Riparian bird populations of the Sacramento River system: Results from the 1993-1999 field seasons

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PRBO REPORT

to

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EXECUTIVE SUMMARY

Through long-term landbird monitoring, PRBO (Point Reyes Bird Observatory) seeks to identify areas of high biodiversity and landbird productivity and determine habitat features associated with primary (demographic) and secondary (species richness, diversity, and abundance) population parameters, in order to guide and evaluate land management actions including acquisition, preservation, and restoration. This pro-active adaptive management approach is taken with the multiple goals of 1) reversing regional population declines of neotropical migrant and resident bird species 2) promoting the recolonization of extirpated or rare species, both listed and non-listed 3) preserving existing populations of breeding species currently considered to be common 4) protecting and increasing overall biodiversity of California's major ecosystems 5) raising public awareness of the importance of riparian conservation and restoration.

PRBO has conducted landbird monitoring on Sacramento River riparian forest and restoration sites annually since 1993, in cooperation with The Nature Conservancy (TNC), U.S. Fish and Wildlife Service (USFWS), and California Partners In Flight (CPIF). In this report, we outline the importance of riparian habitat to breeding and migrating landbirds and summarize historic human impacts to the riparian bird populations of the Sacramento River. In addition, we present results based on seven years of data collection using multiple monitoring methods including nest monitoring, mist-netting, point count surveys and area search censuses.

Using point count survey data, we developed a model that shows a significant trend for riparian bird diversity to increase with age of restoration sites (1993-1999), indicating that as these sites mature, bird species diversity increases. In contrast, while diversity fluctuated over this period on mature riparian forest sites, no trend was detected on these sites. In addition, using point count data form 1998 and 1999, we mapped riparian bird diversity throughout California's Central Valley as well as species abundance for three key riparian breeders -- Lazuli Bunting, Black-headed Grosbeak, and Nuttall's Woodpecker -- in order to depict the importance of the Sacramento River system to the Central Valley's remaining bird populations. We then calculated bird diversity in nine riparian habitat types throughout the Sacramento Valley and determined that diversity was highest in Cottonwood and Valley Oak forests, followed by mixed riparian forest and riparian scrub. We also examined for correlations between riparian bird diversity and several landscape characteristics: mainstem vs. tributary, riparian patch orientation and patch size. We found that diversity is higher on mainstem sites, on northern-oriented riparian patches, and at points with more surrounding riparian habitat.

Using nest data collected over a seven year period (1993-1999), we examined nest success of three open-cup nesting species and compared results across two treatment types, restoration and remnant riparian forest. We found that overall nest success (both habitat types combined) was extremely low overall for two ground/shrub nesting species (Lazuli Bunting, 6% and Spotted Towhee, 11%) and moderate for one mid-canopy nesting species (Black-headed Grosbeak, 31%). Nest success was similar on both restoration and forest sites for all three species. Low nest success on the Sacramento River can be primarily attributed to nest predation for Spotted Towhee and a combination of nest predation and Brown-headed Cowbird parasitism for Lazuli Bunting. Our results indicate that poor productivity may well be the demographic factor driving population declines of many open-cup nesting species in the Sacramento Valley. Future research will seek to identify nest predators and relate productivity to nest predator populations and other biological and physical river processes.

We also establish the importance of the Sacramento River to migrating landbirds, both adult and young, and report on fall migration patterns, including timing, species composition, and age ratios of key species.

Finally, we compile management recommendations submitted to TNC and USFWS by PRBO throughout 1999 and summarize the 1999 activities of our Sacramento Valley conservation education and outreach program.

INTRODUCTION

Scope of report

This report reports results of multiple aspects of PRBO's work in the Sacramento River Valley during the 1990's (1993-1999), including nest success of several open-cup nesting species, diversity and abundance of riparian birds, and fall migration patterns. This work was conducted for The Nature Conservancy (TNC), U.S. Fish and Wildlife Service (USFWS) and California Partners In Flight (CPIF), and it lays the groundwork for future research into system-wide ecological stressors and riparian bird population health. We present landbird data from the mainstem and tributaries of the Sacramento River and map bird diversity and species abundance values throughout California's Central Valley, in order to place our results in a bioregional context (California's Central Valley). We also present recommendations for future restoration work and refuge management and a summary of PRBO's 1999 conservation education efforts in the Sacramento Valley.

Historic perspective

Throughout California, riparian habitats support the most diverse landbird communities, over all other habitat types. Many sources document the importance of riparian habitat to the avifauna of the Central Valley (Gaines 1977, Hehnke and Stone 1978, Geupel et al 1997, RHJV 1998, Small et al 1999). Thirty-three riparian-associate species occur across California, and over sixty landbird species use riparian habitat during some part of the annual cycle.

Historically, the complex vegetation mosaic created by the meandering river systems of the Central Valley provided resources necessary to support an abundance of resident and migrant landbird species (Belding1890, Grinnell 1915, Grinnell and Miller 1944). Birds that occupied Central Valley riparian zones relied upon riparian resources for nesting, foraging, juvenile dispersal corridors, and migration stop-over sites, exploiting all possible niches, from oxbow lake edges, to shrubby point bar vegetation, to mature Cottonwood-Willow and Valley Oak stands.

While the remaining fragments of riparian vegetation harbor some of the last breeding bird populations in the Central Valley (Small et al. 1999, Ballard and Geupel 1999, RHJV 1998), many historic breeding populations are now regionally extirpated or severely depleted (see range maps of select species in appendix 1). The Least Bell's Vireo, a federally endangered species, was once a common breeder on the San Joaquin and Sacramento Rivers, but is now entirely extirpated from these systems. Breeding populations of Willow Flycatchers are also extirpated from the Sacramento and San Joaquin mainstems. It is possible that the now federally endangered Southwest Willow Flycatcher once bred in the Central Valley, but lack of historic data makes it difficult to confirm this (Williams and Craig 1998).

A major population of one California endangered species – the Western Yellow-billed Cuckoo -- breeds on the Sacramento River, as do two California threatened bird species – the Bank Swallow and the Swainson's Hawk. (The latter also nests in the San Joaquin Valley.) Breeding populations of other non-listed species have declined or disappeared entirely from the Sacramento and/or San Joaquin Rivers, such as the Yellow Warbler, Song Sparrow, and Warbling Vireo.

The 1970's saw the advent of systematic landbird censuses in California's riparian forests (mostly in the Sacramento Valley), conducted using standardized methods (Gaines 1977). Gaines (1974) revisited many of Grinnell's historic Sacramento Valley riparian study sites Following his surveys, he eloquently described the importance of riparian woodlands to breeding landbirds and emphasized the strong affinity of breeding neotropical migrant species

to cottonwood-willow habitat. He documented sixty-seven species as current breeders on his study sites, with the highest densities in cottonwood-willow forest. He also noted that many of those species that also breed in the eastern U.S. have evolved western subspecies. Three of those subspecies breed only in the valleys of California – Least Bell's Vireo (*Vireo bellii pusillus*), Red-shouldered Hawk (*Buteo lineatus elegans*), and Blue Grosbeak (*Guiraca caerula salicaria*).

Gaines had grim news to deliver, though. Twelve species had declined or disappeared from these Sacramento River sites in just a few decades. By the time of his surveys, four species – Least Bell's Vireo, Willow Flycatcher, Warbling Vireo, and Bald Eagle (*Haliaeetus leucocephalus)* - no longer breed in the Sacramento Valley. In fact, no breeding pairs of Bell's Vireo had been documented in 20 years.

In addition to these extirpated breeders, other species had dwindled to alarmingly low densities. The Yellow-billed Cuckoo had been added to the state "rare and endangered" wildlife list (Gaines 1974). And others, once common breeders, were now absent from many sites, including the Yellow Warbler and Common Yellowthroat. Laymon (1981) also detected very low numbers of nesting Yellow Warblers at Dog Island City Park, Red Bluff, in the late 1970's.

Gaines attributed the decline of the Yellow-billed Cuckoo (Coccyzus americanus occidentalis) and Red-shouldered Hawk (Buteo lineatus elegans) to loss of riverbottom woodland. He presumed that other open-cup nesting species had been highly impacted by the spread of Brown-headed Cowbirds into the Central Valley, including the Least Bell's Vireo (*Vireo bellii pusillus*), Warbling Vireo (*Vireo gilvus swainsonii*), Willow Flycatcher (*Empidonax traillii brewsteri*), Western Flycatcher (*Empidonax difficilis*), Blue-gray Gnatcatcher (*Polioptila caerulea*), Yellow Warbler (*Dendroica petechia*), Common Yellowthroat (*Geothlypis trichas*), and Song Sparrow (*Melospiza melodia*). But cowbird parasitism is probably only one of multiple factors working in combination to drive population declines in the Central Valley (see Discussion section of this report).

Point count surveys conducted on four wildlife refuges – Sacramento, Delevan, Colusa, and Sutter -- in the Sacramento Valley between 1986 and 1993 showed a declining trend for 17 species and confirmed the absence or very low numbers of several key riparian breeders from these sites, including Least Bell's Vireo, Yellow Warbler, Song Sparrow, and Warbling Vireo (Gilmer et al. 1998). It is important to note, though, that these sites were historically treeless alkali meadows and that creation of managed wetlands on these sites has expanded available riparian habitat in these areas.

Current status of riparian birds

While some historic data exists for the Sacramento River, the first baseline demographic monitoring program was established by the Point Reyes Bird Observatory (PRBO) on the Sacramento River in 1993 and continues through the present. Data collected throughout the nineties shows that, although the early response to horticultural restoration efforts is positive, the overall situation for riparian avifauna of the Sacramento and River is still critical.

Valley-wide point count surveys have confirmed that many species no longer breed on the Valley floor, including Willow Flycatcher, Warbling Vireo, and the federally endangered Least Bell's Vireo (RHJV 1998, Small et al. 1999). In addition, the Yellow Warbler is now nearly extirpated as a breeder from the mainstem of both rivers. In fact, after 7 years of nest surveys, only 3 breeding pairs of this species were documented on the mainstem Sacramento River, all in 1999. A breeding population of Yellow Warblers persists on Clear Creek, a low elevation Sacramento River tributary site (PRBO unpubl. data). While the Song Sparrow still breeds on the San Joaquin River, in the Sacramento Valley it occurs only in very restricted wetland

management areas (Ballard and Geupel, 1999). In the Sacramento Valley, this species may have been associated historically with marsh and oxbow slough habitats, which have been severely depleted over the past century.

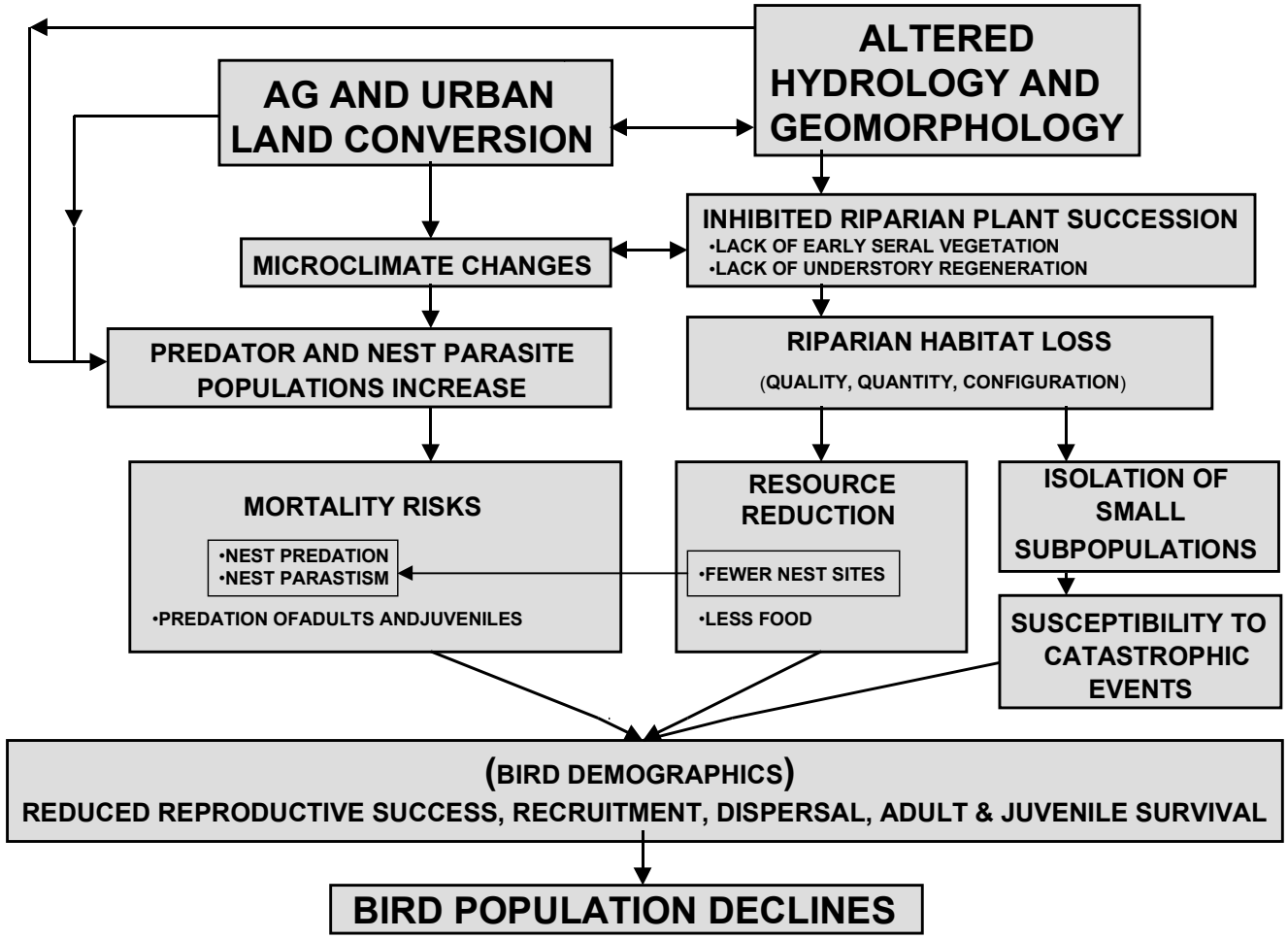
Furthermore, recent data shows that currently breeding species are experiencing poor nest success, including Lazuli Bunting, Common Yellowthroat, and Song Sparrow (Geupel et al. 1996, Gardali et al. 1998, Small et al. 1999, Ballard and Geupel 1999). As a result of high nest predation and parasitism rates, Lazuli Buntings now rarely fledge their own young on the Sacramento River.

Fourteen riparian associate bird species have been targeted for conservation by California's Riparian Habitat Joint Venture. Habitat requirements and management objectives for these species are outlined in detail in the California Partners In Flight (CPIF) Riparian Bird Conservation Plan (RHJV 1998). This plan, compiled by some of California's top landbird experts, proposes a "state-of-the-science" multi-species approach to bird conservation. In addition to detailed species accounts, this plan includes species range maps based on the most current data available, including data from PRBO's Sacramento River project (appendix 1).

Biological stressors on riparian landbird populations

Potential constraints on the reproductive success of riparian birds include: habitat availability and suitability, ability to find a suitable mate and nest site, nest predation, nest parasitism by the Brown-headed Cowbird, human disturbance of nests, predation of adult and fledgling birds, and food availability. These factors may be tied to disrupted hydrologic patterns and human land conversion, as such phenomena relate to the degradation of riparian plant communities and predator population dynamics. Figure 1 proposes a conceptual model of how altered hydrology and land conversion may affect riparian bird populations.

Figure : Potential effects of altered hydrology/geomorpholgy on bird populations



FIELD METHODS

Breeding season

Point count surveys were conducted following the protocol of Ralph et al. (1995). Points on the mainstem were visited three times throughout the breeding season by a field biologist thoroughly trained in identification of bird species by sight and song. (Lassen Foothill tributaries were visited twice and CPIF rapid assessment sites were visited either once or twice.) Survey visits were conducted between May 1 and July 4, and visits to a site were at least one week apart.

Surveys began at sunrise and were completed within five hours. Each point on a survey route was visited for five minutes. The biologist recorded all bird detections by sight, song and call within the five minute period and recorded whether the bird was within or beyond a 50 meter radius, or flying over the survey area. Special note was made of any breeding activity observed.

Nest finding and monitoring followed BBIRD ("Breeding Biology Research and Monitoring Database") protocol and specific guidelines in Martin and Geupel (1993). In summary, nests were mainly located using behavioral clues of adults, a technique that yields larger sample sizes than systematically searching for nests in vegetation and minimizes disturbance to the adults and nest site. Nests were carefully checked at least every four days and contents and outcome (fledged or failed) recorded. Presence of cowbird eggs or chicks and cause of failure were recorded when known.

All data from nest monitoring will be submitted to the BBIRD program, based at the USFWS Cooperative Unit at The University of Montana (Martin et al. 1997).

Spot map censuses were conducted on all nest plots. The same observer covered a plot entirely a minimum of eight times throughout the breeding season (April to July), mapping all territorial individuals and documenting breeding behaviors.

Mist-netting and banding procedures conformed to guidelines described in Ralph et al (1993). In summary, 10 mist nets (in the same locations as in prior years) were operated once every ten day period, eleven times throughout the breeding season (5 May to 11 August).
Nets were unfurled 15 minutes after local sunrise, checked every 30 to 45 minutes (more often in hot weather) and were operated for five hours. Thus, when conditions permitted, 50 net hours (n-h) were accrued in a day of banding.

Birds captured in the mist-nets were removed from the net and processed on site. Each bird captured (except hummingbirds and game birds) received a USFWS service band for permanent identification and to allow estimates of survival from subsequent recapture rates. 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.

Birds hatched in the year of capture were aged hatching-year (HY) birds and adults were classified as after hatching-year (AHY) birds. Individuals that could not be reliably aged were called unknown (UN) aged birds.

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

Breeding status was determined for all species encountered by using all available information collected during all field seasons (1993 to 1999) (Appendix 2). We used the following four categories as derived from breeding bird atlas criteria (Shuford 1993).

0) No evidence of breeding: bird encountered but no territorial or breeding behavior noted; captured birds with high fat scores.

1) Possible breeder: bird encountered singing or acting territorial only once during the breeding season (in suitable habitat).

2) Probable breeder: singing individual encountered on 2 or more different days of point count surveys (within a season, at least one week apart); territorial behavior noted more than once at the same location; pair observed in courtship behavior; female in breeding conditions (with brood patch). Male breeding condition (cloacal protuberances) was not used as evidence of local breeding.

3) Confirmed breeder: nest building observed; nesting material or fecal sac being carried by adult; active nest observed; female captured with eggs in oviduct; dependent juveniles with adults; juvenile with no skull ossification before August 1; territorial behavior observed on more than three days of spot mapping (at least one week apart).

Point count vegetation assessment was conducted at each point count station, using the relevé method (Ralph et al., 1993). A plot of 50 m radius, corresponding to the bird survey radius, was centered on the survey point. General habitat characteristics of the site were recorded (maximum tree dbh, canopy cover, aspect, etc.). The cover, abundance, and height of each vegetation stratum (tree, shrub, herb, and ground) were estimated. Within each vegetation stratum, the species composition was determined, and each species' relative cover was recorded as a percentage of total cover for that stratum.

Nest vegetation assessment was conducted at all nests sites, as well as random sites for comparison, following BBIRD guidelines (Martin and Conway 1995). The nest vegetation plot was centered on the nest. Shrub and ground cover were recorded at a 5 meter radius. Tree density was measured at an 11 meter radius. Trees were defined as vegetation exceeding a dbh of 8 cm and a height of 5 m. Other variables measured included litter depth, canopy cover (using a densiometer), and slope and aspect.

Fall migration

Fall migration monitoring followed guidelines from the Migration Monitoring Council (Hussell and Ralph unpublished).

Mist-netting and banding was conducted weekly on each site between August 18 and October 31. Ten nets were operated at each site; net locations remained consistent throughout the study. Nets were opened 15 minutes after local sunrise, remained open for 5 hours and were opened and closed in the same order. Birds were processed according to the protocol described above.

Area search plots, located at the mist net sites, were censused weekly during the fall. Additional area search plots were censused weekly. The area search protocol followed guidelines described by Geupel, Jones and Ralph (unpublished). In summary, each plot of approximately 3 ha was censused for 20 minutes during the morning hours. Three to seven plots were located at each site. Releve vegetation surveys were conducted on each area search plot according to the protocol described under “point count vegetation assessment.”

STUDY SITES

Figure 2 shows a map of all PRBO study sites in the Sacramento Valley. Table 1 presents field methods employed in 1999 at PRBO long-term Sacramento River study sites.

Breeding season

Point count surveys were conducted in 1999 at 400 points on sites throughout the Sacramento River system (appendix 4). All historic PRBO sites were surveyed, with the addition of points at new baseline monitoring sites -- Pine Creek, Kaiser, Llano Seco, and Millar. Also, 2 tributary sites were added in 1999 – Deer and Battle Creeks, in cooperation with the TNC Lassen Foothills Project. Additional sites were surveyed throughout the system as part of CPIF's Central Valley riparian bird monitoring program.

General habitat types surveyed were riparian, restoration, and orchard.

Nest monitoring plots were visited regularly in 1999 at 8 sites -- Flynn (one climax riparian plot and one revegetation plot, Unit 1), Kopta Slough, River Vista, Phelan Island (River Unit), Kaiser, Sul Norte, Pine Creek, and Packer Island.

Spot mapping was conducted on all nest plots throughout the breeding season.

Fall migration monitoring

Mist-netting and banding
To monitor fall migration throughout the Central Valley, constant effort mist-netting was conducted from 1995 through 1999. Eight sites were monitored in three different regions: Sacramento River National Wildlife Refuge, San Luis National Wildlife Refuge (San Joaquin River), and the TNC Cosumnes Preserve (Cosumnes River). Individual mist-netting operations were operated for three to five consecutive autumns. All sites are located in riparian habitat surrounded by agriculture and/or grazed lands.

We conducted fall mist-netting on three Sacramento River sites. Two were monitored from 1995 through 1999 -- one in Tehama County (Ohm) and one Glenn County (Phelan Island). Another Glenn County site (Sul Norte) was monitored during the autumns of 1995 and 1999

Mist-netting was conducted at two sites on the San Luis National Wildlife Refuge in Merced County in the autumns of 1995, 1996 and 1997. A third site was established mid-season in 1996 and was also monitored in 1997.

Mist-netting was also conducted at two sites on the Cosumnes River in Sacramento County. One site, adjacent to one of the largest remaining old-growth riparian forests in the Central Valley, was monitored from 1995 through 1997. The second site was monitored during 1996 and 1997.

Figure 2: Map of PRBO and California Partners In Flight landbird monitoring sites within the Sacramento River system (mainstem and foothill tributaries), 1998 and 1999.

Table 1: PRBO Sacramento River study sites and monitoring methods employed in 1999 -- nest monitoring, mist-netting, spot mapping and area search. Point count censuses and vegetation assessment were conducted at all sites.

Site	Nest monitoring	Mist-net	Spot map	Point Count	Area Search
Ryan				X	
La Barranca				X	
Ohm		X		X	X
Haleakala				X	
Flynn	X		X	X	X
River Vista	X		X	X	X
Kopta Slough	X		X	X	X
Pine Creek	X		X	X	X
Kaiser	X		X	X	X
Stony Creek (including Phelan Island)	X	X	X	X	X
Llano Seco				X	
Millar				X	
Packer Island	X		X	X	X
Sul Norte	X	X	X	X	X
Codora				X	X

Area searches

Area searches censuses were conducted at all mist-netting locations, with a minimum of three 3 hectare plots covered at each site. We also established 3-9 area search plots at seven other study sites, overlapping with breeding season nest plots and point count survey routes. Area searches were conducted in multiple habitat types at each study site, including riparian forest, restoration sites, and orchards, wherever these habitat types occurred.

DATA SUMMARY AND ANALYSIS

Definition of Riparian Bird Diversity

Riparian bird diversity was calculated for each point count station, based on detections of individuals detected within 50 meters, summed over three visits. Diversity calculations were based on select set of 56 bird species representative of current riparian breeders on the Sacramento River (appendix 3). This list was based on several criteria. To be included, a species had to be 1) known to breed currently along the Sacramento River (between Red Bluff and Colusa) 2) native to North America 3) one that nests in riparian habitat. Because the goal of this analysis was to evaluate breeding habitat, we excluded species that use the sites during spring migration but do not remain to breed. This pertains to several historic breeders that no longer nest on this segment of the Sacramento River (Willow Flycatcher, Warbling Vireo, Pacific Slope Flycatcher) or that breed in extremely low densities at a few isolated sites (Yellow Warbler)*. We also excluded species highly associated with human activity (House Finch, Brewer's Blackbird), as well as ducks, waders, and colonial swallows that are not properly sampled by the point count method.

Species diversity measures ecological diversity based on the number of species detected, weighted by the number of individuals of each species. A high score indicates high ecological (species) diversity. For this analysis, species diversity was measured using a transformation of the usual Shannon-Weiner index, which is symbolized by H^1 (also called the Shannon-Weaver index or just Shannon index; Krebs 1989). This transformed index, which was introduced by MacArthur (1965) is N_1 where $N_1=2^{H'}$.

The advantage of N_1 over H^1 is that N_1 is measured in terms of species, whereas H^1 is measured in terms of bits of information. Thus, N_1 is more easily interpretable, and species diversity (measured as N_1) and richness can be compared.

Temporal patterns of bird diversity on riparian restoration and forest sites

Riparian forest sites
We analyzed data collected between 1993 and 1999 on Sacramento River riparian forest remnant sites to determine if there was a trend in bird diversity on the Sacramento River, independent of restoration activities. For these sites, we examined riparian bird diversity in relation to calendar year using linear statistical models (Neter et al. 1990).

Riparian restoration sites
We then developed comparable linear statistical models to examine trends in riparian bird diversity on four riparian restoration sites: River Vista, Phelan Island, Ryan, and Flynn. River Vista was composed of multiple re-vegetation patches of various ages, while the other sites were of uniform age composition.

Six years of data were available at the oldest site, Phelan Island (Year 3 – Year 8 of restoration). Four years were available at River Vista (Year 1 – Year 4). Two years were available at Ryan (Year 1 – Year 2). One year was available at Flynn (Year 1).

We assigned restoration age (in years) to each point count station based upon the planting year at that location. The planting year itself was assigned an age of Year 0 and was excluded from the analysis. Year 1, the second growing season on the restoration sites, was the earliest to be included in bird diversity analysis. Only sites for which exact planting years were available were incorporated in the analysis.

***** While this list represents many riparian bird species that should be targeted for management on the Sacramento River, it is not a comprehensive list of species for which to manage, as it does not address the status of regionally or locally extirpated breeders, including Least Bell's Vireo, Willow Flycatcher, Warbling Vireo, Yellow Warbler, Pacific-slope Flycatcher and Song Sparrow. However, re-colonization of these species should remain a top management priority, and special attention should be paid to the habitat needs of these species. In the event that any of these species establish breeding populations on our study sites, they will be added to the bird diversity index.

We first combined data from the four restoration sites to examine overall diversity trends. We then used data from the two longer-term sites -- Phelan Island and River Vista -- to examine site-specific diversity trends.

Where the analysis indicated year to year variation in bird diversity, over and above what could be attributed to changes in restoration age, we controlled for annual variation (Neter et al. 1990).

Finally, we fit cubic splines to the data in order to display patterns in diversity over time; this was done for four restoration sites, in relation to restoration age, and six riparian forest control sites, in relation to calendar year. The cubic spline is a non-parametric method that fits a smoothed curve to the data (Chambers et al. 1983). It makes no assumptions about linear or polynomial trends.

Landscape patterns of bird diversity

Landscape features
We examined landscape features, beyond restoration efforts, that may influence riparian bird diversity throughout the Sacramento River system. We asked whether bird diversity was related to the following features: mainstem vs. tributary site, patch orientation, patch size, proportion of riparian habitat within a 500 meter radius, and riparian habitat type.

To do so, we used bird data collected at 400 point count stations throughout the Sacramento River system in 1999 by PRBO's Sacramento River project and California Partners In Flight's Riparian Habitat Joint Venture (see appendix 4 for survey sites and number of points at each site.) In calculating bird diversity for analysis involving tributary data, we used a slightly more inclusive list of riparian species than that used in the mainstem analysis describe above, in order to include a few species that still breed on the tributaries (appendix 3).

Mainstem and tributaries
We ran two-tailed t-tests to compare bird diversity on the mainstem and tributaries of the Sacramento River System, using data from all riparian habitat types, including restoration sites. If a site was on a tributary but within 500 meters of the mainstem, it was classified as "mainstem".

We then looked for a geographic difference in diversity on tributaries only, by comparing tributaries that feed into the mainstem from the East to those that feed in from the West, using two-tailed t-tests.

Patch characteristics
We also looked for the effects associated with characteristics of the riparian habitat patch. A "patch" was defined as a contiguous piece of riparian habitat of any shape, whether it was a thin linear strip strung out for several hundred meters along the streambank, or one large riparian block within a meander zone. We included only points that fell within a riparian patch, as defined and mapped by DWR. Patches labeled as gravel, open water, disturbed or "unlabeled" on DWR GIS vegetation layers were not included. No minimum or maximum limits on patch dimension were set.

Patch orientation
We used two-tailed t-tests to examine whether patch orientation (north vs. east) influenced riparian bird diversity within the Sacramento River system overall, combining data from both mainstem and tributary sites. We then looked for such an "orientation effect" just within eastern tributaries. This could not be done for western tributaries, as nearly all of the habitat patches were of eastern orientation.

Patch size
Next, we developed linear statistical models to examine the relationship of riparian bird diversity to patch size. Bird data from both mainstem and tributary point were incorporated into this analysis.

Per cent riparian vegetation coverage within 500 meters
We used linear regression to investigate whether proportion of riparian habitat within 500 meters of the point count station influenced bird diversity. We calculated per cent of the area covered by all riparian vegetation habitat types within a 500 meter radius of the point count station, using habitat types based on the DWR classification scheme (blackberry scrub, riparian scrub, marsh, mixed forest, cottonwood forest, herbaceous, valley oak). We then created linear statistical models to investigate the relationship between this value and riparian bird diversity We did not include water or gravel bars or "disturbed" riparian. Data from the mainstem and tributaries was included in this analysis. Figure 3 shows an example of how the point was buffered at a 500 meter radius on GIS vegetation data layer.

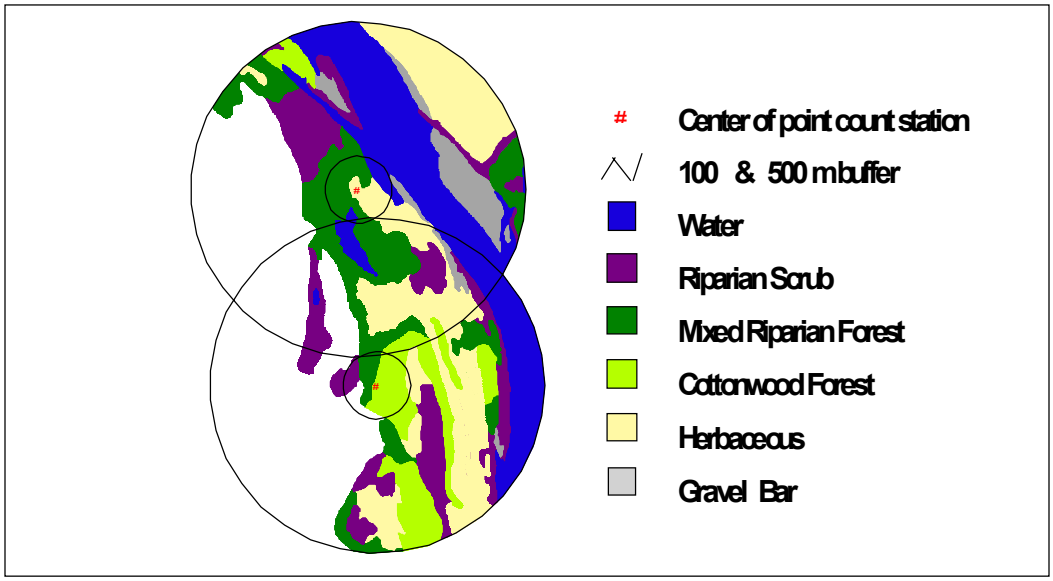
Riparian habitat type
Finally, we examined whether bird diversity was related to riparian habitat type. Point count stations were assigned to one of ten riparian habitat types, based upon riparian habitat classifications outlined in the Sacramento River Conservation Area Handbook (SB 1086 Advisory Council). To do so, we used PRBO vegetation data collected in 1999 at each riparian point count station.

Mean bird diversity was calculated by riparian habitat type and two-tailed t-tests were used to compare diversity between habitat types.

Bioregional Species Diversity – Central Valley
In order to create a picture of riparian biodiversity throughout the Central Valley, we mapped the maximum riparian bird diversity values in 1998 and 1999 for each study site. These values are based on data collected by PRBO and California Partners In Flight, Riparian Habitat Joint Venture. Some CPIF sites were visited only once, so data from a single mid-season point count visit were used for each study site to calculate this index.

Bioregional species abundance – Central Valley
We calculated and mapped maximum abundance values throughout the Central Valley to examine regional abundance patterns for three species, two open-cup nesters (Black-headed Grosbeak and Lazuli Bunting) and one cavity nester (Nuttall's Woodpecker.) As with the species diversity maps, these values are based on data collected by PRBO and California Partners In Flight, Riparian Habitat Joint Venture in 1998 and 1999. As with the bioregional diversity map, data from a single mid-season point count visit were used for each study site to calculate maximum abundance. For sites visited in both 1998 and 1999, the highest abundance value of the two years was used.

Figure 3: Detail of landscape data used in analysis of bird diversity. Percent riparian coverage refers to the proportion of riparian habitat within 500 meters of each point count station. Based on CA Department of Water Resources vegetation layer (1997).



Nest success

Nest success was estimated for three riparian species (Black-headed Grosbeak, Lazuli Bunting, and Spotted Towhee) using the Mayfield method (1975) as recommended by Johnson (1979). The Mayfield method calculates probability of nest mortality on a daily basis by dividing the number of failed nests by total number of days nests were observed active. The daily mortality value is then converted to a daily survivorship value by subtracting it from 1. Standard errors around this value are calculated following Johnson (1979).

The probability of a nest surviving the entire nesting cycle (laying, incubation, and nestling periods) is calculated by raising the daily survivorship value to the power of the total number of days in the nest cycle. The resulting value is referred to as “total nest survivorship” and does not have a standard error associated with it. The number of days in each nesting period, along with data sources, are presented in table 2.

Table 2: Number of days in each nesting period for three species: Black-headed Grosbeak, Lazuli Bunting, and Spotted Towhee. These values were used in Mayfield calculations of nest success on Sacramento River, 1993-1999. Data sources presented in footnotes.

	Number of days in period		
Species	**Laying**	**Incubation**	**Nestling**
Black-headed Grosbeak	2[1]	12[3]	12[3]
Lazuli Bunting			
Spotted Towhee	2[1]	13[3]	11[3]

Data source: 1 = PRBO data from the Sacramento River, 2 = PRBO data from the Palomarin Field Station, Marin Co. CA, 3 = Published data (Baicich and Harrison, 1997).

It is important to note that the Mayfield estimate of nest success is a probability value, rather than an actual proportional ("per cent nests fledged") value. It allows for an analysis of nest mortality and survivorship that may be more precise than such a proportional value, because it attempts to correct for the fact that nests in any sample are likely to be found at various stages in the nest cycle. This is necessary because nests found early in the nest cycle have a higher probability of failure, but a typical sample may contain several nests found in the late stages of the nesting cycle. Therefore, limiting analysis to "proportion fledged" can lead to biased results that overestimate nest success (Martin 1993).

We conducted multi-year Mayfield analyses of nest survivorship using nest data collected between 1993 and 1999. Only nests observed active on at least two visits

were incorporated into the analysis. Cowbird contents were excluded from analysis, so many Lazuli Bunting nests that contained solely cowbird contents during the observation period were entirely excluded. Nests that failed before egg laying were also excluded.

Data were combined from multiple years after determining that annual results were statistically similar (95% confidence intervals around total nest survivorship overlapped among years, by species).

We first calculated overall nest success on the Sacramento River for each of these three species by combining data from both habitat types, revegetation and riparian forest. We then sought to compare nest success between revegetation and riparian forest sites for each of the three study species. Comparisons were made of both total nest survivorship and daily nest survivorship.

Fall migration

For all species banded at Central Valley sites (Sacramento River NWR, San Luis NWR, and Cosumnes Preserve), we calculated total number of individuals and species richness (number of species). We then grouped species by migratory pattern (neotropical migrant, year-round resident, wintering migrant) and calculated species richness of each group. We calculated capture rates as number of individuals captured per 100 net hours, by region, and then determined age ratio of captures (hatch year:adult) for all species. (We assumed no major bias in "catchability" of either age group.)

For reliably aged migrant species with 20 or more captures in at least one region, we determined range of capture dates and peak capture date, by age group and region. Individuals re-captured within one fall season were only counted once in these calculations. We also documented species detected on area search censuses that were never captured in mist-nets. For species that use the region for migration or wintering but do not breed in the Central Valley, we examined for between-year recaptures. We excluded from all calculations (except species richness) birds released unbanded.

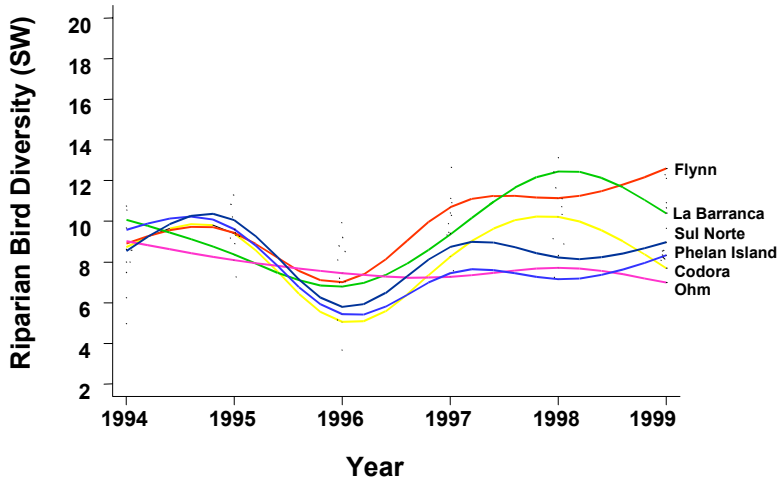
RESULTS

Temporal patterns of bird diversity on riparian restoration and forest sites

Riparian forest sites

No trend in mean riparian bird diversity was detected on Sacramento River riparian forest remnant sites ($P > 0.05$). On these sites, mean riparian bird diversity appears to fluctuate from year to year, with no overall trend. Five sites exhibit similar patterns in through 1997: Flynn, La Barranca, Sul Norte, Phelan Island, Codora. In 1998 and 1999, La Barranca and Codora exhibit similar patterns, as do Flynn, Sul Norte, Phelan Island, with Flynn supporting a more diverse bird community than the others. The sixth site, Ohm, is something of an exception to the fluctuating pattern, with diversity values that remain relatively low and constant through time (figure 4).

Figure 4 : Cubic splines depict patterns of riparian bird diversity (Shannon-Wiener index) in relation to calendar year on six Sacramento River riparian forest sites: Flynn, La Barranca, Sul Norte, Phelan Island, Codora, and Ohm. Based on mean annual diversity of breeding riparian bird species. Data collected between 1994-1999.

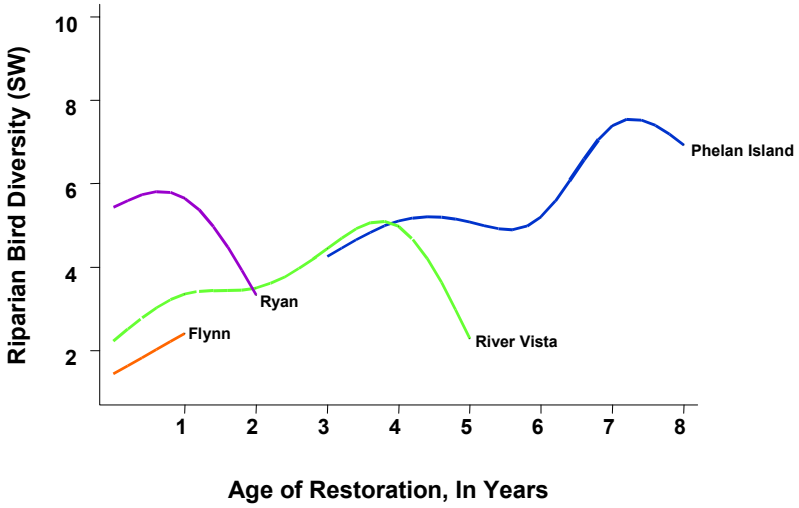


Restoration sites

Patterns of riparian bird diversity are shown for restoration sites (figure 5). Longer-term restoration sites – Phelan Island and River Vista -- show a general increase as restoration sites mature, with a drop-off in the last year of data collection (1999). The drop-off at River Vista is especially pronounced; diversity in year 5 dips to that of year 1, following a four year increase. Such a drop is also apparent at Ryan, a site for which we have fewer years of data. While the drop at Ryan is difficult to explain, the drop at River Vista could potentially be attributed partially

to a high degree of anthropogenic disturbance from large-scale restoration activities occurring across the site throughout the survey season. Also, a similar drop in the year 1999 was seen on riparian forest remnants at La Barranca and Codora, suggesting some larger-scale effect (Figure 4).

Figure 5 : Cubic splines depict patterns of riparian bird diversity (Shannon-Wiener index) in relation to age (in years) of four Sacramento River restoration sites: Phelan Island, River Vista, Ryan, and Flynn. Based on mean annual diversity of breeding riparian bird species. Data collected between 1994-1999.



Diversity on restoration sites in relation to age of restoration plot

Overall diversity on restoration sites

We found a significant increase in riparian bird diversity ($P<0.0001$, $r^2 = 0.259$; figure 6) on four riparian restoration sites combined – Phelan Island, River Vista, Flynn, and Ryan. We detected annual variation beyond that which could be attributed to age of restoration, so data were standardized to eliminate such a year effect. This was done by fitting a model which accounted for calendar year effects and restoration age, simultaneously, and then subtracting the estimated year effect for each year of observation.

Site-specific diversity: Phelan Island and River Vista

Diversity increased over time on two restoration sites for which we have enough years' data to potentially detect a site-specific trend – Phelan Island and River Vista. However, that increase is significant only at Phelan Island ($P<0.01$) and increase was significantly greater at Phelan Island than at River Vista ($P < 0.05$; figure 7).

Figure 6: Overall riparian bird diversity (Shannon-Wiener index) and age (in years) on four Sacramento River restoration sites: Phelan Island, River Vista, Flynn, and Ryan. Data points represent mean annual diversity of individual point count stations. Data are jittered to allow individual points to be seen. Least squares line of best fit is shown. Data have been standardized to eliminate year effect. Based on point count data from 1994-1999.

Figure 7: Riparian bird diversity (Shannon-Wiener index) on two Sacramento River restoration sites: River Vista and Phelan Island. Data points represent mean annual diversity at each point count station. Least squares lines of best fit are shown. Data have been standardized to eliminate year effect. Based on point count data from 1994-1999.

Landscape patterns of riparian bird diversity

Mainstem and tributaries
In 1999, the year for which we have the most robust data set, diversity of riparian birds was marginally higher overall on mainstem Sacramento River sites, all habitat types combined, than on tributary sites (3.84 vs. 3.37, $p<0.05$.)

We did, however, find significantly higher riparian bird diversity in riparian scrub habitats on the tributaries than we did on the mainstem (3.41 vs. 2.24, $p = 0.0004$) and significantly higher diversity in cottonwood forests on the mainstem (2.38 vs. 5.57, $p = 0.001$), but we had only 7 such sites on tributaries. No difference in bird diversity was detected in mixed forest habitats. We had insufficient sample sizes in other habitat types to test for differences.

Patch orientation
Bird diversity is higher on patches oriented north-south than east-west within the Sacramento River system as a whole (3.90 vs. 3.15, p=0.001). Among the Lassen Foothill tributaries, this same "orientation effect" occurred, with diversity being slightly higher on north-south vs. east-west oriented patches (3.90 vs. 3.14, $p<0.05$).

On the mainstem, diversity was also higher on north-south vs. east-west oriented patches, but the difference was only marginally significant (3.89 vs. 2.93, $p = 0.05$). This finding may indicate that broad-scale landscape features, such as the north-south orientation of the entire Sacramento Valley, and the dearth of alternative habitat in the Valley may be more important than patch-specific orientation.

Patch size
The amount of riparian habitat surrounding a point (within 500 m) has a significant effect on riparian bird diversity ($p< 0.001$, $r^2 = 0.10$), while absolute patch size had no significant effect ($p >0.05$). This may be due to the frequency in our sample of very long, linear patches which encompass many acres of habitat but are confined to narrow strips along the banks of the river. These patches do not draw in the diversity of birds that smaller patches blocked together draw. The implication for managers is clear: blocks of riparian habitat are more attractive to breeding birds than strings of habitat.

Riparian habitat type
Examining data from tributaries and mainstem combined, we found that riparian bird diversity differs significantly among habitat types. The highest diversity is associated with Cottonwood and Valley Oak forests, followed by mixed riparian forest and riparian scrub.

Lower diversity was found in riparian herbaceous, grass, marsh, and disturbed riparian habitats. That is not to say that these habitats are unimportant for riparian species, as some riparian bird species are highly associated with marsh (e.g., Common Yellowthroat) or riparian herbaceous (e.g. Lazuli Bunting, Blue Grosbeak) habitats. See tables 3 and 4 for comparisons of mean bird diversity among different habitat types.

Riparian habitat patches
Patches shown in figure 8 represent the largest (greater than 25 ha), most compactly shaped patches, with the greatest vegetation diversity along the river. Areas with these characteristics have been shown in our analysis to harbor the greatest riparian bird species diversity.

Figure 8: Map of riparian habitat patches within the Sacramento River watershed. Color coding indicates diversity of riparian vegetation: blue, orange, and red patches have a higher diversity of riparian habitat types and thus may contain more riparian bird species than purple or green patches.

Table 3: Mean riparian bird diversity (Shannon-Wiener index) by riparian habitat type, and P values resulting from t-tests comparing diversity between habitat types. (** indicates $p < 0.001$, *** indicates $p < 0.0001$.) P values indicating significant differences are presented in bold type. N = number of points in each habitat type. Abbreviations of habitat types explained below. Habitat types based on those described in the Sacramento River Conservation Area Handbook (see appendix 5 of this report for definitions). Point count stations were classified by habitat type based upon PRBO releve data from 1999.

	COFO	**DIRI**	**GRAS**	**HERB**	**MARS**	**MIFO**	**RISC**	**RISC-R**	**RISC-N**	**VAOA**
N	48	20	20	27	22	81	146	60	86	18
Mean	5.11	2.2	2.3	2.36	2.30	4.18	2.96	2.02	3.62	5.80
COFO	.	***	***	***	***	**.05**	***	***	***	.2
DIRI	.	.	.8	.7	.8	**.008**	.18	.7	**.006**	***
GRAS	.	.	.	.9	.9	**.001**	.16	.5	**.009**	***
HERB	.	.	.	.	.8	**	.12	.3	**.002**	***
MARS	.	.	.	.	.	**	.1	.5	**.004**	***
MIFO	.	.	.	.	.	.	***	***	.08	**.009**
RISC	.	.	.	.	.	.	.	.	.	***
RISC-R	.	.	.	.	.	.	.	.	***	***
RISC-N	.	.	.	.	.	.	.	.	.	***

COFO = Cottonwood Forest, DIRI = Disturbed Riparian, GRAS = Grass dominated, HERB = riparian herbaceous, annual plants, MARS = Marsh, MIFO = Mixed Forest, RISC = Riparian Scrub, RISC–R = Riparian Scrub – Restoration, RISC-N = Riparian Scrub

Table 4: Comparison of mean riparian bird diversity by habitat type. Cottonwood forest and riparian scrub categories include both riparian forest and restoration sites. Underscored groups are not significantly different from one another ($p < 0.05$).

REVG	DIRI	GRAS	MARS	HERB	RISC	MIFO	COFO	VAOA
2.02	2.2	2.3	2.30	2.36	3.62	4.18	5.11	5.80

Bioregional species diversity – Central Valley
Figure 9 displays maximum riparian bird diversity across Central Valley riparian sites for 1998 and 1999. Sites exhibiting the highest maximum diversity values (8.1 and above) in one or both of these years are concentrated within the Sacramento River system. Many of these sites are located within the Sacramento River National Wildlife Refuge, including La Barranca, Flynn, Kaiser, Llano Seco and Sul Norte. Other mainstem sites with notably high values include Bloody Island South, Kopta Slough, Woodson Bridge State Park, and Ord Ferry Bridge North. Tributary sites with high maximum diversity indices include Little Cow Creek, Clear Creek, and Oroville Wildlife Area. Only three Central Valley sites outside of the Sacramento River system reached this level of maximum diversity: the Mokulmne River and Caswell Memorial State Park and the Chowchilla Canal, on the San Joaquin River.

Bioregional species abundance – Central Valley
Figures 9 through 11 display maximum species abundance for two open-cup nesting species (Black-headed Grosbeak and Lazuli Bunting) and one cavity-nesting species (Nuttall's Woodpecker).

While small populations of Black-headed Grosbeaks breed on the tributaries and mainstem of the San Joaquin River, it appears that larger populations are concentrated within the Sacramento River system. This contrast is even more striking for the Lazuli Bunting, which occurs in highest abundance on the Sacramento River mainstem but is nearly absent from the San Joaquin River system. Mid-level maximum abundance values for Nuttall's Woodpecker (2.1-3) occur throughout both the Sacramento and San Joaquin River systems. On the Sacramento, this species appears to be concentrated on the mainstem, whereas on the San Joaquin, it is concentrated on the tributaries.

Figure 8: Maps of maximum riparian bird diversity values (Shannon-Wiener index) on study sites throughout the Central Valley, 1998 and 1999. Based on point count data collected by PRBO and California Partners In Flight, Riparian Habitat Joint Venture.

Figure 9: Maximum abundance of Black-headed Grosbeak on Central Valley point count survey sites. Based on data collected by PRBO and California Partners In Flight, 1999.

Figure 10: Maximum abundance of Lazuli Bunting on Central Valley point count survey sites. Based on data collected by PRBO and California Partners In Flight, 1999.

Figure 11: Maximum abundance of Nuttall's Woodpecker on Central Valley point count survey sites. Based on data collected by PRBO and California Partners In Flight, 1999.

Nest success

We sought to evaluate nest success of three open cup nesting species - - Black-headed Grosbeak, Lazuli Bunting, and Spotted Towhee - - that breed on both restoration and riparian forest sites.

This suite of three species represents one mid-canopy nester and two low herb/shrub layer nesters. Black-headed Grosbeaks place their nests in the mid-canopy shrub layer, Lazuli Buntings nest low in herbaceous and shrubby vegetation, and Spotted Towhees nest on or very near the ground, concealing their nests within ground litter or herbaceous and shrubby vegetation (see table 5 for nest heights).

Table 5: Mean (with standard error), minimum, and maximum nest height of three open-cup nesting species on the Sacramento River, based on 1993-1999 nest data

Species	Mean Nest Height (SE), meters	Minimum Nest Height, meters	Maximum Nest Height, meters
Black-headed Grosbeak	3.60 (1.60)	1.30	9.00
Lazuli Bunting	0.74 (0.35)	0.20	2.20
Spotted Towhee	0.24 (0.30)	0.00	1.70

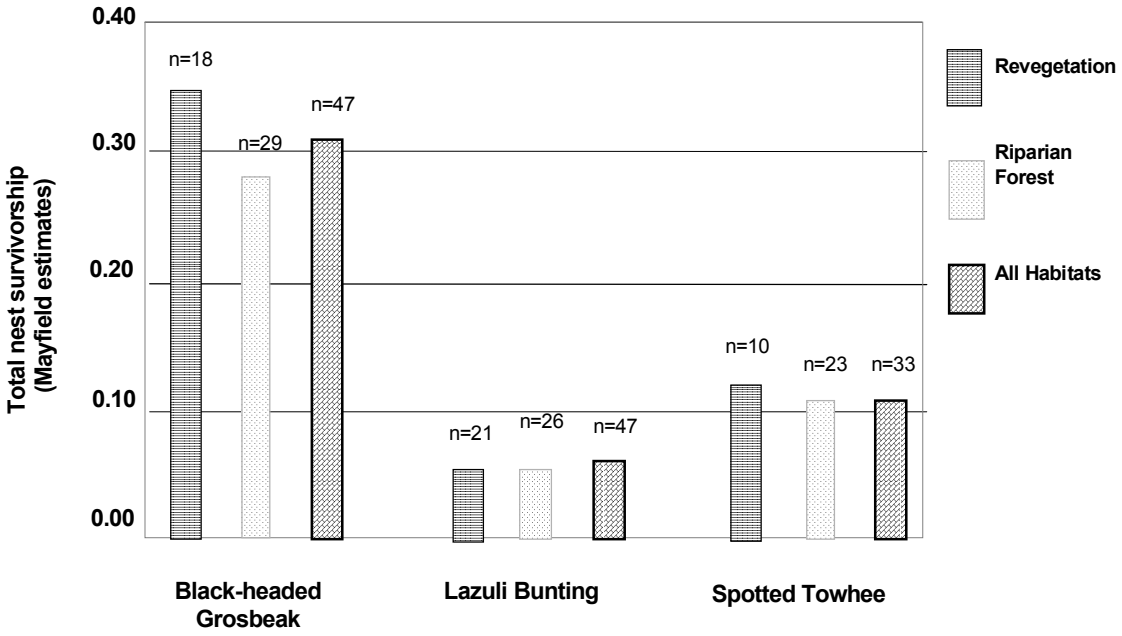
On riparian forest and revegetation sites combined, total estimated nest survivorship was extremely poor between 1993 and 1999 for the two understory nesting species: 6% for Lazuli Bunting and 11% for Spotted Towhee. Black-headed Grosbeak, the mid-canopy nesting species, fared somewhat better, with a total nest survivorship of 31% (table 6).

Table 6: Mayfield estimates of total an daily (with standard error) nest survivorship, with sample sizes, for three open-cup nesting species breeding on the Sacramento River: Lazuli Bunting, Spotted Towhee, and Black-headed Grosbeak. The first two species nest in understory vegetation below 2 meters. Black-headed Grosbeak nests in the mid-canopy. Based on data collected by Point Reyes Bird Observatory between 1993 and 1999.

Species	Total nest survivorship	Daily nest survivorship (SE)	Number of nests
Understory nesting species:			
Lazuli Bunting – Sac River (1993-99)	0.06	0.90(0.01)	47
Spotted Towhee – Sac River (1993-99)	0.11	0.92(0.02)	18
Mid-canopy nesting species:			
Black-headed Grosbeak	0.31	0.95(0.01)	47

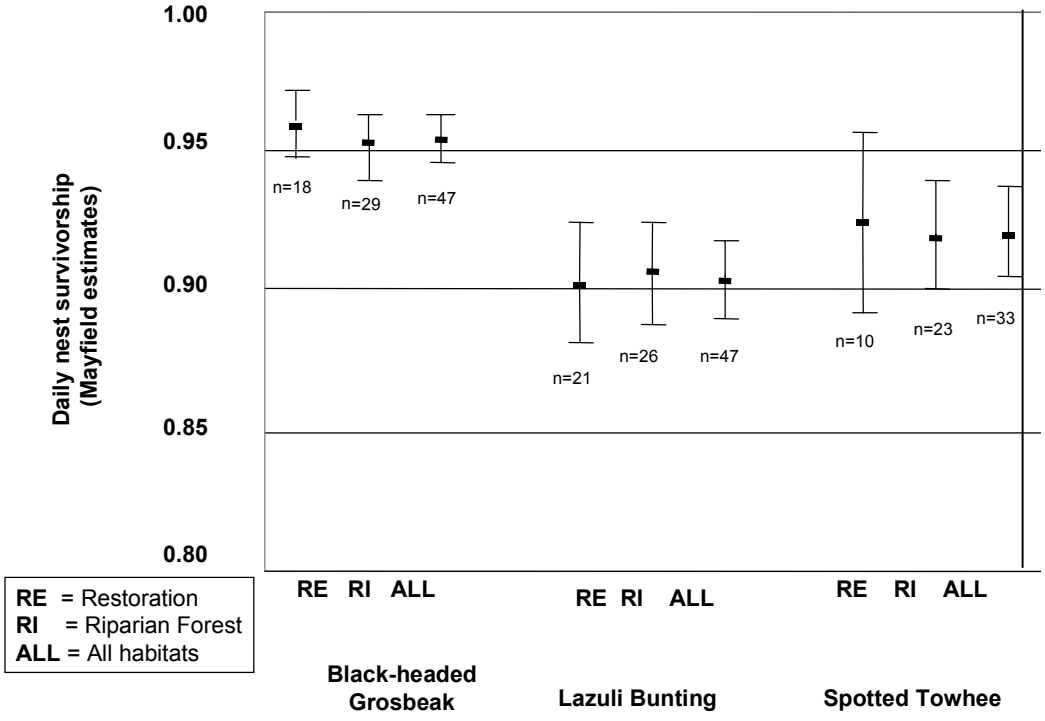
Comparing between revegetation and riparian forest sites, there was little difference in total nest survivorship for the two understory nesting species. Nest success was poor in both habitat types for Lazuli Bunting (6% on revegetation sites, 6% on riparian forest) and Spotted Towhee (12% reveg, 11% on riparian forest). Black-headed Grosbeak, the mid-canopy nesting species, experienced somewhat higher total nest survivorship in revegetation sites (35%) than in riparian forest sites (28%). This species had much higher total nest survivorship in both habitat types than the two understory nesting species (figure 10).

Figure 10: Mayfield estimates of total nest survivorship, by habitat type, of three open-cup nesting species: Black-headed Grosbeak, Lazuli Bunting, Spotted Towhee. Sacramento River 1993-1999.



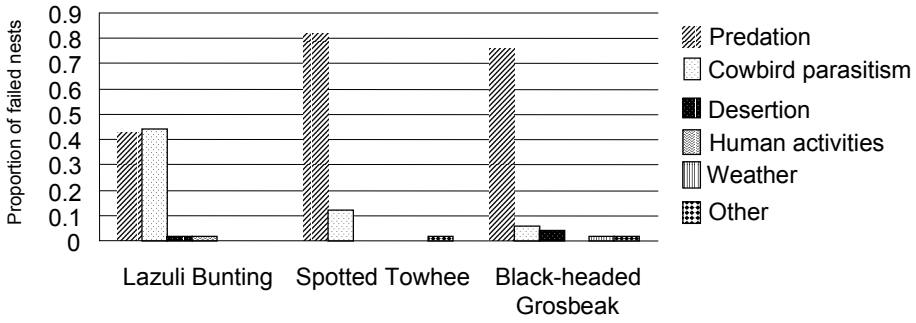
Daily nest survivorship values (presented with standard error bars in figure 11) show very little difference between revegetation and riparian forest sites for all three species. Daily nest survivorship was higher for Black-headed Grosbeak than the two understory nesting species, across all habitat types.

Figure 11: Mayfield estimates of daily nest survivorship (with standard error), by habitat, of three open-cup nesting species: Black-headed Grosbeak, Lazuli Bunting, and Spotted Towhee. Sacramento River, 1993-1999.



Known nest mortality factors for open-cup nesters included: predation of eggs, nestlings, and incubating adults, cowbird parasitism, desertion of unhatched eggs, human activities, and weather (figure 12). For Spotted Towhee and Black-headed Grosbeak, predation was by far the most common nest mortality factor on the Sacramento River between 1993 and 1999. However, during the same period, Lazuli Bunting suffered nearly equal impact from both nest predation and cowbird parasitism. Impacts from other mortality factors were relatively minimal for all species.

Figure 12: Proportional causes of nest mortality of failed open-cup nests for three songbird species breeding on the Sacramento River: Black-headed Grosbeak (n=50 nests), Lazuli Bunting (n=97 nests), and Spotted Towhee (n=51 nests). Lazuli Bunting and Spotted Towhee nest in understory vegetation below 2 meters, while Black-headed Grosbeak nests in mid-canopy vegetation. Based on data collected between 1993 and 1999.



FALL MIGRATION

Central Valley

Species richness by migratory pattern
During the autumns of 1995 through 1999, we captured 73 landbird species (75 identified subspecies) of varying migratory patterns on all three PRBO Central Valley riparian projects combined (Sacramento, San Joaquin, and Cosumnes Rivers.) These captures included: twenty-six species of Neotropical migrants (an additional nine were detected on area searches only), two short-distance migrants that breed in the Valley, fourteen species that winter but do not breed in the Valley, twenty-nine year-round resident species (two subspecies of Song Sparrow were included in the above two counts; these subspecies occur in different regions and exhibit varying migratory behaviors), and one migrant species that breeds and winters in North America but not in the Valley.

Combined with area search censuses of mist-netting sites, we detected a total of 125 species in the fall, over the total study period.

Recaptures between years
Only one species of Neotropical migrant that does not breed in the Central Valley, Orange-crowned Warbler, was re-captured between years (at all sites combined). Two per cent of banded Orange-crowned Warblers were recaptured in subsequent years at the same site as initial capture. Four of the five recaptured individuals were on the Sacramento River.

However, five species that winter in the Central Valley were recaptured between years: Ruby-crowned Kinglet (1%), Fox Sparrow (7%) Lincoln's Sparrow (2%) Gambel's White-crowned Sparrow (4%), and Golden-crowned Sparrow (4%). One-third of these wintering individuals were recaptured at the same net in which they were originally captured.

Sacramento River

Fall capture summary
On the Sacramento River National Wildlife Refuge, 2264 landbirds of 55 species (57 subspecies) were captured in total. An additional 58 species were detected on area searches, yielding a total of 113 species detected with both census methods utilizing the habitat in the fall.

The fall capture rate on the Sacramento River (39.64 birds per 100 net-hours) was less than half that of the Cosumnes (74.36 birds per n-h), but was slightly higher than San Luis (31.98 birds per n-h).

Sacramento River sites show greater overall species richness (113 species detected during mist-netting and area searches at mist-netting sites) than other Central Valley study sites (96 at San Luis and 80 at Cosumnes). This result may reflect actual higher species richness or may be an artifact of a longer study period on the Sacramento River (5 years vs. 3 years for other study sites), providing greater opportunity to detect uncommon or vagrant species. Table 7 summarizes these results.

Table 7: Summary of fall mist-net captures and area search detections on Central Valley mist-netting sites, including study period (in years), total individuals captured in mist nets, capture rate (per 100 net-hours), and species richness based on mist net captures, area search detections at mist netting sites, and combined results of both methods.

Site	Study Period (Years)	Total Captures	Capture Rate (per 100 net-hours)	Species Richness		
				Mist net Captures	Area Search Detections Only	Total from Mist nets and Area Search
Sac River NWR	5	2264	39.64	55	58	113
San Luis NWR	3	1164	31.98	50	46	96
Cosumnes	3	1769	74.36	49	31	80

Capture rates by species
On the Sacramento River, the species most frequently captured in the fall were Yellow Warbler (5.69), Ruby-crowned Kinglet (5.29 per net-hour) and Orange-crowned Warbler (4.53 per n-h). Appendix 6 summaries fall capture rates for all species.

Three species of high conservation priority, Song Sparrow, Yellow Warbler, and Willow Flycatcher, were captured regularly during the fall. Breeding populations of these species are largely extirpated on the Sacramento River mainstem, south of Redding.

Song sparrows were captured at a rate of 0.56 per n-h, compared to 2.73 per n-h at Cosumnes and 0.88 per n-h at San Luis. (The Song Sparrow still breeds on the latter two sites, but not on the Sacramento River mainstem south of Redding.)

Yellow Warblers were captured more frequently on the Sacramento River NWR (5.69) than on the San Luis NWR (0.60) or the Cosumnes Preserve (0.38). Willow Flycatchers were captured at the rate of 1.79 per n-h, compared to 1.35 per n-h at Cosumnes and 0.33 per n-h at San Luis NWR.

Age ratios

Ralph (1971) maintained that the normal age distribution of a landbird species should be between 1:1 and 4:1 (hatching-year birds to after hatching-year birds), based on normal clutch size and survival, and that ratios outside of that range reflect disproportionate use of an area between age classes. Stewart et al. (1974) found that inland California sites generally had lower HY to AHY age ratios in the autumn than two coastal sites, PRBO's Palomarin Field Station (coastal Marin County) and the Southeast Farallon Islands. Taylor et al. (1994) found an overall age ratio of 9:1 at the Palomarin Field Station.

On the Sacramento River, the overall age ratio for all species combined (hatch year/adult) was 2.23:1 (we were able to assign age to 74% of total captures). High hatch year/adult ratios include Myrtle Warblers (9.50), Bewick's Wrens (7.24), Audubon's Warblers (6.42) and Pacific-slope Flycatchers (6.25).

Based on Ralph's criteria, captured Song Sparrows and Yellow Warblers had normal age ratios on migration throughout the Central Valley. Song Sparrows using Sacramento River sites in the fall had a hatch year/adult ratio of 3.00, compared to 2.20
at San Luis NWR and 1.58 at Cosumnes.

The Yellow Warbler fall age ratio on the Sacramento River was lower than other sites (1.09), compared to 2.20 at San Luis NWR and 1.67 at Cosumnes. (This species breeds in extremely low densities on the Sacramento River and does not breed on the other sites.)

The Willow Flycatcher fall age ratio was 2.52 on the Sacramento River NWR, while on the other two sites, this age ratio was strongly skewed toward hatch year birds (11:0 on San Luis NWR and 14.50 on the Cosumnes Preserve.)

Fall capture dates

Figures 13 through 15 summarize fall capture dates by age class of select flycatcher, thrush, sparrow, and warbler species on Central Valley study sites.

Figure 13: Ranges of fall capture dates, with peak capture date and sample size of flycatcher and thrush species, by species and age class, for three Central Valley fall migration study sites: Sacramento River National Wildlife Refuge (SRNWR), San Luis National Wildlife Refuge (SLNWR), and Cosumnes Preserve (CP). Based on data collected between 1995 and 1999 on SRNWR and between 1995 and 1997 on SLNWR

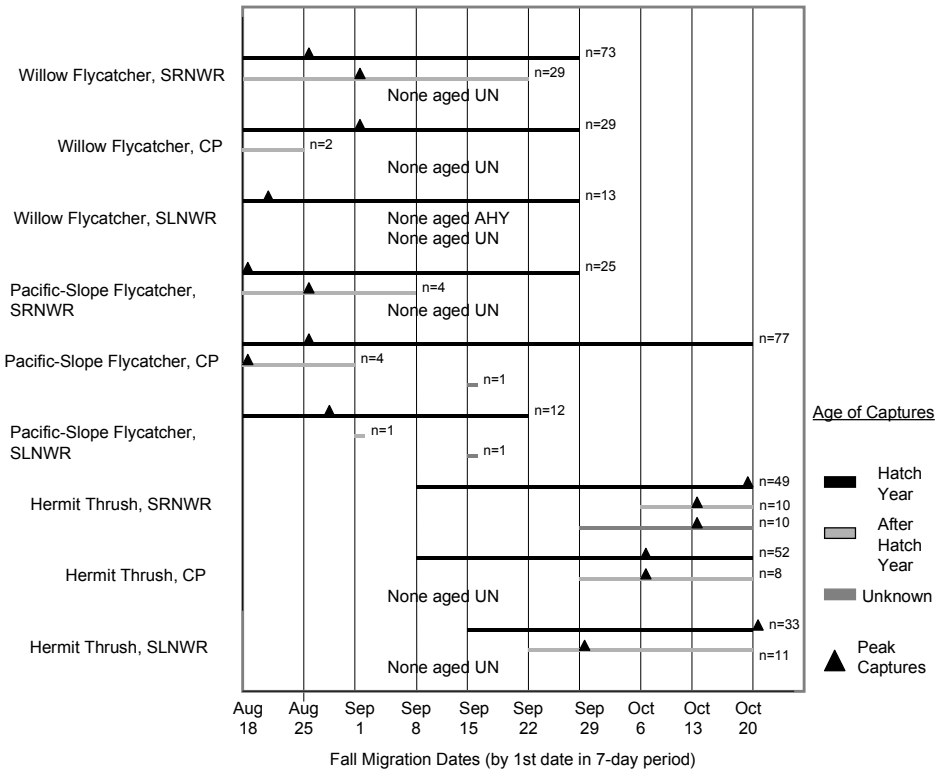
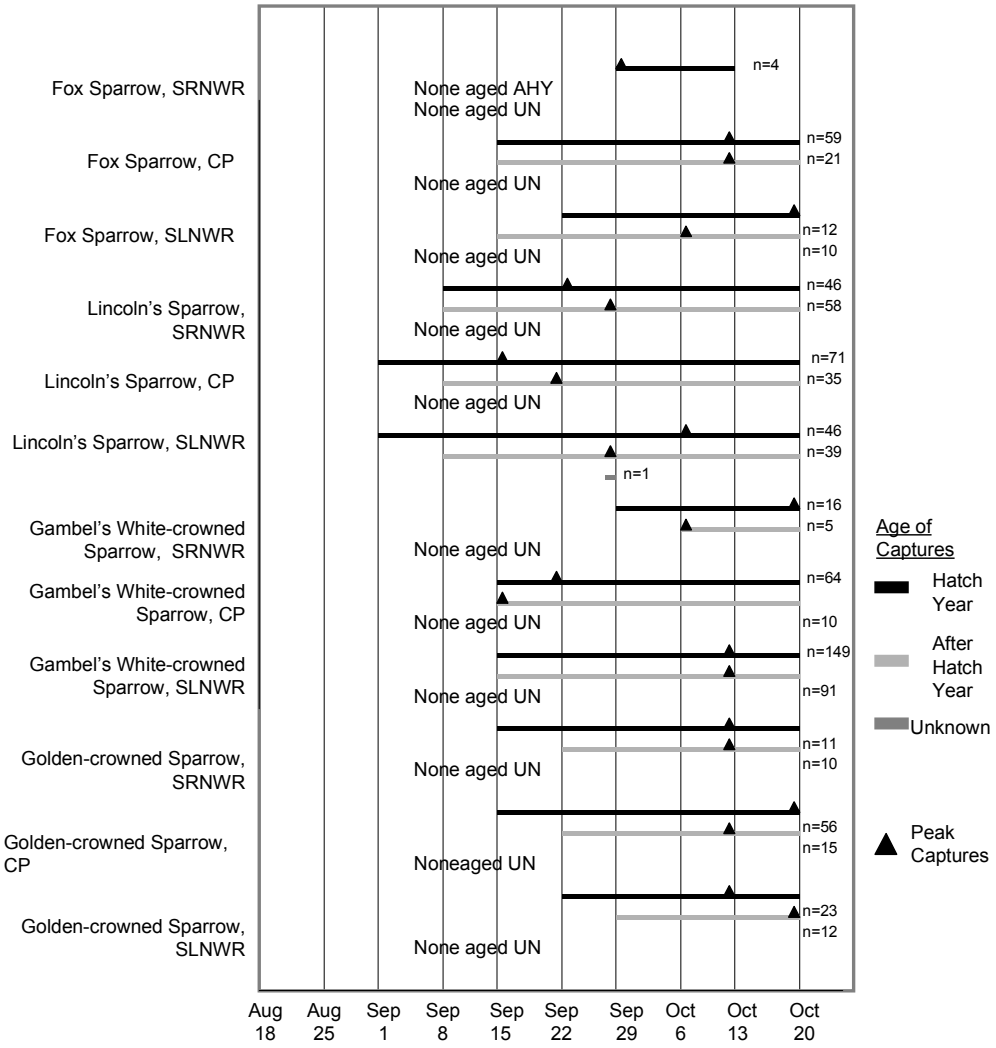
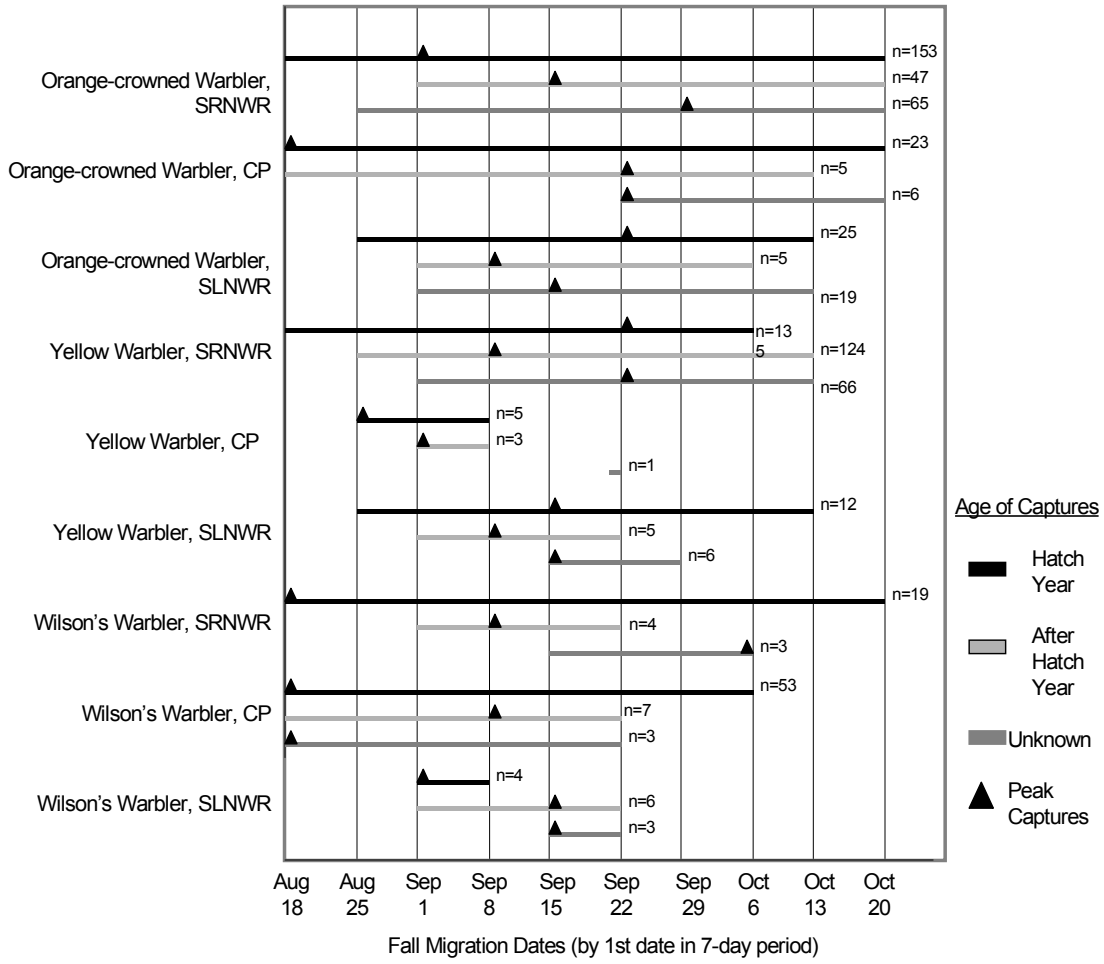


Figure 14: Ranges of fall capture dates, with peak capture date and sample size of wintering sparrow species, by species and age class, for three Central Valley fall migration study sites: Sacramento River National Wildlife Refuge (SRNWR), San Luis National Wildlife Refuge (SLNWR), and Cosumnes Preserve (CP). Based on data collected between 1995 and 1999 on SRNWR and between 1995 and 1997 on SLNWR and CP.



Fall migration dates (by 1st date of 7-day banding period)

Figure 15: Ranges of fall capture dates, with peak capture date and sample size of Neotropical migrant warbler species, by species and age class, for three Central Valley fall migration study sites: Sacramento River National Wildlife Refuge (SRNWR), San Luis National Wildlife Refuge (SLNWR), and Cosumnes Preserve (CP). Based on data collected between 1995 and 1999 on SRNWR and between 1995 and 1997 on SLNWR



DISCUSSION

Riparian bird diversity

Our point count data analyses indicate that bird communities are responding favorably to TNC's horticultural-based restoration efforts on the Sacramento River through recolonization of sites within the first eight years after planting. This is indicated by a significant increase in overall riparian bird diversity on four restoration sites combined – Phelan Island, River Vista, Flynn, and Ryan. The absence of such a trend on riparian forest control sites indicates that this increase is a response to restoration efforts, rather than a system-wide trend.

Site-specific results from Phelan Island, the oldest of our restoration monitoring sites, show riparian bird diversity approaching that of riparian forest remnants along the Sacramento River. In contrast, diversity at River Vista does not appear to be increasing significantly. This may reflect the age difference of the two sites; the steeper increase in bird diversity at Phelan Island may be a function of time and more advanced seral development at this site. Also, our River Vista data includes the early, high-maintenance phase of the restoration project, while our Phelan Island data reflects the post-maintenance phase, when the site has become more self-sustaining. Bird diversity may be depressed during the first several years of restoration, when active maintenance such as mowing, spraying, irrigation, and planting occurs across much of the site. As the River Vista site matures and becomes self-sustaining, we may see an increase in riparian bird diversity similar to that of Phelan Island. (Bird monitoring began several years after planting at Phelan Island, which explains the absence of data from the first several years of this project. With the implementation of a long-term bird monitoring program on TNC's Sacramento River restoration sites, monitoring now begins in the first year of restoration.)

Other possible biological explanations of this difference are related to potential differences in habitat quality, as influenced by combined effects of multiple factors: hydrology, vegetation structure at the developing restoration sites, predator populations, surrounding land use, and quality of adjacent riparian habitat (that may or may not host source populations of riparian birds). Recent efforts to restore hydrologic processes to River Vista through levee removal will provide an exciting opportunity to study bird response to revegetation efforts done in conjunction with physical process restoration.

Bird diversity on riparian forest remnants appears to fluctuate over time (though less so at Ohm.) Diversity patterns on several of these sites, spread over approximately sixty river miles, appear to track one another closely. This suggests that fluctuations in bird diversity are tied to some system-wide physical phenomenon, such as flood regime or weather. Future research should investigate the relationship between such physical phenomenon and bird population dynamics.

While bird diversity fluctuates on other riparian forest sites, it remains fairly low and constant at Ohm, the only site where the understory is grazed during bird breeding season. This contrast suggests that disturbance processes affecting understory vegetation structure are a key factor influencing breeding bird communities on the Sacramento River. Future investigations that involve cattle exclosures around Ohm riparian zones or replicate grazed sites would be valuable for determining the impact of cattle grazing in riparian zones during the bird breeding season.

Our results show that highest bird diversity is found in riparian forest and scrub habitats. This indicates that The Nature Conservancy's efforts to cultivate such habitat types through diverse planting mixes should yield benefits to bird populations throughout all stages of habitat.

Finally, results indicate that landbirds respond to restoration conducted on a large spatial scale (500+ meter radius), as bird diversity increases with amount of habitat surrounding a point.

Nest success

While riparian birds are recolonizing restoration sites at an encouraging rate, poor reproductive success of species nesting in understory vegetation on the Sacramento River continues to be a critical problem on both revegetation sites and riparian forest remnants.

Poor nest success is an issue that must be addressed if bird populations are to persist and continue to recolonize on Central Valley river systems. On the Sacramento River, two species that nest below the 2-meter level, Lazuli Bunting and Spotted Towhee, are experiencing alarmingly low nest survivorship values on both restoration and riparian forest sites. On the San Joaquin River, another understory-nesting species, Song Sparrow, is also experiencing extremely low nest survivorship (Ballard et al., 1999). (The Song Sparrow has already been largely extirpated from the Sacramento River mainstem, south of Red Bluff.) While none of these species are officially recognized as threatened or endangered, it is unlikely that populations will persist at such low levels of nest success, except through emigration from other regions.

Current reproductive failure and the historic decline and disappearance* of many breeding bird species in the Sacramento River Valley can probably be attributed to the cumulative impact of multiple stressors resulting from flood management practices and subsequent large-scale agricultural conversion.

These stressors may include: inflated nest predator populations and concentration of predators in riparian zones, direct loss of breeding habitat, and loss of native plant succession (including regeneration of native herbaceous understory).

While many factors contribute to bird population declines through reduced reproductive success and overwinter survival, direct habitat loss is most likely the overarching stressor in this region. Riparian habitat loss and fragmentation may well have resulted in small isolated sub-populations extremely susceptible to high rates of nest predation and parasitism, which eventually succumbed to high nest mortality rates. Also, lack of connection between patches may prevent dispersal and colonization by some species.

Nest predation, followed by nest parasitism, appears to be the most common cause of nest mortality for open-cup nesting species. Abundance of nest predators and parasites may increase with certain surrounding land uses and disturbed hydrologic patterns, ultimately influencing nest success of birds. In an agricultural landscape, diminished habitat structure may concentrate predators in remaining islands of riparian habitat, where remnant populations of breeding songbirds persist (Heske et al., 1999). Short grasses associated with orchards and grazing provide ideal foraging substrate for Brown-headed Cowbirds. Agricultural land conversion favors an increase in wildlife species that prey upon adult birds and their nests or compete directly with native songbirds for critical resources. Predator species that particularly impact ground and shrub nesting birds include feral and domestic cats, raccoons, possums, rodents, crows and jays. Domestic cats alone kill an estimated 4.4 million songbirds a year in North America (Stallcup, 1991).

* This applies to the federally endangered Least Bell's Vireo, as well as the Yellow Warbler, Warbling Vireo, Willow Flycatcher, Pacific-slope Flycatcher, and Song Sparrow, all of which are largely extirpated as breeders from the mainstem of the Sacramento River.

Populations of European Starlings, Brown-headed Cowbirds, and corvids (crows and jays), avian species that compete directly with breeding riparian birds, increase with livestock use in and adjacent to riparian zones. Short grass and livestock feedlots adjacent to riparian breeding grounds provide ideal foraging conditions for Brown-headed Cowbirds, which will commute over

7 km. daily between foraging and breeding grounds that support abundant host species (Matthews and Goguen, 1998).

A study on the Bitterroot River in Montana, another western riparian system embedded in an agricultural matrix, has examined the relationship of human land use to nest predation and nest parasitism by cowbirds (Tewksbury et al., 1998). This study found that distance from livestock feedlots to riparian breeding grounds influences cowbird parasitism rates and that abundance of avian nest predators (jays and crows) increases with extremely high levels of riparian habitat fragmentation caused by intensive agricultural conversion.

Fall migration

Discussions among California biologists have posed the question of whether the Central Valley is an important fall migration route for adult landbird species. Our results indicate that riparian zones of the Central Valley are indeed important for migrating adults of many species. Age ratios of several migrating species indicate that both adult and hatch year birds of several species of conservation priority in California rely upon the Sacramento River National Wildlife Refuge for migration stopover or wintering habitat.

Of all three Central Valley study sites, the Sacramento River National Wildlife Refuge had the highest capture rates of migrating Yellow Warblers and Willow Flycatchers, but the lowest for Song Sparrows. It is difficult to speculate on these differences, but worth noting as an argument on behalf of riparian habitat conservation and restoration in the Sacramento Valley. Most of the Song Sparrows captured are probably migrating from foothill and montane breeding grounds.

The lack of dispersing hatch year Song Sparrows may indicate the need for improved connecting corridors between nearby source populations (e.g. Butte Sink, Llano Seco, Upper Stony Creek, Clear Creek) and portions of the Sacramento River mainstem.

Because these studies spanned only a few years (3 to 5 years at each site), results may not reflect average numbers of species utilizing the habitat or region. High annual variation in numbers of autumn migrants was found in long-term studies at the Palomarin Field Station (Taylor et al. 1994) and on the Southeast Farallon Islands (DeSante 1983). Short-term fall migration monitoring may underestimate an area's importance to a species or suite of species as a stopover site. Nevertheless, short-term monitoring clearly establishes the importance of the remaining riparian habitat in the Central Valley to a number of species, including resident, migrant and wintering landbirds. A better understanding of the role of this habitat in all aspects of landbird biology will ensure that efforts continue to protect, restore and enhance riparian habitat throughout the state.

FUTURE RESEARCH AND MONITORING

Results presented in this report lay the groundwork for developing future ecosystem-based research topics. Coordinated research efforts involving measures bird populations and other riparian taxa, as well as measures of physical processes could be the foundation of unprecedented ecosystem-level research and monitoring efforts on the Sacramento River. All questions could potentially be addressed across Central Valley river systems. Proposed topics follow:

Population dynamics

- Do Sacramento River riparian forests and restoration sites currently support viable populations of songbirds?
- What are the relative impacts of habitat loss, nest predation, nest parasitism, and food availability on bird demographics? How do these factors interact?
- Are conditions on the breeding or wintering grounds more limiting to riparian bird populations? To what degree do these limits interact to drive population dynamics?

Habitat Quality

- Will levee breaching at restoration sites (River Vista and Flynn) lead to changes in the bird communities at these sites, as measured by abundance, species richness and diversity?
- Does timing, duration, and/or frequency of flooding affect songbird habitat quality/quantity, in particular, native understory vegetation?
- How do efforts to restore native understory affect reproductive success of open-cup nesters?
- Do bird populations on the Sacramento River respond differently to riparian restoration efforts than those on other Central Valley river systems?

Nest predation/parasitism

- How do hydrology conditions affect nest predator (mammalian, reptilian, avian) and nest parasite (Brown-headed Cowbird) populations?
- How does surrounding land use affect nest predator and parasite populations? Does nest success vary with type and extent of adjacent land use?
- Do population levels of predators and nest parasite species relate to songbird reproductive success?
- Can nest parasitism by Brown-headed Cowbirds be reduced by changes in agricultural management practices that eliminate cowbird foraging habitat adjacent to riparian zones (planting cover crops in orchards, removing livestock feedlots from the floodplain)? At what spatial scale must these efforts be undertaken to produce an effect, as measured by nest parasitism rates and fledging success of host species?

MANAGEMENT RECOMMENDATIONS

Habitat-based solutions such as USFWS and TNC's large-scale restoration efforts must be sought to remedy negative impacts to bird populations resulting from anthropogenic disturbances. These include restoring large blocks of riparian habitat adjacent to existing forest fragments, reconnecting forest fragments with each other, and reconnecting the river with the floodplain. Changes in adjacent agricultural land management that reduce cowbird and predator levels may also have beneficial effects for songbirds.

PRBO submitted site specific management recommendations to USFWS and TNC throughout 1999. Those memos are reproduced in their entirety in appendix 7.

We also present several additional management recommendations in the following section that may maximize conservation benefits to songbirds on the Sacramento River.

Hydrology and geomorphology

- We strongly encourage efforts to reconnect the river to the floodplain on cultivated restoration sites, such as recent levee breaches at River Vista and Flynn restoration sites. In upcoming field seasons, PRBO will monitor bird response to these efforts. We predict that such efforts to restore proper hydrologic and geomorphologic conditions will benefit breeding bird populations by enhancing plant succession processes and understory regeneration and by possibly reducing predator levels.

- An opportunity currently exists at the Kaiser site to make a breach in the levee road running between the riparian forest and an adjacent fallow agricultural field. This field supports a large colony of Common Yellowthroats, a migratory bird species that usually nests in emergent wetlands, but at this site is currently utilizing exotic weeds as nesting substrate. Creating proper hydrologic conditions may be all that is required to convert this site to a wetland habitat beneficial to the Common Yellowthroat and other species.

Planting design

- When designing the shape of a restoration planting, focus on creating blocks of riparian habitat, rather than linear strips along riverbanks. Our results show that bird communities respond positively to greater amounts of habitat surrounding a point.

- Continue current efforts to propagate and plant native herbaceous and shrubby understory species that will provide quality nesting habitat below the 2-meter level. Add native CA blackberry to planting mix.

- Work with local landowners and other agencies to create connecting riparian corridors between current Song Sparrow breeding locations (Butte Sink, Gray Lodge, Llano Seco) and Sacramento River NWR units on the river's mainstem, to facilitate juvenile dispersal and recolonization of the mainstem by this species.

Timing of management activities

- Continue to consult with PRBO before weedy fields are mowed, as they may be breeding sites for open-cup nesters. When doing so, provide PRBO staff biologists a projected timeline for mowing. In 1999, several such site visits were made by PRBO biologists to declare the Sul Norte restoration site "safe to mow." However, in the lag time that ensued between the site visits and the actual mowing, Lazuli Buntings established nesting sites in the vegetation.
- Avoid conducting orchard removal during peak breeding season, as these sites are used for nesting by several bird species and as foraging substrate for many others.

Existing agricultural infrastructure on restoration sites

- Remove old roads that run between restoration and remnant forest sites, once they are deemed unnecessary for management or monitoring efforts. These roads, especially those built on levees, may create "hard" edges between riparian forest and restoration sites, inhibiting flooding and slowing native plant recruitment processes. They also may provide travel corridors for mammalian nest predators.

Management of agricultural lands adjacent to riparian zones

- Develop a policy that limits spring and summer cattle grazing in riparian zones on TNC and USFWS sites.

- Fence cattle from riparian forest and willow scrub habitat during spring and summer at Ohm to allow regeneration of native understory vegetation.

- Encourage farmers to plant spring/early summer cover crops in orchards to reduce cowbird foraging area adjacent to riparian nesting habitat.

EDUCATION AND OUTREACH

In 1999, PRBO developed and implemented an extensive conservation education and outreach program on the Sacramento River, in cooperation with The Nature Conservancy, US Fish & Wildlife Service, and the Sacramento River Discovery Center. Birds serve as an excellent entry point into broader discussions of habitat conservation, for they are ecologically diverse, have high aesthetic value, and are easily observable.

The objective of this program was to create a cultural climate that favors restoration of riparian habitats by promoting riparian conservation as a common ground among communities, non-profit organizations, and government agencies. By providing "hands-on" experience in the field whenever possible, we seek to raise the profile of riparian restoration efforts, teach about the benefits of restoration to riparian avifauna, and create an interface between the scientific community and the general public.

We offered many opportunities, free of charge to participants, aimed at meeting these objectives. All of these opportunities were designed to increase "bird literacy" within the community by teaching basic principals of avian ecology and field observation skills, thus raising interest in riparian conservation to new levels.

General highlights include (see Appendix 8 for details on PRBO's 1999 collaborative activities):

- Hosting field trips to our Phelan Island mist-netting site, during which we demonstrated the process of bird banding, discussed the relationship of songbirds to riparian habitat, and promoted habitat restoration through site tours of this 9-year-old riparian restoration site.

- Taking our new traveling display to several regional environmental fairs, where we gave visitors the opportunity to look at bird study skins up close as we discussed current bird conservation efforts on the Sacramento River.

- Developing and hosting several workshops on bird identification and field observation skills.

- Providing technical assistance (through workshops, original written literature, and personal consultation) to organizations and landowners interested in improving riparian bird habitat on their land.

- Providing on-going scientific training for participants with all levels of expertise, including teachers, high school students, and community volunteers. These experiences focused on teaching 1) basic concepts in avian ecology and
  2) relevant field biology skills.

- Developing and testing riparian habitat curriculum that is now being utilized by the Sacramento River Discovery Center in Red Bluff.

- Training high school interns from the Sacramento River Discovery Center who produced a video featuring the "hows and whys" of bird banding (available upon request), assisted in leading tours at our banding sites, and collected nest data throughout the season.

- Participating in several river tours coordinated by TNC, addressing the benefits of riparian restoration to bird populations.

- Developing an electronic database of participants, through which future events can be promoted.

CONCLUSIONS

Loss of riparian habitat has had a drastic impact on bird populations of the Sacramento River over the past century. Several breeding species have disappeared within the last few decades, and some that do still breed here suffer from poor nest success, particularly those which nest in understory vegetation. Therefore, while birds are rapidly recolonizing restoration sites, these and adjacent riparian forest sites may currently represent ecological traps for breeding songbirds.

Large-scale efforts to restore dynamic physical and biotic processes to Sacramento River riparian zones are the only solution to this dilemma. These efforts must focus simultaneously on the regeneration of riparian breeding habitat (particularly understory vegetation) and appropriate management of surrounding agricultural lands to reduce nest predation/parasitism pressure.

As such landscape level changes can only be effected amidst a supportive cultural climate, educational opportunities that highlight the mutual benefits of riparian restoration and offer hands-on field experience are necessary. The local community has shown a strong interest in our recent conservation education offerings, making it clear that public support for riparian restoration is growing.

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SONG SPARROW: HISTORIC CALIFORNIA RANGE AND CURRENT NESTING LOCATIONS

APPENDIX 2

Species List and Breeding Status by Site: Sacramento River and Lassen Foothill Tributaries (updated 1999)

List of all bird species seen or heard at long-term study sites. Species of concern are italicized and state or federally listed species are marked with an asterisk. This list includes all species detected from standardized data collection and casual observations. Common names, breeding status, and migratory behavior are listed for all birds encountered. (Res = resident, Mig = migrant). Species names based on checklist of the American Ornithologists' Union (AOU 1983).

Study sites: BA=Battle Creek, DE=Deer Creek, MI=Mill Creek, DY=Dye Creek, RY=Ryan, LB=La Barranca, OH=Ohm, HA=Haleakakla, FL=Flynn, KS=Kopta Slough, RV=River Vista, PC=Pine Creek, KA=Kaiser, SC=Stony Creek, LL=Llano Seco, SN=Sul Norte, CO=Codora, PI=Packer Island.

Breeding status codes: 0=no e0vidence of breeding, 1=possible breeder, 2=probable breeder, 3=confirmed breeder (See field methods section for definitions)

	Breeding Status by Site																	
A.O.U. Common Name	**BA**	**DE**	**MI**	**DY**	**RY**	**LB**	**OH**	**HA**	**FL**	**KS**	**RV**	**PC**	**KA**	**SC**	**LL**	**SN**	**CO**	**PI**	**Migratory behavior**
Acorn Woodpecker	2	1	2	3	3	3	0	0	1	0	1	0	0	1	1	0	0	1	Res
American Coot	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
American Crow	0	1	1	1	1	1	2	1	1	1	1	1	0	1	1	0	1	1	Res
American Goldfinch	1	2	2	2	3	2	3	2	3	3	3	3	3	3	2	3	2	2	Res?
American Kestrel	1	1	2	2	1	1	0	0	0	0	2	0	0	0	0	0	0	1	Res?
American Pipit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
American Robin	2	2	2	3	2	2	3	3	3	2	2	3	3	3	1	3	2	3	Res?
American Tree-sparrow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
American White Pelican	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Anna's Hummingbird	0	0	1	1	0	1	1	1	0	0	0	0	0	0	0	0	1	0	Res?
Ash-throated Flycatcher	2	2	2	2	2	3	3	2	3	2	2	3	3	3	2	3	2	2	Mig
Audubon's Warbler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
*** Bald Eagle**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Res
*** Bank Swallow**	0	1	0	0	2	3	3	1	3	3	3	1	0	1	0	0	3	1	Mig
Barn Owl	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	Res?
Barn Swallow	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	Mig

A.O.U. Common Name	Breeding Status by Site																		Migratory behavior
	BA	DE	MI	DY	RY	LB	OH	HA	FL	KS	RV	PC	KA	SC	LL	SN	CO	PI	
Belted Kingfisher	1	1	1	1	0	1	1	1	1	1	1	1	0	3	1	2	1	1	Res?
Bewick's Wren	2	2	2	2	2	3	3	2	3	2	2	2	2	3	2	3	3	2	Res
Black-chinned Hummingbird	0	1	2	1	2	3	2	2	3	3	1	1	0	2	0	1	1	1	Mig
Black-crowned Night-heron	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	Res
Black-headed Grosbeak	2	2	2	1	2	3	3	2	3	3	2	3	3	3	3	3	2	2	Mig
Black Phoebe	2	0	2	2	1	2	2	2	2	2	2	3	2	3	1	1	0	2	Res
Black-throated Gray Warbler	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Blue Grosbeak	0	2	1	3	1	2	1	1	3	3	3	3	3	3	2	3	1	3	Mig
Blue-gray Gnatcatcher	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Brewer's Blackbird	1	1	2	2	0	1	1	1	1	0	3	1	1	3	0	3	0	1	Res
Brown-headed Cowbird	2	2	2	2	2	3	3	2	3	3	3	3	3	3	2	3	2	3	Mig
Bullock's Oriole	1	2	2	3	2	2	3	2	3	2	3	3	2	3	2	3	2	2	Mig
Bushtit	2	2	2	2	1	2	3	1	3	2	3	3	2	3	2	3	2	3	Res
California Quail	2	2	2	2	1	2	3	2	2	2	1	1	2	3	1	3	1	2	Res
California Towhee	0	1	1	2	1	2	3	2	2	2	1	1	2	3	1	3	2	2	Res
Canada Goose	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Res
Canyon Wren	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Res
Cassin's Vireo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Caspian Tern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Cedar Waxwing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Chipping Sparrow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Cliff Swallow	2	2	3	2	0	0	0	0	0	0	2	1	0	0	0	0	0	0	Mig
Common Merganser	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	Mig
Common Yellowthroat	0	1	1	0	2	2	2	2	3	3	2	1	3	3	3	3	1	1	Mig
Cooper's Hawk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Dark-eyed Junco	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Double-crested Cormorant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Downy Woodpecker	2	1	2	2	2	2	3	1	3	2	2	0	3	3	1	3	2	1	Res
Dusky Flycatcher	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
European Starling	2	2	3	3	2	3	3	3	3	3	2	2	2	3	2	1	1	3	Res
Forster's Tern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Gambel's White-crowned Sparrow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Golden-crowned Sparrow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Grasshopper Sparrow	0	0	0	0	0	0	3	0	1	0	0	0	0	1	0	0	0	0	Mig
Great Blue Heron	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	Res

A.O.U. Common Name	Breeding Status by Site																		Migratory behavior
	BA	DE	MI	DY	RY	LB	OH	HA	FL	KS	RV	PC	KA	SC	LL	SN	CO	PI	
Great Egret	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	Res
Great Horned Owl	0	0	1	1	0	2	1	0	2	1	0	1	0	2	1	1	1	0	Res
Hairy Woodpecker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Res
Hammond's Flycatcher	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Hermit Warbler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Horned Lark	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Res
House Finch	2	2	2	3	3	3	3	3	3	2	3	3	3	3	2	3	3	2	Res
House Sparrow	1	0	2	0	0	0	0	0	3	0	0	1	0	0	0	0	0	1	Res
House Wren	2	2	2	2	2	3	3	2	3	1	1	1	2	2	2	3	3	2	Mig
Hutton's Vireo	0	0	0	2	0	1	2	0	3	1	0	1	0	0	0	0	0	0	Res?
Killdeer	2	2	2	2	1	2	3	0	2	1	3	2	1	2	1	2	1	1	Res
Lark Sparrow	0	1	2	1	2	3	3	1	3	3	1	3	1	3	1	2	1	1	Res?
Lawrence's Goldfinch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Res?
Lazuli Bunting	2	2	2	3	2	3	3	2	3	3	3	3	3	3	2	3	2	2	Mig
Lesser Nighthawk	0	1	1	0	0	1	1	0	0	0	0	0	0	3	0	0	0	0	Mig
Lesser Goldfinch	1	2	2	2	2	2	3	2	3	3	2	3	3	3	2	3	2	3	Res?
Lewis' Woodpecker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Res
Lincoln's Sparrow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Loggerhead Shrike	0	0	1	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	Mig
MacGillivray's Warbler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Mallard	1	2	1	1	0	0	0	0	0	0	1	0	2	3	1	2	0	3	Mig
Mourning Dove	2	2	2	2	3	2	3	2	3	3	3	3	3	3	2	3	2	2	Mig
Marsh Wren	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	Res
Nashville Warbler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Northern Flicker	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Res
Northern Harrier	0	0	0	0	0	0	0	0	0	3	0	0	2	2	0	0	3	0	Mig
Northern Pygmy-owl	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Res
Northern Mockingbird	0	0	2	2	0	0	0	0	1	2	2	1	0	2	0	0	0	0	Mig
Northern Rough-winged Swallow	1	1	0	0	1	2	3	1	1	0	2	0	0	1	0	1	1	0	Mig
Nuttall's Woodpecker	2	2	2	2	2	3	3	3	3	2	2	3	3	3	2	3	2	3	Res
Oak Titmouse	2	2	2	2	2	2	3	2	3	2	2	2	3	3	2	3	2	2	Res
Orange-crowned Warbler	1	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Osprey	0	1	0	0	0	3	0	0	3	0	0	0	0	3	0	0	0	2	Mig
Pacific-slope Flycatcher	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Pied-billed Grebe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	Res
Purple Finch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig?
Red-breasted Merganser	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig

A.O.U. Common Name	Breeding Status by Site																		Migratory behavior
	BA	DE	MI	DY	RY	LB	OH	HA	FL	KS	RV	PC	KA	SC	LL	SN	CO	PI	
Red-shafted Flicker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Res
Red-shouldered Hawk	1	0	1	0	0	0	1	0	0	1	1	1	0	0	1	3	0	0	Res
Red-tailed Hawk	2	1	2	1	2	2	3	2	3	2	1	2	0	3	2	3	1	2	Res
Red-winged Blackbird	2	1	3	2	2	1	0	0	3	1	2	1	3	3	3	1	2	2	Mig
Ring-necked Pheasant	1	1	1	2	1	1	0	1	1	1	2	1	1	3	2	1	0	2	Res
Rock Wren	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Res
Ruby-crowned Kinglet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Rufous-crowned Sparrow	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Res?
Savannah Sparrow	0	0	0	1	0	0	0	0	0	0	1	1	0	1	0	0	0	0	Mig
Sharp-shinned Hawk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Song Sparrow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	Mig/Res
Spotted Sandpiper	2	1	0	0	0	2	1	0	2	0	0	0	0	1	0	1	0	1	Mig
Spotted Towhee	2	2	2	2	2	3	3	2	3	3	3	3	3	3	2	3	2	2	Mig
*** Swainson's Hawk**	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	1	1	Mig
Swainson's Thrush	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Townsend's Warbler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Tree Swallow	2	2	2	2	3	3	3	2	3	1	1	3	3	3	2	3	2	3	Mig
Tri-colored Blackbird	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Res?
Turkey Vulture	1	1	1	1	0	1	0	0	1	1	0	1	1	1	1	1	0	1	Res?
Virginia Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	Res
Violet-green Swallow	1	0	1	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	Mig
Warbling Vireo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Western Bluebird	0	2	1	3	3	2	1	2	3	1	3	3	3	3	0	3	2	2	Mig
Western Kingbird	2	2	2	3	2	3	3	2	3	3	3	3	3	3	2	3	2	2	Mig
Western Meadowlark	2	1	1	3	0	0	0	0	0	0	2	0	0	0	0	0	0	0	Mig
Western Scrub-jay	2	2	2	2	2	3	3	2	3	3	1	3	2	3	1	2	2	3	Res
Western Tanager	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Western Wood-pewee	2	2	2	3	2	2	3	2	3	3	3	3	3	3	2	3	2	2	Mig
*** Western Yellow-billed Cuckoo**	0	0	0	1	0	1	0	1	1	1	0	1	1	3	0	1	0	1	Mig
White-breasted Nuthatch	2	2	2	1	2	2	2	2	3	1	0	1	1	2	2	3	2	1	Res
White-tailed Kite	0	0	0	0	0	0	0	0	0	0	2	1	1	3	0	0	0	0	Mig
Wild Turkey	0	1	0	0	0	1	3	0	3	3	0	0	0	1	0	0	0	0	Res
*** Willow Flycatcher**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Wilson's Warbler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Wood Duck	0	1	2	2	0	1	3	1	3	3	0	0	0	1	1	1	1	3	Res
Wrentit	1	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	Mig

A.O.U. Common Name	Breeding Status by Site																		
	BA	DE	MI	DY	RY	LB	OH	HA	FL	KS	RV	PC	KA	SC	LL	SN	CO	PI	Migratory behavior
Yellow-billed Magpie	1	0	1	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	Res
Yellow-breasted Chat	2	2	1	3	2	3	3	2	3	2	0	2	0	1	2	1	2	0	Mig
Yellow-rumped Warbler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Mig
Yellow Warbler	0	0	0	1	0	1	1	0	0	1	0	0	3	0	1	3	1	1	Mig

APPENDIX 3

List of breeding riparian species used in mainstem and mainstem/tributary diversity analysis (1=included in analysis, 0=not included).

SPECIES	Mainstem analysis	Mainstem/trib analysis
Acorn Woodpecker	1	1
American Goldfinch	1	1
American Kestrel	1	1
American Robin	1	1
Anna's Hummingbird	0	1
Ash-throated Flycatcher	1	1
Bank Swallow	1	1
Black-chinned Hummingbird	1	1
Belted Kingfisher	1	1
Bewick's Wren	1	1
Brown-headed Cowbird	1	1
Black-headed Grosbeak	1	1
Blue Grosbeak	1	1
Black Phoebe	1	1
Bullock's Oriole	1	1
Bushtit	1	1
California Towhee	1	1
California Quail	1	1
California Thrasher	0	1
Cooper's Hawk	1	1
Common Yellowthroat	1	1
Downy Woodpecker	1	1
House Wren	1	1
Indigo Bunting	0	1
Killdeer	1	1
Lark Sparrow	1	1
Lazuli Bunting	1	1
Lesser Goldfinch	1	1
Lesser Nighthawk	1	1
Marsh Wren	1	1
Mourning Dove	1	1
Northern Rough-winged Swallow	1	1
Nuttall's Woodpecker	1	1
Oak Titmouse	1	1
Osprey	1	1
Pacific Slope Flycatcher	0	1
Red-shafted Flicker	1	1
Red-shouldered Hawk	1	1
Red-tailed Hawk	1	1
Red-winged Blackbird	1	1
Song Sparrow	1	1
Spotted Sandpiper	1	1
Spotted Towhee	1	1
Sharp-shinned Hawk	1	1

SPECIES	Mainstem analysis	Mainstem/trib analysis
Swainson's Hawk	1	1
Tricolored Blackbird	1	1
Tree Swallow	1	1
Turkey Vulture	1	1
Violet-green Swallow	1	1
White-breasted Nuthatch	1	1
Western Bluebird	1	1
Western Kingbird	1	1
Western Scrub-jay	1	1
Western Wood-pewee	1	1
Wrentit	1	1
White-tailed Kite	1	1
Yellow-breasted Chat	1	1
Yellow-billed Cuckoo	1	1
Yellow-billed Magpie	1	1
Yellow-headed Blackbird	0	1
Yellow Warbler	0	1

APPENDIX 4

Point count survey sites incorporated into 1999 Sacramento River mainstem/tributary landscape analysis.

Station	Number of point count stations
Anderson River Park	5
Battle Creek	25
Beehive Bend	8
Bidwell Park	11
Butte Creek	4
Coal Canyon Road	1
Clear Creek	8
Codora	10
Cottonwood Creek	10
Deer Creek	16
Dye Creek	24
Fish & Game, 7 Mile Road	4
Flynn	14
Four Mile Road	4
Haleakala	1
Howard Slough	5
Kaiser	14
KC Grove (Anderson River Park)	1
Kopta Slough	14
La Barranca	15
Little Butte Creek	1
Llano Seco	1
Mill Creek	29
Norman Road	1
Ohm	13
Osbourne Fishing Access	2
Oroville Wildlife Area	12
Pine Creek	20
REBA	5
Redding Island	7
River Vista	15
Ryan	12
Shooting Gallery (Clear Creek)	5
Sacramento National Wildlife Refuge	1
SNWR Car Loop	15
STAR	13
Stony Creek (Phelan Island)	19
Stillwater	8
Sul Norte	10
Thomes Creek	11
Venke Road	1
Wilson's Landing	5
Total # point count stations	**400**

APPENDIX 5

Descriptions of habitat types used in diversity analysis

COFO – **Cottonwood Forest**, dominated by cottonwoods. May have considerable willow and a few other tree types. Earlier 'succession', higher disturbance frequency than Mixed Forest.

DIRI – Disturbed Riparian. Riparian zone with single or few trees. Complete or near absence of understory due to anthropogenic disturbance such mowing, grazing, or plowing. Understory may be dominated by exotic grasses or weeds.

GRAS - Grass dominated. Less than 20% canopy cover, with the exception of Valley Oak Woodland.

HERB - Herbaceous, including mugwort, native annual herbs, but not grass. Less than 20% canopy cover.

MIFO – Mixed Riparian Forest. Older riparian forest with several tree species (black walnut, ash, sycamore, oak.) Cottonwoods and tree willows may be present.

RISC – Riparian Scrub, dominated by willow and/or other shrubs. Small trees may be present.

VAOA – Valley Oak Riparian Forest. Valley Oak with approx. 30% canopy and other co-dominant or dominant tree species.

VAWO – Valley Oak Woodland. Valley oaks with grass understory and $\geq$ 10% canopy cover.

APPENDIX 6

Fall mist-net capture rates (per 100 net hrs) and area search detections from each Central Valley region: Cosumnes Preserve, San Luis NWR, and Sacramento River NWR. Species captured but released unbanded are denoted by an asterix (*). Species detected on area search censuses only are denoted by the • symbol.

Migratory Behaviors: P=permanent residents; I=found year-round in CV with fall movement including influx of wintering individuals; M=species that winter in North America are probably only passing through CV in fall; N=Neotropical migrants that pass through CV but do not breed there; B=neotropical migrants that breed in CV; S=short-distance migrants in CV primarily in summer; W=winters in CV but do not breed there (Gaines 1977, Grinnell and Miller 1944, PRBO unpubl. data, Nat. Geo.).

Species	Migratory Behavior	Cosumnes Preserve	San Luis NWR	Sacramento River NWR
Pied-billed Grebe *Podilymbus podiceps*	P			•
Double-crested Cormorant *Phalocrocorax auritus*	P		•	•
Black-crowned Night-heron *Nycticorax nycticorax*	P		•	
Snowy Egret, *Egretta thula*	P		•	•
Great Egret, *Casmerodius albus*	P		•	•
Great Blue Heron, *Ardea herodias*	P	•	•	•
Wood Duck, *Aix sponsa*	P	•		•
Mallard, *Anas platyrhynchos*	P	•	•	
Turkey Vulture, *Cathartes aura*	P	•		•
Osprey, *Pandion haliaetus*	M?		•	•
White-tailed Kite, *Elanus caeruleus*	P		•	•
Northern Harrier, *Circus cyaneus*	P		•	•
Sharp-shinned Hawk *Accipiter striatus*	W	0.04	0.05	0.05
Cooper's Hawk, *A. cooperii*	P		•	•
Red-shouldered Hawk *Buteo lineatus*	P	•		•
Red-tailed Hawk, *B. jamaicensis*	P	*	•	•
Swainson's Hawk, *B. swainsoni*	B[1]	•		•
American Kestrel, *Falco sparverius*	P	•	•	•
Merlin, *F. columbarius*	W			•
Ring-necked Pheasant *Phasianus colchicus*	P	•	•	•
Wild Turkey, *Meleagris gallopavo*	P			•
California Quail, *Callipepla californica*	P	•	•	*
Sora, *Porzana carolina*	P		•	
Common Moorhen, *Gallinula chloropus*	P		•	
American Coot, *Fulica americana*	P		•	
Sandhill Crane, *Grus canadensis*	W	•		•
Killdeer, *Charadrius vociferus*	P	•	•	•
Greater Yellowlegs, *Tringa melanoleuca*	W			•
Common Snipe, *Gallinago gallinago*	W			•
Mourning Dove, *Zenaida macroura*	P		*	•

Species	Migratory Behavior	Cosumnes Preserve	San Luis NWR	Sacramento River NWR
Yellow-billed Cuckoo, *Coccyzus americanus*	B[2]			•
Barn Owl, *Tyto alba*	P		•	
Great-horned Owl, *Bubo virginianus*	P		•	•
Lesser Nighthawk, *Chordeiles acutipennis*	B		•	•
Common Nighthawk, *C. minor*	N		•	•
Common Poorwill, *Phalaenoptilus nuttallii*	N?		*	•
Vaux's Swift, *Chaetura vauxi*	N			•
Black-chinned Hummingbird, *Archilochus alexandri*	B	*	*	*
Anna's Hummingbird, *Calypte anne*	P		*	*
Rufous Hummingbird, *Selasphorus rufus*	N			*
Belted Kingfisher, *Ceryle alcyon*	P	•	•	•
Acorn Woodpecker, *M. formicivorus*	P			•
Red-breasted Sapsucker, *Sphyrapicus ruber*	W			•
Nuttall's Woodpecker *Picoides nuttallii*	P	0.08	0.27	0.32
Downy Woodpecker, *P. pubescens*	P	0.21	0.08	0.26
Red-shafted Flicker *Colaptes auratus cafer*	I	•	0.11	0.18
Western Wood-pewee *Contopus borealis*	B	•	•	0.35
Willow Flycatcher[d] , *Empidonax trailii*	N	1.35	0.33	1.79
Hammonds Flycatcher, *E. hammondii*	N			•
Dusky Flycatcher, *E. oberholseri*	N	-	-	0.04
Gray Flycatcher, *E. wrightii*	N	-	0.03	-
Pacific Slope Flycatcher, *E. difficilis*	B, N[e]	3.45	0.36	0.51
Black Phoebe, *Sayornis nigricans*	P	0.29	0.16	0.35
Ash-throated Flycatcher *Myiarchus cinerascens*	B	•	0.05	0.09
Western Kingbird *Tyrannus verticalis*	B	•	•	
Loggerhead Shrike, *Lanius ludovicianus*	I?	-	0.03	•
Cassin's Vireo, *Vireo cassinii*	N	0.08	0.03	0.02
Hutton's Vireo, *V. huttoni*	P	0.21	0.05	•
Warbling Vireo, *V. gilvus*	N	0.25	0.05	0.05
Western Scrub-jay *Aphelocoma californica*	P	0.21	0.05	0.05
Yellow-billed Magpie, *Pica nuttalli*	P	•	•	•
American Crow, *Corvus brachyrhynchos*	P	•	•	•
Tree Swallow, *Tachycineta bicolor*	P, N?		•	•
Violet-green Swallow, *T. thalassina*	W, N?			•
Barn Swallow, *Hirundo rustica*	B	•		•
Cliff Swallow, *H. pyrrhonota*	B	•		
Oak Titmouse, *Biaeolophus inornatus*	P	0.25	•	0.82

Species	Migratory Behavior	Cosumnes Preserve	San Luis NWR	Sacramento River NWR
Bushtit, *Psaltriparus minimus*	P	2.90	3.49	1.45
Red-breasted Nuthatch, *Sitta canadensis*	W	•	•	•
White-breasted Nuthatch *S. carolinensis*	P	•	•	0.02
Brown Creeper, *Certhia americana*	W	-	-	0.04
Bewick's Wren, *Thryomanes bewickii*	P	1.35	2.58	3.29
House Wren, *Troglodytes aedon*	S	2.48	1.43	0.67
Winter Wren, *T. troglodytes*	W	0.04	0.03	0.05
Marsh Wren *Cistothorus palustris*	S?	0.08	0.19	-
Golden-crowned Kinglet *Regulus satrapa*	W	0.04	•	0.04
Ruby-crowned Kinglet, *R. satrapa*	W	4.08	2.17	5.29
Blue-gray Gnatcatcher *Polioptila caerulea*	N	0.04	0.11	0.04
Western Bluebird, *Sialia mexicana*	I	-	-	0.04
Swainson's Thrush, *Catharus ustulatus*	N	-	•	0.04
Hermit Thrush, *C. ustulatus*	W	2.52	1.21	1.21
American Robin, *Turdus migratorius*	I	•	•	0.02
Varied Thrush, *Ixoreus naevius*	W			•
Wrentit, *Chamaea fasciata*	P	1.64	•	0.02
Northern Mockingbird, *Mimus polyglottos*	P	-	0.05	•
California Thrasher, *Toxostoma redivivum*	P	-	0.14	-
European Starling, *Sturnus vulgaris*	P	•	•	•
American Pipit, *Anthus rubescens*	W			•
Cedar Waxwing, *Bombycilla cedrorum*	W	•		•
Orange-crowned Warbler *Vermivora celata*	N[f]	1.35	1.35	4.53
Nashville Warbler, *V. ruficapilla*	N	0.04	0.03	0.37
Yellow Warbler, *Dendroica petechia*	N[g]	0.38	0.60	5.69
Myrtle Warbler, *D. coronata coronata*	W	0.04	0.03	0.42
Audubon's Warbler, *D. c. auduboni*	W	0.13	0.49	2.94
Black-throated Gray Warbler *D. nigrescens*	N	•	0.05	0.04
MacGillivray's Warbler, *Oporornis tolniei*	N	0.67	0.08	0.96
Common Yellowthroat, *Geothlypis trichas*	I	4.46	0.47	0.51
Wilson's Warbler, *Wilsonia pusilla*	N	2.65	0.33	0.44
Yellow-breasted Chat, *Icteria virens*	B	0.13	-	0.09
Western Tanager, *Piranga olivacea*	N	0.08	•	0.11
Spotted Towhee, *Pipilo maculatus*	P	2.65	1.18	1.30
California Towhee, *P. crissalis*	P	0.04	0.16	0.21
Chipping Sparrow, *Spizella passerina*	N	0.04	-	-
Brewer's Sparrow, *S. breweri*	M	-	0.03	-
Lark Sparrow, *Chondestes grammacus*	I?	0.38	0.05	•
Savannah Sparrow, *Passerculus sandwichensis*	W	0.08	0.22	•
Fox Sparrow, *Paserella iliaca*	W	3.36	0.60	0.07
Song Sparrow, *Melospiza melodia*	I, W[h]	2.73	0.88	0.56
Lincoln's Sparrow, *M. lincolnii*	W	4.46	2.42	1.82

Species	Migratory Behavior	Cosumnes Preserve	San Luis NWR	Sacramento River NWR
Unidentified White-crowned Sparrow *Zonotrichia leucophrys*	W	1.98	0.22	0.05
Puget Sound White-crowned Sparrow *Z.l. pugetensis*	W	0.08	-	0.19
Gambel's White-crowned Sparrow *Z.l. gambelii*	W	3.11	6.59	0.37
Golden-crowned Sparrow, *Z. atricapilla*	W	3.07	0.96	0.37
Oregon Junco, *Junco hyemalis oreganus*	W	•	0.11	0.33
Black-headed Grosbeak *Pheuticus melanocephalus*	B	0.04	0.03	0.04
Blue Grosbeak, *Guiraca caerulea*	B	-	0.03	•
Lazuli Bunting, *Passerina amoena*	B	0.29	•	0.14
Red-winged Blackbird, *Agelaius phoeniceus*	P	•	•	•
Western Meadowlark, *Sturnella neglecta*	P	•	•	•
Brewer's Blackbird, *Euphagus cyanocephalus*	P	•	•	•
Brown-headed Cowbird, *Molothrus ater*	I	0.04	•	•
Bullock's Oriole, *Icterus bullockii*	B	0.04	-	•
Purple Finch, *Carpodacus purpureus*	W	-	•	-
House Finch, *C. mexicanus*	P	2.90	0.22	0.46
Pine Siskin, *Carduelis pinus*	W			•
Lesser Goldfinch, *C. Psaltria*	P	0.08	•	0.35
American Goldfinch, *C. tristis*	P	17.40	1.76	0.25
House Sparrow, *Passer domesticus*	P		•	

APPENDIX 7

Restoration and management recommendations submitted by PRBO and TNC and USFWS in 1999

PACKER ISLAND

Restoration Memo

To: Vicky Snowden, TNC
From: Stacy Small, PRBO
RE: Packer Island Y2000 restoration
Date: 2 August 1999
CC: TNC Sacramento River Project and USFWS Sacramento NWR

As requested, I am submitting brief recommendations for the planned Packer Island restoration, to be conducted in the year 2000. As we have only begun monitoring the Packer Island site this year, most of these recommendations are a result of our restoration planning meeting on July 22, 1999 and previous years' results from other PRBO monitoring sites on the Sacramento River.

Planting design
We support the planned "finger pattern" of Valley oak riparian planting on existing gravel lenses, which will project into mixed riparian planting. This should achieve a mosaic effect similar to what was attempted at the Pine Creek site in 1999.

However, in both types of planting (Valley oak riparian and mixed riparian), we stress the need to maintain species and structural diversity within planting blocks. So, while Valley Oak/Blue Elderberry may be the dominant cover type, other shrub species should be well represented. In the mixed riparian, we also recommend maintaining high species and structural diversity within planting blocks. Our results show that bird diversity increases with shrub richness of 2 or more and is substantially greater at 7 or more shrub species (within a 50-meter radius). Bird diversity in riparian forest increases substantially with 2 or more tree species and is highest with 5-6 tree species. Bird diversity also increases with shrub and herb species richness, with greatest bird diversity at 6 or more shrub species and 5 or more herb species (also within a 50-meter radius).

If tree species such as Western Sycamore and Oregon Ash are in low supply, consider a second round of planting as these species become available. We recommend planting shrubby species in mixed-species clumps, with some willow or box elder clumps interspersed.

Road construction
In regard to the planned road, we recommend running the road through the restoration site rather than around the perimeter of the site. The existing road, which wraps around the restoration site, creates a potential barrier to vegetation recruitment between the restoration site and the remnant riparian forest. By removing and re-routing the existing road, it may be possible to achieve a "softer" edge around the riparian forest. PRBO is currently investigating the influence of "hard" vs. "soft" edges on bird populations.

Understory restoration
The potential for understory restoration should be considered on all restoration sites. This site may have optimal conditions for native understory recruitment, as the adjacent riparian forest has a dense understory of natives such as California blackberry, stinging nettle, poison oak, and

wild grape. Furthermore, flooding is frequent, and floodwaters run through the riparian forest onto the restoration site, possibly accelerating native plant recruitment.

Elimination of Himalayan blackberry along the edge of the riparian forest may enhance the potential of native plant recruitment onto the restoration site. We recommend elimination of this exotic species, as long as it is replaced by native plant species, either through planting or natural recruitment.

We recommend monitoring of native understory recruitment and creation of a plan for a second round of restoration, focused on the understory, once the 2-year maintenance period has elapsed.

SUL NORTE

Restoration Memo

To: Vicky Snowden, TNC
From: Stacy Small, PRBO
RE: Sul Norte Y2000 restoration
Date: 31 August 1999
CC: TNC Sacramento River Project and USFWS Sacramento NWR

The riparian forest at Sul Norte (located on the Sacramento River in Glenn County) supports an abundant and diverse community of breeding riparian songbirds, including black-headed grosbeak, common yellowthroat, lazuli bunting, blue grosbeak, spotted towhee, and yellow warbler. Several of these species are designated California Partners In Flight species of concern. Yellow warblers are nearly extirpated on the Sacramento River; Sul Norte and Kaiser are the only Refuge sites where this species is known to breed. One key objective of riparian restoration at this site should be to create more high-quality breeding habitat for riparian songbird species currently utilizing the adjacent riparian habitat. This calls for structurally complex, multi-layered vegetation, with a healthy understory, mid-canopy, and semi-open high canopy.

The following site-specific recommendations pertain to proposed riparian habitat restoration at Sul Norte, on the Sacramento River National Wildlife Refuge. They are based on our conversation of 07/22/99 regarding the Sul Norte restoration plan, and are derived from PRBO monitoring results and the Riparian Habitat Joint Venture's Riparian Bird Conservation Plan. I also recommend referring to the full set of recommendations presented in the 1997/98 PRBO annual report for other applicable recommendations.

Understory restoration
Create a native herbaceous layer in proposed floodwater corridor. This layer should include multiple species (at least 5), with Santa Barbara sedge, mugwort, and Urtica (stinging nettle) species being priorities. These plants provide cover for riparian songbirds that nest in the herbaceous layer, such as common yellowthroat, lazuli bunting, and blue grosbeak. Our results show that bird diversity increases with a higher number of herbaceous species, with greatest bird diversity at 5 or more herb species (within a 50-meter radius).

This area could easily serve as an experimental herbaceous planting site, providing critical riparian songbird habitat without restricting the flow of water during flood season. It would be an ideal opportunity to develop understory restoration techniques to be applied at other sites.

Plant 5 or more shrub species and 5-6 tree species on both upper and lower terrace sites, in order to maintain species and structural diversity within planting blocks. ("Shrub species" includes shrubby tree species, such as box elder.) So, while Valley Oak/Blue Elderberry will be the dominant cover type on the upper terrace, other shrub and tree species should be well represented.

Our results show that, within a 50-meter radius, where 2 or more shrub species occur, bird diversity is higher. Where 7 or more shrub species occur, bird diversity is substantially higher. ("Shrub species" includes shrubby tree species, such as box elder). Where 2 or more tree species occur, bird diversity is higher. Bird diversity is highest where 5-6 tree species occur.

Plant shrubby willow patches (sandbar and arroyo). This provides excellent nest and foraging cover for breeding and migrant songbirds.

Management timing
Time mowing to avoid nest damage. Where mowing is practiced, do not let weeds grow high enough to attract nesting birds. An active LAZB nest was accidentally destroyed by mowing at Sul Norte during the peak of the 1999 breeding season.

I will be glad to review and comment on draft restoration plans when they become available. I may have other site-specific recommendations to offer at that time. Please feel free to contact me via phone or e-mail with questions or comments. Thank you for the opportunity to contribute to the restoration planning process.

Truly,

Stacy Small
PRBO biologist

PHELAN ISLAND

Restoration Memo

To: Vicky Snowden, TNC
From: Stacy Small, PRBO
RE: Phelan Island Y2000 restoration
Date: 23 September 1999
CC: TNC Sacramento River Project and USFWS Sacramento NWR

The following recommendations are in response to a request from The Nature Conservancy's Sacramento River Project for contributions to the year 2000 restoration plan for 18.5 acres at Phelan Island.
They are based on PRBO bird and vegetation monitoring results from the Sacramento River and recommendations put forth in the Riparian Habitat Joint Venture's Riparian Bird Conservation Plan.

Understory restoration
We recommend this site for experimental understory propagation – focused on the shrub and herb layer below 2 meters. While trees and shrubs planted at the adjacent River Unit in 1991 are mostly thriving, the understory suffers from colonization of exotics such as Bermuda grass and Arrundo donax. The upcoming restoration is a good opportunity to conduct experimental planting as a method of exotic plant control and habitat improvement.

The relatively diverse and structurally complex understory of the adjacent riparian forest indicates that conditions do exist at Phelan Island to support a native understory; however, horticultural methods may be required to initiate and accelerate the natural recovery process. The adjacent River Unit would be an appropriate control site for evaluating understory restoration.

Shrub cover is one of the most important variables influencing nest placement on our study sites, as high shrub cover is preferred by 5 species nesting on study sites. High shrub richness (number of shrub species) also leads to higher bird diversity. Compared to the Stony Creek Slough Unit, which has lower shrub and tree diversity, the River Unit has a higher diversity of breeding bird species.

To improve understory quality, we make the following recommendations:

Increase shrub richness and shrub density.

Plant in a mosaic design shrub clumps interspersed with tree/shrub patches.

Plant a wide array of native shrubs and forbs in order to provide a more diverse understory, critical as nesting substrate for many riparian associate bird species.

Add to shrub mix: CA Blackberry, Wild Grape, and Poison Oak. These species provide excellent nest cover

Plant in mixed-species clumps: Blue Elderberry, Box Elder, Valley Oak, Willow species, Wild Rose, Coyote Bush. These shrubby species positively influence bird diversity

Plant native sedge species: Native grass/sedge is used frequently as nest substrate by Common Yellowthroat and Spotted Towhee

Plant native forb species, including nettle species. Both stinging nettle and hedge nettle have been shown to be important nest substrate and nest cover for low nesting birds in riparian areas of Marin County, CA.

Plant shrubby willow species in clumps

Exotics Control

Control California black walnut throughout the Phelan Island Unit

CA Black Walnut has low habitat value; it is allelopathic to other plant species, potentially diminishing shrub and herb diversity required for a healthy riparian bird community.

CA Black Walnut is detrimental to Yellow-billed Cuckoo reproductive success and shows no positive influence on nest success of those species which do use it as nest substrate, such as Black-headed Grosbeak, Western Wood-pewee, Western Kingbird, House Wren, and Nuttall's Woodpecker.

CA Black Walnut of various size classes discourages nesting of Lazuli Bunting, House Wren , and Spotted Towhee, and it negatively influences nest success of all cavity nesters

We recommend stump removal at the time of walnut orchard removal. Heavy stump sprouting is occurring at the 1998 Pine Creek restoration site where stumps were left in place. We also recommend removal of the CA black walnut stand growing along the banks of the Sacramento, adjacent to the River Unit restoration site.

Develop Arrundo donax control plan for Stony Creek

Arrundo donax is colonizing in large clumps on the River Unit restoration site, in both open areas beneath the Fremont cottonwood canopy and within arroyo willow clumps; hence, there is reason to believe that sites currently being restored may be impacted by Arrundo donax colonization within ten years or less. Where it occurs, it occupies a high volume of understory, diminishing shrub richness, which is a key factor in bird diversity. This species offers no known habitat benefits to breeding birds, and for birds nesting in the understory, has deleterious effects. Arrundo donax has been shown to have a negative impact on the Bell's Vireo, an endangered species that once bred on the Sacramento River and has potential to re-colonize the Sacramento River in the future.

Restoration timing
We recommend completing orchard removal before April, to avoid bird breeding season, as some species use orchards for nesting and foraging.
If, after orchard removal, the herb layer is allowed to grow high enough to attract nesting species, such as lazuli bunting and blue grosbeak, do not mow during breeding season.

FLYNN

To: Vicky Snowden, TNC
From: Stacy Small, PRBO
RE: Flynn Y2000 restoration
Date: 4 October 1999
CC: TNC Sacramento River Project and USFWS Sacramento NWR

Hi Vicky –

I am writing in response to your request for site specific recommendations for revegetation efforts at Flynn. Regarding placement of the revegetation plot in relation to the existing bank swallow colony: if only ten of the 94.5 acres are to be planted, I would recommend widening the existing 1996 restoration site, therefore planting away from the bank, adjacent to the existing restoration site. This would create a larger block of habitat, rather than a linear strip, and avoid the bank swallow colony altogether.

However, if all 94.5 acres are to be planted, it is not clear to me that planting near the swallow colony would be detrimental to the colony's survival and persistence. Throughout California, bank swallows nest in bare vertical banks and bluffs amid lowland vegetation types, including Fremont Cottonwood /willow forests. However, statewide, they really show no true preference for any one vegetation type. It does happen that on the Sacramento and Feather Rivers that they most commonly nest under cultivated crops. But they are not necessarily restricted to this type of site. Soil type, bank height, and slope are actually the most important factors in colony location (Garrison 1998). As long as physical processes are permitted to maintain the vertical bank structure, the site should remain suitable. In addition, the proposed removal of rock bank protection adjacent to the colony should further improve conditions for bank swallows at the site.

Also, while large colonies tend to persist in one location over more years than do small, colony locations are generally ephemeral (Garrison 1998). In other words, this is not necessarily a permanent site for this colony, and it may eventually relocate regardless of revegetation activities.

While the best efforts should be made to preserve the current colony site, I am not sure that an unplanted buffer zone around the bank swallow colony would be necessary or effective. A good chunk of the proposed restoration site is within the 25-year erosion projection, meaning that the bank would soon erode right up to the edge of the reveg plot anyway. It may be advisable to choose the planting site based on the desired fate of the reveg project and to think also in terms of the resource that would be created for those bird species dependant upon this early successional habitat. Based on what we've seen on the 96 Flynn reveg site where the levee has eroded, valuable early successional habitat with increased understory structure would be created through a combination of planting and levee breaching within the 25-year erosion zone.

The most critical factor, in my opinion, is the timing of the revegetation operations. Any activities involving heavy machinery that could potentially cause the bluff to collapse and crush burrows should be strictly avoided during the months of June and July. If planting must be done during this time, then I would recommend a buffer zone that would minimize risk of disturbing the physical structure of the bank.

As far a plant composition, I would recommend, as on all other sites, maintaining high shrub and tree diversity, and planting blocks of shrubs interspersed with tree/shrub species. It would be ideal to replicate this design (utilized at Pine Creek in 1999) at several sites along the river, to test its effectiveness.

I am very open to comments on the above recommendations. If any hard evidence exists that planting riparian vegetation above a bank swallow colony could have adverse effects, I am willing to consider it. So far, I haven't come across any. Please feel free to circulate this message to others in the field.

Yours truly,

Stacy Small
PRBO biologist
Sacramento River Project

Reference:

Garrison, B.A. 1998. Bank swallow species account. In the Conservation Plan for Riparian Bird Species. Riparian Habitat Joint Venture. Unpublished Report, Edited by K. G. Elliott. Available at the following website: http://www.prbo.org.

Subject:
Re: Flynn restoration recommendations
Date: Fri, 22 Oct 1999 16:04:05 -0700
From: Stacy Small <ssmall@prbo.org>
Organization: PRBO
To: Joe_Silveira@r1.fws.gov
CC: Vicky Snowden <vsnowden@jps.net>, Daryl Peterson <darylrp@jps.net>,
Geoff Geupel <ggeupel@prbo.org>, Gregg Elliott <elliott@nfwf.org>,
Joe Silveira <Joe_Silveira@fws.gov>, Ramon Vega <Ramon_Vega@r1.fws.gov>,
Greg_Mensik@r1.fws.gov, tgriggs@jps.net, bagarris@dfg.ca.gov

Hi-

I had left a phone message for Barry Garrison at DFG, author of the bank swallow species account in RHJV's Riparian Bird Conservation Plan, and

we finally got to speak together today, regarding riparian restoration above bank swallow colonies.

He agreed that bank swallows use vegetated riparian habitat quite commonly throughout California, and suggested that the link between the colonies and ag/orchard sites on the Sac is not necessarily vegetation structure above the colony, but soil type that is attractive to both bank swallows and farmers.

We spoke about the exposed root issue...he said that the two primary predators are kestrels and gopher snakes. It is possible that either of these species could use roots to access burrows, but that the snakes easily access burrows from above (or through ground squirrel burrows) regardless of vegetation type, and that kestrels typically capture young swallows on the wing. Once a snake makes it into one burrow, it's easy pickens from one to the next, with or without roots.
He pointed out that an important function of exposed root systems is to provide perches for fledgling swallows right outside the burrows, as they are weak flyers. Fledging out over water (in many cases along the Sac), they often need to turn around and return to a perch, or else try to make the exhausting flight all the way across the river.
His bottom line statement was that we need more riparian vegetation, he didn't think planting would interfere with the colony site, but planting in lower densities might not be a bad idea (unfortunately I was unable to tell him how dense the proposed planting would be.) He also emphasized the need to restore meander to the river. I think we all agree on that one.
He also warned about using heavy machinery above the colony site (burrows could be crushed.)
Thank you, Barry, for taking the time to share your expertise and weigh in on this issue. Please feel free to comment or elaborate on anything I may have left out. I have attached my initial recommendations regarding this site for you to glance over.

Truly,
Stacy Small
PRBO staff biologist

Reply to:

Joe_Silveira@r1.fws.gov wrote:
>
> Hi Stacy:
>
> Thank you for your thoughts on the Flynn V restoration project. I
> agree that restoration at the Bank Swallow colony site could be
> accomplished without much impact to the colony. However, please
> consider the following:
>
> 1)In talking with Joan Humphrey, one of the three original Bank
> Swallow researchers, I learned that predators such as weasels and
> snakes use tree roots to climb into burrows.
>

> 2)Participation in resent Bank Swallow surveys on the Sacramento River
> I observed that most colonies occur at non-forested and non-orchard
> lands, and
>
> 3)the largest colonies occur in non-orchard and non-forested lands.
> Talking with Ron Schlorff, large colonies are important for species
> recovery because of declining population trends.
>
> 4)Bank Swallow colonies occur at mixed riparian forest sites
> (obviously so, since they exist on the high terrace) dominated by
> Valley Oak, and walnut orchard sites. Both of these types of
> vegetation have lower tree densities than what we typically plant. For
> example, the Flynn V site will have prune orchard row spacing with
> about eight-foot tree centers within rows. This results in much
> greater root mass densities.
>
> Perhaps we should consider planting at lower densities at the colony
> site. We could also plant native grasses and sedges that would benefit
> species such as Common Yellowthroat, Lazuli Bunting, and Blue
> Grosbeak, while maintaining high quality Bank Swallow breeding
> habitat.
>
> Obviously, the present colony site, like all others, is temporary. The
> river will eventually destroy it and in the process create new sites.
> I believe our challenge is to incorporate suitable tree densities at
> projected bank swallow colony sites (i.e., within the 20-year "erosion
> channel"). We can likely accomplish this with a little front end
> planning.
>
> Are we focusing on single species management for one that did not
> historically occur on the Sacramento River? Because egg collecting
> records do not exist for the Sacramento River, or at least to the
> extent they do from southern California, we can not accurately compare
> the species historical and present distributions. The Bank Swallow is
> a migratory bird and a State listed species. Therefore, we must
> consider its habitat and management on refuge land. With careful
> restoration planning we can provide habitat for a complex avian
> community. As always, I look forward to your restoration and
> management recommendations.
>
> Best wishes,
>
> Joe
>
>

APPENDIX 8

PRBO SACRAMENTO RIVER CONSERVATION OUTREACH SUMMARY

Throughout the spring and summer, we brought the message of riparian bird conservation to the public through a series of events, summarized below. By networking with local conservation groups, schools, and hundreds of community members that visited our display at several major environmental fairs, we drew many groups and individuals into the field for banding demonstrations, seminars, bird identification workshops, and walks, virtually free of charge. In total, we estimate that we reached close to one thousand individuals.

Traveling Exhibit

Stacy has created a traveling exhibit, with help from Mike, Melissa, and Jim that:

1. Introduces visitors to PRBO and the Sac River Project
2. Describes how birds use riparian habitat
3. Highlights PRBO bird monitoring methods
4. Shows photos of local birds at the nest and in the hand
5. Illustrates where riparian-associate birds nest, using an enlarged poster-sized version of the "Where do Birds Nest" graphic from the RHJV Riparian Bird Conservation Plan
6. Displays study skins for identification discussions
7. Offers various flyers, such as an invitation to the Stony Creek banding site, re-prints of Rich Stallcup's cat article, and the "Beyond the Birdfeeder" flyer addressing habitat restoration on private land.
8. Provides an information sign-up sheet (upon which we base our mailing list) for those who wish further information on birds and their habitats, the Sacramento River Project, and educational opportunities.

Public Events

- Endangered Species Fair -- May 1

Organized by the *Butte Environmental Council* (local umbrella group).
(485+ visitors
Stacy and Jim, with assistance from interns, took our travelling exhibit to this fair. We had nearly 500 visitors to our booth on that day. It was a great opportunity to make local contacts and disseminate bird conservation information.

- Sacramento River Discovery Center's Watershed Celebration -- May 8

Organized by the *Sacramento River Discovery Center* and the *Water Education Foundation.*
(150+ visitors).
For this event, we had help from the Discovery Center's high school interns. Over a hundred visitors from the northern reaches of our project (Red Bluff area) stopped by our display, giving us the opportunity to answer many questions about bird identification and habitat restoration on private land. We added many names to our mailing list and will be sending out technical info to those who requested it.

- Day with Agriculture - "Farming the Waterways" -- May 14.

Sponsored by the *Farm Bureau* and co-organized by *The Nature Conservancy*
(70+ participants).
This was a teacher training day for 60 classroom teachers from Butte and Glenn counties. We introduced habitat restoration concepts and provided technical information, focusing on school group restoration projects. For this event, we created an experiential habitat assessment

activity for teachers to take back to their students. Our "Beyond the Birdfeeder" and "Feeding Birds Safely" flyers were extremely popular at this event, and we had to run off extra copies during the lunch break. Numerous teachers showed a strong desire to learn more about habitat restoration and sources of funding for such school projects. We offered our assistance to school groups interested in initiating local habitat restoration projects, and will provide further information through our mailing list.

- National Wildlife Refuge Week – October 10

Sponsored by the USFWS's Sacramento River Wildlife Refuge
(20 participants)
Jim was present for this USFWS event at Llano Seco, to help kick off National Wildlife Refuge Week. He worked the booth and showed study skins, and gave a brief synopsis of PRBO's work on the Refuge.

Education Events

- Hamilton City Elementary School – June 1

(42 participants)
Sue conducted a pre-banding classroom visit on June 1 for two Grade 5 classes at Hamilton City Elementary. This consisted of a bird identification activity using study skins of local birds and a discussion about bird banding. This group of students recently planted a TNC restoration site at Stony Creek, and will be returning in the near future to learn about birds on an adjacent, older restoration site. Amy Hoss, from The Nature Conservancy, will be leading a group of 50 Grade 5 students from Hamilton City Elementary School on a bird banding demonstration at the Stony Creek restoration site next spring. Hamilton City is a low-income agricultural community in close proximity to TNC/USFWS riparian restoration sites. TNC and PRBO are working together to offer conservation education opportunities free of charge

- California Science Project – June 26 & 27

(40 participants).
We made an important connection with a participant at the "Day with Agriculture" event, Anne Stephens from the California Science Project, who runs a summer institute every year at CSUC [California State University at Chico] for K-12 teachers. The project theme this year is "water and watersheds." PRBO conducted a two part bird conservation seminar for workshop participants on June 26 and 27. Sue gave an evening classroom program to introduce participants to bird banding and bird identification, using study skins of local riparian bird species. The following day, the 40 teachers visited Stony Creek for a banding demonstration. They received presentations on bird use of riparian habitat, riparian restoration, and conservation education curriculum. They were then led on a walk around the net lanes by a PRBO biologist and student interns from the Sacramento River Discovery Center.

Butte County Office of Education – June 22 & 29
(14 participants: 2 teachers and 12 youth).
10-12 high school students, from the County's alternative education summer school program, worked with PRBO and TNC at the Sul Norte restoration site on June 22 and 29. Students surveyed TNC land for native trees, learned nest searching skills, and searched for active songbird nests. In addition, these students visited the Stony Creek banding site on July 7 to observe bird banding and learn about bird conservation and riparian habitat.

- Phelan Island Banding with Chico's Eagle Scout Group – September 11

(25 participants: 15 youth and 10 adults).

Sue, Chris Rall and Becky Pierce hosted a group of 15 boys and 10 adults from Chico's Eagle Scouts. John Carlon from the Sacramento River Partners helped organize the group's visit to the Stony Creek banding site. PRBO biologists helped scouts fulfill some of the requirements for their "bird merit," by pointing out bird vocalizations and discussing bird biology and riparian habitat.

- SRDC Evening Program -- September 20

(6 participants: 2 children and 4 adults)
Sue and two summer high-school interns presented the intern-produced "Bird Banding" video to a group of SRDC members on September 20, 1999. We answered many questions about the Sacramento River Project and the interns described how they produced the bird banding video. Cathy Klinesteker made a contact with a Red Bluff woman who home schools her children, and would like to bring her children to the SRDC to learn about birds.

- Phelan Island Banding with Corning High School – October 8

(17 participants: 15 youth and 2 adults).
Dave Tinker's senior biology class joined Sue, Chris and Becky for a morning of banding at Stony Creek. The students took detailed notes about the banding process and the study skins. Specifically, we discussed the birds we caught, migration, how and why we band, what we can learn from banding data, how birds use riparian habitat, habitat restoration, and career options for biologists. We were really pleased with the group's obvious interest in birds and bird conservation, and sensed that many learned a great deal through this experience.

Phelan Island Banding with Anne Stephen's class – October 22
(41 participants: 8 adults and 33 youth).
Anne Stephen's, from the California Science Project, brought her Grade 7, gifted science class to the Stony Creek banding site. Sue, Chris and Becky led the group at the banding site, and used study skins and birds in the hand to discuss bird banding, birds and bird conservation. In addition, the students conducted a riparian habitat assessment activity, developed by Stacy and Sue for the Day with Agriculture event.

Conservation Outreach

- Riparian Forest Restoration Implementation Workshop
  Sponsored by the *University Foundation of California State University, Chico.*

(20 participants)
Stacy taught a one hour seminar during this workshop. The seminar was held in the field at Phelan Island, on the Sacramento River National Wildlife Refuge. Other presenters include Tom Griggs, Dawit Zeleke, and Daryl Peterson of The Nature Conservancy. Our focus was bird monitoring methods and recommendations for restoration riparian bird habitat. Use of the RHJV Riparian Bird Conservation Plan as a restoration planning tool was a topic of this segment.

- Central Valley Bird Club – June 26

(25 participants)
On June 26, Stacy led a banding demonstration at Phelan Island and presented a slide show in the afternoon to the Central Valley Bird Club. This event focused on the implementation of the RHJV Riparian Bird Conservation Plan on the Sacramento River.

Sacramento River Discovery Center's (SRDC) High School Intern Program

PRBO has been collaborating closely with *Sacramento River Discovery Center* (SRDC) this year to conduct an innovative bird ecology program, entitled "Songbird Habitat Outreach Project." This program, funded by the National Fish and Wildlife Foundation and CalFed, has

been extremely successful and has reached high school students and adult community members alike.

- Summer SRDC/PRBO Interns

(4 participants)
Three high school students and one college-level student were interviewed by Stacy and Sue at the SRDC on May 13 for four PRBO/SRDC internship positions. These student interns subsequently worked with Sue three days a week as field biologists on riparian forest and restoration sites for over two months. All four nest searched and spot mapped at study sites and at the SRDC. In addition, they observed bird banding and learned about bird biology through frequent visits with PRBO biologists to a banding site. The interns produced two videos on the subjects of bird banding and the nest cycle of songbirds; kept a personal and a group field journal; and were responsible for limited data collection.

- School-year bird program – August 26 – October 27

(45 participants: 40 youth and 5 adults).
PRBO also collaborates with the SRDC to run a school-year bird ecology program. Sue currently works with a group of 40 high school students, who are participants of the Surd's Natural Resource Academy, two times a week through September and October. She facilitates their learning of birds through bird identification workshops, field observation, journalling, biology lessons, reading and library and Internet research.

Sue, Chris and Becky hosted SRDC bird program interns at the Ohm banding site on October 11. The interns joined biologists on net runs, took notes on how birds are banded, and sketched several birds that we caught in the nets. At the end of the visit, interns shared what they had learned, for example: "I learned that even though some nets don't catch a lot of birds, they are put in different habitats on a site"

Bird Identification Workshops

- Bird Identification Workshop – August 14

(10 participants)
Stacy has developed and led five bird identification workshops at the *Sacramento River Discovery Center* this year – three for high school students and two for community members. Workshops use study skins, field journals, games, bird song tapes, and fieldwork to develop participants' observation skills. The objective of the workshop is to build confidence in the participants' own ability to teach themselves and to engage the general public in discussions regarding bird conservation. We feel that community members who have learned bird observation skills through hands-on, personal instruction will become more aware of birds in their surrounding environments and, as they develop these connections, will be more likely to make informed choices regarding local conservation issues.

- Public bird walk at TNC's Dye Creek Preserve – July 10

(8 participants: 7 adults and 1 youth).
We conducted our first public bird walk at TNC's Dye Creek Preserve. This was a great outreach opportunity for both PRBO and TNC. Visitation to the preserve is by appointment only. It was a neat opportunity for local bird enthusiasts to see Lazuli Buntings, Ash-throated Flycatchers, and Yellow-breasted Chats and to hear about local bird conservation efforts. All of the participants have returned to participate in subsequent PRBO activities, such as bird ID workshops and banding demonstrations. We plan to lead another bird walk this fall.

Technical Assistance for Habitat Restoration

- "Beyond the Birdfeeder" Flyer

We have created a flyer that outlines steps that individuals can take to improve habitat for breeding songbirds on their private lands. We encourage those interested in restoration to contact the Sacramento River Project for more information.

- Schoolyard Restoration

We spoke to over 60 teachers about the concept of schoolyard restoration at a teacher training event on May 14, A Day with Agriculture. We provided website addresses, information on funding sources, and offered technical assistance for funding applications. Several teachers expressed interest and discussed with us preliminary plans for restoration projects.

Restoration Workshops

PRBO staff were available throughout the season to participate in restoration workshops and one-on-one site visits to proposed restoration sites throughout the Sacramento River System. We spoke to the California Partners In Flight Western Working Group, highlighting restoration efforts on the Sacramento River, as well as the working relationship among PRBO, TNC and USFWS We also made personal site visits to proposed restoration sites of Parks and Preserves Trust (Butte County) and California Department of Parks and Recreation.

TNC River Tours

Stacy has participated in 5 TNC river tours this year. This has been a good opportunity to talk to leading figures in California conservation about the potential benefits of riparian restoration to songbird populations.