek	Independence Creek	Taboose Creek	Tuttle Creek	Total
American Robin	--	4	--	--	4
Bewick's Wren	2	4	4	1	11
Black-headed Grosbeak	--	3	--	--	3
Bushtit	--	2	--	1	3
House Wren	--	4	--	--	4
Lazuili Bunting	1	--	--	--	1
Orange-crowned Warbler	--	2	--	4	6
Sage Sparrow	1	--	--	--	1
Song Sparrow	--	1	--	--	1
Spotted Towhee	2	2	2	1	7
Western Tanager	--	1	--	--	1
Total	6	23	6	7	42

showed evidence of natal philopatry, banded as hatch years and recaught in the following year at the same creek. These were all resident species: Spotted Towhee, Bewick's Wren and Bushtit. Between-year long distance migrant recaptures included Orange-crowned Warblers, Black-headed Grosbeaks, Lazuli Buntings, House Wrens and Western Tanagers.

Despite support of site fidelity revealed by mist net recaptures, there was also evidence of year-to-year variation in site fidelity among select species at our intensive sites (Table 15). Yellow Warblers bred in 1998 at Birch Creek (7 territories), but did not hold territories in 1999 or 2000. Calliope Hummingbirds bred in very high numbers in 1998 (30 territories), and had less than half the number of territories in subsequent years.

Table 15. Number of active breeding territories for 3 species at Owens Valley alluvial fan study sites, from nest finding and spot-mapping data, 1998-2000.

Species	1998	1999	2000
Yellow Warblers	7	0	0
Calliope Hummingbird	30	7	14
Lazuli Bunting	19	7	6

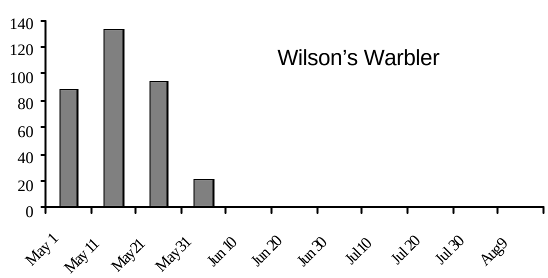
The heavy and late-record snowfall in the winter of 1998 produced a low elevation snow pack well into the spring in the eastern Sierra (USDA 2001, WDCC 2001). It is possible that birds may have been forced to move into the lower alluvial fan of the eastern escarpment. Calliope Hummingbirds, for example, are predominantly a montane-breeding species with nests up to 3,400 m in the Sierra Nevada (Bent 1940). Lazuli Buntings have displayed considerable dispersal between breeding seasons and among habitat types (Greene et al 1996), which may explain the variation in territory numbers in this study.

Use of riparian by migrants and sagebrush-nesting species

Migrants

Migrants made up 47% of all mist net captures among all years (Table 16). Wilson's Warblers and Hammond's Flycatchers did not breed at any of the four banding sites, but adults clearly used these habitats during migration (Figure 16): they were the two most abundant species captured, accounting for 16.34% and 7.85% of all captures respectively (Table 16).

Figure 16. Timing of number of captures for Wilson's Warblers and Hammond's Flycatchers at Owens Valley alluvial fan sites, 1998-2000.



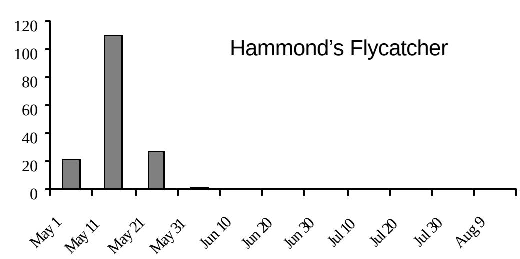
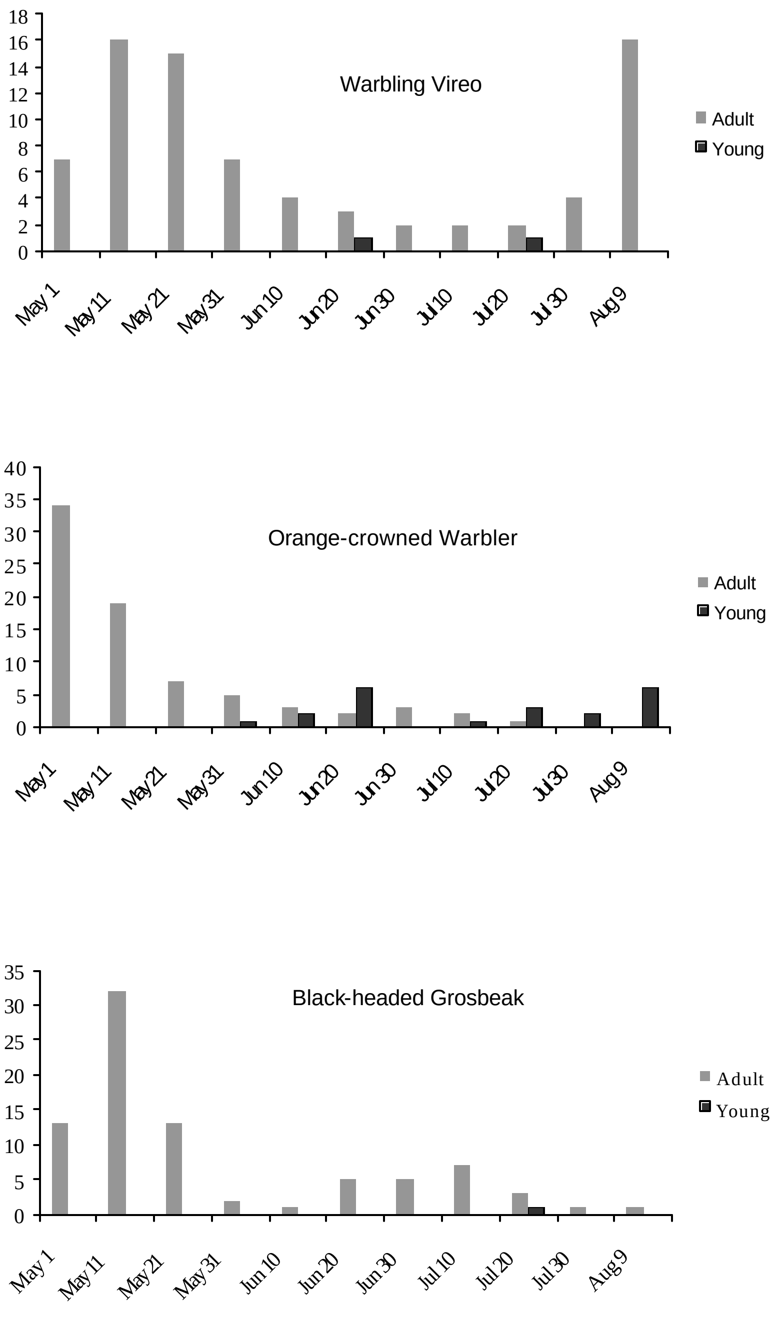


Table 16. Total number and percent of captures of all species by migratory status (migrant or on-site breeder). Results of constant-effort mist netting at Owens Valley alluvial sites 1998-2000.

Migrants			On-site breeders		
	captures			captures	
species	number	% of total	species	number	% of total
Anna's Hummingbird	13	0.63	Mourning Dove	2	0.10
Broad-tailed Hummingbird	1	0.05	Costa's Hummingbird	19	0.92
Rufous Hummingbird	46	2.23	Black-chinned Hummingbird	37	1.79
Downy Woodpecker	1	0.05	Calliope Hummingbird	14	0.68
Nuttall's Woodpecker	2	0.10	Hairy Woodpecker	6	0.29
Olive-sided Flycatcher	3	0.15	Red-shafted Flicker	2	0.10
Western Flycatcher	14	0.68	Western Wood-pewee	28	1.36
Pacific-slope Flycatcher	28	1.31	Loggerhead Shrike	3	0.15
Willow Flycatcher	15	0.73	Warbling Vireo	84	4.07
Hammond's Flycatcher	162	7.85	Steller's Jay	4	0.19
Dusky Flycatcher	76	3.68	Western Scrub-Jay	2	0.10
Gray Flycatcher	5	0.24	Bushtit	93	4.51
Western Kingbird	1	0.05	Bewick's Wren	128	6.2
Cassin's Vireo	16	0.78	House Wren	46	2.23
Solitary Vireo	2	0.10	Blue-gray Gnatcatcher	4	0.19
Ruby-crowned Kinglet	14	0.68	American Robin	27	1.31
Swainson's Thrush	88	4.27	Orange-crowned Warbler	123	5.96
Hermit Thrush	21	1.02	Western Tanager	38	1.84
Gray Catbird	1	0.05	Black-headed Grosbeak	94	4.56
Nashville Warbler	3	0.15	Blue Grosbeak	1	0.05
Yellow Warbler	16	0.78	Lazuli Bunting	18	0.87
Audubon's Warbler	9	0.44	Spotted Towhee	145	7.03
Myrtle Warbler	2	0.10	Green-tailed Towhee	5	0.24
Townsend's Warbler	16	0.78	Sage Sparrow	129	6.25
Hermit Warbler	2	0.10	Black-throated Sparrow	2	0.10
Black-and-white Warbler	2	0.10	Chipping Sparrow	3	0.15
Northern Waterthrush	1	0.05	Song Sparrow	9	0.44
MacGillivray's Warbler	62	3.01	Brown-headed Cowbird	4	0.19
Common Yellowthroat	1	0.05	Bullock's Oriole	8	0.39
Wilson's Warbler	337	16.34	Lesser Goldfinch	6	0.29
Yellow-breasted Chat	2	0.10			
Indigo Bunting	1	0.05			
Black-chinned Sparrow	1	0.05			
Mtn. White-crowned Sparrow	2	0.10			
Fox Sparrow	3	0.15			
Lincoln's Sparrow	5	0.24			
Oregan Junco	1	0.05			
Unidentified Junco	1	0.05			
total migrants	976	47.34	total on-site breeders	1084	52.55

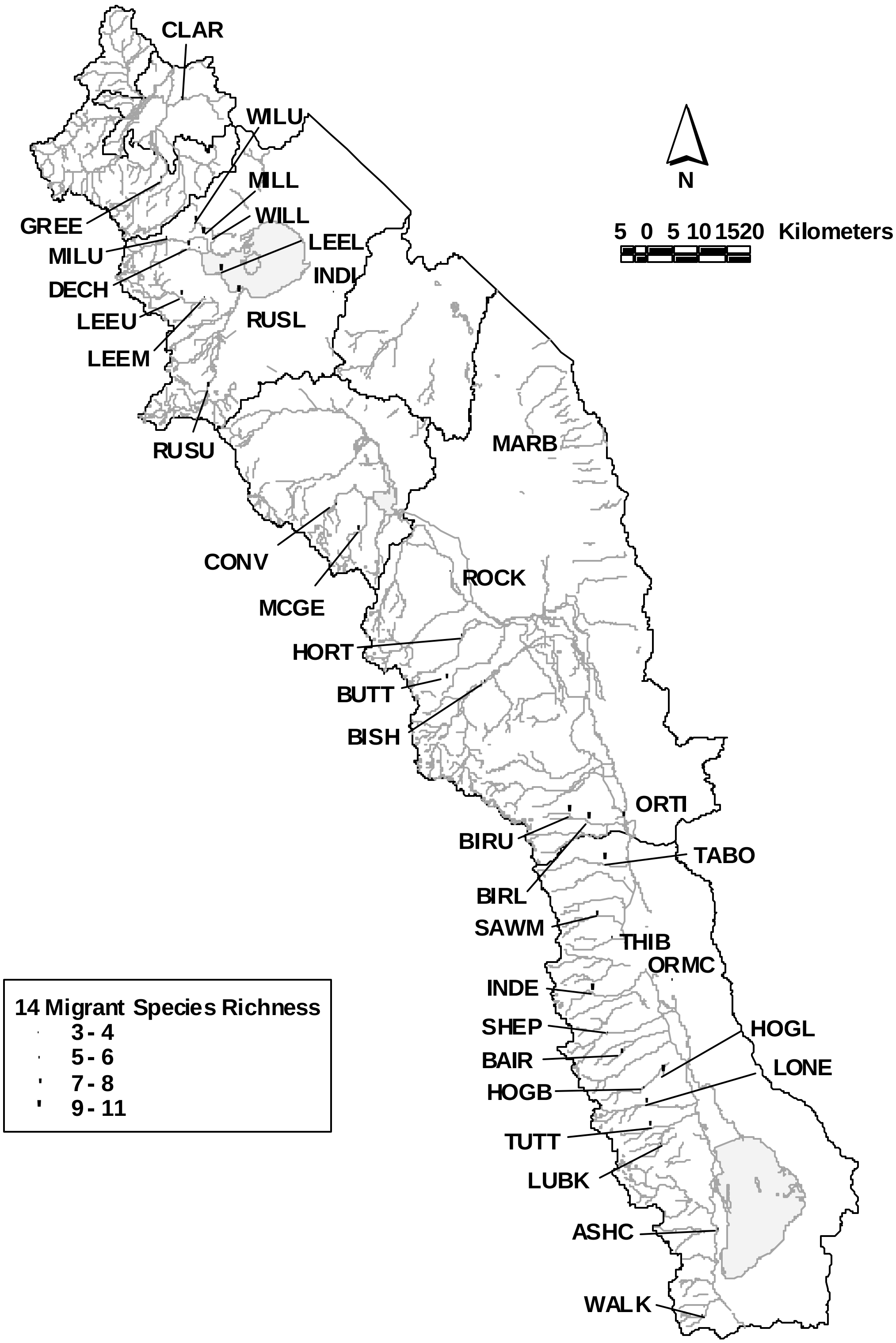
Early and mid May peaks in adult mist net captures for species that bred on site, such as Warbling Vireos, Orange-crowned Warblers and Black-headed Grosbeaks, suggest the use of these sites by migrant and breeding populations of the same species (Figure 17).

Figure 17. Timing of captures for Warbling vireos, Orange-crowned Warblers, and Black-headed Grosbeaks at Owens Valley alluvial fan sites, 1998-2000.



Nearly all of our study sites served as migratory stop-over habitat for several of the 14 riparian focal species (Figure 18).

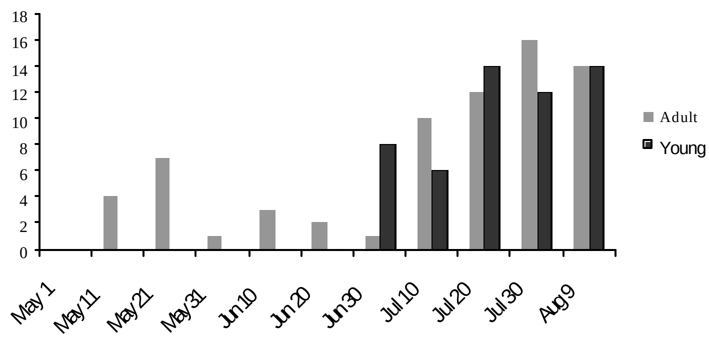
Figure 18. Number of 14 CPIF riparian focal species detected as migrants at each site, based on all methods and observations, 1998-2000.



Sage Sparrow

Sage Sparrows nested exclusively in the sagebrush, but were the second most abundant breeding species captured by mist nets (Table 16). Of the Sage Sparrow nests we found, the mean distance to the riparian edge was 48 meters. Mist net captures of Sage Sparrows were heavily bolstered by the influx of juveniles and adults into the riparian beginning in late June of 1998 (Figure 19). These data matched our observations of 3-5 member family groups drinking, bathing, and foraging in the riparian throughout most of June. Interestingly, 1998 accounted for 100 of the 129 Sage Sparrow captures, while only 8 were caught in 1999.

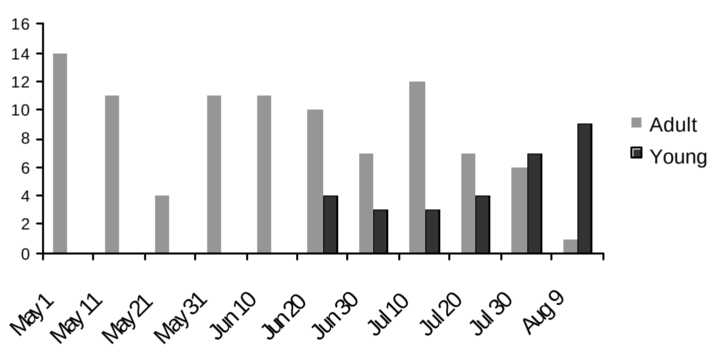
Figure 19. Timing and numbers of captures of Sage Sparrows at Owens Valley alluvial fan sites, 1998-2000.



Spotted Towhee

Spotted Towhee was the most abundant breeding species captured by mist nets (Table 16), detected on point counts, or recorded by territory maps among our four intensive study sites. Both adults and juveniles used the riparian throughout the season (Figure 20), even though the mean distance of Spotted Towhee nests from the riparian edge was 40m and all but three nests found were placed in or under sagebrush-associated plant species. Most Spotted Towhee territories encompassed both the sagebrush and riparian vegetation. Water Birch tops were frequented by males for singing posts and females frequently searched the riparian for nesting material. Both sexes and ages utilized the riparian for foraging.

Figure 20. Timing and numbers of captures of Spotted Towhees, Owens Valley alluvial fan sites, 1998-2000.



PART II: MONO BASIN 2000 PROGRESS REPORT RESULTS AND DISCUSSION

Species abundance and richness

Mist netting capture rates provided us with a set of indices for species richness and abundance at Mono Basin sites for the year 2000 (Table 17), and augmented results derived from point counts (Table 2 and Appendix 9).

Table 17. Summary of constant effort mist netting during the breeding season at Mono Basin sites (May 1 – August 15, 2000).

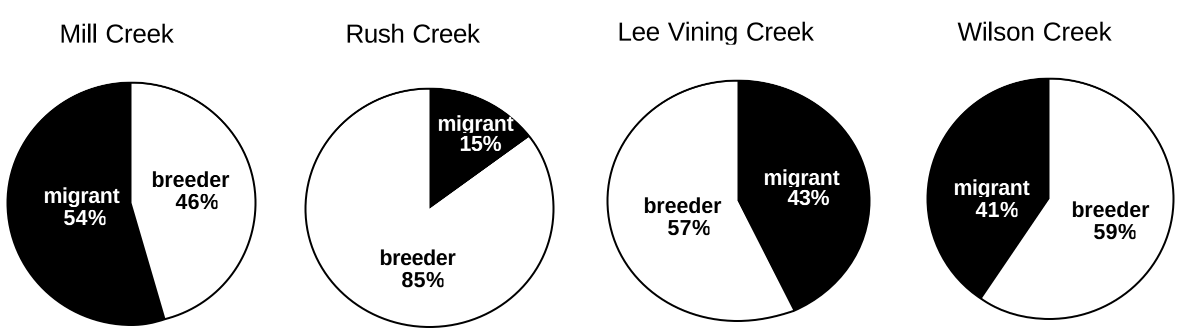
Station	Total birds	birds / 100 net hrs.	Number new birds banded	# birds captured, unbanded	Number individuals recaptured	Species richness
Wilson Creek	166	31.32	146	9	9	28
Lee Vining Creek	227	45.67	208	9	8	34
Mill Creek	251	46.06	217	14	16	44
Rush Creek	176	38.96	147	3	16	24

The total number of individuals (migrants and breeders) captured per 100 net hours (birds/100 net hours) at Lee Vining, Mill and Rush Creek, were higher than the 1996 national average of 37.2, for 410 MAPS stations across the U.S. (DeSante et al. 1998). Wilson Creek was slightly below this national average. Mono Basin captures were higher than those at all PRBO Owens Valley sites except for Independence Creek. Mill Creek had the highest species richness (44) of the four Mono Basin sites.

Use of Mono Basin riparian sites as migratory stop-over habitat

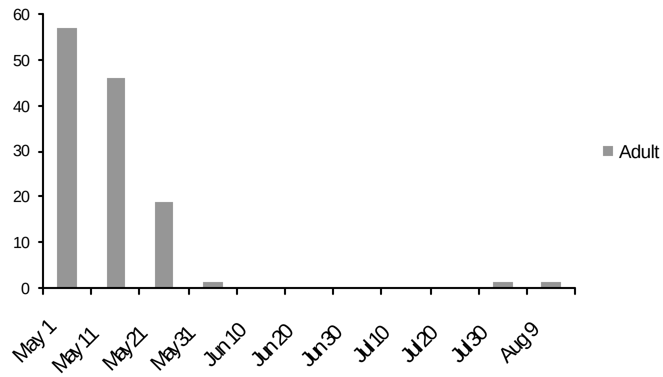
Almost half of all mist net captures at Mill, Wilson, and Lee Vining Creeks were of migratory, non-breeding species (Figure 21). Only 15% of Rush Creek captures were migrants, however due to weather, we did not run mist nets at Rush Creek during the first 10 day period of May, when most migrants were moving through the Mono Basin

Figure 21. Percent of breeders and migrants captured at each site during breeding season constant effort mist netting (May 1 – August 15, 2000).



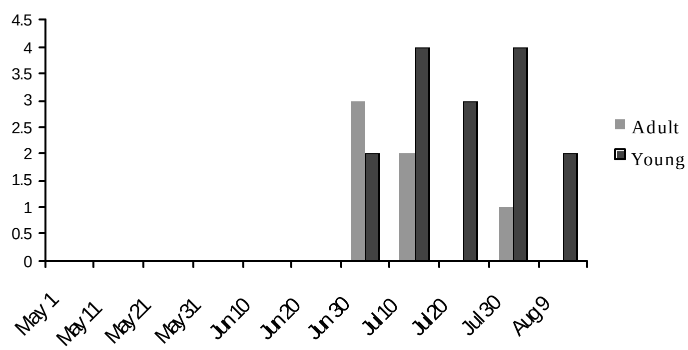
High spring and late summer mist net captures, of species which did not breed in the banding areas, demonstrated the use of the study area as stop-over habitat for migrants heading for and returning from breeding grounds at other locations. Wilson's Warblers, for example, accounted for 21% of all adult captures and were present on Mono's creeks in May and August (Figure 22).

Figure 22. Timing and numbers of captures of Wilson's Warblers at all Mono Basin banding sites combined, 2000.



Rufous Hummingbirds breed from southern Oregon and Idaho, north to Alaska (Calder 1993), but utilized Mono's Creeks during fall migration (Figure 23). Juvenile Rufous Hummingbirds accounted for 10% of all hatch year captures.

Figure 23. Timing and numbers of captures of adult and hatching year Rufous Hummingbirds at all Mono Basin banding sites combined, 2000.



Species such as Warbling Vireo, Audubon's Warbler and Western Tanager did not breed within 1 km of mist netting stations, but did breed at higher elevations along the same creek (Appendix 7). Captures of these species (Table 18) may demonstrate the use of study sites for localized pre and post breeding dispersal. Captures of species such as Sage Thrasher, Brewer's Sparrow and Gray Flycatchers within the riparian zone demonstrated the use of multiple habitats by these primarily sagebrush and pinyon-juniper nesting species. Species such as Black-and-white

Warblers breed primarily in the Midwest and Eastern Coast of the United States and are considered vagrants in the Mono Basin (Gaines 1988).

Table 18. Species and age class of all birds banded at Lee Vining, Mill, Rush and Wilson Creeks during constant effort mist netting in the breeding season, (May 1 – August 15, 2000). Confirmed or probable breeding species (detected as breeders within 1 km of banding site) in bold. Total = migrants and breeders combined, adjusted total = breeding species only. 4-letter AOU species codes in Appendix 13.

Lee Vining Creek

species	HY	AHY	ratio
AMRO	**4**	**6**	**0.67**
AUWA	5	4	1.25
BEWR	**0**	**1**	**0**
BHCO	**0**	**1**	**0**
BLPH	1	0	0
BRSP	**5**	**1**	**5.00**
BUOR	**6**	**4**	**1.50**
CAFI	**0**	**1**	**0**
COHU	0	1	0
COYE	0	1	0
DOWO	1	0	~
DUFL	0	9	0
GRFL	1	0	~
GTTO	**2**	**7**	**0.29**
HAFL	0	5	0
HAWO	0	1	0
HOWR	**1**	**2**	**0.50**
NAWA	0	2	0
OCWA	0	4	0
RSFL	**0**	**2**	**0**
RUHU	4	1	4.00
SATH	1	0	~
SOSP	**6**	**5**	**1.20**
SPSA	**0**	**2**	**0**
SPTO	**0**	**8**	**0**
SWTH	0	1	0
VGSW	**1**	**1**	**1.00**
WAVI	0	6	0
WETA	1	4	0.25
WEWP	0	2	0
WIFL	0	2	0
WIWA	0	41	0
YWAR	**15**	**34**	**0.44**
Total	54	159	0.34
Adj. Tot.	**40**	**75**	**0.53**

Mill Creek

species	HY	AHY	ratio
AMKE	**0**	**1**	**0**
AMRO	**2**	**7**	**0.29**
AUWA	1	4	0.25
BAWW	0	1	0
BEKI	**0**	**1**	**0**
BEWR	**4**	**3**	**1.33**
BHGR	0	1	0
BRBL	**1**	**4**	**0.25**
BRSP	**0**	**2**	**0**
BUOR	**0**	**3**	**0**
CAFI	**0**	**13**	**0**
CAHU	1	0	~
CAVI	0	1	0
COYE	0	1	0
DOWO	0	3	0
DUFL	0	10	0
FOSP	1	0	0
GRFL	0	1	0
GTTO	**1**	**7**	**0.14**
HAFL	0	8	0
HAWO	**0**	**6**	**0**
HOFI	**0**	**2**	**0**
HOWR	**1**	**7**	**0.14**
LEGO	0	1	0
MGWA	0	1	0
MODO	**1**	**0**	**~**
MWCS	0	2	0
OCWA	1	3	0.33
RCKI	0	2	0
RSFL	**1**	**1**	**1.00**
RUHU	5	2	2.50
SAGS	1	0	~
SATH	0	2	0
SOSP	**1**	**4**	**0.25**
SPTO	**5**	**5**	**1.00**
STJA	**0**	**1**	**0**
SWSP	0	1	0
SWTH	0	17	0
WAVI	0	4	0
WEFL	0	1	0
WIFL	0	2	0
WIWA	0	49	0
YBCH	0	1	0
YWAR	**5**	**9**	**0.56**
Total	32	194	0.16
Adj. Tot.	**22**	**76**	**0.29**

Rush Creek

species	HY	AHY	ratio
AMRO	**0**	**2**	**0**
AUWA	1	1	1.00
BEWR	**1**	**3**	**0.33**
BHCO	**1**	**1**	**1.00**
BHGR	**0**	**5**	**0**
BRSP	**1**	**12**	**0.08**
BTSP	**1**	**0**	**~**
BUSH	**0**	**2**	**0**
DUFL	0	3	0
GRFL	0	1	0
GTTO	**1**	**6**	**0.17**
HOWR	**0**	**1**	**0**
MGWA	**1**	**3**	**0.33**
OCWA	0	2	0
PSFL	0	1	0
RUHU	3	0	~
SAVS	**1**	**4**	**0.25**
SOSP	**4**	**8**	**0.50**
SPTO	**0**	**6**	**0**
WAVI	0	2	0
WEWP	0	1	0
WIFL	**1**	**1**	**1.00**
WIWA	0	10	0
YWAR	**19**	**42**	**0.45**
Total	35	117	0.30
Adj. Tot.	**31**	**96**	**0.32**

Wilson Creek

species	HY	AHY	ratio
AMRE	0	1	0
AMRO	**0**	**2**	**0**
AUWA	0	1	0
BEWR	**4**	**3**	**1.33**
BHCO	**0**	**2**	**0**
BRSP	**1**	**6**	**0.17**
DUFL	0	12	0
GRFL	0	2	0
GTTO	**0**	**8**	**0**
HAFL	0	1	0
HOWR	**1**	**1**	**1.00**
LISP	0	1	0
MAWR	0	1	0
MGWA	0	2	0
OCWA	3	3	1.00
RSFL	**0**	**2**	**0**
RUHU	3	3	1.00
SAVS	**0**	**2**	**0**
SOSP	**3**	**6**	**0.50**
SPTO	**2**	**7**	**0.29**
SWTH	0	5	0
VESP	**0**	**3**	**0**
WAVI	0	1	0
WEFL	0	2	0
WEME	**0**	**1**	**0**
WIFL	0	1	0
WIWA	0	25	0
YWAR	**9**	**23**	**0.39**
Total	26	127	0.20
Adj. Tot.	**20**	**66**	**0.30**

Estimates of productivity

Mono Basin sites exhibited similar young (HY) to adult (AHY) ratios (breeding species only), suggesting fair to good productivity overall (defined here as ratios over 0.30) (Table 18). Combined captures of several young Yellow Warblers, Song Sparrows and Brewer's Sparrows at Lee Vining Creek made overall productivity for this site high (0.54). Yellow Warblers had high productivity ratios at all sites (0.39 – 0.56), as did Song Sparrows, with the exception of Mill Creek.

Productivity indices derived from mist netting data are helpful because they reflect the survival of hatch year birds after they have left the nest, whereas nest success determines successful fledging of nestlings. However, species and site comparisons must be interpreted with caution due to the inherent differences in species capture probabilities and the vegetation structure of each site (DeSante and Geupel 1987, PRBO data). In addition, juveniles at some sites may begin dispersing so quickly that they are missed when nets are operated once per ten-day period (PRBO data). It is therefore important to consider productivity indices in conjunction with results from nest monitoring efforts.

Nest success in the Mono Basin

Mayfield and proportional estimates of nest success for Yellow Warblers and Song Sparrows

We determined Mayfield and proportional nest success for Song Sparrows and Yellow Warblers, at all sites combined (Table 19). We define average nests success as 0.30. Song Sparrow nest success was poor and Yellow Warbler nest success was slightly below standard.

Table 19. Mayfield estimates of nest success for study species for which we found more than 20 nests at Mono Basin sites (Rush, Lee Vining, Mill and Wilson Creeks), 2000. Proportional success is provided for comparison, but is generally an overestimate of true success.

Species	Number of Nests	Daily nest survival	SE	Total Nest survival	Proportional Nest Success
Song Sparrow	52	0.94	0.01	0.18	0.31
Yellow Warbler	49	0.95	0.01	0.28	0.39

Song Sparrow nest success was lower than at other riparian sites in California. Yellow Warbler nest success was slightly lower than at other riparian sites, and much lower than at Lassen National Forest and Volcanic National Park (Table 20).

Table 20. Mayfield and proportional estimates of nest success for Song Sparrows and Yellow Warblers at other riparian songbird monitoring sites in California and Montana, using same data collection and analysis methods, for comparison with Mono Basin sites.

Location	Year	# nests	Mayfield estimate	Proportional success (n nests)	Citation
Song Sparrows					
Cosumnes River	2000	53	0.58	0.59	Haff et al. 2001
San Luis NWR	2000	37	0.28	0.40 (45)	Hammond and Geupel 2000
Golden Gate NRA	1998	43	0.24	0.42	Gardali et al. 1999
Lassen NF & NP	1997-1999	47	0.59	0.76 (38)	King et al. 2001
Yellow Warblers					
Clear Creek	2000	9	0.32	0.36 (15)	Wood et al. 2001
Lassen NF & NP	1997-1999	14	0.89	0.72 (18)	King et al. 2001
Montana (forested)	1995-1996	24	0.29	--	Tewksbury et al. 1998
Montana (agricultural)	1995-1996	266	0.36	--	Tewksbury et al. 1998

Proportional nest success by nest category and site

Two hundred and three nests were found for 22 species on Mill, Wilson, Rush and Lee Vining Creeks in the Mono Basin in 2000. Outcomes were determined for 165 nests observed with at least one egg or young and can be used for estimates of proportional nest success (Table 21).

Yellow Warbler nest success at Lee Vining Creek (25%) was not significantly lower than at Rush Creek (34%, P = 0.47). Yellow Warblers at Mill Creek faired extremely well (100%). Song Sparrow nest success was similar at Rush, Lee Vining Creek and Wilson Creeks (35%, 36% and 30% respectively), and not significantly lower at Mill Creek (13%, P = 0.51).

Success for open cup nesters at all sites combined (39%) was slightly lower than the mean derived from several studies in North America (44% Martin 1989), and lower than at Owens Valley alluvial fan sites (51%). Nest success for pendulum or sphere nesters among all sites combined was very high at 94%. Similarly, proportional nest success for cavity, crevice or burrow nesters was 100%, though the sample size is low.

Table 21. Total number of nests observed with at least one egg or young and known outcome, and proportion successful at Mono Basin sites 2000: Rush Creek, Lee Vining Creek, Mill Creek, Wilson Creek and All Sites Combined.

Species	Nest Type[1]	Rush Creek		Lee Vining Creek		Mill Creek		Wilson Creek		All Sites Combined	
		# nests	proportion successful	#nests	proportion successful	# nests	proportion successful	# nests	proportion successful	# nests	proportion successful
American Dipper	B	--	--	--	--	1	1.00	--	--	1	1.00
American Kestrel	B	--	--	1	1.00	--	--	--	--	1	1.00
American Magpie	C	--	--	1	1.00	2	1.00	4	1.00	7	1.00
American Robin	A	1	0.00	2	1.00	2	1.00	1	0.00	6	0.67
Belted Kingfisher	B	--	--	--	--	1	1.00	--	--	1	1.00
Bewick's Wren	B	--	--	--	--	1	1.00	--	--	1	1.00
Brewer's Blackbird	A	--	--	--	--	3	1.00	--	--	3	1.00
Bullock's Oriole	C	--	--	1	1.00	--	--	--	--	1	1.00
Bushtit	C	3	1.00	--	--	1	1.00	3	1.00	7	1.00
Cassin's Finch	A	--	--	--	--	2	0.00	--	--	2	0.00
Green-tailed Towhee	A	--	--	2	0.00	--	--	1	1.00	3	0.33
Green-winged Teal	A	--	--	--	--	--	--	2	0.00	2	0.00
Hairy Woodpecker	B	--	--	--	--	1	1.00	--	--	1	1.00
Killdeer	A	1	1.00	--	--	1	1.00	--	--	2	1.00
Mourning Dove	A	1	1.00	--	--	--	--	--	--	1	1.00
Red-shafted Flicker	B	--	--	1	1.00	3	0.67	--	--	4	0.75
Red-winged Blackbird	A	2	1.00	1	0.00	0	0.00	2	1.00	5	0.80
Song Sparrow	A	23	0.35	11	0.36	8	0.13	10	0.30	52	0.31
Spotted Sandpiper	A	2	0.00	1	0.00	--	--	--	--	3	0.00
Spotted Towhee	A	4	0.25	4	0.50	4	0.25	--	--	12	0.33
Violet-green Swallow	B	1	1.00	--	--	--	--	--	--	1	1.00
Yellow Warbler	A	32	0.34	12	0.25	5	1.00	--	--	49	0.39
TOTAL TYPE A NESTS		66	0.36	33	0.33	25	0.52	16	0.38	140	0.39
TOTAL TYPE B NESTS		1	1.00	2	1.00	7	0.86	--	--	10	0.90
TOTAL TYPE C NESTS		3	1.00	2	1.00	3	1.00	7	1.00	15	1.00
TOTAL ALL NESTS		70	0.40	37	0.41	35	0.63	23	0.57	165	0.47

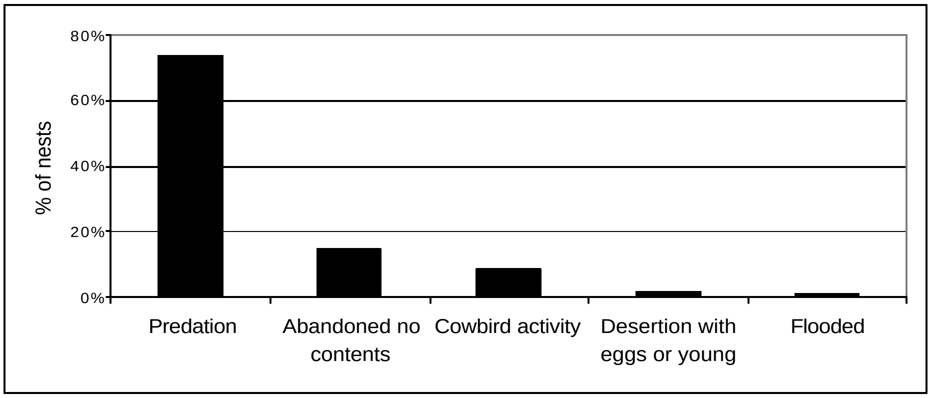
[1] Nest Types: A = open cup, scrape, saucer or platform B = cavity, crevice or burrow C = pendulum or sphere

Factors influencing nest success

Nest mortality

Five nest mortality factors were identified for open cup nesters for all Mono Basin nest plots in 2000: predation, abandoned prior to egg laying, cowbird activity (failure due to parasitism), desertion of nest with eggs or young, and flooding (Figure 24).

Figure 24. Mortality factors of 113 failed open cup nests at Mono Basin sites 2000.

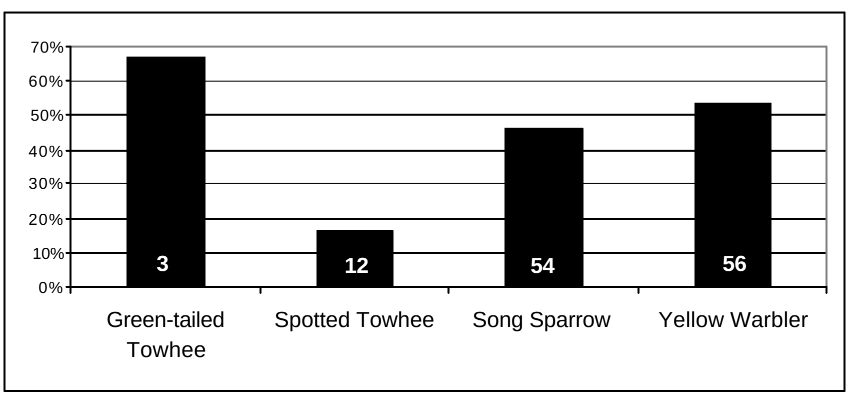


Predation by mammalian, avian or reptilian nest predators (Appendix 11) accounted for 74% of all nest failure. These results corroborates those of Martin (1992) who found that on average, predation accounted for 77% of nest failure among several different species of neotropical migrants nationwide.

Brown-headed Cowbird parasitism

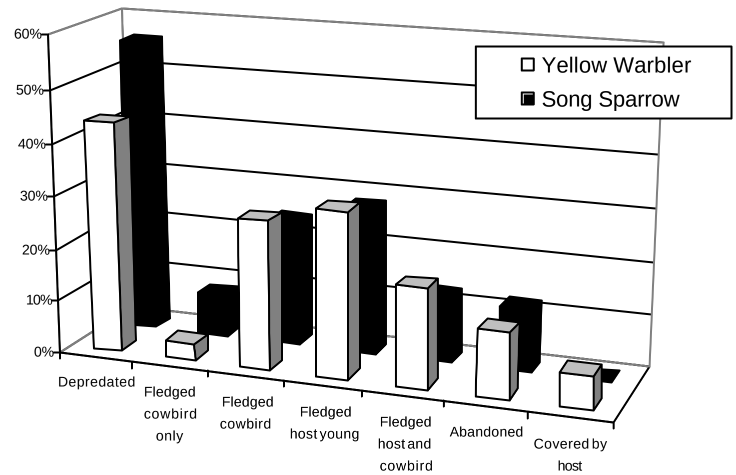
Brown-headed Cowbird parasitism accounted for 9% of all nest failure. Forty-seven percent of all host species nests' that were observed with at least one egg or young were parasitized. Green-tailed Towhee, Spotted Towhee, Yellow Warbler and Song Sparrow were the only observed host species in the basin (Figure 25). Parasitism rates for Yellow Warblers and Song Sparrows were 60% and 48% respectively.

Figure 25. Parasitism rates for 4 host species at Mono Basin sites, 2000. Nest numbers shown on bars – note low sample size for Green-tailed Towhees.



Depredation accounted for 44% of Yellow Warbler and 56% of Song Sparrow parasitized nests (Figure 26). Brown-headed cowbirds successfully fledged from 28% of Yellow Warbler and 24% of Song Sparrow parasitized nests, but only 3% and 8% of these species nests' respectively, fledged *only* cowbirds. Thirty-one percent of Yellow Warbler and 28% of Song Sparrow nests fledged their own young, despite parasitism. 19% Yellow Warbler and 13% Song Sparrow nests fledged both host and cowbird young. 13% Yellow Warbler and 12% Song Sparrow nests were abandoned and Yellow Warblers rebuilt new nesting attempts, covering cowbird eggs, in 6% of their parasitized nests.

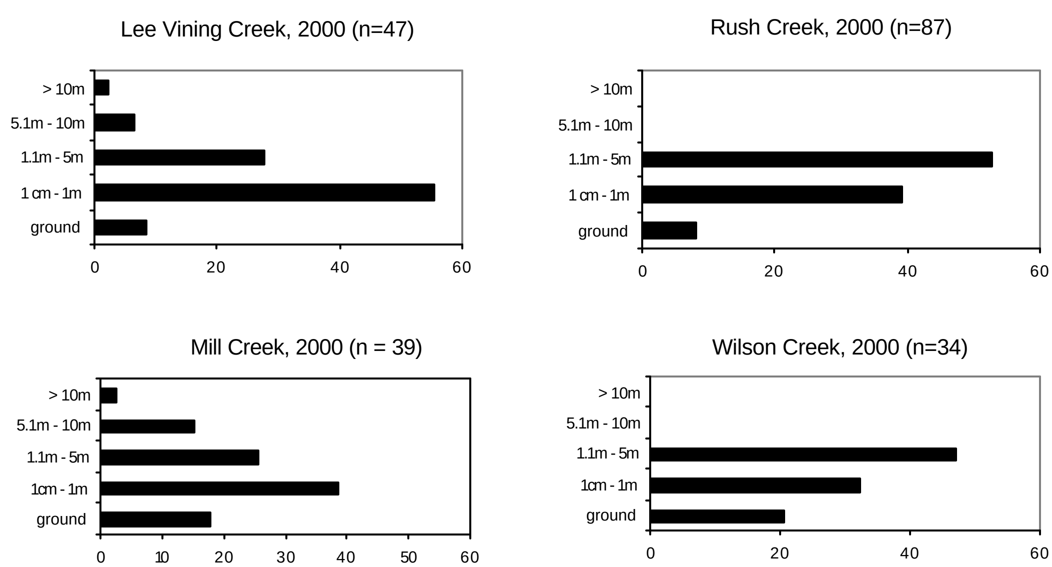
Figure 26. Outcome of parasitized Yellow Warbler and Song Sparrow nests at Mono Basin sites, 2000.



Nest site selection

Most nests were located within 5 meters of the ground at all sites (Figure 27). Approximately

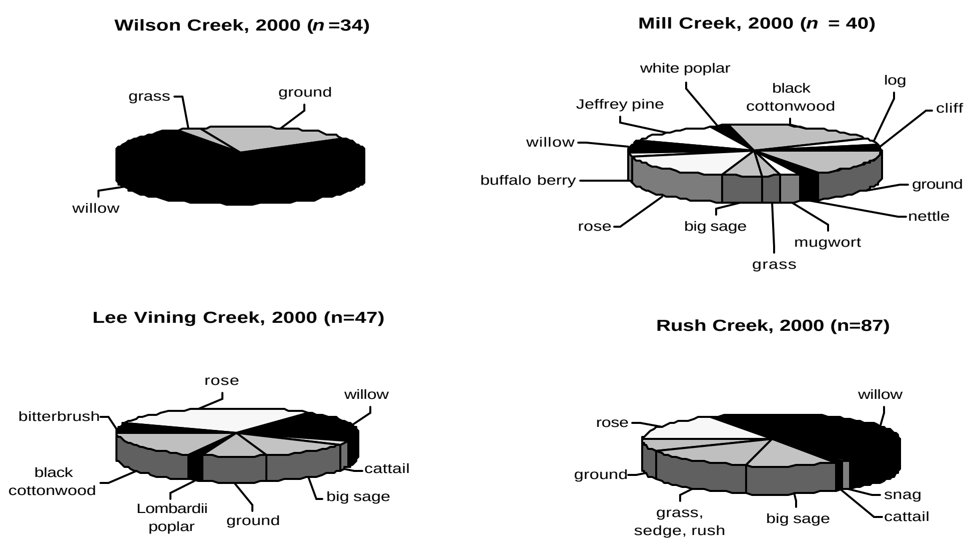
Figure 27. Nest height categories for all nests found on Lee Vining, Rush, Mill, and Wilson Creeks, 2000. X axes are % of nests within each height category.



half of all nests at each site were located within 1 meter of the ground, demonstrating the importance of low shrub and herbaceous understory vegetation to breeding birds at these study sites. 18% of nests at Mill Creek and 9% of nests at Lee Vining Creek were also located above 5 meters, demonstrating the importance of multiple vegetation layers (Figure 27).

Birds at Wilson Creek utilized the ground, grass and willows for nest site locations, while birds chose at least 7 different types of substrate at all other sites (Figure 28). Nests were placed in forb species such as mugwort and stinging nettle; in shrub species such as willow, wild rose, big sage and buffalo berry; and tree species such as black cottonwood and Jeffrey pine.

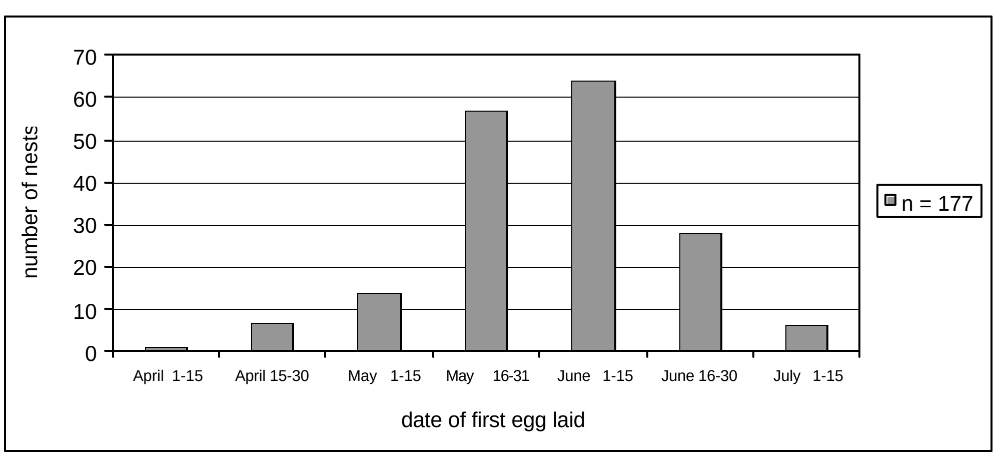
Figure 28. Nesting substrate utilized by all bird species at Wilson, Mill, Lee Vining and Rush Creeks, 2000. *n* = number of nests used at each site.



Nest timing

The peak of egg initiation for birds in riparian habitats of the Mono Basin in 2000 was mid May through mid June (Figure 29). The breeding season begins prior to the laying of an egg, when

Figure 29. Date of first egg laid for Mono Basin sites, 2000.



pair bonding, nest location choices and nest building takes place. After the first egg is laid, at least a month is required for the pair or individual to raise and successfully fledge a brood of young. Additionally, the young of some species will remain dependent on their parent(s) for up to a month after fledging. Based on 2000 data, the breeding season for the Mono Basin region should be considered between the 2nd week of April, through August 15. Future years of data will solidify these dates, and take annual variation into account.

The earliest first egg date in 2000 was that of the American Dipper on April 13, who nested in culverts (Table 22). The latest first egg date was that of the Song Sparrow, on July 13. American Robins, Spotted Towhees and Song Sparrows exhibited wide ranges for first egg dates, initiating nests as early as late April/early May and as late as early to mid July. Yellow Warblers initiated nests primarily in June. American Magpies did not initiate nests after mid May.

Table 22. Mean date of first egg for all species nests at Mill, Wilson, Rush and Lee Vining Creeks, 2000.

Species	*n*	Mean date of first egg	Earliest first egg	Latest first egg
American Dipper	1	April 13	April 13, 2000	April 13, 2000
American Magpie	8	May 3	April 24, 2000	May 17, 2000
American Kestrel	1	May 15	May 15, 2000	May 15, 2000
Bewick's Wren	1	May 19	May 19, 2000	May 19, 2000
Hairy Woodpecker	1	May 20	May 20, 2000	May 20, 2000
Killdeer	1	May 20	May 20, 2000	May 20, 2000
Green-winged Teal	2	May 21	May 16, 2000	May 26, 2000
Bushtit	8	May 22	April 28, 2000	June 9, 2000
Belted Kingfisher	1	May 24	May 24, 2000	May 24, 2000
Cassin's Finch	3	May 24	May 23, 2000	May 25, 2000
Spotted Towhee	12	May 30	April 30, 2000	July 3, 2000
Red-shafted Flicker	4	June 2	May 24, 2000	June 17, 2000
American Robin	6	June 3	April 29, 2000	July 2, 2000
Brewer's Blackbird	3	June 3	June 1, 2000	June 5, 2000
Green-tailed Towhee	3	June 6	May 14, 2000	June 23, 2000
Bullock's Oriole	2	June 8	May 31, 2000	June 16, 2000
Spotted Sandpiper	3	June 8	May 30, 2000	June 22, 2000
Song Sparrow	57	June 9	May 9, 2000	July 13, 2000
Yellow Warbler	55	June 11	May 30, 2000	July 1, 2000
Red-winged Blackbird	5	June 12	May 25, 2000	July 1, 2000
Mourning Dove	1	June 15	June 15, 2000	June 15, 2000
Violet-green Swallow	1	June 22	June 22, 2000	June 22, 2000

RECOMMENDATIONS

We provide 14 management and habitat recommendations, based on results derived from 1998-2000 data. These results are presented in detail in Part I and Appendix 8 of this report.

1. <u>Limit management activities such as control burning, seasonal movement of livestock, and other vegetation disturbance or removal to the non-breeding season</u>. The breeding season for birds begins prior to the laying of an egg, when pair bonding, nest location choices and nest building takes place. Hawks laid their first eggs in Owens Valley alluvial fan riparian zones as early as March 24 and first egg dates for shrub-nesting songbirds were as early as April 9. Because hawks tend to nest high in the canopy, management activities that disturb high shrub and canopy layers should not be initiated after the second week of March. Because most songbirds nested between the ground and 5m, management activities that disturb ground, shrub or canopy layer vegetation should not commence after April 1. Songbirds will take at least a month after the first egg is laid to fledge and care for young. Because several species initiated nests during the 2nd and 3rd week of July, the breeding season should be considered to last through August.

2. <u>Maintain willow cover as a component of water birch habitat types in the Owens Valley alluvial fan</u>. Among alluvial fan sites, willow shrub cover positively influenced breeding species diversity, and nest success of Black-chinned Hummingbirds. Willow was chosen as substrate by several species, including Yellow Warblers, Black-headed Grosbeaks, Song Sparrows and Warbling Vireos. It is important to note that willow shrub cover was important when associated with water birch. For example, while willow shrub cover influenced positive nest outcomes for Black-chinned Hummingbirds, they consistently used water birch as nesting substrate.

3. <u>Maintain and encourage riparian width</u>. Width of riparian zone (defined here as the distance from one edge of riparian vegetation to the other, perpendicular to the streamflow) positively influenced breeding species diversity throughout the entire study area, and particularly at Owens Valley and alluvial fan sites with water birch and mixed willow habitat types. The occurrence of Yellow Warblers and Song Sparrows was also positively influenced by riparian width across the entire study area. It is important to note that riparian width is strongly correlated with stream flow in addition to general geomorphologic conditions (Taylor 1982), and one must apply riparian widths that are appropriate for a given geologic condition. However, even within naturally incised and relatively narrow water birch habitat types, where riparian width ranged from 1 to 35m, riparian width positively influenced breeding bird diversity.

4. <u>Maintain herbaceous cover</u>. Herbaceous cover (defined here as forb, grass, sedge, rush and fern cover) positively influenced breeding bird diversity across the entire study area and within mixed willow habitats in the Owens Valley and alluvial fan regions. Herbaceous cover also positively influenced nest success of Calliope Hummingbirds. Grass cover in particular, positively influenced the likelihood of occurrence of Yellow

Warblers and Song Sparrows at all sites. Ground and low nesting species such as Orange-crowned Warblers, Spotted Towhees and Song Sparrows used herbaceous ground cover for nest substrate and concealment.

5. Manage for tree species richness. Breeding bird diversity at Mono Basin and upper Owens River watershed sites, and in montane wetland shrub habitat types, increased with an increase in tree species richness, as did the occurrence of Black-headed Grosbeaks across the entire study area. High tree species richness was 4 – 6 species per 50m radius plot. Species included black cottonwoods, aspen, water birch, willow, or Jeffrey and lodgepole pines, as well as small numbers of white fir, juniper or piñon pine.

6. Manage the excessive encroachment of pines in the riparian zone. Total tree cover was negatively associated with breeding bird diversity within Mono Basin and upper Owens River watershed sites, and Jeffrey pine cover was negatively influential across the entire study area. Sites with very high cover of Jeffrey and lodgepole pine had relatively little other riparian vegetation, which may drive the negative correlation with tree cover. Sites with high tree species richness in this area are typified by trees of different heights and patchy canopies, and do not necessarily have high overall percentages of tree cover. Managing or restoring for a variety of encroaching or patchy (but not dominant) tree species may be important for maintaining breeding bird diversity, particularly within the willow dominated montane wetland shrub habitat types. Some pine cover in the riparian enhances structural diversity and provides nesting substrate for several species. Discerning an encroachment threshold is key to balancing these two dynamics.

7. Encourage structural diversity. In both the Owens Valley alluvial fan and Mono Basin sites, songbirds nested at heights ranging from the ground to over 10m, and in several different types of vegetation. Nest success for the predominantly shrub-nesting Calliope Hummingbird was positively correlated with the number of black cottonwood trees (over 5m tall and >8 cm DBH) and forb ground cover (< 50 cm) surrounding the nest site. Grass cover was highly predictive of the occurrence of Yellow Warblers, who nested exclusively in shrubs and tress. These results suggest that structurally diverse habitat patches are as important for nesting success, and species occurrence, as the nesting substrate itself. Diverse vegetation (in terms of height, structure and species) provides more complex cover and protection from a variety of nest predators (Martin 1992). Additionally, a more diverse vegetative structure may benefit other important elements of avian breeding ecology such as easy access to nesting material, more singing perches or a wider variety of prey items.

8. Where appropriate, manage for aspen and black willow tree cover. Habitats dominated by aspen and black willow trees are bioregionally important, supporting some of the most diverse riparian breeding songbird populations in the eastern Sierra Nevada. Both tree species positively influenced breeding bird diversity across the entire study area. Aspens supported the highest breeding bird diversity Mono Basin/upper Owens River watershed

sites and black willow supported the highest diversity in Owens Valley floor/alluvial fan sites. Aspen tree cover was also highly predictive of the occurrence of Warbling Vireo, a CPIF focal species that is declining in other regions of California (Gardali et al. 2000).

9. <u>Maintain black and canyon live oak cover among Owens Valley alluvial fan sites</u>. Black oak and canyon live oak are anomalous components of eastern Sierra riparian vegetation. They are either remnant patches of the former Pliocene forests of the interior or the result of the west-to-east acorn trade among native people of the Sierra (Taylor 1982). Among Owens Valley alluvial fan sites, Warbling Vireos were most abundant at sites with black oak or canyon live oak. These sites included Independence Creek, Walker Creek, and Lubken Creek. At Independence Creek, Warbling Vireos chose black oak as nesting substrate for 66% of their nests (n = 32) and Western Wood-Pewees for 80% (n = 35). Oaks also provide a unique habitat for cavity-nesting species and supply acorns to diversify the food base.

10. <u>Manage habitats adjacent to riparian to enhance songbird populations</u>. High mist net capture rates of predominantly sagebrush nesting species in the riparian zone suggest their use of both riparian and sagebrush habitats during the breeding season. In Owens Valley alluvial fan sites Spotted Towhees, Costa's Hummingbirds, Bewick's Wrens, Bushtits and Lazuli Buntings nested primarily among big sagebrush, but utilized the riparian to obtain nesting material, food and singing perches. Sage Sparrow and Black-throated Sparrow families flocked to the riparian soon after fledging, accessing foraging areas, water, and perhaps better cover from predators. When managing for diverse and healthy songbird populations, it is important to consider the connectivity of different habitat types, and the influences that management in one type may have on another.

11. <u>Enforce regulations that discourage the feeding of wild animals on public lands</u>. Nest success among Owens Valley alluvial fan sites was generally high and with the exception of Warbling Vireos and Blue-gray Gnatcatchers, is not cause for immediate concern. However, predation at these sites accounted for 52-72% of all nest failure. Although relatively high rates of songbird nest predation by mammalian, avian and reptilian taxa are typical, several documented nest predator and parasite species (e.g. raccoons, squirrels and Brown-headed Cowbirds) are likely increasing because of human development. These species equate humans with consistent, non-seasonal food sources. Bird and livestock feeders, if not carefully monitored, attract nest predators such as jays, magpies, crows, ravens, small mammals, and the parasitic Brown-headed Cowbird (Rothstein et al. 1984). Since regulations restricting the feeding of wild animals on federal public lands already exist, the USFS and BLM are encouraged to enforce them to preempt any current or future negative effects on songbird productivity.

12. <u>Avoid constructing new human facilities within or adjacent to riparian areas</u>. Riparian habitat attracts recreationists who enjoy the fishing and camping opportunities along eastern Sierra streams and support the region's recreational tourist economy. At least

thirteen streams within our 230 km study area have USFS developed campgrounds within the riparian zone, totaling 44 campgrounds among them. BLM and public campgrounds on LADWP lands account for at least seven others. We have no direct evidence from this study that riparian campgrounds are detrimental to songbirds. However, other studies have connected high concentrations of Brown-headed Cowbirds to artificially rich sources of food associated with campgrounds, roads, towns, pack stations and small horse corrals in the eastern Sierra (Rothstein et al.1980, Rothstein et al. 1984). Our recovery of a dead Green-tailed Towhee (banded in Mill Creek and victim to an adjacent Mono City house cat) indicates another feature of human development that can be detrimental to songbirds.

13. <u>Maintain or increase connectivity between riparian areas</u>. Although Owens Valley alluvial fan sites had the lowest indices of breeding bird diversity and abundance among our study sites, these habitats may serve as important connectors between more productive high elevation and Owens River habitats. During the heavy, late and low elevation snow pack of 1998 (USDA 2001, WDCC 2001), Owens Valley alluvial fan sites provided breeding habitat for species that did not breed as densely, or at all, in subsequent years. These included the generally high elevation-breeding Calliope Hummingbird and Yellow Warbler, suggesting that alluvial fan riparian served as flow-over habitat when the preferred higher elevation habitats were unavailable. Alluvial fan riparian may serve the same purpose for lower elevation Owens River habitats: we observed dispersing juveniles of species that nested exclusively in the valley (Nuttall's Woodpeckers) and sporadic nesting by primarily valley-nesting species (Western Kingbirds and Blue Grosbeaks).

    These alluvial fan creeks may also connect populations of relatively sedentary and resident songbird species such as Song Sparrows. Although extremely common among Owens River sites (Owens River North of Tinemaha Resevoir supported Song Sparrow densities over twice as high as that of any other study site), only Birch Creek and Independence Creek supported a few Song Sparrow pairs. Because most alluvial fan streams within our study area are disconnected from the Owens River due to water diversions, it is possible that the ubiquitous Song Sparrow is unable to disperse to habitats along the alluvial fan.

14. <u>Maintain riparian sites as migratory stopover habitat, even in areas with relatively low breeding bird densities</u>. Non-breeding migrants accounted for 47% of Owens Valley alluvial fan and 42% of Mono Basin riparian mist net captures. Highest mist net captures were of species such as Wilson's Warblers, Hammond's Flycatchers and Dusky Flycatchers in the spring and Rufous Hummingbirds in the fall, none of which breed at our mist netting locations. Up to eleven of the 14 riparian focal species utilize eastern Sierra riparian during migration.

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Appendix 1.California Partners in Flight Riparian Habitat Joint Venture 14 riparian focal species.

The Riparian Habitat Joint Venture selected fourteen riparian focal species whose needs, when considered in the design and management of a landscape, will presumably encompass the requirements of other species (Lambeck 1997, RHJV 2000). The Riparian Bird Conservation Plan, based on species accounts written for each of the 14 focal species, has been developed to guide conservation policy and action on behalf of riparian habitats and California's landbirds. The plan includes recommendations for conservation action, restoration, habitat/landscape management, monitoring/research, and policy (RHJV 2000).

Appendix A – Table a. California Partners in Flight Riparian Habitat Joint Venture 14 Riparian Focal Species

Common Name	Latin Name
Swainson's Hawk	*Buteo swainsoni*
Yellow-billed Cuckoo	*Coccyzus americanus*
Willow Flycatcher	*Empidonax traillii*
Warbling Vireo	*Vireo gilvus*
Bell's Vireo	*Vireo bellii*
Bank Swallow	*Riparia riparia*
Swainson's Thrush	*Catharsus ustulatus*
Yellow Warbler	*Dendroica petechia*
Common Yellowthroat	*Geothlypis trichas*
Wilson's Warbler	*Wilsonia pusilla*
Yellow-breasted Chat	*Icteria virens*
Black-headed Grosbeak	*Pheucticus melanocephalus*
Blue Grosbeak	*Guiraca caerulea*
Song Sparrow	*Melospiza melodia*

Appendix 2. Point count transect codes, dates of 2000 visits, GPS locations and route maps.

Appendix 2 – Table A. Point count transects, 4-letter codes, number of points, number of points established each year and census dates in 2000. 1998 & 1999 census dates in Heath and Ballard 1999a, 1999b.

Site	Code	# points	points est. 98/99/00	Visit 1	Visit 2	Visit 3
Ash Creek	ASHC	9	9/0/0	21-May	6-Jun	19-Jun
Bairs Creek - South Fork	BAIR	15	15/0/0	23-May	16-Jun	30-Jun
Birch Creek - Lower	BIRL	9	9/0/0	28-May	12-Jun	25-Jun
Birch Creek - Upper	BIRU	10	10/0/0	27-May	10-Jun	25-Jun
Bishop Creek	BISH	13	13/0/0	28-May	16-Jun	23-Jun
Buttermilk Country	BUTT	8	8/0/0	25-May	11-Jun	28-Jun
Clark Canyon	CLAR	10	10/0/0	9-Jun	18-Jun	30-Jun
Convict Creek	CONV	12	12/0/0	1-Jun	15-Jun	30-Jun
Dechambeau Creek	DECH	5	5/0/0	4-Jun	18-Jun	1-Jul
Green Creek	GREE	15	11/4/ -	12-Jun	19-Jun	1-Jul
Hogback Creek - Lower	HOGL	15	0/15/0	23-May	8-Jun	25-Jun
Hogback Creek - Upper	HOGB	15	15/0/0	23-May	8-Jun	26-Jun
Horton Creek	HORT	15	15/0/0	6-Jun	22-Jun	28-Jun
Independence Creek	INDE	15	15/0/0	30-May	15-Jun	27-Jun
Indian Spring	INDI	8	8/0/0	29-May	15-Jun	27-Jun
Lee Vining Creek - Lower	LEEL	15	0/15/0	5-Jun	20-Jun	29-Jun
Lee Vining Creek - Middle	LEEM	11	11/0/0	3-Jun	21-Jun	6-Jul
Lee Vining Creek - Upper	LEEU	13	13/0/0	2-Jun	19-Jun	29-Jun
Lone Pine Creek	LONE	15	11/4/ -	24-May	9-Jun	29-Jun
Lubkin Creek - North Fork	LUBK	9	9/0/0	22-May	14-Jun	27-Jun
Marble Creek	MARB	21	21/0/0	29-May	17-Jun	27-Jun
McGee Creek	MCGE	15	14/1/0	31-May	15-Jun	27-Jun
Mill Creek - Lower	MILL	21	21/0/0	2-Jun	19-Jun	8-Jul
Mill Creek - Upper	MILU	15	13/2/0	7-Jun	20-Jun	2-Jul
Owens River - N. of Mazourka Canyon	ORMC	8	0/15/0	25-May	10-Jun	26-Jun
Owens River - N. of Tinemaha	ORTI	15	0/15/0	25-May	11-Jun	26-Jun
Rock Creek - Lower	ROCK	20	20/0/0	1-Jun	15-Jun	27-Jun
Rush Creek - Lower	RUSL	15	9/7/ -	4-Jun	20-Jun	30-Jun
Rush Creek - Upper	RUSU	17	17/0/0	3-Jun	18-Jun	1-Jul
Sawmill Creek	SAWM	12	12/0/0	26-May	9-Jun	29-Jun
Shepherd Creek	SHEP	15	15/0/0	29-May	16-Jun	26-Jun
Taboose Creek	TABO	19	19/0/0	1-Jun	13-Jun	1-Jul
Thibault Creek	THIB	15	14/1/0	26-May	14-Jun	23-Jun
Tuttle Creek	TUTT	15	15/0/0	24-May	13-Jun	27-Jun
Walker Creek	WALK	9	9/0/0	20-May	5-Jun	23-Jun
Wilson Creek - Lower	WILL	18	18/0/0	30-May	20-Jun	28-Jun
Wilson Creek - Upper	WILU	18	18/0/0	30-May	17-Jun	28-Jun
37 transects		505 pts			111 census days	

Appendix 2 – Table B. GPS locations of all point count stations, 1998-2000, in decimal degrees, NAD83.

station	site	lat	lon	station	site	lat	lon	station	site	lat	lon
ASHC	1	36.38711	-118.03043	BUTT	2	37.30476	-118.61334	HOGB	9	36.61971	-118.20230
ASHC	2	36.38846	-118.03239	BUTT	3	37.30374	-118.61524	HOGB	10	36.61968	-118.20462
ASHC	3	36.38867	-118.03472	BUTT	4	37.30464	-118.61654	HOGB	11	36.62008	-118.20663
ASHC	4	36.38889	-118.03697	BUTT	5	37.29728	-118.62416	HOGB	12	36.62055	-118.20872
ASHC	5	36.38943	-118.03901	BUTT	6	37.29724	-118.62108	HOGB	13	36.62135	-118.21057
ASHC	6	36.38967	-118.04110	BUTT	7	37.29761	-118.61845	HOGB	14	36.62161	-118.21253
ASHC	7	36.38991	-118.04325	BUTT	8	37.29830	-118.61576	HOGB	15	36.62131	-118.21473
ASHC	8	36.38985	-118.04531	CLAR	1	38.27005	-119.19215	HOGL	1	36.64770	-118.14544
ASHC	9	36.38976	-118.04768	CLAR	2	38.26959	-119.19038	HOGL	2	36.65030	-118.14613
BAIR	1	36.68146	-118.23393	CLAR	3	38.26865	-119.18864	HOGL	3	36.65122	-118.14508
BAIR	2	36.68346	-118.23303	CLAR	4	38.26732	-119.18729	HOGL	4	36.65321	-118.14567
BAIR	3	36.68553	-118.23189	CLAR	5	38.26615	-119.18550	HOGL	5	36.65467	-118.14842
BAIR	4	36.68768	-118.23059	CLAR	6	38.26480	-119.18396	HOGL	6	36.65638	-118.14753
BAIR	5	36.69009	-118.22844	CLAR	7	38.26313	-119.18313	HOGL	7	36.65801	-118.14607
BAIR	6	36.69115	-118.22688	CLAR	8	38.26142	-119.18296	HOGL	8	36.65954	-118.14431
BAIR	7	36.69319	-118.22483	CLAR	9	38.25986	-119.18243	HOGL	9	36.65908	-118.14264
BAIR	8	36.69492	-118.22283	CLAR	10	38.25814	-119.18206	HOGL	10	36.66118	-118.14236
BAIR	9	36.69659	-118.22078	CONV	1	37.59497	-118.85093	HOGL	11	36.66262	-118.14228
BAIR	10	36.69760	-118.21861	CONV	2	37.59612	-118.84848	HOGL	12	36.66455	-118.14093
BAIR	11	36.69770	-118.21589	CONV	3	37.59803	-118.84868	HOGL	13	36.66596	-118.13991
BAIR	12	36.69846	-118.21379	CONV	4	37.60054	-118.84997	HOGL	14	36.66685	-118.13799
BAIR	13	36.69941	-118.21129	CONV	5	37.60267	-118.85040	HOGL	15	36.66830	-118.13666
BAIR	14	36.68017	-118.23612	CONV	6	37.60439	-118.84940	HORT	1	37.37583	-118.57809
BAIR	15	36.67929	-118.23839	CONV	7	37.60678	-118.84863	HORT	2	37.37393	-118.57896
BIRL	1	37.07109	-118.30648	CONV	8	37.60904	-118.84868	HORT	3	37.37247	-118.58002
BIRL	2	37.07247	-118.30942	CONV	9	37.61145	-118.84792	HORT	4	37.37140	-118.58059
BIRL	3	37.07411	-118.31122	CONV	10	37.61307	-118.84561	HORT	5	37.36990	-118.58152
BIRL	4	37.07510	-118.31307	CONV	11	37.61400	-118.84453	HORT	6	37.36835	-118.58255
BIRL	5	37.07613	-118.31525	CONV	12	37.61439	-118.83950	HORT	7	37.36679	-118.58367
BIRL	6	37.07581	-118.31782	DECH	1	38.02018	-119.17361	HORT	8	37.36502	-118.58413
BIRL	7	37.07614	-118.32111	DECH	2	38.02021	-119.17152	HORT	9	37.36307	-118.58442
BIRL	8	37.07597	-118.32385	DECH	3	38.02013	-119.16933	HORT	10	37.36049	-118.58476
BIRL	9	37.07588	-118.32620	DECH	4	38.01936	-119.16694	HORT	11	37.35871	-118.58518
BIRU	1	37.08167	-118.34613	DECH	5	38.01891	-119.16439	HORT	12	37.35689	-118.58601
BIRU	2	37.08018	-118.34454	GREE	1	38.13439	-119.23514	HORT	13	37.35513	-118.58705
BIRU	3	37.07948	-118.34278	GREE	2	38.13534	-119.23336	HORT	14	37.35341	-118.58622
BIRU	4	37.07846	-118.34133	GREE	3	38.13655	-119.23169	HORT	15	37.35145	-118.58621
BIRU	5	37.07771	-118.33952	GREE	4	38.13837	-119.23188	INDE	1	36.78435	-118.29381
BIRU	6	37.07674	-118.33768	GREE	5	38.13992	-119.23120	INDE	2	36.78355	-118.29108
BIRU	7	37.07656	-118.33534	GREE	6	38.14077	-119.22973	INDE	3	36.78236	-118.28818
BIRU	8	37.07647	-118.33283	GREE	7	38.14172	-119.22768	INDE	4	36.78201	-118.28529
BIRU	9	37.07651	-118.33026	GREE	8	38.14265	-119.22562	INDE	5	36.78090	-118.28298
BIRU	10	37.07541	-118.32857	GREE	9	38.14453	-119.22378	INDE	6	36.77984	-118.28077
BISH	1	37.30051	-118.53298	GREE	10	38.14655	-119.22353	INDE	7	36.77913	-118.27815
BISH	2	37.29945	-118.53509	GREE	11	38.14873	-119.22320	INDE	8	36.77885	-118.27506
BISH	3	37.29887	-118.53722	GREE	12	38.12777	-119.23940	INDE	9	36.77905	-118.27184
BISH	4	37.29774	-118.53932	GREE	13	38.12868	-119.23658	INDE	10	36.77820	-118.26864
BISH	5	37.29716	-118.54149	GREE	14	38.13055	-119.23558	INDE	11	36.77827	-118.26559
BISH	6	37.29627	-118.54367	GREE	15	38.13273	-119.23556	INDE	12	36.77938	-118.26258
BISH	7	37.29560	-118.54614	HOGB	1	36.62447	-118.18776	INDE	13	36.77919	-118.25976
BISH	8	37.29427	-118.54815	HOGB	2	36.62290	-118.18915	INDE	14	36.77986	-118.25664
BISH	9	37.29281	-118.55049	HOGB	3	36.62225	-118.19070	INDE	15	36.78042	-118.25353
BISH	10	37.29186	-118.55244	HOGB	4	36.62122	-118.19244	INDI	1	37.94963	-118.86170
BISH	11	37.28996	-118.55383	HOGB	5	36.62010	-118.19427	INDI	2	37.95106	-118.86279
BISH	12	37.28815	-118.55534	HOGB	6	36.61995	-118.19626	INDI	3	37.95260	-118.86397
BISH	13	37.28685	-118.55721	HOGB	7	36.61961	-118.19841	INDI	4	37.95327	-118.86606
BUTT	1	37.30563	-118.61100	HOGB	8	36.61937	-118.20036	INDI	5	37.95308	-118.86833

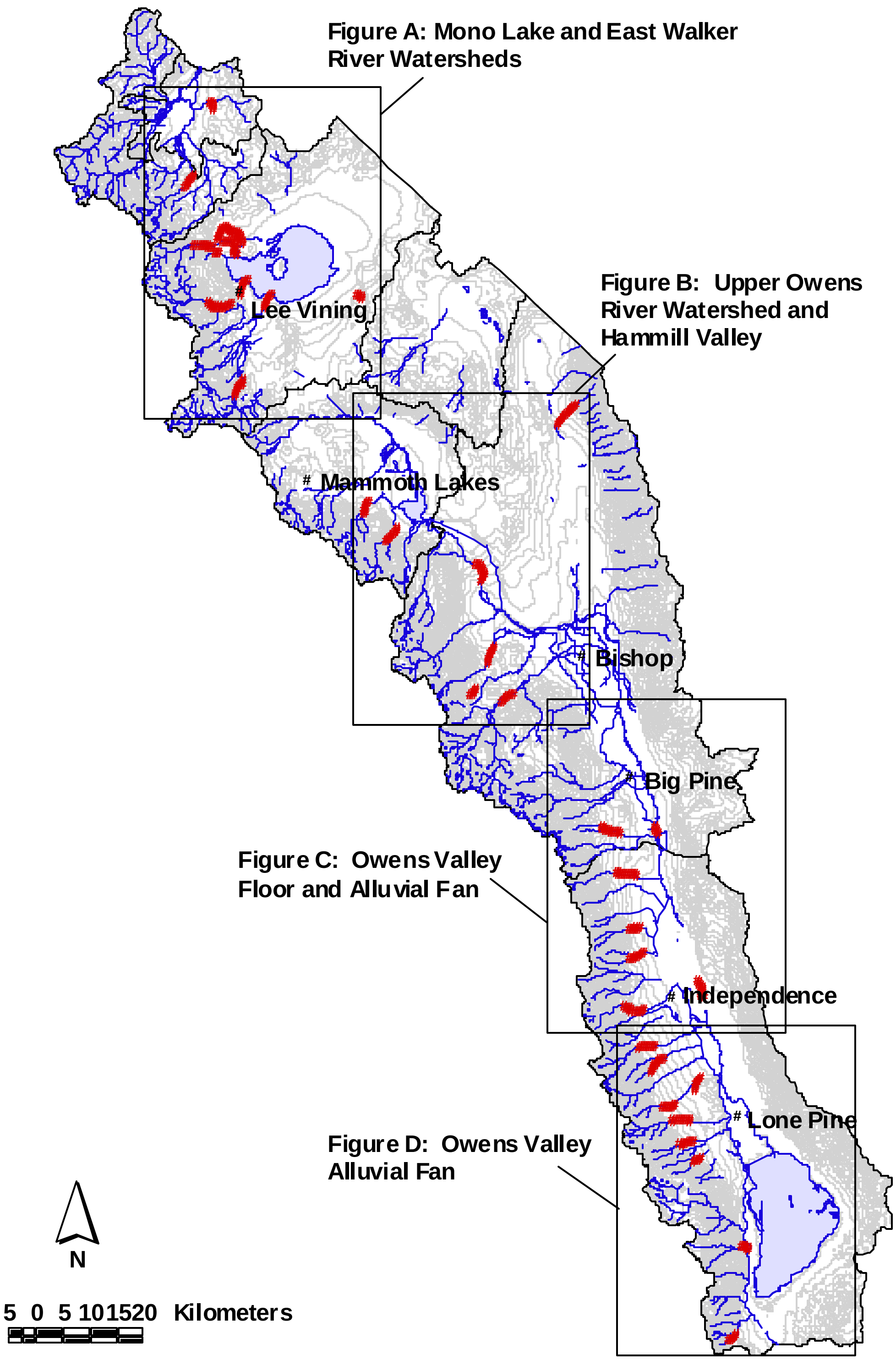
Appendix 2 – Table B. GPS locations of all point count stations, 1998-2000, in decimal degrees, NAD83.

station	site	lat	lon	station	site	lat	lon	station	site	lat	lon
INDI	6	37.95396	-118.87036	LUBK	1	36.52974	-118.14792	MILL	13	38.03774	-119.13667
INDI	7	37.95529	-118.87237	LUBK	2	36.53046	-118.14570	MILL	14	38.03840	-119.13931
INDI	8	37.95496	-118.87441	LUBK	3	36.53143	-118.14386	MILL	15	38.03997	-119.14191
LEEL	1	37.97725	-119.10455	LUBK	4	36.53153	-118.14202	MILL	16	38.03915	-119.14448
LEEL	2	37.97591	-119.10696	LUBK	5	36.53228	-118.14013	MILL	17	38.03919	-119.14716
LEEL	3	37.97441	-119.10907	LUBK	6	36.53249	-118.13794	MILL	18	38.04049	-119.15023
LEEL	4	37.97299	-119.11124	LUBK	7	36.53393	-118.13660	MILL	19	38.04039	-119.15290
LEEL	5	37.97115	-119.11284	LUBK	8	36.53532	-118.13538	MILL	20	38.03943	-119.15535
LEEL	6	37.96954	-119.11401	LUBK	9	36.53705	-118.13334	MILL	21	38.03988	-119.15775
LEEL	7	37.96771	-119.11520	MARB	1	37.74749	-118.44903	MILU	1	38.03275	-119.21911
LEEL	8	37.96589	-119.11559	MARB	2	37.74919	-118.44745	MILU	2	38.03309	-119.21625
LEEL	9	37.96397	-119.11640	MARB	3	37.75083	-118.44615	MILU	3	38.03290	-119.21375
LEEL	10	37.96193	-119.11713	MARB	4	37.75276	-118.44513	MILU	4	38.03275	-119.20926
LEEL	11	37.95966	-119.11718	MARB	5	37.75500	-118.44295	MILU	5	38.03331	-119.20616
LEEL	12	37.95780	-119.11675	MARB	6	37.75656	-118.44126	MILU	6	38.03298	-119.20336
LEEL	13	37.95575	-119.11734	MARB	7	37.75829	-118.43955	MILU	7	38.03326	-119.19996
LEEL	14	37.95351	-119.11770	MARB	8	37.76001	-118.43793	MILU	8	38.03350	-119.19710
LEEL	15	37.95090	-119.11633	MARB	9	37.76180	-118.43638	MILU	9	38.03335	-119.19600
LEEM	1	37.93576	-119.13775	MARB	10	37.76357	-118.43475	MILU	10	38.03213	-119.19180
LEEM	2	37.93641	-119.14039	MARB	11	37.76537	-118.43322	MILU	11	38.03204	-119.18906
LEEM	3	37.93520	-119.14167	MARB	12	37.76678	-118.43121	MILU	12	38.03130	-119.18654
LEEM	4	37.93402	-119.14353	MARB	13	37.76836	-118.42936	MILU	13	38.03086	-119.18376
LEEM	5	37.93279	-119.14497	MARB	14	37.76940	-118.42711	MILU	14	38.03051	-119.18144
LEEM	6	37.93120	-119.14677	MARB	15	37.77077	-118.42509	MILU	15	38.03064	-119.17935
LEEM	7	37.93085	-119.14952	MARB	16	37.77226	-118.42313	ORMC	1	36.80270	-118.13094
LEEM	8	37.92971	-119.15066	MARB	17	37.77371	-118.42107	ORMC	2	36.80466	-118.13277
LEEM	9	37.92800	-119.15297	MARB	18	37.77508	-118.41918	ORMC	3	36.80649	-118.13454
LEEM	10	37.92851	-119.15580	MARB	19	37.77733	-118.41795	ORMC	4	36.80865	-118.13454
LEEM	11	37.92869	-119.15852	MARB	20	37.77867	-118.41587	ORMC	5	36.81127	-118.13360
LEEU	1	37.93730	-119.18500	MARB	21	37.77956	-118.41354	ORMC	6	36.81343	-118.13394
LEEU	2	37.93646	-119.18327	MCGE	1	37.55073	-118.80249	ORMC	7	36.81537	-118.13338
LEEU	3	37.93449	-119.18153	MCGE	2	37.55215	-118.80085	ORMC	8	36.81748	-118.13331
LEEU	4	37.93304	-119.17919	MCGE	3	37.55354	-118.79881	ORMC	9	36.81955	-118.13482
LEEU	5	37.93179	-119.17749	MCGE	4	37.55455	-118.79625	ORMC	10	36.82060	-118.13693
LEEU	6	37.93039	-119.17577	MCGE	5	37.55576	-118.79277	ORMC	11	36.82176	-118.13917
LEEU	7	37.92923	-119.17364	MCGE	6	37.55697	-118.79209	ORMC	12	36.82429	-118.14022
LEEU	8	37.92960	-119.17226	MCGE	7	37.55883	-118.79067	ORMC	13	36.82559	-118.14191
LEEU	9	37.92961	-119.17017	MCGE	8	37.56041	-118.78909	ORMC	14	36.82852	-118.14223
LEEU	10	37.92966	-119.16692	MCGE	9	37.56143	-118.78663	ORMC	15	36.82990	-118.14445
LEEU	11	37.93006	-119.16459	MCGE	10	37.56302	-118.78481	ORTI	1	37.07726	-118.23368
LEEU	12	37.93008	-119.16230	MCGE	11	37.56501	-118.78378	ORTI	2	37.07889	-118.23484
LEEU	13	37.92958	-119.16138	MCGE	12	37.56670	-118.78361	ORTI	3	37.08108	-118.23566
LONE	1	36.59825	-118.17927	MCGE	13	37.56770	-118.78274	ORTI	4	37.08364	-118.23634
LONE	2	36.59882	-118.17626	MCGE	14	37.56923	-118.78370	ORTI	5	37.08581	-118.23536
LONE	3	36.59931	-118.17381	MCGE	15	37.57112	-118.78376	ORTI	6	37.07494	-118.23353
LONE	4	36.59780	-118.17133	MILL	1	38.01647	-119.12600	ORTI	7	37.07332	-118.23178
LONE	5	36.59808	-118.16859	MILL	2	38.01775	-119.12840	ORTI	8	37.07244	-118.22949
LONE	6	36.59859	-118.16619	MILL	3	38.01873	-119.13114	ROCK	1	37.48560	-118.60305
LONE	7	36.59861	-118.16372	MILL	4	38.02053	-119.13297	ROCK	2	37.48743	-118.60201
LONE	8	36.59922	-118.16111	MILL	5	38.02333	-119.13366	ROCK	3	37.48941	-118.60101
LONE	9	36.59869	-118.15874	MILL	6	38.02568	-119.13339	ROCK	4	37.49114	-118.59966
LONE	10	36.59764	-118.15632	MILL	7	38.02754	-119.13278	ROCK	5	37.49325	-118.59827
LONE	11	36.59632	-118.15437	MILL	8	38.02950	-119.13232	ROCK	6	37.49517	-118.59740
LONE	12	36.59839	-118.18369	MILL	9	38.03159	-119.13244	ROCK	7	37.49722	-118.59768
LONE	13	36.59782	-118.18664	MILL	10	38.03366	-119.13216	ROCK	8	37.49922	-118.59799
LONE	14	36.59701	-118.18932	MILL	11	38.03583	-119.13217	ROCK	9	37.50096	-118.59926
LONE	15	36.59832	-118.19219	MILL	12	38.03739	-119.13408	ROCK	10	37.50259	-118.60014

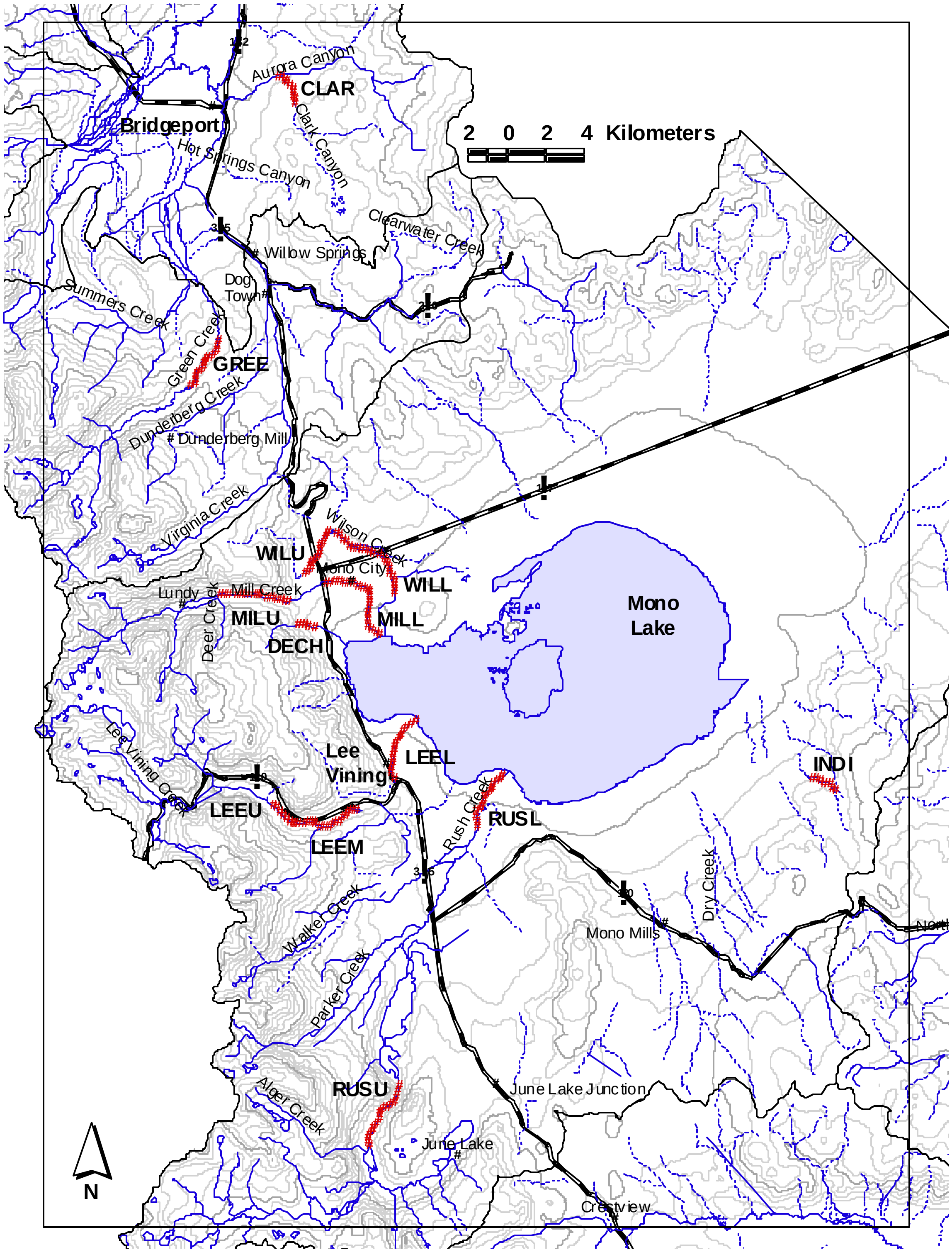
Appendix 2 – Table B. GPS locations of all point count stations, 1998-2000, in decimal degrees, NAD83.

station	site	lat	lon	station	site	lat	lon	station	site	lat	lon
ROCK	11	37.50396	-118.60161	SHEP	3	36.71779	-118.25822	TUTT	11	36.56272	-118.15695
ROCK	12	37.50550	-118.60332	SHEP	4	36.71797	-118.25575	TUTT	12	36.56286	-118.15488
ROCK	13	37.50749	-118.60428	SHEP	5	36.71809	-118.25316	TUTT	13	36.56271	-118.15235
ROCK	14	37.50937	-118.60558	SHEP	6	36.71806	-118.25076	TUTT	14	36.56264	-118.15026
ROCK	15	37.51095	-118.60730	SHEP	7	36.71849	-118.24827	TUTT	15	36.56279	-118.14804
ROCK	16	37.51230	-118.60926	SHEP	8	36.71799	-118.24578	WALK	1	36.24323	-118.05715
ROCK	17	37.51267	-118.61181	SHEP	9	36.71790	-118.24337	WALK	2	36.24177	-118.05882
ROCK	18	37.51285	-118.61422	SHEP	10	36.71806	-118.24101	WALK	3	36.24048	-118.06035
ROCK	19	37.51290	-118.61713	SHEP	11	36.71785	-118.23849	WALK	4	36.23905	-118.06191
ROCK	20	37.51301	-118.61970	SHEP	12	36.71782	-118.23598	WALK	5	36.23794	-118.06354
RUSL	1	37.94397	-119.06369	SHEP	13	36.71833	-118.23373	WALK	6	36.23679	-118.06536
RUSL	2	37.94473	-119.06153	SHEP	14	36.71893	-118.23125	WALK	7	36.23665	-118.06749
RUSL	3	37.94647	-119.06021	SHEP	15	36.71891	-118.22883	WALK	8	36.23627	-118.06968
RUSL	4	37.94782	-119.05857	TABO	1	37.00199	-118.27223	WALK	9	36.23525	-118.07139
RUSL	5	37.94944	-119.05903	TABO	2	37.00267	-118.27433	WILL	19	38.05676	-119.14477
RUSL	6	37.95136	-119.05670	TABO	3	37.00336	-118.27674	WILL	20	38.05592	-119.14245
RUSL	7	37.95157	-119.05493	TABO	4	37.00299	-118.27911	WILL	21	38.05541	-119.14028
RUSL	8	37.95371	-119.05361	TABO	5	37.00299	-118.28173	WILL	22	38.05512	-119.13822
RUSL	10	37.94224	-119.06400	TABO	6	37.00263	-118.28439	WILL	23	38.05499	-119.13608
RUSL	11	37.94014	-119.06483	TABO	7	37.00325	-118.28680	WILL	24	38.05438	-119.13279
RUSL	12	37.93833	-119.06543	TABO	8	37.00348	-118.28925	WILL	25	38.05371	-119.13057
RUSL	13	37.93676	-119.06787	TABO	9	37.00335	-118.29190	WILL	26	38.05284	-119.12775
RUSL	14	37.93437	-119.06799	TABO	10	37.00357	-118.29418	WILL	27	38.05156	-119.12480
RUSL	15	37.93218	-119.06728	TABO	11	37.00354	-118.29678	WILL	28	38.04990	-119.12363
RUSL	16	37.93010	-119.06750	TABO	12	37.00377	-118.29915	WILL	29	38.04867	-119.12229
RUSU	1	37.78314	-119.12484	TABO	13	37.00423	-118.30153	WILL	30	38.04702	-119.12149
RUSU	2	37.78502	-119.12560	TABO	14	37.00433	-118.30409	WILL	31	38.04517	-119.12120
RUSU	3	37.78680	-119.12566	TABO	15	37.00420	-118.30677	WILL	32	38.04346	-119.11943
RUSU	4	37.78854	-119.12495	TABO	16	37.00571	-118.30950	WILL	33	38.04105	-119.11840
RUSU	5	37.79013	-119.12345	TABO	17	37.00682	-118.31162	WILL	34	38.03913	-119.11821
RUSU	6	37.79179	-119.12286	TABO	18	37.00764	-118.31412	WILL	35	38.03741	-119.11803
RUSU	7	37.79328	-119.12151	TABO	19	37.00816	-118.31653	WILL	36	38.03559	-119.11782
RUSU	8	37.79557	-119.12074	THIB	1	36.87410	-118.25622	WILU	1	38.04431	-119.17012
RUSU	9	37.79801	-119.12023	THIB	2	36.87331	-118.25840	WILU	2	38.04475	-119.16783
RUSU	10	37.79949	-119.11918	THIB	3	36.87282	-118.26062	WILU	3	38.04590	-119.16644
RUSU	11	37.80050	-119.11750	THIB	4	36.87211	-118.26297	WILU	4	38.04760	-119.16739
RUSU	12	37.80108	-119.11549	THIB	5	36.87090	-118.26471	WILU	5	38.04890	-119.16687
RUSU	13	37.80220	-119.11314	THIB	6	36.87000	-118.26675	WILU	6	38.05005	-119.16487
RUSU	14	37.80365	-119.11172	THIB	7	36.86934	-118.26885	WILU	7	38.05151	-119.16296
RUSU	14	37.81090	-119.10938	THIB	8	36.86899	-118.27119	WILU	8	38.05310	-119.16184
RUSU	15	37.80537	-119.11078	THIB	9	36.86819	-118.27321	WILU	9	38.05494	-119.16121
RUSU	16	37.80801	-119.10973	THIB	10	36.86757	-118.27546	WILU	10	38.05676	-119.16191
RUSUS	17	37.81090	-119.10938	THIB	11	36.86628	-118.27723	WILU	11	38.05791	-119.16027
SAWM	1	36.91193	-118.28877	THIB	12	36.86562	-118.27900	WILU	12	38.06017	-119.15956
SAWM	2	36.91252	-118.28671	THIB	13	36.86507	-118.28110	WILU	13	38.06197	-119.15841
SAWM	3	36.91315	-118.28459	THIB	14	36.86413	-118.28294	WILU	14	38.06266	-119.15707
SAWM	4	36.91406	-118.28257	THIB	15	36.86337	-118.28580	WILU	15	38.06238	-119.15260
SAWM	5	36.91352	-118.28011	TUTT	1	36.55901	-118.17118	WILU	16	38.06102	-119.15051
SAWM	6	36.91403	-118.27812	TUTT	2	36.55841	-118.17278	WILU	17	38.05984	-119.14863
SAWM	7	36.91449	-118.27592	TUTT	3	36.55758	-118.17357	WILU	18	38.05846	-119.14617
SAWM	8	36.91391	-118.27371	TUTT	4	36.55787	-118.17720				
SAWM	9	36.91359	-118.27150	TUTT	5	36.56047	-118.16980				
SAWM	10	36.91381	-118.26911	TUTT	6	36.56124	-118.16770				
SAWM	11	36.91389	-118.26677	TUTT	7	36.56144	-118.16533				
SAWM	12	36.91480	-118.26475	TUTT	8	36.56233	-118.16341				
SHEP	1	36.71688	-118.26275	TUTT	9	36.56272	-118.16121				
SHEP	2	36.71775	-118.26059	TUTT	10	36.56303	-118.15909				

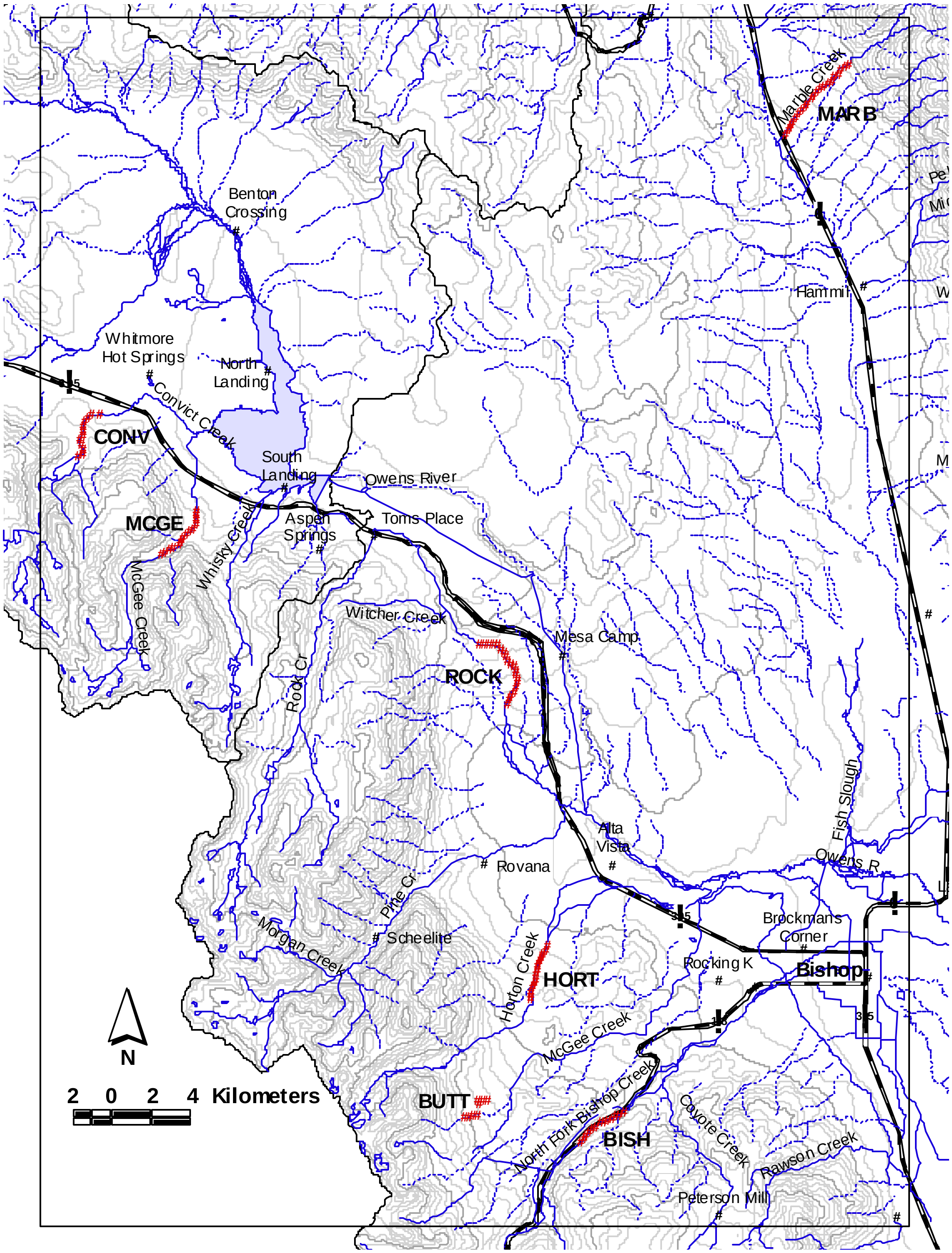
Appendix 2. Point count locations, 1998-2000. Overview map for Figures A – D.



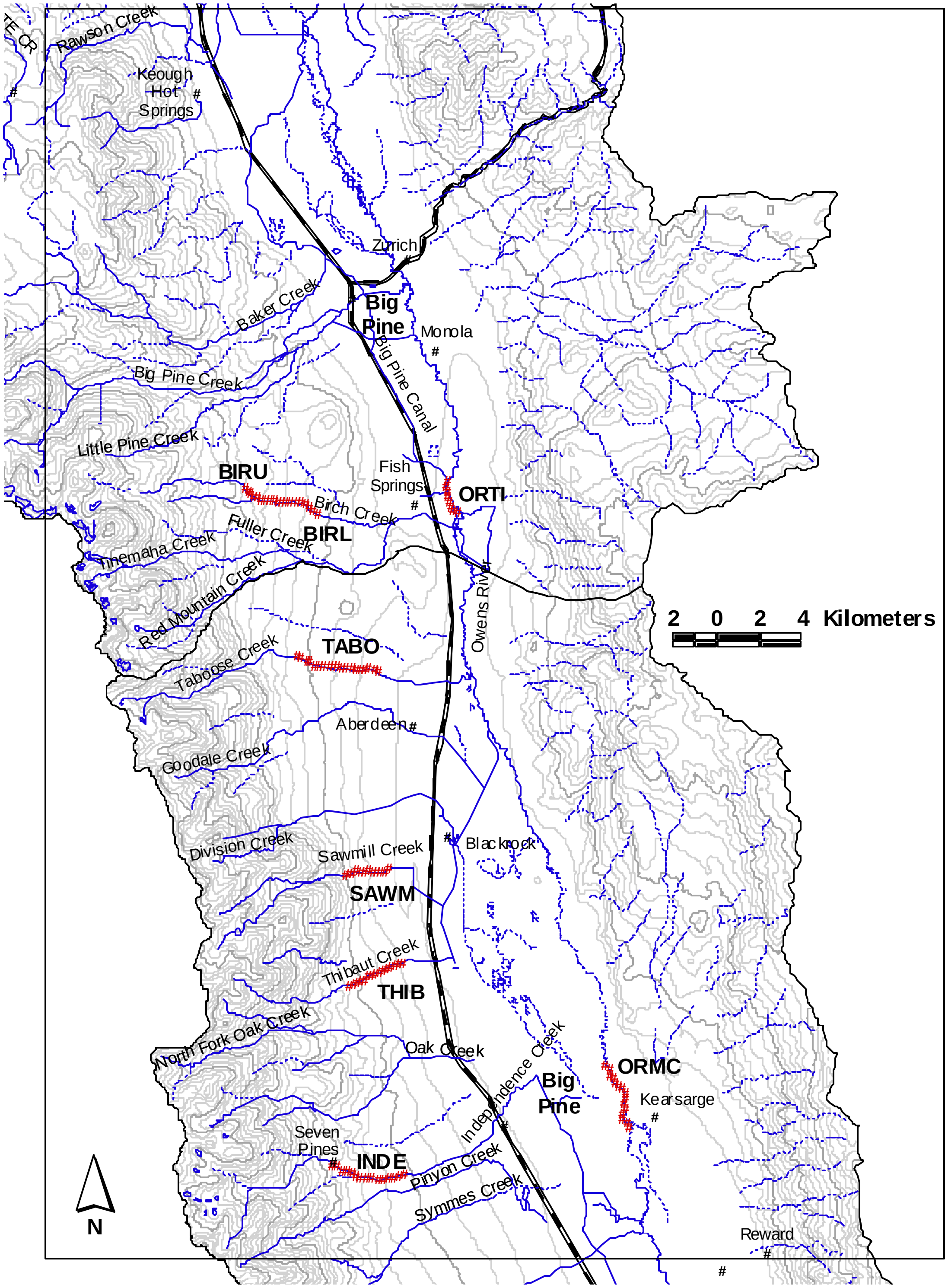
Appendix 2 – Figure A. Mono Lake and East Walker River watershed point count transects, 1998-2000. Four-letter transect codes correspond with Appendix 2 – Table A.



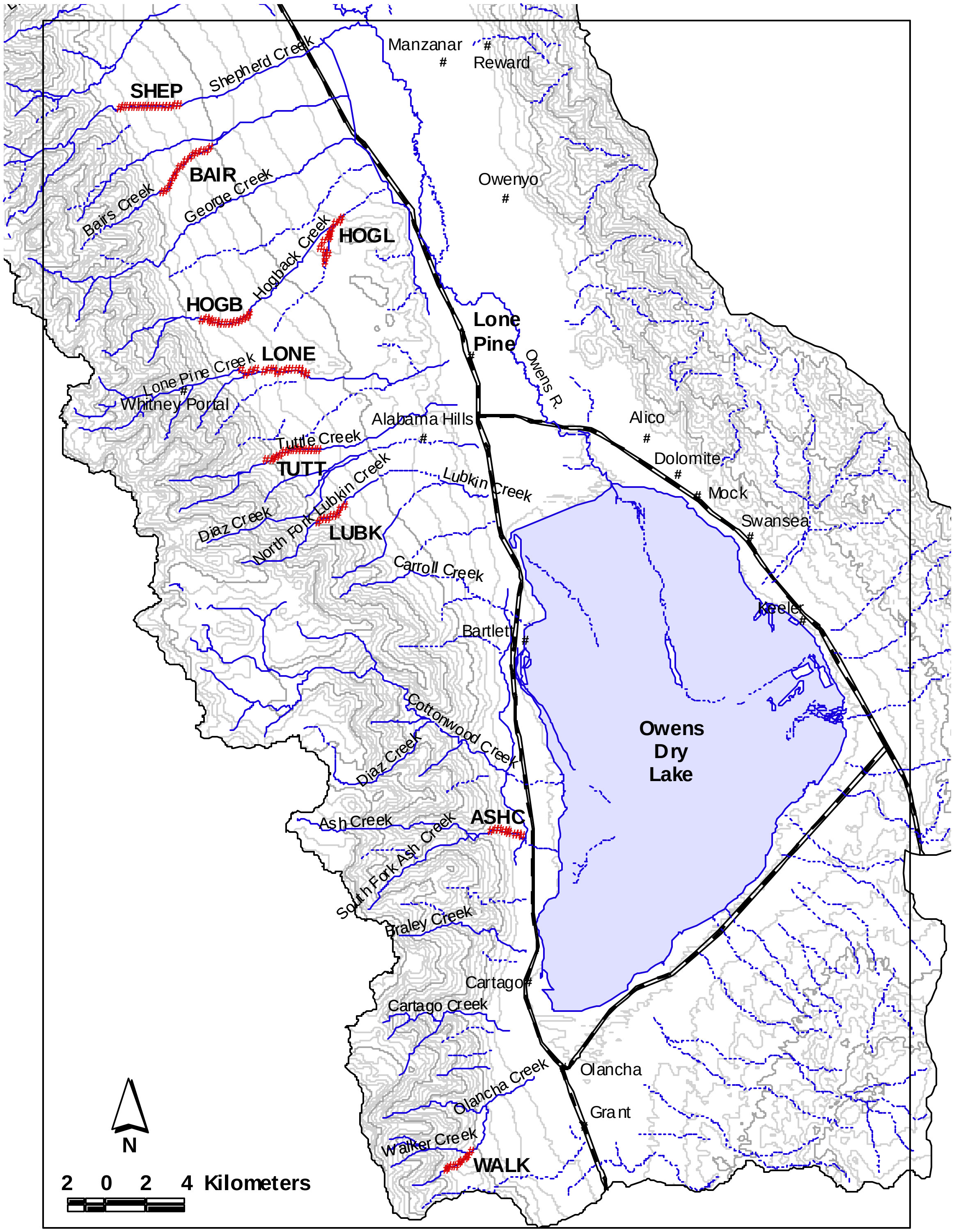
Appendix 2 – Figure B. Upper Owens River watershed and Hammill Valley point count transects, 1998-2000. Four-letter transect codes correspond with Appendix 2 – Table A.



Appendix 2 – Figure C. Owens Valley floor and alluvial fan point count transects, 1998-2000. Four-letter transect codes correspond with Appendix 2 – Table A.



Appendix 2 – Figure D. Owens Valley alluvial fan point count transects, 1998-2000. Four-letter transect codes correspond with Appendix 2 – Table A.



Appendix 3. Areas search plot and census descriptions, 1998-2000.

Appendix 3 – Table A. Area search sites, number of sub-plots, total plot size, year and census dates, 1998-2000.

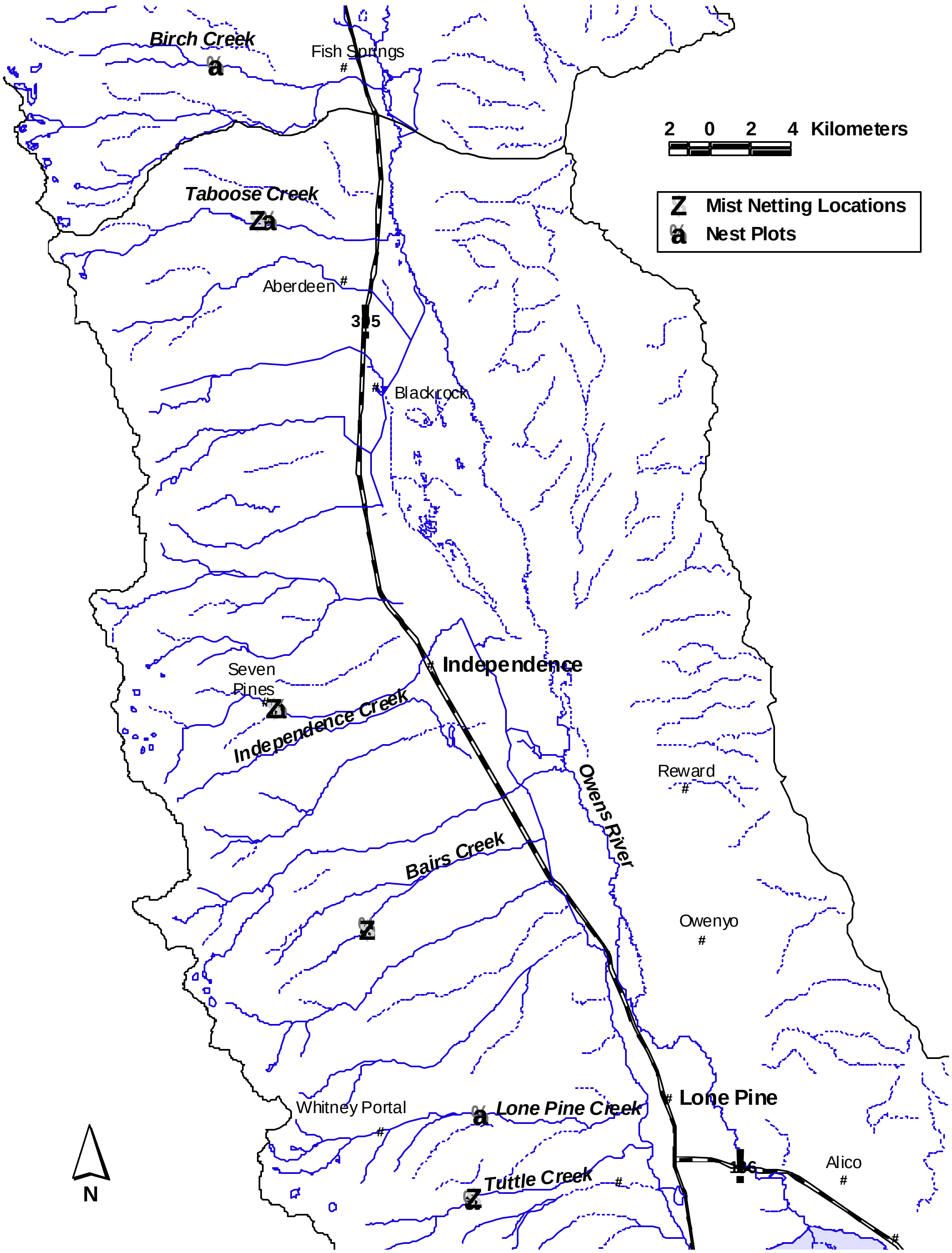
Site	# Sub plots	Total plot size (ha)	Year	Visit 1	Visit 2	Visit 3
Buttermilk Country	4	9	1998	28-May	9-Jun	~
Lee Vining Creek	3	6	1998	4-Jun	18-Jun	2-Jul
			1999	13-Jun	25-Jun	13-Jul
Mill Creek	3	14	1998	12-Jun	25-Jun	9-Jul
Rush Creek	3	14	1998	8-Jun	20-Jun	2-Jul
			1999	9-Jun	23-Jun	6-Jul
Wilson Creek	3	9	1998	8-Jun	19-Jun	2-Jul
Thompson Ranch	1	8	2000	16-Jun	22-Jul	~

Appendix 4. Nest plot descriptions and census dates, 1998-2000.

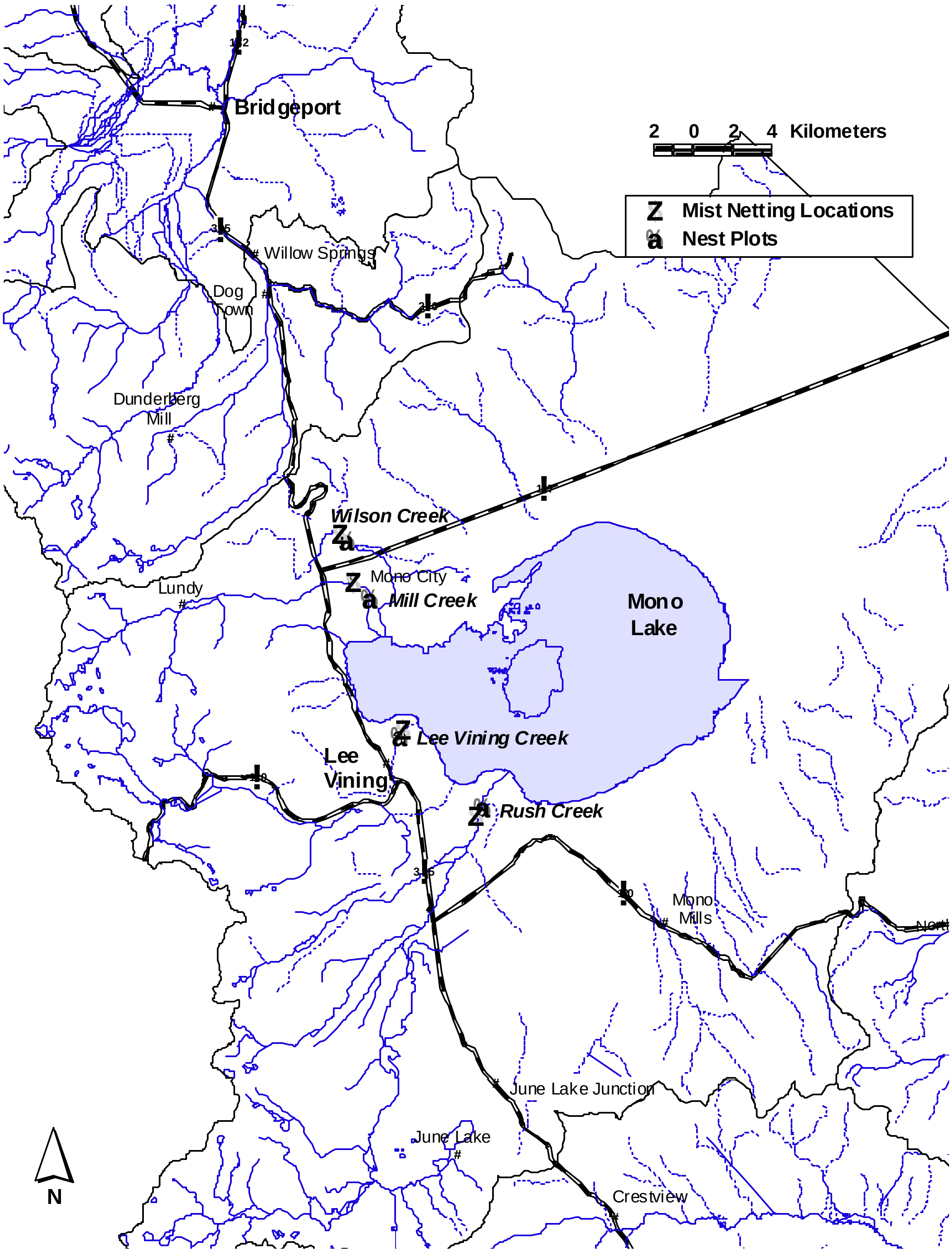
Appendix 4 – Table A. Nest plot sites, size of plots in creek kilometers and hectares, census dates and hours, and number of visits at Owens Valley alluvial fan and Mono Basin sites 1998-2000.

Site	Creek Kilometers	Size of Plot (ha)	Year	Census Period	Total Hours	Total Visits
Owens Valley alluvial fan sites						
Tuttle Creek	1.2	4	1998	May 8 - July 24	52	12
Lone Pine Creek	1.2	4	1998	May 9 - August 3	62	15
Bairs Creek	1.5	4	1998	May 8 - July 15	126	29
Birch Creek	4.6	18	1998	May 8 - July 29	348	83
			1999	May 7 - August 14	391	78
			2000	May 3 - August 9	365	72
Independence Creek	1.35	16	1998	May 9 - August 15	255	55
			1999	May 7 - August 13	526	95
			2000	April 15 - August 11	410	102
Taboose Creek	6.3	10	1998	May 10 - August 16	198	46
			1999	May 8 - August 12	450	81
			2000	May 1 - August 12	424	84
Mono Basin sites						
Rush Creek	2.2	39	2000	May 7 - August 5	232	54
Lee Vining Creek	1.9	24	2000	May 6 - August 2	240	57
Wilson Creek	2.4	15	2000	May 9 - August 6	211	53
Mill Creek	3.0	15	2000	May 8 - August 8	184	49

Appendix 5 – Figure A: Nest plots and mist netting station locations, Owens Valley alluvial fan, 1998-2000.



Appendix 5 – Figure B: Nest plots and mist netting locations, Mono Basin 2000.



Appendix 5. Mist netting sites and census dates, 1998-2000.

Appendix 5 – Table A. Constant effort mist netting locations, year, and census dates per period for each year at Owens Valley alluvial fan and Mono Basin sites 1998-2000.

		Census periods										
Site	Year	1	2	3	4	5	6	7	8	9	10	11
Owens Valley alluvial fan sites												
Independence	1998	7-May	15-May	21-May	2-Jun	11-Jun	23-Jun	30-Jun	14-Jul	22-Jul	31-Jul	10-Aug
Creek	1999	10-May	17-May	24-May	3-Jun	17-Jun	24-Jun	2-Jul	12-Jul	28-Jul	4-Aug	9-Aug
	2000	2-May	15-May	24-May	31-May	14-Jun	21-Jun	30-Jun	11-Jul	20-Jul	2-Aug	9-Aug
Tuttle Creek	1998	9-May	14-May	26-May	1-Jun	13-Jun	25-Jun	7-Jul	15-Jul	24-Jul	2-Aug	11-Aug
	1999	7-May	13-May	21-May	1-Jun	10-Jun	22-Jun	30-Jun	10-Jul	23-Jul	30-Jul	10-Aug
	2000	4-May	14-May	25-May	1-Jun	13-Jun	23-Jun	3-Jul	13-Jul	23-Jul	31-Jul	11-Aug
Taboose Creek	1998	10-May	13-May	22-May	31-May	12-Jun	26-Jun	8-Jul	16-Jul	23-Jul	1-Aug	9-Aug
	1999	9-May	14-May	23-May	2-Jun	18-Jun	27-Jun	1-Jul	11-Jul	24-Jul	5-Aug	12-Aug
	2000	6-May	12-May	22-May	2-Jun	11-Jun	20-Jun	1-Jul	10-Jul	21-Jul	30-Jul	10-Aug
Bairs Creek	1998	8-May	12-May	27-May	3-Jun	14-Jun	24-Jun	9-Jul	17-Jul	25-Jul	3-Aug	12-Aug
	1999	8-May	15-May	22-May	9-Jun	19-Jun	26-Jun	8-Jul	13-Jul	25-Jul	31-Jul	11-Aug
	2000	3-May	13-May	23-May	3-Jun	12-Jun	22-Jun	2-Jul	12-Jul	22-Jul	1-Aug	12-Aug
Mono Basin sites												
Lee Vining Creek	2000	9-May	18-May	29-May	6-Jun	17-Jun	26-Jun	6-Jul	19-Jul	27-Jul	4-Aug	14-Aug
Rush Creek	2000	wind	19-May	30-May	7-Jun	18-Jun	27-Jun	7-Jul	18-Jul	28-Jul	7-Aug	16-Aug
Mill Creek	2000	7-May	17-May	27-May	5-Jun	16-Jun	25-Jun	5-Jul	17-Jul	26-Jul	6-Aug	15-Aug
Wilson Creek	2000	8-May	16-May	26-May	4-Jun	15-Jun	24-Jun	4-Jul	16-Jul	25-Jul	5-Aug	13-Aug

Appendix 7. Breeding status of all species detected at all sites using all methods and observations, May 1 1998 – August 15 2000.

Owens River watershed sites

SPECIES	ASHC	BAIR	BIRL	BIRU	BISH	BUTT	CONV	HOGB	HOGL	HORT	INDE	LONE	LUBK	MCGE	ORMC	ORTI	ROCK	SAWM	SHEP	TABO	THIB	TUTT	WALK
Acorn Woodpecker	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	~	~	~	~
American Crow	~	~	0	0	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	0	~	0	~
American Dipper	~	~	3	~	1	~	1	~	~	~	1	~	~	1	~	2	1	~	~	2	~	~	~
American Goldfinch	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~
American Kestrel	~	0	0	~	2	2	2	~	1	3	0	2	~	1	1	1	~	3	~	0	~	2	0
American Magpie	~	~	0	0	~	0	2	~	2	~	~	~	~	2	1	2	~	~	~	0	~	~	~
American Redstart	~	~	0	0	~	0	~	~	~	~	~	0	~	0	~	~	~	~	~	~	~	~	~
American Robin	~	1	2	1	1	1	1	0	1	0	1	1	~	1	0	0	1	0	0	1	~	2	0
Anna's Hummingbird	2	2	0	~	0	~	~	~	~	~	2	2	~	~	~	~	~	~	~	0	~	2	0
Ash-throated Flycatcher	0	~	0	0	0	~	~	~	3	0	0	~	~	~	1	0	~	0	0	0	2	~	~
Band-tailed Pigeon	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0
Barn Owl	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	3	~	~	~	~	~	~	~
Barn Swallow	0	0	0	0	0	~	~	~	0	~	0	0	~	~	~	~	~	0	~	0	~	~	~
Belted Kingfisher	0	~	0	0	0	0	2	~	~	1	0	~	~	~	~	2	~	~	~	0	~	~	~
Bewick's Wren	2	1	1	1	2	3	2	3	3	3	1	1	3	2	1	1	~	3	2	1	3	1	1
Black Phoebe	0	0	2	0	~	~	~	0	~	0	0	0	~	0	1	1	~	0	0	0	~	0	0
Black Swift	~	0	~	~	~	~	~	0	~	0	0	~	~	~	~	~	~	~	0	0	0	~	~
Black-and-white Warbler	~	~	~	~	~	~	~	~	~	~	0	0	~	~	~	~	~	~	~	0	0	0	~
Black-chinned Hummingbird	2	1	1	1	~	1	2	2	1	2	1	1	0	2	~	~	~	3	2	1	2	2	1
Black-chinned Sparrow	~	~	~	0	~	~	~	~	~	~	~	~	~	~	~	~	~	2	~	~	~	0	0
Black-crowned Night-Heron	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
Black-headed Grosbeak	0	3	1	1	2	1	3	2	2	2	1	0	3	2	~	2	~	2	2	1	2	1	1
Black-throated Gray Warbler	~	0	0	0	~	~	~	0	~	~	0	~	0	~	~	~	~	~	~	0	0	0	0
Black-throated Sparrow	3	2	1	1	~	~	~	~	2	3	1	1	1	~	~	~	~	1	2	1	3	3	0
Blue Grosbeak	~	~	1	0	~	0	~	~	2	2	0	0	~	~	1	2	~	1	0	1	2	~	~
Blue Grouse	~	~	~	~	~	1	~	~	~	~	~	~	~	2	~	~	~	~	~	~	~	~	0
Blue-gray Gnatcatcher	~	1	1	1	~	2	~	1	3	2	1	2	0	~	0	1	~	1	0	1	2	0	0
Brewer's Blackbird	~	~	~	~	~	2	1	~	2	~	0	~	~	1	2	2	~	0	2	0	~	0	~
Brewer's Sparrow	2	1	0	3	2	1	3	2	0	0	0	3	0	1	~	~	~	2	0	2	2	2	0
Broad-tailed Hummingbird	~	0	~	0	~	~	~	0	~	0	0	~	~	~	~	~	~	~	~	0	~	2	2
Brown Creeper	~	~	~	~	~	~	~	~	~	~	~	~	~	1	~	~	~	~	~	~	~	~	~
Brown-headed Cowbird	2	1	1	1	3	1	1	3	3	3	1	3	2	3	3	3	~	3	3	1	3	2	~
Bullock's Oriole	0	0	0	1	1	2	1	~	3	2	1	1	~	3	~	~	0	2	2	0	2	0	0

Confirmed Breeding – 1 Probable Breeding – 3 Possible Breeding – 2 No Evidence of Breeding - 0 Not Detected - ~ (see methods for further explanation of codes)

Appendix X. Breeding status of all species detected at all sites using all methods and observations, May 1 1998 – August 15 2000.

Owens River watershed sites

SPECIES	ASHC	BAIR	BIRL	BIRU	BISH	BUTT	CONV	HOGB	HOGL	HORT	INDE	LONE	LUBK	MCGE	ORMC	ORTI	ROCK	SAWM	SHEP	TABO	THIB	TUTT	WALK
Bushtit	2	1	1	1	1	~	~	3	1	2	1	3	1	~	2	2	~	3	1	1	1	1	1
California Gull	~	~	~	~	~	~	0	~	~	0	~	~	~	~	~	~	0	~	~	0	~	~	~
California Quail	2	1	2	2	2	1	0	3	3	2	1	1	1	0	2	2	2	1	2	1	3	1	2
California Towhee	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0
Calliope Hummingbird	~	1	1	1	3	3	1	2	~	3	1	2	1	1	~	~	~	1	~	1	~	0	2
Canyon Wren	~	~	0	3	~	~	~	~	~	~	~	~	0	~	~	~	1	~	~	~	~	3	0
Caspian Tern	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~
Cassin's Finch	~	0	~	~	1	2	1	~	~	~	~	~	~	2	~	~	~	~	0	~	0	~	~
Cedar Waxwing	0	0	0	~	~	~	0	~	0	~	0	~	~	~	~	~	~	0	~	0	~	0	~
Chestnut-sided Warbler	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	~	~	~	~
Chipping Sparrow	~	1	0	2	0	2	~	~	~	~	0	0	~	~	~	~	~	~	2	0	~	0	0
Chukar	~	0	2	3	~	~	~	~	0	~	~	~	~	~	~	~	~	0	~	0	~	0	0
Cinnamon Teal	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~
Clark's Nutcracker	~	~	0	0	2	~	1	~	~	~	0	~	0	~	~	~	~	~	0	0	~	0	~
Cliff Swallow	1	0	0	0	~	~	0	~	0	0	0	~	~	0	0	0	~	0	~	0	~	~	0
Common Nighthawk	~	0	0	0	~	0	~	0	~	0	0	0	~	0	~	0	~	0	~	0	~	~	0
Common Poorwill	~	~	~	0	~	0	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~
Common Raven	0	1	0	1	1	2	0	0	0	0	1	1	0	1	0	1	0	1	0	0	1	0	0
Common Snipe	~	~	~	~	~	~	~	~	~	~	~	~	~	2	~	0	~	~	~	~	~	~	~
Cooper's Hawk	~	~	~	~	~	~	~	~	0	~	0	~	0	~	~	~	~	~	~	~	~	0	~
Common Yellowthroat	~	0	~	~	~	~	~	~	~	~	~	~	~	~	3	3	~	~	~	~	~	~	~
Costa's Hummingbird	1	1	1	1	~	~	~	~	0	2	3	1	3	1	~	~	~	1	0	1	3	3	2
Dickcissel	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~
Double-crested Cormorant	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~
Downy Woodpecker	~	0	~	~	0	~	~	~	~	~	0	~	~	1	~	~	~	~	~	0	~	0	~
Dusky Flycatcher	0	0	0	0	~	3	2	0	0	0	0	0	~	0	0	~	~	~	0	0	0	0	0
Empidonax species	0	0	~	0	~	~	~	0	~	~	~	0	~	0	~	~	0	0	0	0	0	~	0
European Starling	0	~	0	1	~	0	1	~	0	0	0	~	~	1	1	~	~	0	~	~	~	~	~
Evening Grosbeak	~	~	~	0	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	~	~	~	~
Fox Sparrow	~	~	~	~	2	1	3	~	~	~	0	~	~	3	~	~	~	~	0	0	~	0	0
Gadwall	~	~	0	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~
Golden Eagle	0	~	0	0	~	0	~	~	0	~	0	~	0	0	~	~	~	~	~	0	0	0	0
Golden-crowned Sparrow	~	~	~	~	~	~	~	0	~	~	0	~	~	~	~	~	~	~	~	0	~	~	~

Confirmed Breeding – 1 Probable Breeding – 3 Possible Breeding – 2 No Evidence of Breeding - 0 Not Detected - ~ (see methods for further explanation of codes)

Appendix 7. Breeding status of all species detected at all sites using all methods and observations, May 1 1998 – August 15 2000.

Owens River watershed sites

SPECIES	ASHC	BAIR	BIRL	BIRU	BISH	BUTT	CONV	HOGB	HOGL	HORT	INDE	LONE	LUBK	MCGE	ORMC	ORTI	ROCK	SAWM	SHEP	TABO	THIB	TUTT	WALK
Gray Catbird	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~
Gray Flycatcher	~	0	~	0	~	0	~	0	~	~	0	~	~	~	~	~	~	0	~	0	~	0	0
Gray-crowned Rosy-Finch	~	~	0	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~
Great Blue Heron	~	~	~	~	0	~	~	~	~	~	~	0	~	~	~	0	~	~	~	0	~	~	~
Great-horned Owl	~	~	2	0	~	~	~	~	0	~	~	~	~	~	~	1	~	~	~	~	~	~	~
Great-tailed Grackle	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~
Greater Roadrunner	2	0	0	2	~	~	~	~	~	~	~	3	0	~	0	~	~	2	0	3	2	0	~
Greater Yellowlegs	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~
Green-tailed Towhee	~	2	2	3	1	3	3	0	~	2	3	0	2	1	~	~	~	~	3	0	~	2	2
Hairy Woodpecker	~	1	0	0	2	~	0	0	~	~	1	~	~	1	~	~	~	~	~	0	~	2	0
Hammond's Flycatcher	~	0	0	0	~	~	0	0	0	0	0	0	~	0	~	~	~	0	~	0	0	0	0
Hermit Thrush	0	~	0	0	0	0	0	~	~	~	0	0	~	3	~	~	0	~	~	0	~	0	0
Hermit Warbler	~	0	0	0	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	~	~	0	~
Hooded Oriole	~	0	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~
Horned Lark	~	0	0	0	~	~	~	0	~	~	~	~	~	~	~	~	~	~	~	0	0	~	~
House Finch	0	~	0	0	~	3	~	~	0	~	~	0	~	~	0	~	2	~	~	0	~	~	~
House Sparrow	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	~	~	~	~
House Wren	~	2	0	1	1	3	1	0	1	3	1	2	2	1	0	3	~	~	~	0	~	0	0
Indigo Bunting	0	~	1	0	2	~	~	~	~	~	2	~	~	~	~	~	~	~	~	0	~	0	~
Kentucky Warbler	~	~	~	0	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
Killdeer	~	~	~	~	~	~	~	~	~	~	~	~	~	1	~	3	~	~	~	~	~	~	~
Ladder-backed Woodpecker	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
Lark Sparrow	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~
Lazuli Bunting	3	1	1	1	2	3	3	2	0	3	1	2	3	3	3	3	1	1	3	1	2	2	0
Lazuli X Indigo Bunting hybrid	~	~	0	0	2	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
Le Conte's Thrasher	~	~	~	~	~	~	~	~	~	~	~	~	~	~	2	~	~	~	~	~	~	~	~
Lesser Goldfinch	2	2	1	1	2	3	0	2	3	2	2	1	2	2	0	~	2	2	2	1	2	2	2
Lesser Nighthawk	~	~	0	~	~	~	~	~	0	~	0	~	~	~	0	~	~	~	~	0	~	~	~
Lewis' Woodpecker	~	~	~	0	~	~	1	~	~	0	~	~	~	1	~	~	~	~	~	~	~	~	~
Lincoln's Sparrow	~	~	~	~	~	0	~	~	~	~	0	~	~	~	~	~	~	~	~	0	~	~	~
Loggerhead Shrike	~	0	0	1	~	~	~	0	0	2	0	0	~	~	1	~	~	2	2	3	~	2	~
Long-eared Owl	~	~	~	~	~	3	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	0	~
MacGillivray's Warbler	0	1	2	2	~	2	2	0	~	~	3	2	0	2	~	~	0	0	~	0	2	2	0

Confirmed Breeding – 1 Probable Breeding – 3 Possible Breeding – 2 No Evidence of Breeding - 0 Not Detected - ~ (see methods for further explanation of codes)

Appendix 7. Breeding status of all species detected at all sites using all methods and observations, May 1 1998 – August 15 2000.

Owens River watershed sites

SPECIES	ASHC	BAIR	BIRL	BIRU	BISH	BUTT	CONV	HOGB	HOGL	HORT	INDE	LONE	LUBK	MCGE	ORMC	ORTI	ROCK	SAWM	SHEP	TABO	THIB	TUTT	WALK
Mallard	~	~	0	0	~	~	~	~	~	~	0	~	~	0	~	1	0	~	~	~	~	~	~
Marsh Wren	~	~	~	~	~	~	~	~	~	~	~	~	~	~	2	1	~	~	~	~	~	~	~
Mountain Bluebird	~	~	~	~	0	2	0	~	~	~	~	~	~	1	~	~	0	~	~	~	~	~	~
Mountain Chickadee	~	0	~	~	3	2	1	~	~	~	2	~	3	2	~	~	2	~	~	~	~	0	~
Mountain Quail	~	1	~	~	~	2	~	~	0	~	~	~	0	~	~	~	~	~	1	2	2	2	2
Mourning Dove	3	1	1	1	3	3	0	3	3	3	0	1	3	0	1	0	2	2	2	1	2	1	2
Nashville Warbler	~	~	0	0	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	~	~	0	~
Northern Harrier	~	~	0	1	~	3	~	~	0	0	0	~	~	~	0	0	~	0	~	0	0	0	~
Northern Mockingbird	~	~	~	~	~	~	~	~	~	~	~	~	~	~	2	0	~	~	~	~	~	~	~
Northern Pintail	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	~
Northern Rough-winged Swallow	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	1	2	~	0	0	~	~	~
Nuttall's Woodpecker	~	0	~	~	0	~	~	~	3	~	0	~	~	~	3	2	~	~	~	0	~	0	~
Oak Titmouse	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	2
Olive-sided Flycatcher	0	0	0	0	0	0	2	0	0	0	0	0	0	0	~	~	0	0	0	0	0	0	0
Orange-crowned Warbler	~	1	1	3	2	3	0	2	2	~	1	1	3	3	~	~	~	2	~	0	2	1	2
Oregon Junco	~	0	~	~	~	2	0	~	~	~	0	0	2	~	~	~	0	~	~	~	~	0	~
Phainopepla	0	~	0	0	~	~	~	~	1	~	~	~	~	~	~	~	~	~	~	0	~	~	~
Pied-billed Grebe	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~
Pine Siskin	~	~	~	~	~	0	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
Piñon Jay	~	~	0	0	2	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	0	2
Prairie Falcon	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	0	~	~	~
Red Crossbill	~	0	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
Red-breasted Nuthatch	~	~	0	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	~	~	~	~
Red-breasted Sapsucker	~	~	~	0	3	3	3	~	~	0	0	~	~	2	2	~	~	~	~	0	~	~	~
Red-shafted Flicker	~	1	0	1	2	1	1	~	1	3	1	1	~	1	1	0	0	0	0	0	~	2	~
Red-tailed Hawk	0	0	0	1	~	0	0	0	0	0	0	0	~	1	0	0	1	0	0	0	~	~	0
Red-winged Blackbird	~	~	0	0	~	0	0	~	~	~	0	~	~	3	1	3	0	0	~	~	~	~	~
Ring-billed Gull	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
Rock Dove	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	0	~	~	~
Rock Wren	2	~	1	3	1	0	~	~	~	2	~	3	~	~	~	~	1	~	~	0	~	2	2
Rose-breasted Grosbeak	~	~	0	0	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
Ruby-crowned Kinglet	~	0	0	0	~	~	~	0	~	~	0	~	~	~	~	~	0	~	~	0	~	0	~
Rufous Hummingbird	~	0	0	0	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	0	~	0	~

Confirmed Breeding – 1   Probable Breeding – 3   Possible Breeding – 2   No Evidence of Breeding - 0   Not Detected - ~   (see methods for further explanation of codes)

Appendix 7. Breeding status of all species detected at all sites using all methods and observations, May 1 1998 – August 15 2000.

Owens River watershed sites

SPECIES	ASHC	BAIR	BIRL	BIRU	BISH	BUTT	CONV	HOGB	HOGL	HORT	INDE	LONE	LUBK	MCGE	ORMC	ORTI	ROCK	SAWM	SHEP	TABO	THIB	TUTT	WALK
Sage Sparrow	3	1	1	3	~	0	0	3	2	3	3	3	3	2	2	~	0	1	1	1	1	3	0
Sage Thrasher	~	~	~	~	~	0	0	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
Savannah Sparrow	~	~	~	~	~	1	~	~	~	~	~	~	~	~	~	3	~	~	~	~	~	~	~
Say's Phoebe	~	~	0	~	~	~	~	~	0	~	~	0	~	~	0	0	0	~	~	~	~	~	~
Scott's Oriole	~	~	~	0	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
Sharp-shinned Hawk	~	~	0	0	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	~	~	~	2
Solitary Vireo	~	0	0	0	0	0	2	~	0	~	0	0	2	2	~	~	~	0	~	0	~	0	~
Song Sparrow	~	~	1	1	2	1	1	~	1	~	1	~	~	1	1	1	2	2	~	0	2	2	~
Sora	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~
Spotted Sandpiper	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	0	0	~	~	~
Spotted Towhee	1	1	1	1	1	3	1	1	1	1	1	1	1	3	3	3	3	1	1	1	1	1	3
Steller's Jay	3	1	0	0	3	0	3	2	~	~	1	1	1	0	~	~	1	~	2	1	2	1	3
Summer Tanager	~	~	~	~	~	~	0	~	~	~	0	~	~	~	~	~	~	~	~	0	~	~	~
Swainson's Hawk	~	~	0	~	~	~	~	~	~	~	~	~	~	~	~	1	~	~	~	~	~	~	~
Swainson's Thrush	~	0	0	0	~	0	0	0	~	~	0	0	~	0	~	~	~	~	~	0	~	0	0
Tennessee Warbler	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	~	~	~	~
Townsend's Solitaire	~	0	~	0	~	~	~	~	~	~	0	~	~	0	~	~	2	~	~	~	~	~	0
Townsend's Warbler	0	0	0	0	0	~	0	0	~	0	0	0	0	0	~	~	0	0	~	0	~	0	0
Tree Swallow	~	~	~	~	0	~	1	~	~	0	~	~	~	0	~	~	~	~	~	0	~	~	~
Turkey Vulture	~	0	0	0	0	0	0	~	~	~	0	0	~	0	0	0	0	0	~	0	0	0	~
Vaux's Swift	~	0	0	0	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	0	~	0	~
Vesper Sparrow	~	~	~	~	~	2	0	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
Violet-green Swallow	~	0	0	0	0	~	1	0	0	~	3	0	0	1	0	0	0	0	0	0	~	0	0
Warbling Vireo	0	0	0	1	3	3	1	0	2	2	1	0	1	3	2	0	0	2	~	0	0	3	2
Western Bluebird	~	~	~	~	0	~	~	~	~	~	1	~	~	~	~	~	~	~	~	0	~	~	~
Western Flycatcher	0	0	0	0	0	0	~	~	0	~	0	0	~	3	~	~	0	2	~	0	~	0	0
Western Kingbird	0	0	0	1	0	0	~	0	0	0	0	0	~	~	0	3	~	0	~	0	0	0	0
Western Meadowlark	~	~	0	0	~	3	~	~	~	0	0	~	~	~	2	3	~	~	~	0	~	~	~
Western Scrub-Jay	0	1	0	0	~	~	~	1	0	~	1	1	3	~	0	~	~	~	2	1	2	1	1
Western Tanager	0	1	0	0	3	2	2	0	2	0	1	0	3	0	0	~	1	2	0	0	0	2	3
Western Wood-Pewee	0	0	0	2	1	3	1	2	2	2	1	3	3	3	0	0	3	3	0	0	2	0	2
White-breasted Nuthatch	~	0	~	~	~	~	0	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
White-crowned Sparrow	~	0	0	0	~	3	~	0	~	~	0	0	~	~	~	~	0	~	0	0	0	~	~

Confirmed Breeding – 1   Probable Breeding – 3   Possible Breeding – 2   No Evidence of Breeding - 0   Not Detected - ~   (see methods for further explanation of codes)

Appendix 7. Breeding status of all species detected at all sites using all methods and observations, May 1 1998 – August 15 2000.

Owens River watershed sites

SPECIES	ASHC	BAIR	BIRL	BIRU	BISH	BUTT	CONV	HOGB	HOGL	HORT	INDE	LONE	LUBK	MCGE	ORMC	ORTI	ROCK	SAWM	SHEP	TABO	THIB	TUTT	WALK
White-faced Ibis	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~
White-throated Sparrow	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	~	~	~	~
White-throated Swift	~	0	0	0	~	~	0	0	0	~	0	0	0	~	~	~	1	2	0	0	0	0	0
Willet	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	~
Williamson’s Sapsucker	~	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~	~
Willow Flycatcher	0	0	0	0	~	0	~	0	0	~	0	0	~	0	~	~	~	~	~	0	~	0	0
Wilson's Warbler	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	~	0	0	0	0	0	0	0
Wrentit	~	~	~	~	~	~	~	~	2	~	~	~	~	~	~	~	~	~	~	~	~	~	~
Wood Duck	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	1	~	~	~	~	~	~	~
Yellow Warbler	0	0	1	1	3	1	1	0	3	3	0	0	~	1	2	3	0	0	0	0	0	0	0
Yellow-billed Cuckoo	~	~	0	~	~	~	~	~	0	~	0	~	~	~	~	~	~	~	~	~	~	~	~
Yellow-breasted Chat	~	~	0	0	~	~	~	~	3	~	0	~	~	2	~	3	~	0	~	0	~	~	~
Yellow-headed Blackbird	~	~	~	~	~	~	~	~	~	~	~	~	~	0	0	2	~	~	~	0	~	~	~
Yellow-rumped Warbler	~	0	0	0	3	0	2	0	~	0	0	0	~	0	~	~	~	0	~	0	~	0	0

Confirmed Breeding – 1 Probable Breeding – 3 Possible Breeding – 2 No Evidence of Breeding - 0 Not Detected - ~ (see methods for further explanation of codes)

Appendix 7. Breeding status of all species detected at all sites using all methods and observations, May 1 1998 – August 15 2000.

Mono Basin, west Walker River and Hammil Valley watershed sites

SPECIES	CLAR	DECH	GREE	INDI	LEEL	LEEM	LEEU	MARB	MILL	MILU	RUSL	RUSU	THOM	WILL	WILU
American Avocet	~	~	~	~	0	~	~	~	0	~	~	~	~	~	~
American Coot	~	~	~	~	0	~	~	~	~	~	~	~	~	~	~
American Dipper	~	~	~	~	0	3	3	~	1	2	1	3	~	~	~
American Goldfinch	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~
American Kestrel	~	1	0	0	1	1	2	0	1	3	1	~	3	0	1
American Magpie	~	0	~	~	1	~	0	2	1	~	3	~	1	1	1
American Redstart	~	~	~	~	~	~	~	~	0	~	~	~	~	~	0
American Robin	1	1	1	3	1	1	1	2	1	1	1	1	3	1	1
American Wigeon	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~
Anna’s Hummingbird	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~
Ash-throated Flycatcher	~	~	~	~	~	~	~	~	0	~	~	~	~	0	0
Bald Eagle	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~
Barn Swallow	~	~	~	~	0	~	~	~	0	~	0	~	~	0	0
Belted Kingfisher	~	0	2	~	0	~	~	~	1	~	1	~	~	2	1
Bewick's Wren	3	2	~	3	3	3	0	3	1	0	1	2	3	3	3
Black Phoebe	~	~	~	~	0	~	~	~	~	~	0	~	~	~	~
Black-and-white Warbler	~	~	~	~	0	~	~	~	0	~	~	~	~	~	~
Black-chinned Hummingbird	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0
Black-crowned Night-Heron	~	~	~	~	0	~	~	~	0	0	0	0	~	0	0
Black-headed Grosbeak	1	1	2	2	0	3	3	3	2	3	1	3	~	0	2
Black-necked Stilt	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~
Black-throated Gray Warbler	~	~	~	~	~	0	~	~	~	0	~	~	~	~	~
Black-throated Sparrow	~	~	~	~	~	~	~	1	~	~	0	~	~	~	~
Blue Grosbeak	~	~	~	~	~	~	~	3	0	~	~	~	~	~	~
Blue Grouse	~	3	2	~	~	~	~	~	~	~	~	2	~	~	~
Blue-gray Gnatcatcher	0	~	~	3	0	~	~	2	~	~	0	~	~	0	2
Brewer's Blackbird	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1
Brewer's Sparrow	2	3	3	2	1	0	3	2	3	3	1	3	~	3	1
Brown Creeper	~	~	3	~	~	3	3	~	~	1	~	3	~	~	~
Brown-headed Cowbird	3	3	3	3	1	3	3	3	1	1	1	1	3	1	1
Bullock's Oriole	~	1	0	~	1	0	0	2	1	3	1	1	~	0	2
Bushtit	1	1	~	1	0	~	~	1	1	~	1	0	~	1	0
California Gull	0	0	0	~	0	0	0	~	0	0	0	0	~	0	0

Confirmed Breeding – 1 Probable Breeding – 3 Possible Breeding – 2 No Evidence of Breeding- 0 Not Detected - ~ (see methods for further explanation of codes)

Appendix 7. Breeding status of all species detected at all sites using all methods and observations, May 1 1998 – August 15 2000.

Mono Basin, west Walker River and Hammil Valley watershed sites

SPECIES	CLAR	DECH	GREE	INDI	LEEL	LEEM	LEEU	MARB	MILL	MILU	RUSL	RUSU	THOM	WILL	WILU
California Quail	~	~	~	2	1	~	~	1	0	~	0	~	~	1	0
Calliope Hummingbird	~	~	1	~	~	~	~	~	~	3	~	~	~	~	~
Canyon Wren	0	~	~	~	~	~	~	~	~	~	~	2	~	~	~
Caspian Tern	~	~	0	~	~	~	~	~	0	~	0	~	~	0	0
Cassin's Finch	2	0	1	~	0	3	2	0	1	1	~	2	~	0	2
Cedar Waxwing	~	~	~	~	0	~	~	~	0	0	0	~	~	~	~
Chestnut-sided Warbler	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~
Chipping Sparrow	1	0	2	~	~	~	0	~	~	0	~	~	~	0	0
Cinnamon Teal	~	~	~	~	~	~	~	~	~	~	0	~	~	~	0
Clark's Nutcracker	0	0	2	~	2	0	~	~	0	2	0	0	0	~	~
Cliff Swallow	0	~	~	~	0	~	~	~	0	~	0	~	~	2	0
Common Nighthawk	3	0	~	0	0	~	~	0	0	~	0	~	~	0	0
Common Poorwill	~	1	~	~	~	~	~	~	~	0	~	~	~	0	~
Common Raven	0	~	~	~	0	0	0	0	0	0	0	0	~	0	0
Common Snipe	~	~	~	~	0	~	0	~	2	~	~	~	~	~	0
Common Yellowthroat	~	~	~	~	0	~	0	~	0	~	0	0	~	~	0
Cooper's Hawk	~	~	~	~	0	~	~	~	~	2	~	~	~	~	~
Costa's Hummingbird	2	~	~	~	0	~	~	3	~	0	~	~	~	~	~
Double-crested Cormorant	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~
Downy Woodpecker	~	0	1	~	0	0	1	~	3	1	~	~	~	0	0
Dusky Flycatcher	2	0	0	3	0	~	3	~	0	2	3	3	~	0	0
Eared Grebe	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~
Empidonax species	~	0	~	0	0	0	0	0	0	0	0	~	~	0	0
European Starling	~	1	1	~	0	~	0	~	1	~	0	0	1	0	1
Forster's Tern	~	~	~	~	~	~	~	~	~	~	~	~	~	0	0
Fox Sparrow	~	3	~	~	~	~	3	~	2	1	~	3	~	0	0
Gadwall	~	~	~	~	0	~	~	~	0	~	0	~	~	0	0
Golden Eagle	~	~	~	~	~	~	~	~	~	~	0	0	~	~	~
Gray Catbird	~	~	~	~	~	~	0	~	~	~	~	~	~	~	~
Gray Flycatcher	~	~	~	~	0	~	~	~	0	2	0	2	~	0	0
Great Blue Heron	~	~	~	~	~	~	~	~	0	~	0	~	~	0	0
Great Egret	~	~	~	~	~	~	~	~	~	~	~	0	~	~	~
Great Horned Owl	~	~	~	~	~	~	~	~	2	0	~	~	~	2	0

Confirmed Breeding – 1 Probable Breeding – 3 Possible Breeding – 2 No Evidence of Breeding- 0 Not Detected - ~ (see methods for further explanation of codes)

Appendix 7. Breeding status of all species detected at all sites using all methods and observations, May 1 1998 – August 15 2000.

Mono Basin, west Walker River and Hammil Valley watershed sites

SPECIES	CLAR	DECH	GREE	INDI	LEEL	LEEM	LEEU	MARB	MILL	MILU	RUSL	RUSU	THOM	WILL	WILU
Greater Roadrunner	~	~	~	~	~	~	~	2	~	~	~	~	~	~	~
Green Heron	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0
Green-tailed Towhee	3	1	3	3	1	2	3	~	1	3	1	3	~	1	1
Green-winged Teal	~	~	~	~	0	~	~	~	0	~	0	0	~	0	1
Hairy Woodpecker	~	3	~	~	0	2	3	~	1	3	0	0	0	0	0
Hammond's Flycatcher	~	0	~	~	0	~	0	~	0	~	~	0	~	0	0
Hermit Thrush	~	0	0	~	0	~	2	~	0	2	0	3	~	~	~
Horned Lark	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~
House Finch	0	~	~	2	~	~	~	1	0	~	0	~	~	0	0
House Sparrow	~	~	~	~	~	~	~	~	2	~	~	~	~	~	~
House Wren	1	1	1	~	1	1	1	~	1	1	1	1	3	2	3
Hutton's Vireo	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~
Juniper Titmouse	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~
Killdeer	~	~	2	~	3	~	~	~	1	~	1	~	~	1	0
Lark Sparrow	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~
Lazuli Bunting	~	2	~	~	3	~	2	3	~	2	0	0	3	0	0
Lesser Goldfinch	0	0	~	~	0	~	~	2	0	~	~	0	~	0	0
Lincoln's Sparrow	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0
Loggerhead Shrike	0	~	~	0	0	~	~	2	~	~	0	~	~	~	~
Long-billed Curlew	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~
Long-eared Owl	~	~	~	3	~	~	~	~	0	~	~	~	~	~	0
MacGillivray's Warbler	2	3	~	3	1	0	2	3	2	3	1	2	~	0	2
Magnolia Warbler	~	~	~	~	0	~	~	~	~	~	0	~	~	~	~
Mallard	1	~	~	~	0	~	0	~	0	~	0	0	~	3	1
Marsh Wren	~	~	~	~	~	~	~	~	~	~	~	~	~	~	0
Mountain Bluebird	3	1	1	~	0	~	0	~	~	~	~	2	~	~	~
Mountain Chickadee	1	3	1	~	1	1	1	~	2	1	~	1	0	0	0
Mountain Quail	1	~	~	2	0	~	~	~	2	2	0	0	~	2	0
Mourning Dove	1	0	3	3	0	~	0	3	2	0	1	0	3	3	2
Nashville Warbler	~	~	~	~	0	~	~	~	~	~	~	~	~	~	~
Northern Harrier	~	~	~	~	1	~	~	~	0	~	0	~	~	~	~
Northern Pintail	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~
Northern Rough-winged Swallow	~	~	~	~	0	~	~	~	0	~	2	2	~	0	1

Confirmed Breeding – 1 Probable Breeding – 3 Possible Breeding – 2 No Evidence of Breeding- 0 Not Detected - ~ (see methods for further explanation of codes)

Appendix 7. Breeding status of all species detected at all sites using all methods and observations, May 1 1998 – August 15 2000.

Mono Basin, west Walker River and Hammil Valley watershed sites

SPECIES	CLAR	DECH	GREE	INDI	LEEL	LEEM	LEEU	MARB	MILL	MILU	RUSL	RUSU	THOM	WILL	WILU
Northern Saw-whet Owl	~	~	~	~	0	~	~	~	~	~	~	~	~	~	~
Northern Shoveler	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~
Nuttall's Woodpecker	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~
Olive-sided Flycatcher	~	0	2	~	0	2	~	~	0	2	~	3	~	~	0
Orange-crowned Warbler	2	2	~	~	0	0	2	~	2	1	0	2	~	0	2
Oregon Junco	~	~	1	~	0	1	1	~	~	1	~	3	~	~	0
Osprey	~	~	~	~	1	~	~	~	0	~	0	~	~	0	0
Phainopepla	~	~	~	~	~	~	~	~	~	~	0	~	~	~	0
Pine Siskin	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~
Piñon Jay	3	~	~	2	~	~	~	2	~	~	0	~	~	0	~
Prairie Falcon	~	~	~	~	~	0	~	~	~	~	~	~	~	0	0
Pygmy Nuthatch	~	~	~	~	~	~	1	~	~	0	~	~	~	~	~
Red-breasted Sapsucker	~	1	1	~	2	1	1	~	0	1	~	3	~	0	2
Red-breasted X Red-naped Sapsucker Hybrid	~	1	1	~	~	~	~	~	~	~	~	~	~	~	~
Red-naped Sapsucker	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
Red-shafted Flicker	2	1	1	2	1	3	1	2	1	3	1	1	3	3	3
Red-tailed Hawk	~	0	2	~	0	0	0	~	0	0	0	0	1	0	1
Red-winged Blackbird	~	0	3	~	1	~	3	~	3	3	1	3	~	1	1
Rock Dove	~	~	~	~	0	~	~	~	~	~	~	~	~	~	~
Rock Wren	3	1	~	3	~	~	~	~	~	0	~	~	~	~	2
Rose-breasted Grosbeak	~	~	~	~	~	~	~	~	~	0	~	~	~	0	~
Ruby-crowned Kinglet	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~
Ruddy Duck	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~
Rufous Hummingbird	~	0	~	~	0	~	~	~	0	0	0	~	~	0	0
Sage Grouse	~	~	~	~	~	~	~	~	~	~	~	~	~	0	0
Sage Sparrow	~	~	~	3	~	~	~	1	2	~	2	~	~	2	0
Sage Thrasher	~	~	~	2	0	~	~	~	2	~	0	~	~	3	~
Savannah Sparrow	~	~	~	~	~	~	0	~	~	~	1	~	~	0	3
Say's Phoebe	~	~	~	0	~	~	~	~	~	~	~	~	~	~	~
Snowy Egret	~	~	~	~	~	~	~	~	0	~	0	~	~	0	0
Solitary Vireo	2	~	~	~	~	~	0	~	0	2	0	~	~	~	~
Song Sparrow	1	1	1	1	1	3	1	1	1	1	1	1	2	1	1
Sora	~	~	2	~	~	~	~	~	~	~	~	~	~	~	~

Confirmed Breeding – 1 Probable Breeding – 3 Possible Breeding – 2 No Evidence of Breeding- 0 Not Detected - ~ (see methods for further explanation of codes)

Appendix 7. Breeding status of all species detected at all sites using all methods and observations, May 1 1998 – August 15 2000.

Mono Basin, west Walker River and Hammil Valley watershed sites

SPECIES	CLAR	DECH	GREE	INDI	LEEL	LEEM	LEEU	MARB	MILL	MILU	RUSL	RUSU	THOM	WILL	WILU
Spotted Sandpiper	~	~	3	~	1	~	~	~	3	~	1	2	~	2	~
Spotted Towhee	3	1	3	1	1	0	2	3	1	2	1	2	2	1	1
Steller's Jay	1	3	3	~	2	1	3	~	3	3	0	3	~	~	2
Summer Tanager	~	~	~	~	~	~	~	~	~	~	~	~	0	~	~
Swainson's Thrush	~	0	~	~	0	~	2	~	0	~	0	2	~	0	0
Swamp Sparrow	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~
Townsend's Solitaire	~	~	0	~	0	0	0	~	~	0	~	2	~	~	~
Townsend's Warbler	~	~	0	~	0	~	0	0	0	~	0	0	~	0	0
Tree Swallow	~	0	1	~	0	1	1	~	~	0	~	0	~	~	~
Turkey Vulture	~	~	0	~	0	~	~	~	0	0	0	~	~	0	0
Varied Thrush	~	~	~	~	~	~	~	~	0	~	~	~	~	~	~
Vaux's Swift	~	~	~	~	0	~	~	~	~	~	~	~	~	~	~
Vesper Sparrow	~	~	~	~	~	~	~	~	~	~	~	~	~	2	1
Violet-green Swallow	0	2	1	1	1	0	3	0	2	1	1	2	3	2	0
Virginia Rail	~	~	~	~	0	~	~	~	~	1	~	~	~	~	~
Warbling Vireo	3	1	1	~	3	3	3	3	2	3	2	1	3	0	0
Western Bluebird	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
Western Flycatcher	~	0	3	~	0	~	0	~	0	0	0	2	~	~	0
Western Kingbird	~	~	~	~	0	~	~	~	~	~	0	~	~	0	0
Western Meadowlark	~	1	~	~	~	~	~	2	3	~	0	~	~	2	1
Western Scrub-Jay	~	~	~	1	0	~	~	2	0	~	0	~	~	2	0
Western Tanager	2	2	1	~	2	1	1	0	0	3	0	3	~	0	0
Western Wood-Pewee	1	3	1	0	3	1	1	0	1	1	0	1	0	0	0
White-breasted Nuthatch	~	~	~	~	0	2	0	~	0	1	~	~	~	~	~
White-crowned Sparrow	~	~	~	~	0	~	0	~	0	~	~	0	~	0	0
White-headed Woodpecker	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~
White-throated Swift	~	~	~	~	~	~	~	0	~	~	~	~	~	~	~
Willow Flycatcher	~	0	~	~	0	~	~	~	0	~	2	~	~	~	0

Appendix 7. Breeding status of all species detected at all sites using all methods and observations, May 1 1998 – August 15 2000.

Mono Basin, west Walker River and Hammil Valley watershed sites

SPECIES	CLAR	DECH	GREE	INDI	LEEL	LEEM	LEEU	MARB	MILL	MILU	RUSL	RUSU	THOM	WILL	WILU
Wilson's Phalarope	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~
Wilson's Warbler	0	0	0	0	0	~	0	0	0	2	0	2	~	0	0
Yellow Warbler	~	1	1	~	1	3	3	2	1	1	1	1	2	3	1
Yellow-billed Cuckoo	~	~	~	~	~	~	~	~	~	~	0	~	~	~	~
Yellow-breasted Chat	~	~	~	~	0	~	~	~	0	0	0	~	~	~	~
Yellow-headed Blackbird	~	~	0	~	0	~	1	~	0	~	0	0	~	0	0
Yellow-rumped Warbler	2	0	1	~	0	3	3	~	0	2	0	3	~	0	0

Confirmed Breeding – 1 Probable Breeding – 3 Possible Breeding – 2 No Evidence of Breeding- 0 Not Detected - ~ (see methods for further explanation of codes)

Appendix 8. Heath and Ballard (2001)

RIPARIAN SONGBIRD AND HABITAT RELATIONSHIPS IN THE EASTERN SIERRA NEVADA

DRAFT MANUSCRIPT

Submitted to the proceedings for

THE RIPARIAN HABITAT AND FLOODPLAINS CONFERENCE, MARCH 12-15, 2001, SACRAMENTO, CA.

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ABSTRACT. We conducted point counts and vegetation assessments in riparian habitat over a 250km stretch of the eastern Sierra Nevada between 1998 and 2000. Breeding bird diversity and the presence or absence of selected species was related to several vegetation and landscape features at different scales ranging from the entire study area to specific habitat types within climate zones. In particular, Aspen and Black Willow habitats and tree species richness were positively correlated with breeding bird diversity, as was width of the riparian zone and elevation. Habitat models predicting selected individual species occurrence accurately classified 65-83% of test sites. We discuss implications to management and restoration of riparian habitats in the region.

INTRODUCTION

California's eastern Sierra Nevada encompasses 3 distinct biogeographic regions: the Sierra Nevada, the Great Basin Desert, and the Mojave Desert (Smith 2000). Accordingly, riparian habitats in the area vary, representing elevational, climatic, geomorphological and vegetative diversity (Taylor 1982, Kondolf et al. 1987). Eastern Sierra riparian vegetation provides habitat for up to 75% of local wildlife (Kondolf et al. 1987) and, similar to other riparian habitats throughout the west, songbirds especially benefit (Knopf et al. 1988, Ohmart 1994). Historically, eastern Sierra riparian habitats hosted a wide variety of breeding songbirds, including all 14 California Partners In Flight riparian focal species (CPIF focal species, Fisher 1893, Rowley 1939, Grinnell and Miller 1944, RHJV 2000).

Located mostly in the Mono Lake and Owens River watersheds, riparian habitat within our study area is managed by a host of federal, state and city agencies, including the Bureau of Land Management - Bishop Field Office (BLM), Inyo National Forest (USFS) and the Los Angeles Department of Water and Power (LADWP). Historic and current management of the habitat includes water diversions for hydroelectric projects and the Los Angeles Aqueduct, livestock grazing, recreation, and non-native fish stocking (Brothers 1984, Stine et al. 1984).

Bird-habitat relationships derived from analyses of data from the entire study area should allow us to identify riparian habitat features of importance to songbirds in the bioregion. Similar wide-scale approaches have determined habitat characteristics that influence bird populations at large spatial scales in California's Klamath bioregion (Alexander 1999), the Northern Rocky Mountains (Hutto and Young 1999), and the Columbia Plateau (Holmes and Geupel 2000). Managers can use results derived from these approaches to determine which vegetative features to manage for regionally (Hutto and Young 1999). It is sometimes inappropriate to extrapolate bird-habitat relationships derived from a small study area (Wiens 1981), and large scale conservation efforts are rarely orchestrated from the management unit level where research and monitoring is conducted. Therefore, state and bioregional riparian songbird and habitat conservation efforts (e.g. RHJV 2000) need data derived from larger scale projects to fulfill some of their more general objectives.

There is also justification for taking a finer scale approach. Our study area, and the eastern Sierra in general, is made up of riparian drainages of various geophysical settings and structures, and it is therefore difficult to make generalizations about vegetation across the entire study area (Kondolf et al. 1985, Harris et al. 1987). Also, bird-habitat relationships derived from an area covering numerous habitat types and geomorphologic regions may not be meaningful or applicable to local management efforts. By bracketing our study sites within climate zones and habitat types, we take some of this variation into consideration and are able to offer suggestions to managers at more local scales.

Our efforts fit in the context of ongoing state, regional, and local conservation activities. State riparian habitat and songbird conservation efforts (e.g. RHJV 2000) promote the idea that managing for riparian associated songbirds will benefit other wildlife and the quality of riparian ecosystems in general. Intelligent management of bird populations requires information about the habitat relationships of those populations (Wiens and Rotenberry 1981). Current BLM and USFS landbird monitoring and management plans (BLM 1993, USFS 1996) provide directives to evaluate riparian area suitability for avian species of special concern and to evaluate riparian habitats before implementing management. Primary goals of the LADWP and Inyo County Water Department (ICWD) Lower Owens River Project (LORP) include the establishment of a "healthy, functioning Lower Owens River riverine-riparian ecosystem" while "providing for the continuation of sustainable uses" (LORP 1999). However, we are unaware of any previous investigation of the relationships between riparian habitat features, management practices, and bird numbers in the eastern Sierra. Here we provide some of this information, identifying characteristics of the habitat related to breeding bird species diversity (BBD), and the occurrence of four CPIF focal species: Yellow Warbler (*Dendroica petechia*), Warbling Vireo (*Vireo gilvus*), Song Sparrow (*Melospiza melodia*) and Black-headed Grosbeak (*Pheucticus melanocephalus*). We discuss our results in the context of different spatial scales and their implications to management and restoration activities in the eastern part of the Sierra Nevada bioregion.

METHODS

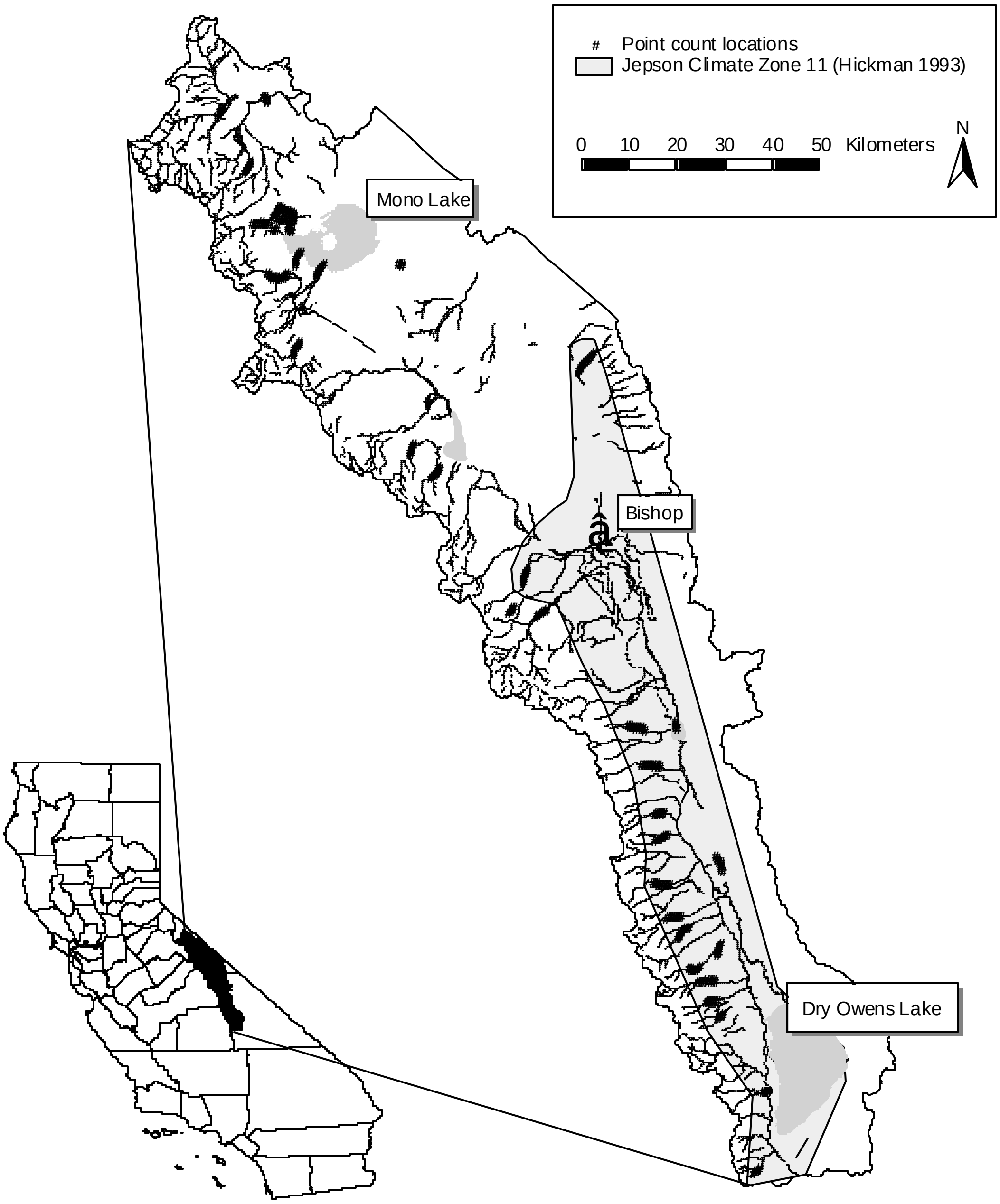
Study area. The study area consists of riparian corridors along 250 km of the eastern Sierra Nevada foothills and western Great Basin regions of California (38º 16' N, 119º 11' W to 36º 14' N, 118º 4' W, Figure 1). The area falls into two Jepson Climate Zones (JCZ, Hickman 1993). Higher elevation sites are mostly within JCZ 2-3, characterized by 150 to 160 d growing seasons and regular frost. These sites are located in the Mono Basin and headwater reaches of the Owens River and East Walker River watersheds. Lower elevation sites are mostly in JCZ 11, characterized by high desert climate with hot, windy summers, longer growing seasons, and harsh temperature variations. These sites are situated along the alluvial fan and floor of the Owens Valley.

Point Counts. We conducted 5 minute 50 m fixed radius point counts at 480 stations in the area, following standards recommended by Ralph et al. (1993, 1995). Thirty-six groups of stations on 28 separate creeks totaling approximately 120 stream-km and 180 ha of riparian habitat were covered. We conducted all counts during the peak songbird breeding season, May 15 to July 10, 1998-2000 (Heath and Ballard 1999a, 1999b). Stations were situated within riparian vegetation following most streams in the area. Stations were placed every 250 m regardless of riparian habitat type, generally with 15 to 20 points on each creek, depending on creek length. In most cases we covered most of the riparian habitat on public lands along these creeks.

All stations were censused three times each season by field biologists familiar with the songs and calls of the birds in the area, and trained in distance estimation. Censuses were conducted from within 30 minutes after local sunrise until approximately 3 hours later, and were not conducted in excessively windy or rainy conditions. All birds detected within a 50 m radius

Figure 1. Study area in the eastern Sierra Nevada, 1998-2000. Dots are locations of individual point count stations. Area inside of hatching is Jepson Climate Zone 11, area outside of hatching is Jepson Climate Zone 2-3 (Hickman 1993).

Figure 1.



of the census station were recorded separately from those greater than 50 m. Breeding status for each species detected was evaluated using a combination of all available data, including nests found, mist netting records, and expert opinion based on behavior.

Habitat Assessments. We collected habitat and vegetation data at all point count stations to determine major structural characteristics which we hypothesized had some logical relationship with bird requirements for nesting or feeding. Following a slightly modified version of the Relevé method described by Ralph et. al (1993), we estimated percent cover by height category for every species of plant located within 50 m of point count stations. Height categories were "herb" (0 - .5 m), "shrub" (.5 - 5 m) and "tree" (> 5 m, > 8 cm DBH). Four hundred and five of these assessments were conducted in 1998, 9 in 1999, and 66 in 2000. We also estimated the width of the riparian zone at the point (riparian width) and the percent of the 50 m radius census area that consisted of riparian plants (percent riparian). We determined elevations at each point using 7.5' USGS topographical maps. Our efforts yielded 170 potential vegetation and habitat variables.

We used our vegetation measurements and guidance provided by Sawyer and Keeler-Wolf (1995) to assign dominant habitat series (habitat types) to each point. The most common riparian habitat types on our study sites in JCZ 2-3 were Montane Wetland Shrub, Aspen, Black Cottonwood and Water Birch. The primary riparian habitat types on our study sites in JCZ 11 were Water Birch, Mixed Willow, Black Cottonwood, Black Willow and Oak Riparian.

Data Analyses. We estimated BBD for each point count station using the transformed Shannon-Wiener index of biological diversity (MacArthur 1965, Krebs 1989) for species we confirmed breeding on our study area. This index of diversity is usually highly correlated with bird species richness, but also takes the number of individuals of each species into account. Higher scores on the Shannon-Wiener index indicate higher species richness and more balanced numbers of individuals of each species added. We further limited the species included in calculation of the diversity index to those which we felt were best counted with the point count protocol. Thus we removed non-territorial species, and species whose territories are typically so large that we could not assure independence of individual observations among points. Nocturnal species were also excluded.

Diversity indices were averaged over the 3 annual visits. We then looked for annual variation in these indices using the Kruskall- Wallis equality of populations rank test (variances on the mean diversity indices were similar). Finding that annual variation was not significant ($\chi^2 = 2.46$, $P = 0.3$), we calculated a mean of annual mean diversities for each point and used that as the dependent variable in a series of pairwise correlations with vegetation measurements. We limited the number of vegetation variables for potential inclusion to the 21 (from 170 possible) which we thought were most likely to contribute to models predicting species diversity, abundance or occurrence (Table 1). This selection process benefited from our field experience on the study area and from work using similar methods in other California riparian study areas. We then used all significant correlates as independent variables to build the most parsimonious model predicting BBD across the entire study area using stepwise, backwards elimination multiple linear regression.

Since combining sites from a large area including a 1377 m elevation gradient and several watersheds may have little biological meaning or application to local land managers (Meents et. al 1983), we bracketed our data set by JCZ and habitat type. Using the same procedure outlined above, we looked for vegetative correlates and predictors of BBD at stations within JCZ 11, JCZ 2-3 and habitat types with large enough sample sizes. We also compared

BBD among habitat types using a one-way ANOVA for each JCZ. When results from ANOVA indicated significant differences among habitat types, we used Kruskall-Wallace tests to evaluate the differences in BBD between specific habitat types in question.

Finally, we selected 4 of the CPIF focal species that breed in the region which are considered to be good indicators of various kinds of riparian habitat (RHJV 2000): Song Sparrow, Yellow Warbler, Black-headed Grosbeak, and Warbling Vireo. For each of these species, we performed pairwise correlations between the number of individuals detected and the same 21 habitat variables. We only included points on transects on which these species occurred at least once during the study. We then used stepwise, backwards elimination multiple logistic regression to assess which of the significantly correlated vegetation variables combined to best predict these species' occurrence (presence or absence) within 50m of point count stations. The models were built using half of the point count stations (odd numbered ones) and their predictive power was assessed by testing them on the other half (even numbered).

All statistical calculations were performed using Stata (Stata Corp. 1999). Significance was assumed at $P = 0.05$, after Bonferroni adjustment when necessary. We square-root or log-transformed the diversity index in all cases to normalize the distribution of residuals of linear regression models and ANOVA's. Residuals from linear regression models and ANOVA's passed Skewness/Kurtosis tests for normality ($P>0.05$) and Cook-Weisenberg tests for heteroscedasticity ($P>0.05$). Logistic regression models passed goodness of fit χ^2 tests ($P > 0.2$).

RESULTS

Relationships between habitat features and breeding bird diversity. We present all correlation coefficients for BBD and the 21 habitat variables we tested in Table 1. Results from the stepwise models built with significant correlates are presented in Table 2.

Entire study area. BBD ranged from 0.7 to 13.3 for the entire study area. Of the 21 habitat variables included in the correlation matrices, 18 were correlated with BBD (15 positively and 3 negatively, $P < 0.05$, Table 1). Once these significant correlates were put through the stepwise regression process and the final linear model was produced, BBD was positively correlated with 6 of these variables: riparian width, tree DBH, elevation, ground cover provided by forbs, and tree cover provided by aspen (*Populus trichocarpa*) and black willow (*Salix goodingii*). Shrub species richness and Jeffrey pine (*Pinus jeffreyi*) cover were negatively correlated with BBD (Table 2A).

Jepson Climate Zones and Sawyer Keeler-Wolf habitat types. BBD ranged from 0.7 – 8.2 in JCZ 11. BBD was negatively correlated with 3 habitat features and positively correlated with 9 habitat features ($P < 0.05$, Table 1). The final model indicates a positive correlation between BBD and percent riparian, riparian width, and cover provided by both black willow trees and willow (*Salix* spp) shrubs, and a negative correlation with shrub species richness ($P < 0.001$, Table 2B).

Table 1. Correlations for breeding bird diversity (Shannon-Weiner Index , mean over 3 annual visits 1998-2000, square root transformed) and 21 habitat variables within 50m at point count stations among seven geographic or habitat types (*n* stations). All coefficients are significant ($P < 0.05$) after Bonferroni adjustment
.

			Jepson Climate Zone 11			Jepson Climate Zone 2/3	
	Entire Study Area	Jepson Climate Zone 11	Water Birch	Mixed Willow	Jepson Climate Zone 2/3	Montane Wetland Shrub	Aspen
Habitat Variable	(477)	(253)	(128)	(77)	(224)	(99)	(56)
riparian width	+.518	+.599	+.333	+.618	+.208		
percent riparian	+.525	+.609	+.308	+.663	+.207		
forb cover	+.355	+.454		+.617	+.264		
grass cover	+.406	+.239			+.256	+.306	
shrub cover							
tree cover	+.399	+.374		+.469	+.322	+.370	
tree height	+.390	+.200			+.276	+.484	
tree DBH	+.415	+.363		+.354	+.288	+.408	
tree spp richness	+.274				+.372	+.500	
shrub spp richness	-.343	-.377		-.424			
herb spp richness	+.258						
willow cover	+.205	+.290		+.363			
water birch shrub cover	-.192	-.196				+.340	
aspen cover	+.428				+.396		
black cottonwood cover							
Jeffrey pine cover	+.207						
water birch tree cover	-.154						
black willow tree cover	+.152	+.453		+.531			
lodgepole pine cover	+.207						
black oak cover				+.245			
elevation	+.475	-.269			+.547	+.562	

Table 2. Breeding bird diversity in relation to habitat features within 50m of point count stations for (A) entire study area, (B) Jepson Climate Zone 11, (C) Water Birch habitat in Jepson Climate Zone 11, (D) Mixed Willow habitat in Jepson Climate Zone 11, (E) Jepson Climate Zone 2/3, and (F) Montane Wetland Shrub habitat in Jepson Zone 2/3. Multiple linear regression models (using stepwise, backward elimination procedure) presented. Breeding bird diversity (Shannon Weiner Index, mean over 3 annual visits 1998-2000, square root transformed) as dependent term in all cases.

Habitat Varible	t	*P* > |t|	Regression Coefficient (ß)	SE (ß)
A. Entire study area (n = 477) *P* < 0.001, $R^2_a = 0.51$				
elevation	8.39	< 0.001	0.0005	0.0001
forb cover	3.90	< 0.001	0.0072	0.0019
aspen tree cover	3.10	0.002	0.0067	0.0022
riparian width	4.94	< 0.001	0.0032	0.0006
black willow tree cover	4.01	< 0.001	0.0157	0.0039
shrub species richness	-2.77	0.006	-0.0180	0.0065
Jeffrey pine cover	-2.28	0.023	-0.0085	0.0037
tree dbh	6.33	< 0.001	0.0034	0.0005
B. Jepson Climate Zone 11 (n = 253) *P* < 0.001, $R^2_a = 0.42$				
percent riparian	2.83	0.005	0.0045	0.0016
shrub species richness	-2.44	0.016	-0.0197	0.0081
riparian width	2.08	0.039	0.0032	0.0015
black willow tree cover	2.38	0.018	0.0084	0.0035
willow shrub cover	2.42	0.016	0.0059	0.0024
C. Water Birch habitat (n = 128) *P* = 0.0001, $R^2_a = 0.10$				
riparian width	3.96	< 0.001	0.0148	0.0037
D. Mixed Willow habitat (n = 77) *P* < 0.001, $R^2_a = 0.46$				
forb cover	2.27	0.026	0.0089	0.0039
percent riparian	3.35	0.001	0.0061	0.0018
E. Jepson Climate Zone 2/3 (n = 224) *P* < 0.001, $R^2_a = 0.36$				
elevation	6.95	< 0.001	0.0013	0.0002
tree species richness	3.41	0.001	0.0820	0.0240
aspen tree cover	3.24	0.001	0.0111	0.0034
tree cover	-2.20	0.029	-0.0051	0.0023
F. Montane Wetland Shrub habitat (n = 99) *P* < 0.001, $R^2_a = 0.40$				
elevation	5.15	< 0.001	0.0016	0.0003
tree species richness	3.96	< 0.001	0.1445	0.0365

Percent riparian and riparian width were positively correlated with BBD at Water Birch stations in JCZ 11 (*P* < 0.05, Table 1), but only riparian width remained in the final model (*P* = 0.0001, Table 2C). BBD at Mixed Willow stations was positively correlated with 8 habitat variables and negatively correlated with 1 (*P* < 0.05, Table 1). Forb cover and percent riparian remained as positive correlates in the final model (*P* < 0.001, Table 2D).

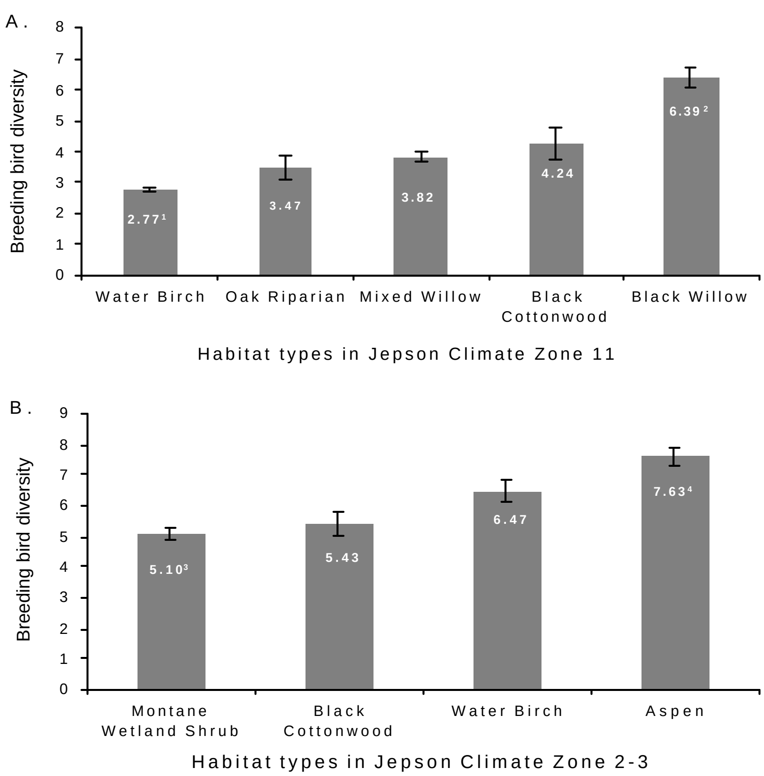
BBD ranged from 1.25 – 13.3 for JCZ 2-3 and was positively correlated with 10 habitat features (*P* < 0.05, Table 1). Elevation, tree species richness and aspen cover remained as positive and tree cover as negative correlates with BBD in the final model (*P* < 0.001, Table 2E).

BBD correlated positively with 7 habitat features at Montane Wetland Shrub sites in JCZ 2-3 ($P < 0.05$, Table 1). Elevation and tree species richness account for variation in BBD in the final model ($P < 0.001$, Table 2F). No significant correlations were determined for BBD and any habitat variables at Aspen sites (Table 1).

Differences in breeding bird diversity between habitat types. Within JCZ 11, BBD was lower at Water Birch sites than at either Black Cottonwood, Mixed Willow or Black Willow sites ($P < 0.005$). Black Willow sites had higher BBD than the other four habitat types ($P < 0.005$). BBD at Black Cottonwood and Mixed Willow sites was not significantly different, and BBD at Oak Riparian sites was not significantly different from BBD at habitat types other than Black Willow (Figure 2A).

Within JCZ 2-3, BBD was higher at Aspen sites than at Montane Wetland Shrub, Black Cottonwood and Water Birch sites ($P < 0.02$). BBD at Black Cottonwood and Montane Wetland Shrub sites were not significantly different and Water Birch sites had higher BBD than the latter ($P < 0.002$, Figure 2B).

Figure 2. Comparisons of breeding bird diversity between habitat types for (A) Jepson Climate Zone 11 and (B) Jepson Climate Zone 2-3. Standard error bars and mean breeding bird diversity displayed for each habitat type. Breeding bird diversity is mean of Shannon-Wiener Index within 50m of point count stations for each habitat type and over 3 annual visits 1998-2000.



[1] Water Birch BBD < all other habitat types ($P < 0.005$) except Oak Riparian ($P = 0.10$), [2] Black Willow BBD > all other habitats ($P < 0.005$), [3] Montane Wetland Shrub BBD < Water Birch and Aspen ($P < 0.002$), [4] Aspen BBD > all other habitats ($P < 0.02$)

Relationships between habitat features and the number of individuals detected and occurrence of 4 CPIF riparian focal species across the entire study area. Numbers of individuals detected for the 4 focal species were significantly correlated with several vegetation and habitat features on the study area (Table 3).

Table 3. Number of individuals detected (mean over 3 annual visits, 1998-2000) of Yellow Warbler, Warbling Vireo, Song Sparrow and Black-headed Grosbeak within 50m, at point count stations in transects where they occur (*n* stations), correlated with 21 habitat variables. All coefficients are significant ($P < 0.05$) after Bonferroni adjustment.

Habitat variable	Yellow Warbler (350)	Warbling Vireo (330)	Song Sparrow (191)	Black-headed Grosbeak (429)
riparian width	+.456	+.231	+.292	
percent riparian	+.463	+.278	+.231	
forb cover				
grass cover	+.379	+.219	+.283	
shrub cover				
tree cover		+.430		
tree height		+.442		
tree DBH		+.350		
tree spp richness		+.352		+.158
shrub spp richness	-.391	-.167	-.414	
herb spp richness	+.196	+.246		
willow cover	+.385		+.266	
water birch shrub cover				
aspen tree cover	+.206	+.523		
black cottonwood tree cover				
Jeffrey pine cover			-.218	
water birch tree cover	-.186			
black willow tree cover			+.254	
lodgepole pine cover		+.240		
black oak cover				
elevation	+.498	+.480		+.150

Logistic regression models which incorporated 2 – 4 of these significant correlates accurately predicted occurrence of the focal species 65 - 83% of the time, and models differed by species (Table 4).

Table 4. Probability of species occurrence in relation to habitat features within 50 m of point count stations for (A) Yellow Warbler, (B) Warbling Vireo, (C) Song Sparrow and (D) Black-headed Grosbeak. Multiple logistic regression models (using stepwise, backward elimination) presented with occurrence of each species (over 3 annual visits, 1998-2000) as the dependent term in all cases. Models built using odd stations (n = 251) and tested on even stations (n = 228), results expressed as % correctly classified.

	Z	$P > \|z\|$	Odds Ratio	SE
A. Yellow Warbler				
LRS (3) = 108.39, $P < 0.001$, Pseudo $R^2 = 0.32$				
Correctly classified: 74.6%				
elevation	4.76	< 0.001	1.0026	0.0005
grass cover	2.39	0.012	1.0240	0.0102
riparian width	4.95	< 0.001	1.0279	0.0057
B. Warbling Vireo				
LRS (3) = 110.04, $P < 0.001$, Pseudo $R^2 = 0.35$				
Correctly classified: 82.9%				
elevation	3.65	< 0.001	1.1003	0.0007
aspen tree cover	2.68	< 0.001	1.1117	0.0439
tree height	3.55	< 0.001	1.0393	0.0113
C. Song Sparrow				
LRS (4) = 98.69, $P < 0.001$, Pseudo $R^2 = 0.30$				
Correctly classified: 74.1%				
grass cover	2.53	0.007	1.0025	0.0120
willow shrub cover	3.04	0.001	1.0482	0.0162
riparian width	2.54	0.005	1.0144	0.0057
shrub species richness	-2.42	0.014	0.8453	0.0588
D. Black-headed Grosbeak				
LRS (2) = 19.49, $P < 0.001$, Pseudo $R^2 = 0.06$				
Correctly classified: 65.4%				
elevation	2.88	0.003	1.0012	0.0004
tree species richness	2.53	0.011	1.3217	0.1460

DISCUSSION

Vegetative features associated with high breeding bird diversity and single species occurrence across the study area. Our results demonstrate that habitats dominated by aspen and black willow trees are bioregionally important, supporting some of the most diverse riparian breeding songbird populations in the eastern Sierra Nevada. This was evident at all spatial scales we examined: for the entire study area, within the two climate zones, and in comparisons between habitats within each climate zone (Table 2, Figure 2). Also, aspen tree cover was highly predictive of the occurrence of Warbling Vireo (Table 4B): a CPIF focal species which is declining in other regions of California (Gardali et al. 2000).

The importance of aspen and black willow habitats in the area should be considered in the context of documented degradation to each. Burton (2000) reported declines in condition and lack of regeneration for a significant number of aspen stands in the Sierra Nevada. He cited several potential contributing factors, including fire suppression, livestock grazing, wild ungulate browsing and conifer succession. Encroachment on remaining Black Willow habitat types along the Owens River by Russian olive (*Elaeagnus angustifolia*) and salt cedar (*Tamarix ramosissima*), and the degradation of this habitat due to water diversions (Brothers 1984) is also of concern, since these sites tended to have high BBD in our study. However, non-native plant removal and native plant revegetation projects are underway (Yamashita 1999, ICWD 2000) as are plans to return water to a 60 mile section of the Owens River (LORP 1999).

Vegetative features associated with high breeding bird diversity and single species occurrence within climate zones and habitat types. Results from these smaller scale analyses not only substantiated findings for the entire study area, but also illuminate habitat features that are important for bird diversity and species occurrence at a finer scale.

Jepson Climate Zone 11. In addition to black willow tree cover, willow shrub cover was correlated with high BBD in JCZ 11 (Table 2B). The importance of willow shrub cover is of particular interest because it is structurally similar to water birch (*Betula occidentalis*), and it co-occurs with water birch as one of the most prevalent alluvial fan riparian vegetation types in the region (Taylor 1982). Yet water birch cover was eliminated from all models by the stepwise regression procedure (Table 2), and BBD at Mixed Willow sites was significantly higher than at Water Birch sites (Fig 2B). Forb cover was positively correlated with BBD in the Mixed Willow model (Table 2D), and this may account for the differences with Water Birch, where forb cover did not play an important role. It has been noted that arroyo willow (S*alix lasiolepis*) is out-competed by water birch in the alluvial fan region (Taylor 1982), and therefore should be of interest when managing for BBD.

Wiens and Rotenberry (1981) warn against using low bird diversity indices and associated habitat features as a means to deem a particular habitat unimportant. We echo this warning and point out that water birch is unique in California as it reaches its southwestern distributional limit in the eastern Sierra (Taylor 1982). Additionally, water birch provides nesting substrate for rather dense populations of breeding Calliope (*Stellula calliope*), Black-chinned (*Archlochus alexandri*) and Costa's (*Calypte costae*) hummingbirds (Heath and Ballard 1999a & 1999b) – species that often go undetected by point counts. Further, Water Birch sites at higher elevations (i.e., in JCZ 2-3) had relatively high BBD (Figure 2).

Jepson Climate Zone 2-3. In addition to aspen tree cover, BBD was correlated positively with tree species richness and negatively with tree cover in JCZ 2-3 (Table 2E). The negative correlation with tree cover is probably driven by sites with very high cover of Jeffrey pine and lodgepole pine (*Pinus contorta*), which had relatively little other riparian vegetation (pers. obs). In addition to these two pines, sites with high tree species richness also had non-conifer species such as black cottonwood (*Populus trichocarpa*), water birch, willow and aspen, as well as small numbers of white fir (*Abies concolor*), juniper (*Juniperus occidentalis*), or piñon pine (*Pinus monophyla*). Sites with high tree species richness in this area are typified by trees of different heights and patchy canopies, and do not necessarily have high overall percentages of tree cover. Managing the over-encroachment of pines, while maintaining tree species richness, should benefit BBD.

Tree species richness was also correlated with BBD in the model for Montane Wetland Shrub habitat of JCZ 2-3 (Table 2F). This suggests that within this willow shrub dominated habitat, managing or restoring for a variety of slightly encroaching, but not dominant, tree species may be important for maintaining BBD. Sites within this habitat type are mostly located at higher elevation moist alluvial outwash meadows (Taylor 1982) and along the lower reaches of Mono Lake's tributary creeks, some of which are undergoing restoration. Tree species richness also predicted the occurrence of Black-headed Grosbeaks over the entire study area, though this model had relatively low explanatory power (Table 4D).

Black Cottonwood and Montane Wetland Shrub habitats had lower BBD than Aspen sites but relatively high BBD compared with most habitat types in JCZ 11 (Figure 2). This is an important consideration for restoration efforts on the lower reaches of Mono Lake’s tributary creeks, where these two habitat types are common. Different bird species may utilize the distinct niches the two habitats provide, therefore restoration efforts and hydrological processes that maintain the characteristics of both habitat types should theoretically maintain higher BBD.

BBD for Water Birch sites in JCZ 2-3 was higher than for Water Birch sites in JCZ 11. It was also significantly higher than BBD in Montane Wetland Shrub habitat (Figure 2). Water Birch sites in JCZ 2-3 differ geomorphologically and hydrologically from their lower elevation counterparts. Most of these sites in JCZ 11 are characterized by stream flows less than about $0.3m^3$ sec $^{-1}$ (Taylor 1982). Water birch in JCZ 2-3 is predominantly found along creeks with higher flow rate, and co-occurs with Jeffrey pines, black cottonwoods and occasionally aspens (Taylor 1982, Kondolf et al. 1985, Stromberg and Patton 1992). These factors may contribute to higher BBD at Water Birch sites in JCZ 2-3.

Landscape correlates with BBD. Two landscape features, elevation and riparian width/percent riparian, contributed to most models predicting BBD and single species occurrence in our study. Abiotic factors such as elevation, climate, topography, and soil type have been demonstrated to influence bird-habitat relationships, and the inclusion of these factors should improve the reliability of bird-habitat models (Irwin 1998). On a continental scale, James et al. (1996) suggested that landbird populations may be regulated by correlates associated with elevation. Knopf (1985) found that riparian bird communities tended to be more diverse at both ends of an elevational continuum. Physical landscape characteristics contribute strongly to vegetative structure of riparian systems in the eastern Sierra (Kondolf et al. 1987).

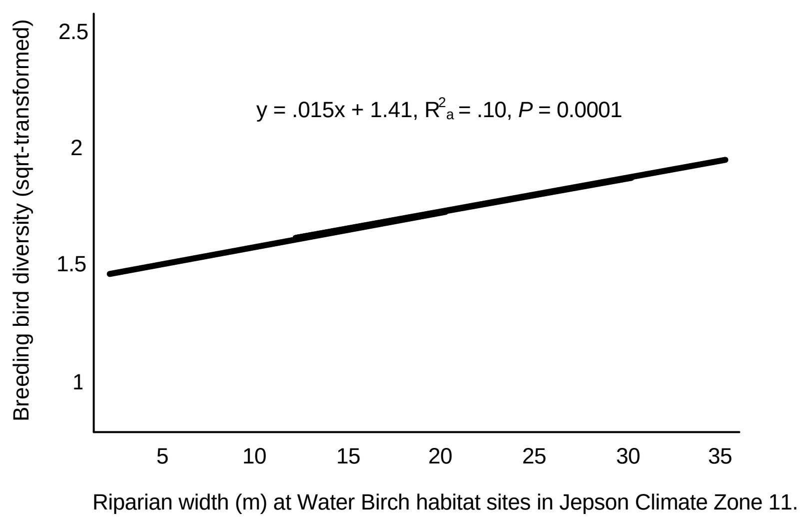
Elevation. Elevation contributed to variation in BBD and the probability of occurrence of Yellow Warblers, Warbling Vireos and Black-headed Grosbeaks across the entire study area. Elevation was also positively correlated with BBD in JCZ 2-3 and Montane Wetland Shrub habitat (Table 2, 4). Across the entire study area, sites located within JCZ 2-3 are generally at higher elevations and had more diverse breeding populations than those within JCZ 11. Similarly, both Yellow Warblers and Warbling Vireos were absent as abundant breeders among most of our sites in JCZ 11, but were relatively abundant at higher elevation sites in JCZ 2-3. In the Mono Basin of JCZ 2-3 and Montane Wetland Shrub habitat types, sites had higher BBD on the upper reaches versus the lower reaches of the same creeks (Heath and Ballard 1999a, 1999b).

Riparian width. Riparian width and/or percent riparian was correlated with BBD for the entire study area, within JCZ 11, both habitat types investigated within Zone 11, and with the occurrence of Yellow Warblers and Song Sparrows across the entire study area (Table 2, 4). In cases where riparian width and percent riparian were highly correlated, only one of the two variables remained in the model. The model where these variables were not correlated (Table 2B) probably reflects sites with patchy riparian vegetation, where the total riparian area was wide, but vegetation such as willow or cottonwoods was interspersed with large areas of grass, water or forb cover. This situation is reflected in the wide but patchy Owens River valley bottom sites.

The importance of riparian width for the entire study area and for JCZ 11 is not surprising. These models incorporated riparian widths ranging from 0 to 100 m and sites across different geophysical settings including glacial valleys, narrowly incised alluvial fan drainages and a river floodplain (Kondolf et al 1985). Additionally, habitat types with high BBD (e.g. Aspen and Black Willow) were generally wider than those with low BBD in JCZ 11 (e.g. Water Birch). Our results also corroborate those of Stauffer and Best (1980), who found that species richness increased with the width of wooded riparian habitats in Iowa.

However, we were surprised by the significance of riparian width in models for Water Birch and Mixed Willow habitat types in JCZ 11. Sites dominated by water birch and willow shrub are characteristically narrow, incised riparian strips with low flow rate (Taylor 1982). Our Water Birch sites, for example, range in width from 1-35m (Figure 3). It is interesting that BBD significantly increased with riparian width within these

Figure 3. Relationship between riparian width and breeding bird diversity for Water Birch habitat sites within Jepson Climate Zone 11, results of linear regression model. Breeding bird diversity is Shannon - Wiener Index, mean over 3 annual visits 1998-2000 square-root transformed.



habitats, even though they had relatively low BBD and geomorphologically-limited potential increase of riparian width (Taylor 1982, Kondolf et al. 1985). We therefore urge managers to maintain riparian width even within these relatively narrow habitats.

Riparian characteristics in relation to stream flows in the eastern Sierra Nevada. We have demonstrated that vegetative cover such as that provided by willow, aspen, forbs and grass, and vegetative characteristics such as tree species richness, tree height and tree DBH accounted for variation in BBD and individual species occurrence. Similarly, landscape features such as riparian width and elevation accounted for variation in bird indices.

There have been several studies assessing correlations between vegetative features and stream diversions in eastern Sierra streams. Taylor (1982) found that average flow, gradient and degree of channel incision accounted for 68% of the variation in riparian width and that average flow alone accounted for 44% of the variance. Harris et al. (1987) argued that riparian width was correlated with floodplain width rather than directly with changes in stream flow. This study also suggested that vegetative thinning or loss of near-stream plants may result from stream diversion and that sites downstream from diversions had significant decreases in shrub and herbaceous cover. Smith et al. (1991) suggested that stream flow diversions, and the subsequent elimination of floods and high flows, may cause long term selective mortality of juvenile plants. Stromberg and Patten (1990) demonstrated a strong relationship between growth rates of riparian trees and annual and prior-year flow volumes, and pointed out the importance of seasonal distribution of flows to riparian tree growth.

As most streams within our study area are diverted for either hydroelectric projects or the Los Angeles Aqueduct (Stine et al. 1984, Brothers 1984, Kondolf et al. 1985), it is important to consider the effects of diversions on vegetation and the subsequent effect on BBD and songbird species occurrence.

CONCLUSIONS

We have produced a series of riparian bird-habitat models for the eastern Sierra Nevada, incorporating a variety of habitat types, spatial scales and bird indices including breeding bird diversity and single species occurrence. We acknowledge the demonstrated limitations of bird-habitat models (Rotenberry 1986), and the use of bird numbers to determine habitat suitability (Van Horne 1983, Wiens and Rotenberry 1981). We also acknowledge the importance of understanding the demographic parameters that most directly influence songbird fitness (such as productivity and survival) and the biological processes that may limit these parameters (e.g. predation and parasitism, Martin 1989, DeSante and Rosenberg 1998). However, we believe that our findings contribute to the current state of knowledge and will assist riparian habitat management and songbird conservation efforts. The accuracy and utility of these models (and proactive conservation in general) can improve with increased communication among researchers and managers (Toth and Baglien 1986, Martin 1995), and continual reevaluation over time.

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Appendix 9 Table A. Mean of total individuals, Shannon-Weiner index of species diversity (SW) and species richness (SR) for breeding species detected within 50m radius circle at individual point count stations, mean of annual means, 1998-2000.

Station	Site	Mean Tot. Ind.	Mean SW	Mean SR
ASHC	1	3.00	1.94	2.00
ASHC	2	5.67	2.80	3.00
ASHC	3	1.67	1.33	1.33
ASHC	4	1.33	0.96	1.00
ASHC	5	1.67	1.30	1.33
ASHC	6	6.00	4.13	4.33
ASHC	7	7.00	4.81	5.33
ASHC	8	6.67	3.23	3.67
ASHC	9	7.00	3.58	4.00
BAIR	1	7.00	3.18	3.67
BAIR	2	9.00	2.76	3.67
BAIR	3	10.33	2.37	3.00
BAIR	4	5.67	2.44	2.67
BAIR	5	5.33	1.83	2.00
BAIR	6	7.67	4.13	4.67
BAIR	7	5.33	2.69	3.00
BAIR	8	2.33	1.67	1.67
BAIR	9	4.33	2.39	2.67
BAIR	10	6.00	2.92	3.33
BAIR	11	6.00	3.04	3.33
BAIR	12	4.00	1.58	1.67
BAIR	13	3.33	2.19	2.33
BAIR	14	5.67	3.11	3.33
BAIR	15	5.67	3.42	3.67
BIRL	1	4.33	2.08	2.33
BIRL	2	3.00	1.79	2.00
BIRL	3	7.33	5.03	5.33
BIRL	4	10.67	5.09	5.67
BIRL	5	4.33	3.19	3.33
BIRL	6	6.33	2.45	3.00
BIRL	7	8.33	4.05	4.67
BIRL	8	6.00	2.44	2.67
BIRL	9	5.33	2.98	3.33
BIRU	1	6.67	3.92	4.33
BIRU	2	5.33	2.99	3.33
BIRU	3	6.33	4.76	5.00
BIRU	4	15.33	7.61	8.33
BIRU	5	3.67	2.52	2.67
BIRU	6	4.33	2.53	2.67
BIRU	7	4.33	2.55	2.67
BIRU	8	11.33	5.15	5.67
BIRU	9	7.00	2.47	3.00
BIRU	10	8.00	4.02	4.33
BISH	1	21.00	10.10	11.67
BISH	2	7.67	3.63	4.33
BISH	3	4.00	2.82	3.00
BISH	4	9.00	4.23	4.67
BISH	5	6.33	4.37	4.67
BISH	6	5.00	4.58	4.67

Station	Site	Mean Tot. Ind.	Mean SW	Mean SR
BISH	7	4.00	2.84	3.00
BISH	8	14.33	5.81	6.67
BISH	9	8.67	4.83	5.33
BISH	10	15.00	7.95	9.00
BISH	11	7.67	5.36	5.67
BISH	12	16.33	6.50	7.33
BISH	13	16.67	8.17	9.67
BUTT	1	17.00	9.18	10.33
BUTT	2	20.67	8.77	10.33
BUTT	3	35.00	10.55	13.67
BUTT	4	33.67	13.34	15.67
BUTT	5	17.67	9.38	11.00
BUTT	6	18.33	11.00	12.00
BUTT	7	20.67	10.98	12.33
BUTT	8	20.33	10.89	12.33
CLAR	1	10.00	6.79	7.33
CLAR	2	21.33	4.99	7.67
CLAR	3	15.33	6.59	7.67
CLAR	4	9.00	4.26	4.67
CLAR	5	16.00	6.28	7.33
CLAR	6	12.00	6.14	7.00
CLAR	7	21.67	4.33	6.00
CLAR	8	16.33	7.06	8.67
CLAR	9	20.00	8.69	10.33
CLAR	10	14.33	6.77	7.67
CONV	1	20.67	8.79	10.33
CONV	2	20.67	7.13	9.00
CONV	3	28.00	7.62	10.00
CONV	4	25.33	7.13	9.33
CONV	5	18.67	5.38	6.33
CONV	6	17.33	7.51	8.67
CONV	7	12.67	6.61	7.33
CONV	8	7.33	5.38	5.67
CONV	9	11.00	5.87	7.00
CONV	10	20.33	9.25	11.33
CONV	11	11.67	7.17	8.00
CONV	12	28.33	10.33	12.33
DECH	1	12.67	7.75	8.33
DECH	2	20.33	9.44	11.00
DECH	3	19.00	8.72	10.33
DECH	4	28.67	8.44	11.00
DECH	5	23.33	8.72	10.67
GREE	1	18.00	7.33	8.33
GREE	2	20.00	8.04	9.33
GREE	3	12.67	6.45	7.33
GREE	4	22.33	7.48	9.33
GREE	5	14.67	4.95	6.67
GREE	6	23.00	9.69	10.67
GREE	7	10.33	5.03	6.00

Appendix 9 Table A. Mean of total individuals, Shannon-Weiner index of species diversity (SW) and species richness (SR) for breeding species detected within 50m radius circle at individual point count stations, mean of annual means, 1998-2000.

Station	Site	Mean Tot. Ind.	Mean SW	Mean SR	Station	Site	Mean Tot. Ind.	Mean SW	Mean SR
GREE	8	11.00	6.61	7.33	HORT	11	8.33	3.64	4.33
GREE	9	6.67	4.01	4.33	HORT	12	9.00	4.05	5.00
GREE	10	23.33	7.61	9.33	HORT	13	12.33	4.57	6.00
GREE	11	23.00	7.26	9.67	HORT	14	13.33	5.51	6.33
GREE	12	25.00	7.92	9.50	HORT	15	18.33	6.43	8.00
GREE	13	12.50	4.16	5.00	INDE	1	15.67	7.65	8.67
GREE	14	29.50	10.15	12.50	INDE	2	7.67	4.29	4.67
GREE	15	19.50	6.75	8.50	INDE	3	9.67	5.49	6.00
HOGB	1	7.67	3.12	4.00	INDE	4	3.33	2.20	2.33
HOGB	2	6.67	2.63	3.00	INDE	5	3.00	3.00	3.00
HOGB	3	9.00	2.66	3.33	INDE	6	5.33	3.56	3.67
HOGB	4	10.67	4.03	5.00	INDE	7	7.33	4.33	4.67
HOGB	5	4.33	2.54	2.67	INDE	8	5.33	2.24	2.67
HOGB	6	5.00	2.41	2.67	INDE	9	5.33	3.80	4.00
HOGB	7	6.00	3.44	3.67	INDE	10	3.33	2.20	2.33
HOGB	8	5.67	3.54	4.00	INDE	11	3.33	2.30	2.33
HOGB	9	8.33	3.11	3.67	INDE	12	5.00	3.82	4.00
HOGB	10	8.33	4.29	4.67	INDE	13	4.33	2.42	2.67
HOGB	11	4.00	2.08	2.33	INDE	14	4.00	2.12	2.33
HOGB	12	4.33	1.33	1.33	INDE	15	4.33	2.87	3.00
HOGB	13	3.33	1.33	1.33	INDI	1	5.67	3.47	3.67
HOGB	14	0.67	0.67	0.67	INDI	2	8.33	3.47	4.33
HOGB	15	2.00	1.00	1.00	INDI	3	8.67	3.95	4.33
HOGL	1	16.00	5.77	7.00	INDI	4	18.00	7.20	8.00
HOGL	2	28.00	8.22	11.00	INDI	5	11.67	5.52	6.00
HOGL	3	21.50	4.87	6.50	INDI	6	14.00	6.69	7.67
HOGL	4	22.00	5.86	8.00	INDI	7	16.67	5.59	6.33
HOGL	5	14.50	5.27	6.50	INDI	8	24.67	5.35	6.67
HOGL	6	11.50	4.91	5.50	LEEL	1	20.00	5.03	6.00
HOGL	7	17.50	7.60	9.00	LEEL	2	5.50	4.90	5.00
HOGL	8	14.50	5.99	7.00	LEEL	3	13.50	5.94	7.00
HOGL	9	16.50	6.94	8.00	LEEL	4	7.00	5.10	5.50
HOGL	10	32.00	8.01	10.50	LEEL	5	18.00	6.70	8.00
HOGL	11	18.50	7.01	8.00	LEEL	6	11.50	3.78	4.50
HOGL	12	13.00	6.63	8.00	LEEL	7	15.00	4.85	5.50
HOGL	13	10.50	8.10	8.50	LEEL	8	8.50	3.84	4.00
HOGL	14	14.00	4.65	6.00	LEEL	9	18.00	4.52	6.00
HOGL	15	2.50	1.95	2.00	LEEL	10	15.50	7.95	9.00
HORT	1	6.67	3.35	3.67	LEEL	11	14.00	5.94	7.00
HORT	2	5.00	3.10	3.33	LEEL	12	16.50	7.39	8.50
HORT	3	5.33	3.06	3.33	LEEL	13	11.50	5.41	6.00
HORT	4	8.00	5.42	5.67	LEEL	14	10.00	6.06	6.50
HORT	5	4.00	3.21	3.33	LEEL	15	5.00	2.73	3.00
HORT	6	4.67	2.54	2.67	LEEM	1	9.00	4.94	5.67
HORT	7	3.00	1.00	1.00	LEEM	2	17.33	7.33	8.00
HORT	8	5.33	2.29	2.67	LEEM	3	11.00	4.58	5.67
HORT	9	8.33	2.97	3.33	LEEM	4	18.00	7.75	9.00
HORT	10	11.67	5.30	6.33	LEEM	5	10.67	5.84	6.33

Appendix 9 Table A. Mean of total individuals, Shannon-Weiner index of species diversity (SW) and species richness (SR) for breeding species detected within 50m radius circle at individual point count stations, mean of annual means, 1998-2000.

Station	Site	Mean Tot. Ind.	Mean SW	Mean SR
LEEM	6	14.67	6.36	7.33
LEEM	7	11.00	5.54	6.33
LEEM	8	19.33	7.92	9.33
LEEM	9	19.00	7.64	9.67
LEEM	10	5.00	3.45	3.67
LEEM	11	6.67	3.75	4.33
LEEU	1	25.33	8.33	10.00
LEEU	2	19.67	7.03	8.00
LEEU	3	22.67	6.98	7.67
LEEU	4	16.67	6.48	7.33
LEEU	5	7.67	4.74	5.33
LEEU	6	7.00	4.48	4.67
LEEU	7	17.33	8.34	9.33
LEEU	8	16.67	8.72	10.00
LEEU	9	13.00	6.46	7.33
LEEU	10	18.67	5.29	7.67
LEEU	11	33.00	12.33	14.67
LEEU	12	10.67	6.21	7.00
LEEU	13	15.33	6.66	8.00
LONE	1	3.33	2.19	2.33
LONE	2	3.00	1.93	2.00
LONE	3	1.67	1.67	1.67
LONE	4	3.67	2.55	2.67
LONE	5	6.00	3.73	4.00
LONE	6	7.33	2.49	3.33
LONE	7	3.00	1.32	1.33
LONE	8	2.67	1.92	2.00
LONE	9	1.67	1.26	1.33
LONE	10	2.00	1.61	1.67
LONE	11	4.00	2.46	2.67
LONE	12	10.00	4.98	5.50
LONE	13	3.00	1.94	2.00
LONE	14	7.50	5.04	5.50
LONE	15	3.50	2.95	3.00
LUBK	1	10.00	5.71	6.33
LUBK	2	9.00	4.60	5.00
LUBK	3	9.67	3.75	4.33
LUBK	4	14.00	5.14	5.67
LUBK	5	5.33	3.32	3.67
LUBK	6	6.33	3.74	4.33
LUBK	7	4.33	3.57	3.67
LUBK	8	3.67	2.58	2.67
LUBK	9	7.67	3.38	3.67
MARB	1	2.33	1.33	1.33
MARB	2	4.00	2.24	2.33
MARB	3	5.00	2.70	3.00
MARB	4	6.00	3.70	4.00
MARB	5	2.33	1.28	1.33
MARB	6	6.00	4.11	4.33
MARB	7	9.33	4.60	5.00
MARB	8	12.33	4.27	5.67
MARB	9	9.33	4.83	5.33
MARB	10	9.67	3.27	4.00
MARB	11	11.00	4.66	5.33
MARB	12	5.33	3.04	3.33
MARB	13	7.33	3.39	3.67
MARB	14	12.33	5.22	6.67
MARB	15	9.33	4.17	5.00
MARB	16	15.67	6.32	7.33
MARB	17	14.33	5.57	6.33
MARB	18	11.33	3.79	4.67
MARB	19	9.33	3.79	4.67
MARB	20	14.67	4.76	6.00
MARB	21	9.00	5.41	5.67
MCGE	1	16.00	6.78	7.67
MCGE	2	11.67	5.17	6.33
MCGE	3	12.00	7.17	7.67
MCGE	4	20.00	5.84	8.00
MCGE	5	32.33	6.43	9.00
MCGE	6	16.67	5.56	7.00
MCGE	7	8.00	6.92	7.00
MCGE	8	10.33	6.02	6.33
MCGE	9	10.67	5.71	6.33
MCGE	10	11.33	5.81	6.67
MCGE	11	8.00	4.17	4.67
MCGE	12	10.67	6.45	7.33
MCGE	13	8.67	6.57	7.00
MCGE	14	16.33	7.67	9.33
MCGE	15	8.50	6.17	6.50
MILL	1	18.33	4.09	5.33
MILL	2	5.67	2.32	2.67
MILL	3	10.33	4.62	5.33
MILL	4	7.67	3.71	4.00
MILL	5	11.00	5.85	7.00
MILL	6	4.67	2.46	2.67
MILL	7	6.00	2.75	3.00
MILL	8	12.00	5.08	5.67
MILL	9	8.33	5.14	5.67
MILL	10	6.00	4.14	4.33
MILL	11	7.00	3.74	4.00
MILL	12	12.67	5.85	6.67
MILL	13	18.00	6.90	8.33
MILL	14	10.33	5.92	6.33
MILL	15	19.00	4.69	6.67
MILL	16	12.33	5.28	6.33
MILL	17	17.67	6.82	8.33
MILL	18	10.67	6.29	7.00
MILL	19	8.67	6.11	6.67

Appendix 9 Table A. Mean of total individuals, Shannon-Weiner index of species diversity (SW) and species richness (SR) for breeding species detected within 50m radius circle at individual point count stations, mean of annual means, 1998-2000.

Station	Site	Mean Tot. Ind.	Mean SW	Mean SR
MILL	20	11.00	6.10	7.00
MILL	21	17.00	4.59	6.67
MILU	1	24.00	11.01	12.67
MILU	2	19.67	9.68	11.00
MILU	3	11.67	6.33	7.00
MILU	4	22.67	9.62	11.00
MILU	5	24.67	10.52	12.33
MILU	6	19.33	8.22	10.00
MILU	7	22.67	7.32	9.33
MILU	8	16.67	9.24	10.67
MILU	9	17.33	8.49	9.33
MILU	10	10.00	7.98	8.33
MILU	11	10.67	6.48	7.00
MILU	12	12.33	7.53	8.33
MILU	13	12.00	8.29	9.00
MILU	14	6.00	4.78	5.00
MILU	15	7.50	5.73	6.00
ORMC	1	13.00	5.04	5.50
ORMC	2	16.50	5.23	6.50
ORMC	3	18.50	7.26	8.00
ORMC	4	14.00	7.73	8.50
ORMC	5	13.00	5.39	6.50
ORMC	6	16.50	6.96	8.00
ORMC	7	12.00	5.08	6.00
ORMC	8	6.50	4.08	4.50
ORMC	9	6.50	4.73	5.00
ORMC	10	9.00	3.71	5.00
ORMC	11	8.50	3.17	3.50
ORMC	12	11.00	4.92	6.00
ORMC	13	9.50	4.88	5.50
ORMC	14	9.50	4.66	5.50
ORMC	15	16.50	5.99	7.50
ORTI	1	20.00	6.48	7.50
ORTI	2	22.00	6.43	9.00
ORTI	3	15.50	6.61	7.50
ORTI	4	8.50	4.40	5.00
ORTI	5	21.00	5.93	8.00
ORTI	6	13.50	4.76	5.50
ORTI	7	21.50	4.95	6.00
ORTI	8	22.00	4.64	6.00
ROCK	1	3.00	2.26	2.33
ROCK	2	2.67	1.82	2.00
ROCK	3	3.00	2.26	2.33
ROCK	4	1.67	1.33	1.33
ROCK	5	1.67	0.96	1.00
ROCK	6	1.33	1.00	1.00
ROCK	7	6.33	2.23	2.67
ROCK	8	2.00	1.00	1.00
ROCK	9	2.67	2.00	2.00
ROCK	10	1.33	1.33	1.33
ROCK	11	2.00	0.99	1.00
ROCK	12	1.33	0.96	1.00
ROCK	13	1.00	0.67	0.67
ROCK	14	4.67	3.46	3.67
ROCK	15	0.67	0.67	0.67
ROCK	16	3.00	1.83	2.00
ROCK	17	4.67	3.17	3.33
ROCK	18	0.00	0.00	0.00
ROCK	19	3.00	1.62	1.67
ROCK	20	4.00	2.86	3.00
RUSL	1	12.67	4.14	5.33
RUSL	2	11.33	3.99	5.00
RUSL	3	11.00	2.87	3.67
RUSL	4	9.00	3.91	4.33
RUSL	5	14.00	6.19	7.00
RUSL	6	12.67	3.63	4.67
RUSL	7	11.33	4.55	5.33
RUSL	8	21.67	2.62	4.00
RUSL	10	12.00	4.45	5.50
RUSL	11	15.00	4.84	6.00
RUSL	12	14.50	4.86	6.00
RUSL	13	9.00	5.36	6.00
RUSL	14	19.00	5.39	7.00
RUSL	15	15.00	4.02	5.50
RUSL	16	18.00	4.67	5.50
RUSU	1	26.33	7.19	8.67
RUSU	2	26.67	7.54	10.00
RUSU	3	21.67	5.76	7.00
RUSU	4	20.00	7.34	9.33
RUSU	5	18.00	7.81	9.00
RUSU	6	15.33	5.85	7.00
RUSU	7	18.33	7.26	9.00
RUSU	8	17.33	8.96	10.00
RUSU	9	8.00	4.90	5.33
RUSU	10	11.00	7.33	8.00
RUSU	11	11.33	5.59	6.67
RUSU	12	8.33	5.30	5.67
RUSU	13	4.00	2.17	2.33
RUSU	14	11.33	5.48	6.33
RUSU	15	3.67	3.67	3.67
RUSU	16	5.33	4.54	4.67
RUSU	17	23.67	9.62	11.33
SAWM	1	9.67	3.94	4.33
SAWM	2	6.33	3.63	4.00
SAWM	3	6.00	4.42	4.67
SAWM	4	7.33	2.97	3.67
SAWM	5	5.33	3.13	3.33
SAWM	6	7.33	4.65	5.00

Appendix 9 Table A. Mean of total individuals, Shannon-Weiner index of species diversity (SW) and species richness (SR) for breeding species detected within 50m radius circle at individual point count stations, mean of annual means, 1998-2000.

Station	Site	Mean Tot. Ind.	Mean SW	Mean SR	Station	Site	Mean Tot. Ind.	Mean SW	Mean SR
SAWM	7	6.33	3.94	4.33	THIB	10	6.00	3.24	3.67
SAWM	8	8.67	4.86	5.33	THIB	11	8.67	3.87	4.33
SAWM	9	7.33	4.10	4.67	THIB	12	7.33	3.14	3.33
SAWM	10	5.67	3.92	4.00	THIB	13	5.00	2.72	3.00
SAWM	11	7.00	4.03	4.67	THIB	14	5.33	2.38	2.67
SAWM	12	3.33	2.28	2.33	THIB	15	4.00	1.33	1.50
SHEP	1	2.00	2.00	2.00	TUTT	1	4.00	3.22	3.33
SHEP	2	2.67	1.63	1.67	TUTT	2	4.00	1.80	2.00
SHEP	3	5.33	2.08	2.33	TUTT	3	3.33	2.94	3.00
SHEP	4	9.00	3.11	3.67	TUTT	4	4.00	2.92	3.00
SHEP	5	8.00	2.46	3.00	TUTT	5	4.67	3.11	3.33
SHEP	6	6.33	2.41	2.67	TUTT	6	7.00	2.66	3.00
SHEP	7	4.33	2.49	2.67	TUTT	7	4.67	2.55	2.67
SHEP	8	4.33	2.41	2.67	TUTT	8	2.67	1.93	2.00
SHEP	9	3.00	1.93	2.00	TUTT	9	2.33	1.94	2.00
SHEP	10	3.33	1.93	2.00	TUTT	10	6.00	2.89	3.33
SHEP	11	5.67	3.03	3.33	TUTT	11	5.67	3.08	3.33
SHEP	12	5.33	2.79	3.00	TUTT	12	2.67	1.61	1.67
SHEP	13	1.33	1.33	1.33	TUTT	13	3.00	2.20	2.33
SHEP	14	2.00	1.67	1.67	TUTT	14	4.33	3.55	3.67
SHEP	15	3.33	1.47	1.67	TUTT	15	5.33	2.44	2.67
TABO	1	2.67	2.00	2.00	WALK	1	6.00	3.67	4.00
TABO	2	4.00	2.45	2.67	WALK	2	7.33	5.73	6.00
TABO	3	5.67	2.17	2.67	WALK	3	2.33	1.94	2.00
TABO	4	2.00	1.63	1.67	WALK	4	4.00	2.48	2.67
TABO	5	2.67	1.25	1.33	WALK	5	3.00	1.93	2.00
TABO	6	8.00	2.64	3.33	WALK	6	12.67	4.20	5.00
TABO	7	4.00	2.45	2.67	WALK	7	4.67	2.46	2.67
TABO	8	5.00	2.18	2.33	WALK	8	4.33	3.15	3.33
TABO	9	3.67	1.96	2.00	WALK	9	3.33	2.49	2.67
TABO	10	2.00	1.60	1.67	WILL	19	5.00	2.16	2.33
TABO	11	7.67	3.92	4.33	WILL	20	7.00	2.92	3.33
TABO	12	9.00	3.78	4.33	WILL	21	1.33	1.33	1.33
TABO	13	3.00	2.67	2.67	WILL	22	8.00	3.75	4.33
TABO	14	5.00	3.08	3.33	WILL	23	7.33	3.56	4.00
TABO	15	4.33	2.47	2.67	WILL	24	9.67	3.38	4.00
TABO	16	3.33	2.33	2.33	WILL	25	6.00	2.78	3.33
TABO	17	2.67	1.29	1.33	WILL	26	4.67	3.87	4.00
TABO	18	4.00	2.86	3.00	WILL	27	8.33	2.35	3.33
TABO	19	2.67	2.67	2.67	WILL	28	6.33	4.42	4.67
THIB	1	5.33	2.47	2.67	WILL	29	5.00	2.78	3.00
THIB	2	6.00	3.30	3.67	WILL	30	4.00	2.49	2.67
THIB	3	4.67	2.19	2.33	WILL	31	2.00	1.30	1.33
THIB	4	9.67	5.07	5.67	WILL	32	9.00	3.86	4.33
THIB	5	5.00	3.02	3.33	WILL	33	2.00	1.25	1.33
THIB	6	5.00	2.82	3.00	WILL	34	7.00	2.49	2.67
THIB	7	7.33	3.75	4.00	WILL	35	7.67	3.79	4.33
THIB	8	7.67	3.35	3.67	WILL	36	5.33	2.79	3.00
THIB	9	9.67	3.97	4.67	WILU	1	13.67	3.69	4.33

Appendix 9 Table A. Mean of total individuals, Shannon-Weiner index of species diversity (SW) and species richness (SR) for breeding species detected within 50m radius circle at individual point count stations, mean of annual means, 1998-2000.

Station	Site	Mean Tot. Ind.	Mean SW	Mean SR
WILU	2	7.00	4.41	4.67
WILU	3	5.67	4.34	4.67
WILU	4	10.00	5.32	6.00
WILU	5	11.33	6.15	6.67
WILU	6	10.67	5.20	6.00
WILU	7	29.67	4.46	6.33
WILU	8	14.67	5.46	6.67
WILU	9	10.00	5.15	5.67
WILU	10	9.67	4.93	5.67

Station	Site	Mean Tot. Ind.	Mean SW	Mean SR
WILU	11	10.33	4.22	4.67
WILU	12	15.33	7.88	8.67
WILU	13	16.67	5.45	6.67
WILU	14	8.33	4.86	5.33
WILU	15	10.67	5.72	6.67
WILU	16	10.00	3.03	3.67
WILU	17	6.00	3.24	3.67
WILU	18	10.67	5.84	6.33

Appendix 10. Variables investigated in by point-Brown-headed Cowbird analysis.

We investigated the following habitat features and by-point host abundance in relationship to by-point Brown-headed Cowbird abundance. There were no significant relationships. (Host and cowbird abundance was all detections <50m, breeders only, by point, mean of annual means 1998-2000).

elevation
grass cover
shrub cover
tree cover
willow shrub cover
riparian width
percent riparian
host abundance
mean species diversity
mean species richness
mean Song Sparow abundance
mean Yellow Warbler abundance
mean Blue-gray Gnatcatcher abundance

Transect-level (as opposed to by-point) investigations of cowbird detections are probably more appropriate, because cowbirds are known to travel several kilometers from feeding sites to breeding locations in the eastern Sierra (Rothstein et al. 1984).

Appendix 11 – Table A. Potential reptilian, avian and mammalian nest predators observed at all nest plot sites, 1998-2000, with note of whether predation event was observed.

Common name	Latin name	Inyo	Mono	Predation event observed?
racer	*Coluber constrictor*	x		
whipsnake	*Masticophis spp.*	x		
common kingsnake	*Lampropeltis getula*	x		
common garter snake	*Thamnophis spp.*	x	x	
gopher snake	*Pituophis melanoleucus*	x		
western rattlesnake	*Crotalus viridis*	x	x	
Black-crowned Night Heron	*Nycticorax nycticorax*		x	
Osprey	*Pandion haliaetus*		x	
Northern Harrier	*Circus cyaneus*	x	x	yes
Sharp-shinned Hawk	*Accipiter striatus*	x		
Cooper's Hawk	*Accipiter cooperii*		x	
Red-tailed Hawk	*Buteo jamaicensis*	x	x	
Golden Eagle	*Aquila chrysaetos*	x	x	
American Kestrel	*Falco sparverius*	x	x	
Prairie Falcon	*Falco mexicanus*	x		
California Gull	*Larus californicus*		x	
Greater Roadrunner	*Geococcyx californianus*	x		
Great-horned Owl	*Bubo virginianus*	x	x	
Long-eared Owl	*Asio otus*		x	
Belted Kingfisher	*Ceryle alcyon*		x	yes
Steller's Jay	*Cyanocitta stelleri*	x	x	yes
Western Wcrub-Jay	*Aphelocoma californica*	x	x	yes
Pinyon Jay	*Gymnorhinus cyanocephalus*	x	x	
Clark's Nutcracker	*Nucifraga columbiana*	x	x	
American magpie	*Pica pica*		x	
Common Raven	*Corvus corax*	x	x	
Bewick's Wren	*Thryomanes bewickii*	x	x	yes
House Wren	*Troglodytes aedon*	x	x	yes
Loggerhead Shrike	*Lanius ludovicianus*	x	x	yes
Brown-headed Cowbird	*Molothrus ater*	x	x	yes
least chipmunk	*Tamias minimus*	x	x	
white-tailed antelope ground squirrel	*Ammospermophilus leucurus*	x		
Belding's ground squirrel	*Spermophilus beldingi*	x		
California ground squirrel	*Spermophilus beecheyi*	x	x	
golden-mantled ground squirrel	*Spermophilus lateralis*	x	x	
western gray squirrel	*Sciurus griseus*	x		yes
woodrat	*Neotoma spp.*	x		
gray fox	*Urocyon cinereoargenteus*	x		
coyote	*Canis latrans*	x	x	
black bear	*Ursus americanus*	x		
common raccoon	*Procyon lotor*			
long-tailed weasel	*Mustela frenata*		x	
spotted skunk	*Spilogale putorius*	x		
bobcat	*Lynx rufus*	x	x	
domestic house cat	*Felis domestica*		x	yes
mule deer	*Odocoileus hemionus*	x	x	
domestic sheep	*Ovis aries*		x	

Appendix 12. Variables investigated in nest success analyses: definitions and variables.

Definitions
Tree: vegetation over 5m tall, with DBH $\geq$ 8cm, regardless of species
Shrub: vegetation $\geq$ 50cm that is not a tree, regardless of species
Herb: vegetation of all heights, that is either forb, grass, sedge, rush or fern species.
Total green: all green vegetation < 50 cm
Ground cover: < 50 cm
True canopy: ocular estimate of tree cover, using only trees
Densiometer canopy: densiometer reading of cover provided by all layers
Clump: continuous patch of vegetation, regardless of species.

Variables
Height of nest plant
Height of nest from the ground
Distance from the nest to the closest edge of vegetation
Height of the true canopy covering nest
Distance from the nest to the center of the nest clump
Area of clump surrounding nest
Compass direction from base of nest plant stem to nest
Slope of topography at nest
Aspect of topography at nest
Nest concealment (averaged from estimations of % concealment taken in 4 cardinal directions and above and below nest, from 1m away)
Width of riparian zone at nest, perpendicular to the stream
Distance from nest to the riparian zone, if nest outside the riparian

The following variables correspond to a 5m-radius circular plot, with the nest as center.
Shrub richness (*n* number of species)
% shrub cover (total and by species)
% herb cover (total and by species)
average herb height by species
% densiometer canopy cover (mean of 4 readings 1m away from nest in cardinal directions)
% true canopy cover (mean of 4 estimates 1m away from nest in cardinal directions)

Ground cover
% total green, % grass, % forbs, % ferns, % shrubs, % logs and stumps, % litter, % bare ground, includes pavement, % water, % rock

average litter depth at ten points surrounding and under the nest
number of stems (that aren't trees) surrounding the nest, by species

The following variables correspond to an 11.3m-radius circular plot, with the nest as center.
total number of trees
total number of trees by species
tree richness (*n* number of species)

Non-habitat variables
first egg date
hatch date
human path: number code rating new human-created path to nest while finding, ranging from 0=no path to 4=trail created directly to nest.
find disturbance: number code for rating the amount of disturbance caused to the host parents (e.g. amount of distress calling) while finding the nest, ranging from 0=no disturbance to 4=high disturbance.

Appendix 12 – table A. Variables investigated in nest success analyses: plant species.

Code	Latin Name	Common Name	Code	Latin Name	Common Name
ABCO	*Abies concolor*	white fir	HOLOD	*Holodiscus spp.*	oceanspray
ACER	*Acer spp.*	maple	JUNCU	*Juncus spp.*	rush
ANCA13	*Angelica callii*	Call's angelica	LILIU	*Lilium spp.*	lily
ANLI2	*Angelica lineariloba*	poison angelica	LONIC	*Lonicera spp.*	honeysuckle
AQUIL	*Aquilegia spp.*	columbine	LUPIN	*Lupinus spp.*	lupine
ARLU	*Artemesia ludoviciana*	mugwort	MEAL2	*Melilotus albus*	white sweet-clover
ARTR2	*Artemesia tridentata*	big sagebrush	MENTH	*Mentha spp.*	mint
ASFA	*Asclepias fascicularis*	Mexican whorled milkweed	MIMUL	*Mimulus spp.*	monkey-flower
ASTER	*Aster spp.*	aster	MOOD	*Monardella odoratissima*	pennyroyal
BEOC2	*Betula occidentalis*	water birch	MOSS		moss
BRASSI	Brassicaceae spp.	mustard	OPBA2	*Opuntia basilaris*	beavertail pricklypear
CAREX	*Carex spp.*	sedge	PENST	*Penstemon spp.*	penstemon
CASTI	*Castilleja spp.*	paintbrush	PHACE	*Phacelia spp.*	Phacelia
CEANO	*Ceanothus spp.*	Ceanothus	PIJE	*Pinus jeffreyi*	Jeffrey pine
POCA2	*Polemonium caeruleum*	Western polemonium	PIMO	*Pinus monophyllla*	pinyon pine
CELE3	*Cercocarpus ledifolius*	mountain mahogany	POTR15	*Populus trichocarpa*	black cottonwood
CHRYS9	*Chrysothamnus spp.*	rabbitbrush	PRAN2	*Prunus andersonii*	desert peach
CIRSI	*Cirsium spp.*	thistle	PREM	*Prunus emarginata*	bitter cherry
CLLI2	*Clematis ligusticifolia*	Western white clematis	PRUNU	*Prunus spp.*	Prunus
CONVO	*Convolvulus spp.*	morning-glory	PSAR4	*Psorothamnus arborescens*	Mojave indigo bush
CORNU	*Cornus spp.*	dogwood	PTAQ	*Pteridium aquilinum*	Western brackenfern
DAUCU	*Daucus spp.*	wild carrot	PUTR2	*Purshia tridentata*	bitterbrush
DERI	*Dendromecon rigida*	tree poppy	QUKE	*Quercus kelloggii*	California black oak
ELAN	*Elaeagnus angustifolia*	Russian olive	RHRU	*Rhamnus rubra*	Sierra coffeeberry
ENVI	*Encelia virginensis*	Virgin River brittlebush	RIBES	*Ribes spp.*	wild currant
EPHED	*Ephedra spp.*	Mormon tea	ROWO	*Rosa woodsii*	mountain rose
EPILO	*Epilobium spp.*	willow -herb	RUMEX	*Rumex spp.*	dock
EPIPA	*Epipactis spp.*	helleborine	SALIX	*Salix spp.*	wIllow
EQUIS	*Equisetum spp*	horsetail	SAMBU	*Sambucus spp.*	elderberry
ERDE2	*Eriastrum densifolium*	giant woolstar	SHEPH	*Shepherdia spp.*	buffaloberry
ERFA2	*Eriogonum fasciculatum*	Eastern Mojave buckwheat	SMST	*Smilacina stellata*	false Solomon's seal
ERICA2	*Ericameria spp.*	heathgoldenrod	SOLID	*Solidago spp.*	goldenrod
ERIN4	*Eriogonum inflatum*	Native American pipeweed	SPAM2	*Sphaeralcea ambigua*	desert globemallow
ERUM	*Eriogonum umbellatum*	sulphur eriogonum	SPCA5	*Sphenosciadium capitellatum*	ranger's button
FABAC	Fabaceae spp.	wild pea	SYMPH	*Symphoricarpos spp.*	snowberry
FRAXI	*Fraxinus spp.*	ash	TEAX	*Tetradymia axillaris*	longspine horsebrush
GRASS		grass species	UMBEL	Umbelliferaea spp.	carrot
GRSP	*Grayia spinosa*	spiny hopsage	URDI	*Urtica dioica*	stinging nettle
HEBI	*Helenium bigelovii*	Bigelow's sneezeweed	VIAMT2	*Vicia americana var. truncata*	vetch
HEMA3	*Hesperis matronalis*	Dame's rocket	VIOLA	*Viola spp.*	violet

Appendix 13. Common names and 4-letter AOU codes.

Appendix 13 – Table A. Common names and 4-letter AOU codes for birds caught during constant effort mist netting, Owens Valley alluvial fan and Mono Basin sites 1998-2000.

AOU 4-letter Code	Common Name	AOU 4-letter Code	Common Name
AMKE	American Kestrel	OCWA	Orange-crowned Warbler
SPSA	Spotted Sandpiper	NAWA	Nashville Warbler
MODO	Mourning Dove	YWAR	Yellow Warbler
COHU	Costa's Hummingbird	AUWA	Audubon's Warbler
CAHU	Calliope Hummingbird	BAWW	Black-and-white Warbler
RUHU	Rufous Hummingbird	AMRE	American Redstart
BEKI	Belted Kingfisher	MGWA	MacGillivray's Warbler
DOWO	Downy Woodpecker	COYE	Common Yellowthroat
HAWO	Hairy Woodpecker	WIWA	Wilson's Warbler
RSFL	Red-shafted Flicker	YBCH	Yellow-breasted Chat
WEWP	Western Wood-Pewee	WETA	Western Tanager
PSFL	Pacific-slope Flycatcher	BHGR	Black-headed Grosbeak
WEFL	Western Flycatcher	SPTO	Spotted Towhee
WIFL	Willow Flycatcher	GTTO	Green-tailed Towhee
HAFL	Hammond's Flycatcher	SAGS	Sage Sparrow
DUFL	Dusky Flycatcher	BTSP	Black-throated Sparrow
GRFL	Gray Flycatcher	BRSP	Brewer's Sparrow
BLPH	Black Phoebe	SAVS	Savannah Sparrow
WAVI	Warbling Vireo	VESP	Vesper Sparrow
CAVI	Cassin's Vireo	MWCS	Mountain White-crowned Sparrow
STJA	Steller's Jay	FOSP	Fox Sparrow
WESJ	Western Scrub-Jay	SOSP	Song Sparrow
VGSW	Violet-green Swallow	LISP	Lincoln Sparrow
BUSH	Bushtit	SWSP	Swamp Sparrow
BEWR	Bewick's Wren	WEME	Western Meadowlark
HOWR	House Wren	BHCO	Brown-headed Cowbird
MAWR	Marsh Wren	BRBL	Brewer's Blackbird
RCKI	Ruby-crowned Kinglet	BUOR	Bullock's Oriole
AMRO	American Robin	CAFI	Cassin's Finch
SWTH	Swainson's Thrush	HOFI	House Finch
GRCA	Gray Catbird	LEGO	Lesser Goldfinch
SATH	Sage Thrasher		