Avian Monitoring and Assessment for the Landowners Incentive Program - Riparian Agriculture Buffers Initiative

2009 – 2011 FINAL REPORT

Song Sparrow illustration by Andy Birch

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Introduction

Central Valley riparian habitat is known to support a wealth of biological diversity, including more than 225 species of birds, mammals, reptiles, and amphibians. However, over the past 150 years, riparian habitat has dramatically declined - current estimates of the remaining riparian habitat in the Central Valley range from 2% to 7%, depending on geographic region (Katibah 1984, Dawdy 1989). The loss of riparian habitat may be the leading cause of population declines among land bird species in western North America (DeSante and George 1994). Thus, riparian areas have been identified as the most important habitat for the protection and conservation of songbirds in California (Manly and Davidson 1993, Davidson 1995) and have been the focus of a variety of conservation partners in California (RHJV 2004).

In the Central Valley, about 80% of the riparian habitat is privately owned, thus underscoring the need for landowner participation in restoring riparian habitat in the region. California Department of Fish Game's Landowner Incentive Program (LIP) is a voluntary incentive program whose purpose is to reverse the decline of at-risk (i.e. special status) species on private lands in California's Central Valley by providing monetary incentives and technical assistance to private landowners to enhance and manage the region's three predominant historic habitat types: riparian, wetland, and native grassland. The agricultural riparian buffers initiative within LIP specifically supports the restoration and management of riparian habitat within marginal or flood-prone farmland (CDFG 2010).

Monitoring the biological response of programs such as LIP is necessary for demonstrating the programs' success in achieving its goals. More importantly, however, empirical biological data derived from monitoring can evaluate the efficacy of management and restoration practices. Monitoring, therefore, provides the necessary information to complete the feedback loop for adaptive management, can inform future management decisions, and thus achieve desired conservation objectives. Birds are an

ideal taxon to monitor because they are reliable indicators of ecosystem health, respond relatively fast to ecological changes, and compared to other taxa, are highly visible and thus relatively easy and cost effective to monitor (Chase and Geupel 2005).

In order to document and assess riparian restoration activities supported by the LIP program, CDFG, PRBO Conservation Science and partners conducted bird and associated habitat monitoring at six LIP-supported restoration sites during the breeding season in 2009, 2010 and 2011 (Fig. 1); the sites were Site 1 (Tehama County); Site 2, Site 3, and Site 4 (Yolo County); Site 5 (San Joaquin County); and Site 6 (Merced County). This report presents results and recommendations from the three years of avian monitoring conducted 2009-2011.

Methods

To assess landbird populations at LIP riparian restoration sites, we used 5-minute variable circular plot point count surveys during the breeding season. Point count surveys are designed to assess landbird presence/absence, diversity, and abundance (Ralph et al. 1993; Ralph et al. 1995). We established at total of 42 point count stations across the 6 different restoration sites enrolled in LIP (Table 1). Point count station were spaced at a minimum of 200 meters apart from each other, and since restoration sites varied in size from 91.4 acres to 1.5 acres, the number of point count stations established at each site varied accordingly. For 3 of the 6 sites we established 2-7 auxiliary point count stations that were outside of the restoration project boundary but in otherwise contiguous riparian habitat, and thus may serve as local reference points for post-restoration monitoring.

Point count surveys began within 15 minutes of sunrise and were completed within four hours (i.e. peaking singing hours). We recorded all species detected by sight or sound and placed them in distance bins based on their initial distance from the point count station; the bin intervals were 0-10m, 10-20, 20-30, 30-40, 40-50, 50-75, 75-100, and

greater than 100. Type of detection (song, visual, or call) and breeding behavior (e.g. copulation, nest building, food carry to fledgling) were recorded. Birds flying over the study site not using the habitat were noted separately. Surveys were not conducted in weather conditions that could significantly influence observers' ability to detect birds such as rain or wind over 10mph. Each year all transects were surveyed 2 times at least 30 days apart during peak landbird breeding season. The PRBO point count method is explained in greater detail at http://data.prbo.org/cadc2/index.php?page=songbird-point-counts. All point count data was entered online at the California Avian Data Center (http://data.prbo.org/cadc2/) and is password protected. The data may be accessed by obtaining permission from CDFG and PRBO, and registering for a California Avian Data Center account at http://data.prbo.org/apps/public/index.php?page=new-user-registration.

Evidence of breeding for each species was noted, where we considered a species a confirmed breeder if at least one of the following behaviors were observed: nest found, distraction display, copulation, feeding young or fledglings, and food or fecal sac carries. We considered a species as a probable breeder if observed exhibiting breeding behavior (singing, paired, courtship and/or territorial behavior) on at least two visits during the breeding season ≥ 10 days apart. Birds were considered potential breeders if observed singing or exhibiting breeding behavior in suitable habitat only one time during the breeding season.

We assessed vegetation characteristics at each point count station using a relevé method (Ralph et al. 1993; see: http://www.prbo.org/cadc/songbird/pc.php for details). General habitat characteristics of each station were recorded (e.g. number of snags, canopy cover, and height of herb, shrub and tree layers). We estimated percent cover within a 50 m-radius of the point for 3 height-defined layers of vegetation, the herb layer (0 to 0.5 m), shrub layer (0.5 to 5 m) and tree layer (>5 m). We recorded relative percent cover within each layer for individual plant species comprising ≥5% cover.

Analysis

Density of focal species. Although the primary conservation objective of LIP is to reverse the decline of at-risk species on private lands, at-risk species themselves often make for poor monitoring subjects because they are infrequently found in standardized surveys due to their low population sizes. Monitoring the population trends of more common riparian *focal* species, however, can provide a proxy or surrogate measure of success of LIP's conservation objectives (Chase and Geupel 2005). Habitat-specific focal species are meant to represent a variety of habitat elements or ecosystem attributes (Alexander et al. 2007), and thus managing for the needs of these species should also benefit the larger community, including species at risk. (Chase and Geupel 2005, Alexander et al. 2007). The Riparian Habitat Joint Venture's riparian bird conservation plan describes 16 riparian focal species for California (RHJV 2004), and the Central Valley Joint Venture 2006 implementation plan established basin-specific population density targets for six riparian focal species (CVJV 2006): Black-headed Grosbeak (*Pheucticus melanocephalus*), Common Yellowthroat (*Geothlypis trichas*), Song Sparrow (*Melospiza melodia*), Spotted Towhee (*Pipilo maculates*), Yellow-breasted Chat (*Icteria virens*), and Yellow Warbler (*Setophaga petechia*).

We compared the CVJV target densities with observed densities from the each riparian site surveyed for each year. Since not all of the CVJV riparian focal species occurred at measurable densities for all sites, we only calculated focal species densities for sites that supported at least one of the focal species (Site 1, Site 4, Site 5, and Site 6). Following the method used for determining bird densities in the CVJV plan, we similarly calculated density as birds per acre, based on average detections within 50 meters of each point (50 m radius= 0.785 hectares, or 1.94 acres). Initial density values were then multiplied by species-specific detectability coefficients to correct for variable detection rates among the species, and thus yield more accurate density estimates (CVJV 2006). Densities were determined for each point and averaged across each transect to yield

mean density estimates, bracketed by 95% confidence intervals for each transect for each year.

Avian community indices. Community indices calculated from the point count data were abundance, species richness, and species diversity. For each year, these community indices were calculated per point and averaged separately for each transect; averaging the indices in this manner controlled for the different number of point count stations between transects, and also provided a measure of variance within each site. *Abundance* is the total number of individual birds detected within 50 m of a point count station for the two visits combined; *species richness* is the number of unique species detected within 50 m for the two visits combined; bird *species diversity* measures ecological diversity based on the number of species detected, weighted by the proportional abundance of each species. A high score indicates high ecological species diversity. Species diversity was measured using a transformation of the usual Shannon-Weiner index, which is symbolized by H' (also called the Shannon-Weaver index or Shannon index; Nur et al. 1999). This transformed index, which was introduced by MacArthur (1965) is N_1 where $N_1 = e^{H'}$. The advantage of N_1 over H' is that N_1 is measured in terms of species, whereas H' 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. P_i is the proportion of the total number of individuals for the *ith* species:

$$N_1 = e^{H'} \text{ and } H' = \sum_{i=1}^{i=S} (p_i)(\ln p_i)$$

For data analysis, we only used detections from within 50 m of the point count stations in order to minimize detection variance. Furthermore, excluding fly-over detections and birds detected beyond 50 m removed most non-riparian bird species associated with adjacent upland habitats. For calculating community indices (abundance, richness, and diversity), we only included species that are considered good indicators of riparian vegetation conditions; therefore we excluded all flocking and colonial species (e.g. Red-

winged Blackbirds and Cliff Swallows), species not considered indicators of good ecological health (exotic species and Brown-headed Cowbirds, a nest parasite), and all waterbirds (ducks, geese, gulls, terns, herons, egrets and shorebirds).

Results

Species Occurrence and Breeding Status

A total of 111 bird species were detected in 2009 - 2011 from all riparian restoration and reference sites combined, including species detected from all distances and flyovers (Table 2, Appendix A). Thirteen out of the 16 RHJV riparian focal species were detected: Swainson's Hawk, Spotted Sandpiper, Willow Flycatcher, Warbling Vireo, Tree Swallow, Swainson's Thrush, Yellow Warbler, Wilson's Warbler, Yellow-breasted Chat, Song Sparrow, Black-headed Grosbeak, Blue Grosbeak, and Tricolored Blackbird (Appendix A). Fourteen special status species (species of conservation concern from various state, regional, continental, and global assessments) were detected: Bald Eagle, Northern Harrier, Swainson's Hawk, Whimbrel, Long-billed Curlew, Nuttall's Woodpecker, Willow Flycatcher, Loggerhead Shrike, Yellow-billed Magpie, Oak Titmouse, Yellow Warbler, Yellow-breasted Chat, Tricolored Blackbird, and Lawrence's Goldfinch (Table 2; Appendices A and B). Thirty species were confirmed breeding, 31 were suspected of breeding, and 14 were considered potential breeders (Table 2).

Focal Species Target Densities vs. Observed Densities

Since not all sites supported focal species, and not all focal species occurred at every site, we limited the focal species analysis to four of the six CVJV riparian focal species at four of the riparian restoration sites. Specifically, we examined Black-headed Grosbeak at Site 1, Site 5, and Site 6, Song Sparrow at Site 4, Site 5, and Site 6, Spotted Towhee at Site 1 and Site 5, and Yellow-breasted Chat at Site 1 (Fig. 3). Whereas most focal species appear to fall below their respective CVJV target densities, Song Sparrow density appears to be increasing at Site 4, nearly achieving the target density in 2011 of 0.4 birds per acre (Fig. 3b). Spotted Towhee also appears to be within range of its target

density at Site 5. Yellow Warblers were detected at two of the riparian restoration sites (and three of the reference sites), however it appeared these were transient individuals during spring migration, as there were no indications that Yellow Warblers nested or held territories at any of the sites. One focal species, Common Yellowthroat, was entirely absent from all LIP sites for all years, perhaps due to an insufficient amount of emergent aquatic vegetation this species favors, such as cattails (*Typha spp.*).

Community Indices: Species Diversity, Species Richness, and Abundance

Species diversity (Shannon-Weaver) indices ranged from 0.8 at Site 4 in 2009 to 9.8 at Site 2 in 2011 (Table 3, Fig. 2). Diversity indices appeared to remain relatively stable over the three year period of the study at all but three of restoration sites, where diversity appeared to increase over time; these were Site 4, Site 3, and Site 2 (Fig. 2). Between 2009 and 2011, diversity at Site 3 increased from 2.9 to 9.2, whereas diversity at Site 2 increased from 3.9 to 9.8 (Table 3). Though less dramatically, diversity at Site 4 increased from 0.8 in 2009 to 1.4 in 2011. Species diversity indices closely tracked the trends observed for both species diversity and abundance across all sites and years; in other words, where diversity increased from one year to another at a specific site, species richness and abundance also increased (Table 3 and Fig. 2).

Discussion

The timing of initial restoration activities varied by site, as did the restoration practices themselves. With the exception of the Site 2 LIP restoration site, survey data from 2009 represent a pre-restoration baseline status of the avian community. In the summer of 2008, the Site 2 site was scraped clean, an old almond orchard was removed, herbicide was applied to control weeds, drip-lines were installed, and native trees, shrubs and grasses were planted. By spring 2010, restoration had begun at Site 4 and Site 3, where at both sites native shrubs, trees, and grasses planted. By the beginning of the 2011 survey season, restoration had begun at the Site 1, which primarily entailed fencing

cattle out of the riparian area and planting native shrubs. Restoration activities had not yet begun at Site 5 or Site 6 by the conclusion of field work in June of 2011.

Most sites already contained remnant patches of riparian vegetation within or adjacent to the restoration plots; these included mature valley oak (*Quercus lobata*), Freemont's cottonwood (*Populus freemontii*) and Gooding's black willow (*Salix gooddingii*). As found elsewhere in the Central Valley of California (Gardali and Holmes 2011), sites with extensive preexisting riparian habitat (e.g. Site 1 and Site 6) supported higher bird species diversity, species richness, and abundance than sites that lacked any riparian habitat (Tables 2 and 3). Conversely, Site 4 supported the lowest riparian bird diversity, species richness, and abundance of all the sites, a site where mature riparian habitat was restricted to about half a dozen large, senescent Gooding's black willow trees (Fig. 2).

Despite lacking extensive mature riparian habitat, Site 4 had sufficient habitat to support at least three active Swainson's Hawk nests (state threatened species), whereas we found no evidence of nesting Swainson's Hawks at any of the other sites. Site 4 was also the only site with confirmed nesting for Loggerhead Shrike, a California bird species of special concern (Appendices A and B). This example demonstrates that a site with low bird diversity may nonetheless support priority at-risk species, and that the conservation value of a specific site cannot be solely measured in terms of community indices of diversity, species richness, and abundance alone.

Due to site-specific variation, each of the LIP restoration sites supported different types of riparian vegetation, thus making generalized conclusions and recommendations difficult. For example, Site 2 supports vegetation features characteristic of a blue-oak woodland (*Quercus douglasii*), whereas Site 6 exemplifies a more typical valley-foothill riparian plant community, which includes Freemont's cottonwoods (*Populus freemontii*) and arroyo willow (*Salix lasiolepis*). Furthermore, the baseline condition of the riparian

habitat (pre-restoration) varied across sites. Therefore, we would expect to see different baseline riparian bird communities at each site, and the bird community response to restoration activities will likely differ at each site.

Changes in each of the restoration site's bird communities from 2009 to 2011, as measured by riparian bird diversity, species richness, and abundance (Fig. 2), likely reflects the timing and degree to which each site was restored. We did not detect significant changes in riparian bird diversity, species richness, or abundance at Site 5 and Site 6, the two sites where restoration had not been initiated during the study period. Similarly, we did not detect changes in these community indices at the reference sites (sites that were not restored or enhanced). However, bird diversity, species richness, and abundance increased from 2009 to 2011 at sites where restoration and enhancement activities did occur- Site 4, Site 3, and Site 2 (Fig. 2). Site 1 was the exception in this regard, where restoration had occurred prior to the 2011 surveys but no changes were detected in its diversity, species richness, or abundance. However, we expect that the avian community indices will increase at Site 1 in future years as the riparian vegetation community and structure recovers from cessation of cattle grazing (Dobkin et al. 1998). More years of monitoring data at a minimum of once every 3 years is recommended to be sure that a positive trajectory in the avian community continues at all of the riparian restoration sites, and thus ensure that the LIP program is achieving its conservation objectives of benefiting wildlife species.

General Recommendations for Riparian Habitat Restoration and Enhancement

- **Site-specific planning.** Riparian restoration, enhancement and management plans should be uniquely tailored for each site. Each property has a unique set of opportunities and constraints based on its baseline habitat and avifauna conditions, existing threats (e.g. weeds or grazing), plant and bird species expected for its geographic region, and resources available for habitat restoration, enhancement, and management in both the short and long-term.
- **Use the Central Valley Decision Support Tool to target conservation delivery.** The Central Valley Decision Support Tool (DST) is an online interactive mapping tool that shows the probability of occurrences of riparian focal species at the parcel-level throughout the Central Valley. This mapping tool can help program managers design new restoration programs with informed decisions about priority habitats and regions for riparian focal species, understand better where restoration is most feasible and has the most potential to benefit species, and prioritize resource allocations in accordance with conservation needs down to the parcel level. Visit the DST online at www.prbo.org/cadc/lip.
- **Restore riparian corridor width and connect habitat patches with corridors.** The effect of riparian corridor width varies by bird species and riparian type. In general, a width of at least 100 meters (approximately 330 feet) is considered optimal for creating quality riparian habitat, though narrower corridors are still beneficial for wildlife movement and dispersal (RHJV 2004, Gardali et al. 2004).
- **Focus habitat restoration projects near existing riparian habitat patches.** Mature riparian patches can act as a source of birds for newly restored riparian patches. PRBO's work in the Sacramento Valley indicates that the greater the amount of riparian habitat near a restoration site results in a greater abundance of birds (Gardali and Holmes 2011).
- **Diversify and enhance surrounding habitats.** Preserve and restore the transitional and upland habitats adjacent to riparian corridors. In the Central Valley landscape,

this may include wetlands, oxbow lakes, scrubby willows, oak woodlands, oak savannah, and grasslands. Birds are not confined to any one habitat type, and species that regularly nest in riparian may use adjacent habitats for foraging (White et al. 2005).

- **Provide brushpiles for cover.** A brushpile can provide cover from predators, loafing cover, nesting location, and protection from inclement weather. Artificial brushpiles should be large and tall (at least 3 feet), close to existing cover (e.g. blackberry bushes), and contain primarily branches, limbs, and few logs (Gorenzel et al. 1995).
- **Focus on increasing the number and diversity of fruiting plant species.** Fruiting plants will increase food resources for birds, especially for wintering birds. Examples of fruiting riparian plants important to birds include California grape (*Vitis californica*), blue elderberry (*Sambucus Mexicana*) and California blackberry (*Rubus ursinus*).
- **Promote diverse vegetation structure.** A diversity of plant species, ages, shapes, and sizes will provide more nesting and feeding sites for a greater variety of birds (RHJV 2004, Griggs 2009).
- **Plant native plants from local stocks.** Plant native grasses, shrubs, and trees that are adapted to local conditions. Use plant material (seeds, cuttings, divisions, etc.) preferably from adjacent riparian areas if not from within the same floodplain or watershed. Planting with locally derived plant stocks is important for maintaining the natural genetic diversity of plants in the Central Valley. Furthermore, using local plant stocks ensures greater success with restoration projects, because local plant stocks are best adapted to site-specific conditions, such as soil pH (Griggs 2009).
- **Remove non-native vegetation.** Non-native vegetation can out-compete and hinder the establishment of native plant species thereby reducing vegetation structure, and thus reduces habitat quality for birds. Removal of invasive non-native vegetation will facilitate growth of native vegetation and subsequently provide more riparian habitat for birds.

- **Consider the timing of management activities.** Disturbances during the breeding season may result in nest abandonment, the elimination of nest sites, destroying nests, exposing nests to predators, and decreasing food sources such as insects. Habitat enhancement and management activities, such as grazing, disking, herbicide application, and mowing should therefore be limited to the non-breeding season, which in the Central Valley is generally between September and February.
- **If mowing is necessary, mow early and often.** Many songbirds nest very close to the ground in grasses and 'weedy' areas. If mowing is necessary, mow early (beginning in February) and often, as this will prevent birds from nesting where mowing occurs.
- **Modify grazing practices.** Modify timing, duration, and frequency of grazing to ensure plant vigor, re-growth and reproduction, as well as meeting the habitat requirements of target wildlife species. Rotate grazing away from riparian areas just prior to and during the breeding season (March – August) to protect ground and shrub-nesting birds. Providing alternate sources of water away from watercourses and riparian vegetation, as well as fencing-off of riparian areas can be an effective means of improving the quality of riparian habitat.
- **Use wildlife-friendly fences.** Where fencing is used to exclude livestock from riparian corridors, wildlife-friendly fencing techniques should be used such that the fencing allows the free passage of wildlife movement and/or prevents entanglement and mortality (Harrington and Conover 2006). For detailed guidelines, see http://knowledge.sonomacreek.net/files/FencingGuidelines.pdf.
- **Encourage native cavity nesting birds.** Retain snags and woody material, as decaying trees and limbs provide nesting and food storage sites for cavity nesting birds (e.g. woodpeckers, wrens, bluebirds, and others). Allowing dead limbs to remain on living trees and retaining dead trees will allow birds to excavate cavities in rotting wood. The use of nest boxes can also increase the number of native cavity nesting birds.

- **Manage non-native animals and nest predators.** Eliminate sources of food such as open garbage cans, open compost piles, or outdoor pet food dishes that attract and increase the number of feral cats and other nest predators, such as rats, raccoons and opossums.
- **Plan for future needs.** Restoration plans should address the long-term management and maintenance needs well into the future. Long-term needs may include weed management, irrigation, livestock fence maintenance, and additional plantings to achieve restoration goals.

Site-specific Recommendations

Site 1: Use wildlife-friendly fencing to exclude cattle in the riparian corridor. Since Yellow-breasted Chat use the Himalayan blackberry here, only remove Himalayan blackberry patches incrementally when native vegetation with comparable structure (e.g. native blackberry) has established itself. Increasing understory vegetation should increase the density of Spotted Towhee and Yellow-breasted Chat, and may lead to the recruitment of Common Yellowthroat and Song Sparrow, which currently do not occur here. Encouraging more mid-canopy trees, particularly willow (*Salix spp.*) should increase the density of Black-headed Grosbeak and possibly recruit Yellow Warbler.

Site 2 and Site 3: Continue to encourage the establishment of newly planted native vegetation by providing adequate irrigation and weed control. As the young shrubs and understory plants become more establish, we can expect early successional focal species to recruit here first, such as Song Sparrow, Common Yellowthroat, and Blue Grosbeak. When trees eventually become established and forms a closed canopy forest, late-successional species should recruit, such as Black-headed Grosbeak. Furthermore, the presence of a structurally diverse understory should attract species such as Spotted Towhee and Yellow-breasted Chat.

Site 4: Continue to encourage the establishment of newly planted native vegetation by ensuring adequate irrigation and weed control. Eradicating a wild mustard infestation at this site may be the largest challenge here. The replacement of wild mustard with native forbs and shrubs would promote the expansion of early successional riparian focal species, such as Song Sparrow, Common Yellowthroat, and Blue Grosbeak. The existing stand of Gooding's black willow, which are currently used by nesting Swainson's Hawks and Loggerhead Shrikes, are extremely senescent and will eventually die. Therefore it is important that more willows and other tree species are established to eventually replace the old willow trees.

Site 5: This site already supports a substantial amount of mature riparian vegetation, primarily large valley oaks. The primary focus, therefore, should be on the establishment of a native understory while encouraging the expansion of the existing oak forest with acorn or sapling plantings. The current condition of the understory is degraded due to an infestation of noxious weeds, primarily blessed milkthistle (*Silybum marianum*) and Italian ryegrass (*Lolium multiflorum*). The establishment of a native understory would create more favorable nesting habitat for understory species, such as Song Sparrow and Spotted Towhee. A sample of suggested native understory plants should include creeping wildrye (*Leymus triticoides*), Santa Barbara sedge (*Carex barabarae*), California wild grape (*Vitis californica*), California wild rose (*Rosa californica*), blue elderberry (*Sambucus mexicana*), California blackberry (*Rubus ursinus*), and mugwort (*Artemisia douglasiana*).

Site 6: This site already supports a substantial amount of mature albeit fragmented riparian vegetation, including large Freemont's cottonwoods, valley oaks, and various willow species. Sections of the site, however, are infested with large patches of *Arundo donax*, an especially insidious noxious weed of riparian habitat (Cal IPC 2011); the eradication of *A. donax* should therefore be the highest priority for restoration at this site. There are also opportunities to enhance the understory of the existing riparian

forest, and bridge the gaps fragmenting the forest patches by planting native trees. The current understory is infested in many places with non-native grasses, primarily ripgut brome (*Bromus diandrus*). Replacing non-native plants with diverse understory plants will help increase the density of Song Sparrow and may recruit other understory riparian bird species, such as Spotted Towhee, Common Yellowthroat, and Yellow-breasted Chat. See the palette of native understory plants recommended for Site 5 for suggested plantings here.

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Table 1. Riparian LIP sites, acres enrolled in LIP, and the number of point count stations established. Reference sites, representing similar contiguous riparian habitat outside of the LIP restoration boundaries, are also indicated.

LIP Riparian Site	Acres in LIP*	Point Count Stations
Site 1	91.4	16
Site 1 Reference	--	2
Site 2	34.5	5
Site 3	1.5	1
Site 3 Reference	--	3
Site 4	36.3	11
Site 5	22.6	3
Site 5 Reference	--	7
Site 6	15.8	6

*Acres calculated based on LIP polygons provided by CDFG; no polygon was available for the Site 4 property, therefore area estimated by author.

Table 2. Total numbers of all species detected, riparian focal species, special status species, and breeding species (confirmed, suspected, or potential) from 2009 – 2011.

Site	Total Bird Species	Riparian Focal Species	Special Status Species	Breeding Species		
				Confirmed	Suspected	Potential
Site 1	68	8	7	9	29	14
Site 1 Reference	30	3	3	0	14	13
Site 2	44	2	5	9	17	9
Site 3	22	1	3	0	7	7
Site 3 Reference	35	3	5	2	11	11
Site 4	47	4	6	10	7	9
Site 5	39	4	3	2	18	13
Site 5 Reference	57	7	4	10	24	9
Site 6	55	9	6	7	25	9
All sites combined:	**111**	**13**	**14**	**30**	**31**	**14**

Table 3. Average species diversity (Shannon-Weaver index), abundance and species richness (standard errors in parentheses) for riparian LIP and reference sites, 2009 – 2011.

Site	No. Points	Diversity (SW)			Abundance			Richness		
		2009	2010	2011	2009	2010	2011	2009	2010	2011
Site 1	16	6.3 (0.7)	5.6 (0.6)	6 (0.9)	10.9 (1.1)	9.6 (1.1)	9.8 (1.5)	6.9 (0.7)	6.3 (0.7)	6.5 (1)
Site 1 Reference	2	4.7 (0.9)	4.6 (2.6)	8.1 (0.9)	7 (2)	7 (5)	12 (3)	5 (1)	5 (3)	8.5 (0.5)
Site 2	5	3.9 (0.6)	5.2 (0.6)	9.8 (0.7)	7.2 (1.7)	18.6 (5.1)	20.8 (2.5)	4.4 (0.7)	7.4 (1.1)	11 (0.9)
Site 3	1	2.9 (n/a)	4 (n/a)	9.2 (n/a)	5 (n/a)	4 (n/a)	16 (n/a)	3 (n/a)	4 (n/a)	10 (n/a)
Site 3 Reference	3	2.7 (0.9)	4 (1.2)	4.6 (1.7)	4.7 (1.2)	9.7 (3.7)	11 (7.5)	3 (1)	4.7 (1.7)	5.3 (2.3)
Site 4	11	0.8 (0.4)	1.2 (0.4)	1.4 (0.2)	1.2 (0.6)	1.6 (0.5)	2.6 (0.4)	0.8 (0.4)	1.3 (0.4)	1.5 (0.2)
Site 5	3	6 (1.3)	8 (0.8)	6.5 (0.8)	14.3 (1.2)	22.7 (6.9)	19.7 (4.3)	7 (1.5)	10.3 (2)	8 (1.2)
Site 5 Reference	7	7.9 (1)	7.3 (0.5)	6.7 (0.6)	20.7 (2.9)	21 (3.3)	18.1 (2.2)	10.1 (1.3)	9.1 (0.6)	8.1 (0.8)
Site 6	6	4.9 (0.5)	4.7 (1.1)	6 (1.3)	9.2 (1.9)	13.3 (2.7)	11.3 (2.7)	5.5 (0.7)	6 (1.3)	6.7 (1.5)

Figure 1. PRBO avian monitoring sites for properties enrolled in the Landowners Incentive Program's riparian agricultural buffers initiative.

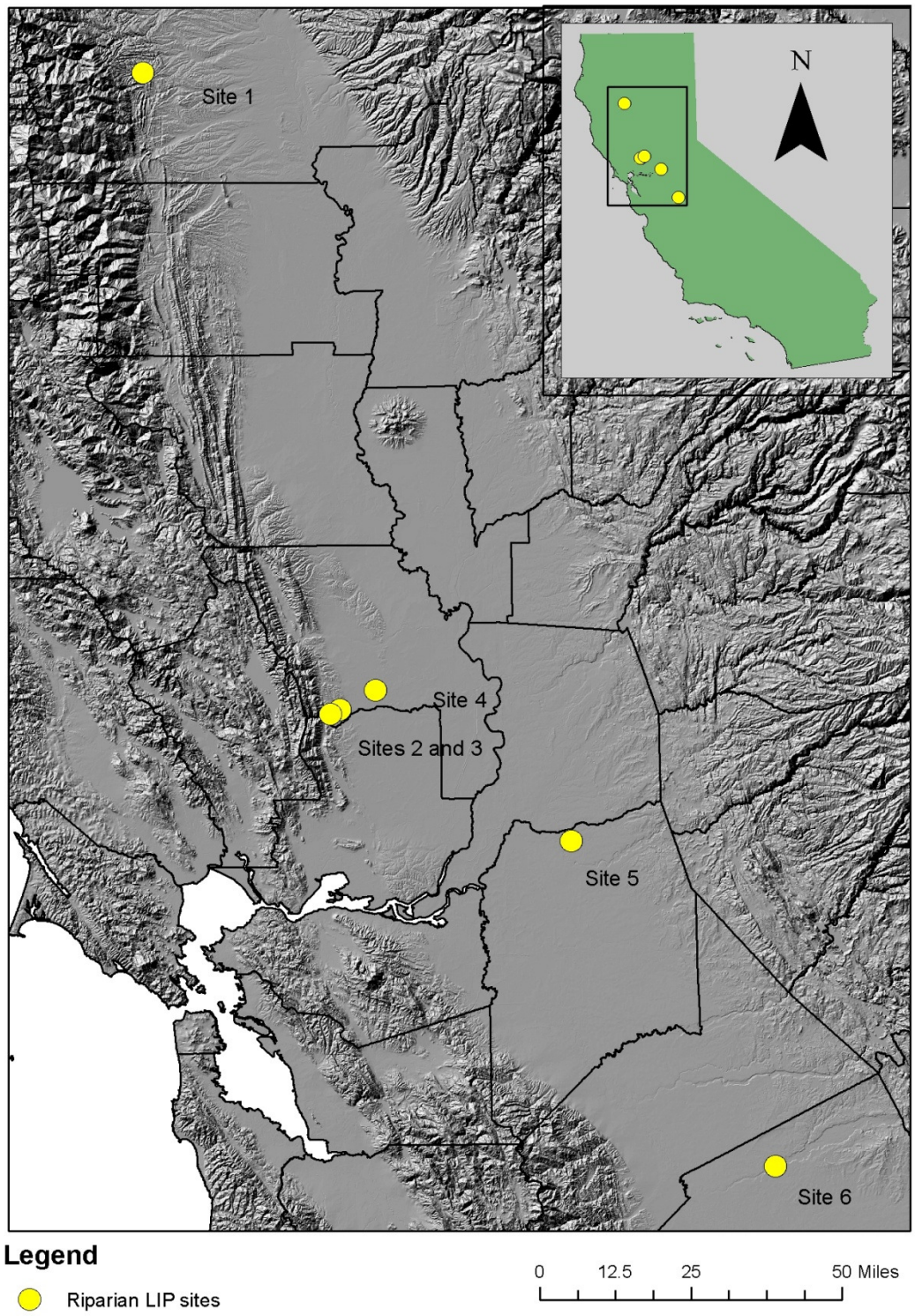
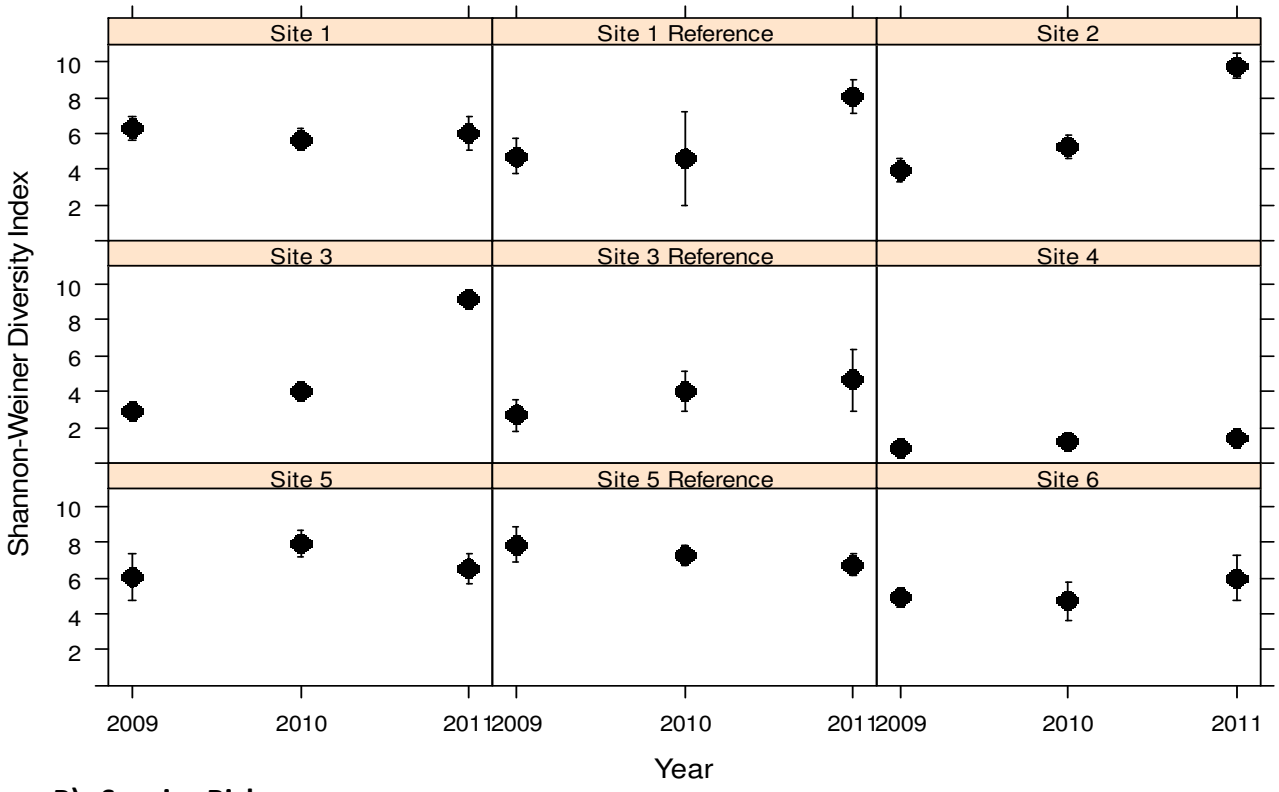


Figure 2. Species diversity (A), species richness (B), and abundance (C) of selected species at LIP riparian restoration and reference sites in the Central Valley, 2009 – 2011.

A) Species Diversity (Shannon-Weaver index):



B) Species Richness

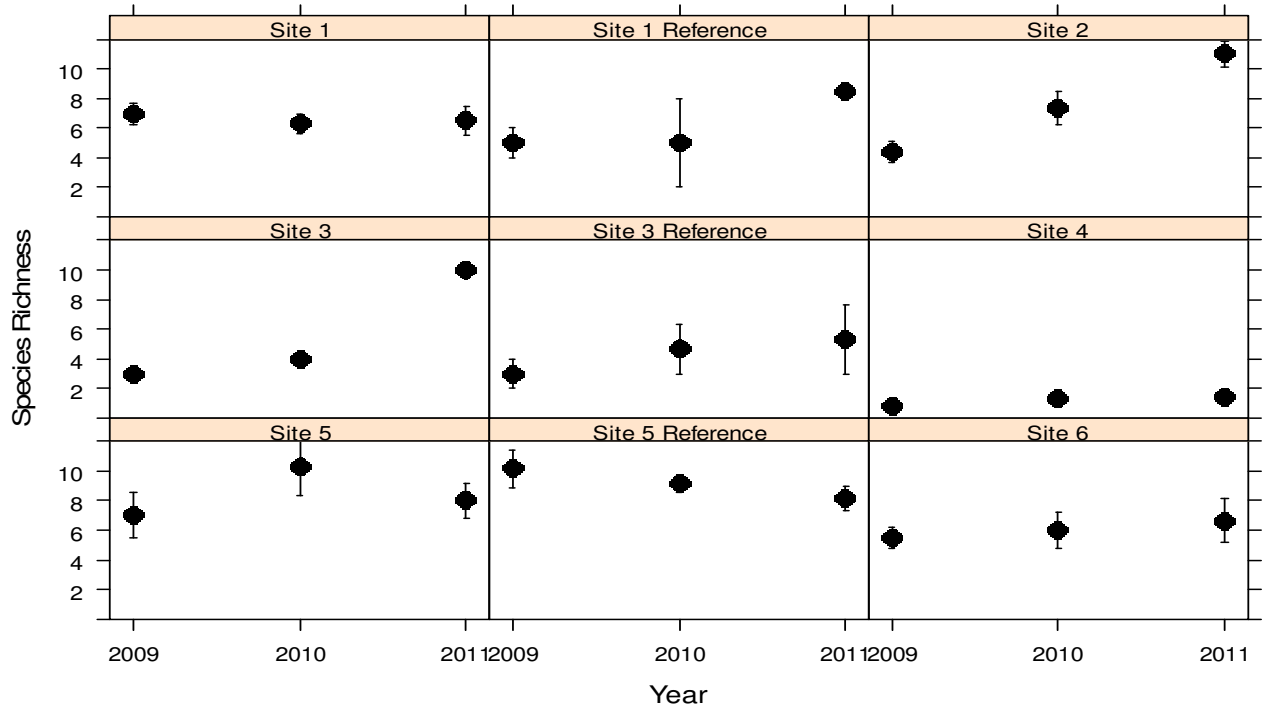


Figure 2 (continued):

C) Abundance

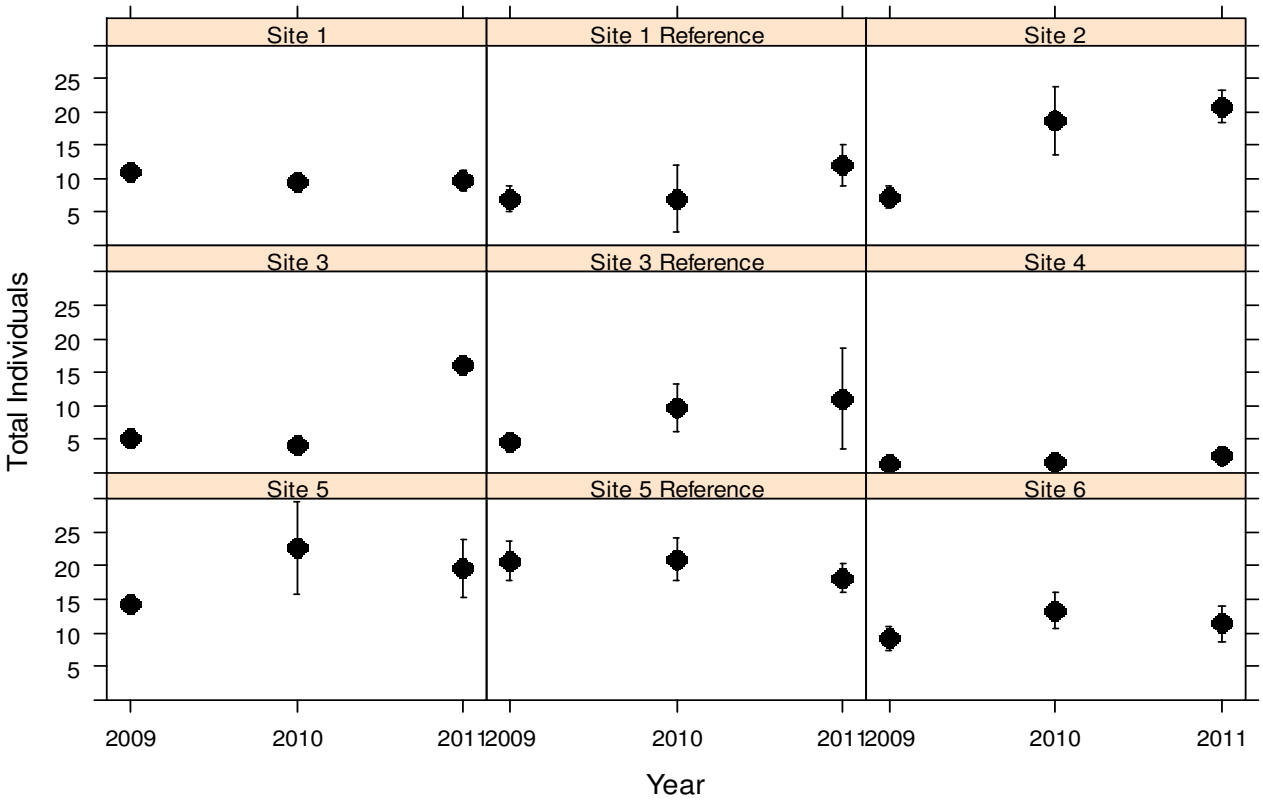


Figure 3. 2009 – 2011 population density estimates for four riparian focal species at LIP riparian restoration sites in the Central Valley. Densities (birds per acres) are given with ±95% confidence interval bars, and are compared against the basin-specific target density (horizontal red line) established for each species by the Central Valley Joint Venture (CVJV 2006). Density is zero for sites and/or focal species not given.

A) Black-headed Grosbeak density at LIP riparian restoration sites. CVJV target density (red line) is 0.54 birds/acre for Sacramento Valley sites and 0.15 birds/acre for San Joaquin Valley sites.

B) Song Sparrow density at LIP riparian restoration sites. CVJV target density (red line) is 0.40 birds/acre for Sacramento Valley sites and 0.68 birds/acre for San Joaquin Valley sites.

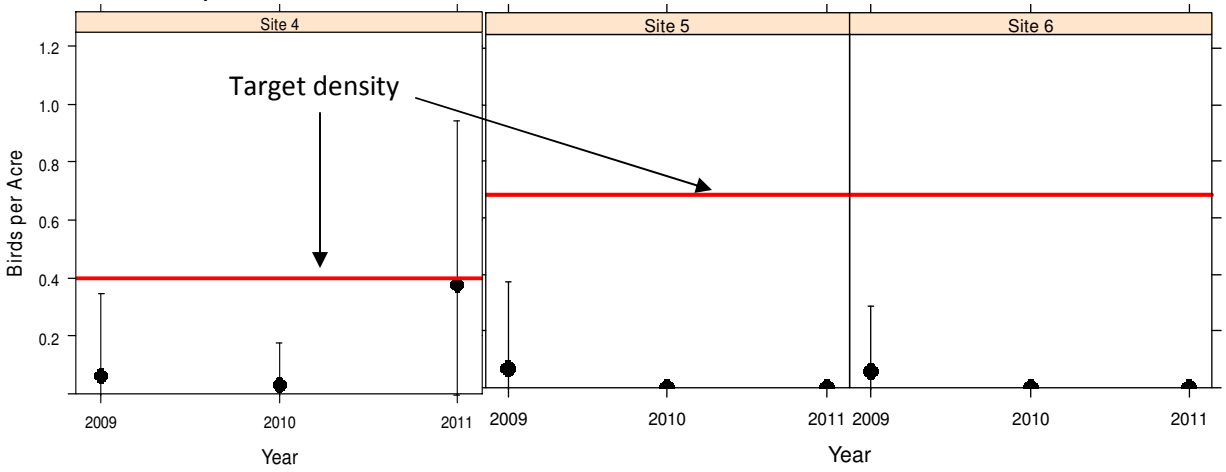
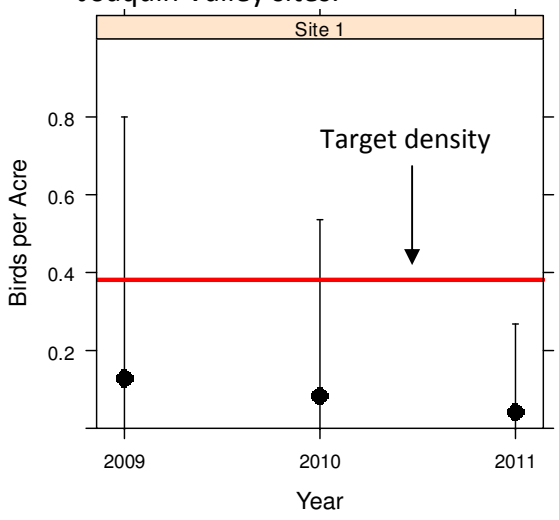


Figure 3. (continued)

C) Spotted Towhee density at LIP riparian restoration sites. CVJV target density (red line) is 0.78 birds/acre for Sacramento Valley and San Joaquin Valley sites.

D) Yellow-breasted Chat density at LIP riparian restoration sites. CVJV target density (red line) is 0.38 birds/acre for Sacramento Valley sites and 0.68 birds/acre for San Joaquin Valley sites.



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Appendix A. All species detected and breeding status from riparian LIP and reference (ref.) sites, 2009 - 2011. **Codes:** B = confirmed breeder; b = suspected breeder; p = potential breeder; x = detected but no evidence of breeding. [a]Special status species (species of conservation concern from various state, regional, continental, and global assessments); [b]riparian focal species.

Common Name	Scientific Name	Site 1	Site 1 ref.	Site 2	Site 3	Site 3 r ef.	Site 4	Site 5	Site 5 ref.	Site 6
Canada Goose	*Branta canadensis*					x	x			x
Wood Duck	*Aix sponsa*									b
Mallard	*Anas platyrhynchos*	p	p				B		x	x
Cinnamon Teal	*Anas cyanoptera*						b			
Common Merganser	*Mergus merganser*	x								
California Quail	*Callipepla californica*	b	b	B	x	B	b	b	b	b
Ring-necked Pheasant	*Phasianus colchicus*						b			
Wild Turkey	*Meleagris gallopavo*	p								
Pied-billed Grebe	*Podilymbus podiceps*								x	
American Bittern	*Botaurus lentiginosus*						x			
Great Blue Heron	*Ardea herodias*	x					x			x
Great Egret	*Ardea alba*						x		x	
Snowy Egret	*Egretta thula*						x		x	
Cattle Egret	*Bubulcus ibis*						x			
Green Heron	*Butorides virescens*	p							x	
Black-crowned Night-Heron	*Nycticorax nycticorax*						x			
Turkey Vulture	*Cathartes aura*	p	p	x	x	x				
White-tailed Kite	*Elanus leucurus*			p		b		p		
Bald Eagle[a]	*Haliaeetus leucocephalus*	b								
Northern Harrier	*Circus cyaneus*					x	p			
Sharp-shinned Hawk	*Accipiter striatus*		p							
Red-shouldered Hawk	*Buteo lineatus*							B	b	
Swainson's Hawk [a,b]	*Buteo swainsoni*			x	x		B		b	b
Red-tailed Hawk	*Buteo jamaicensis*	p	p	B		b		b	B	p
American Kestrel	*Falco sparverius*	b		p	p	p	p			B
Killdeer	*Charadrius vociferus*	b		b	p	p	b		b	p
Black-necked Stilt	*Himantopus mexicanus*						x			x
Spotted Sandpiper[b]	*Actitis macularius*									b
Greater Yellowlegs	*Tringa melanoleuca*						x			
Whimbrel[a]	*Numenius phaeopus*						x			
Long-billed Curlew[a]	*Numenius americanus*						x			
California Gull	*Larus californicus*						x			

Common Name	Scientific Name	Site 1	Site 1 ref.	Site 2	Site 3	Site 3 r ef.	Site 4	Site 5	Site 5 ref.	Site 6
Forster's Tern	*Sterna forsteri*									x
Rock Pigeon	*Columba livia*	p							p	
Eurasian Collared-Dove	*Streptopelia decaocto*	p		b						
Mourning Dove	*Zenaida macroura*	b	b	b	b	b	b	p	b	b
Barn Owl	*Tyto alba*							p		
Great Horned Owl	*Bubo virginianus*						B	p	b	b
Black-chinned Hummingbird	*Archilochus alexandri*								p	b
Anna's Hummingbird	*Calypte anna*	b	p	b		p			b	
Belted Kingfisher	*Megaceryle alcyon*	p								b
Acorn Woodpecker	*Melanerpes formicivorus*	B	b	b				b	b	x
Nuttall's Woodpecker[a]	*Picoides nuttallii*	b	b	B		p		b	b	b
Downy Woodpecker	*Picoides pubescens*	p							p	b
Hairy Woodpecker	*Picoides villosus*	p								
Northern Flicker	*Colaptes auratus*	b		b				p	b	b
Western Wood-Pewee	*Contopus sordidulus*	b						p	p	p
Willow Flycatcher[a,b]	*Empidonax traillii*	x						x		
Pacific-slope Flycatcher	*Empidonax difficilis*								x	
Black Phoebe	*Sayornis nigricans*	B	b	b	p	p	p	b	b	b
Ash-throated Flycatcher	*Myiarchus cinerascens*	B	b	b	b	p		b	B	b
Western Kingbird	*Tyrannus verticalis*	B	b	b	b	b	B	b	b	b
Loggerhead Shrike[a]	*Lanius ludovicianus*			b		p	B			
Hutton's Vireo	*Vireo huttoni*	p								
Warbling Vireo[b]	*Vireo gilvus*	x				x		x		x
Western Scrub-Jay	*Aphelocoma californica*	b	p	B	b	b		b	B	B
Yellow-billed Magpie[a]	*Pica nuttalli*			p	x	x				b
American Crow	*Corvus brachyrhynchos*	x		x	x	x	x		x	
Common Raven	*Corvus corax*	x	x				x			
Tree Swallow[b]	*Tachycineta bicolor*	b	p	B		B			b	B
Violet-green Swallow	*Tachycineta thalassina*	b								
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	p		x			x			b
Cliff Swallow	*Petrochelidon pyrrhonota*	x		x	x	x	x	x	B	x
Barn Swallow	*Hirundo rustica*	x		x	x	x	x			
Oak Titmouse[a]	*Baeolophus inornatus*	B	b	b	p			b	b	B
Bushtit	*Psaltriparus minimus*	B	b	p				b	B	b
Red-breasted Nuthatch	*Sitta canadensis*							p		x
White-breasted Nuthatch	*Sitta carolinensis*	b	p	p				b	b	p

Common Name	Scientific Name	Site 1	Site 1 ref.	Site 2	Site 3	Site 3 r ef.	Site 4	Site 5	Site 5 ref.	Site 6
Bewick's Wren	*Thryomanes bewickii*	b	b						b	
House Wren	*Troglodytes aedon*	b						b	B	b
Marsh Wren	*Cistothorus palustris*						p			
Blue-gray Gnatcatcher	*Polioptila caerulea*	x								
Western Bluebird	*Sialia mexicana*	b		b		b		b	B	b
Swainson's Thrush[b]	*Catharus ustulatus*	x						x	x	
American Robin	*Turdus migratorius*	B	p	p		p	p	p	b	b
Wrentit	*Chamaea fasciata*	b	p							
Northern Mockingbird	*Mimus polyglottos*			b	b	b	p	b	b	p
European Starling	*Sturnus vulgaris*	b	p	B		p	B	B	B	B
American Pipit	*Anthus rubescens*						x			
Cedar Waxwing	*Bombycilla cedrorum*	x								
Phainopepla	*Phainopepla nitens*			x						
Orange-crowned Warbler	*Oreothlypis celata*	x	x							
Yellow Warbler[a,b]	*Setophaga petechia*	x	x			x			x	x
Black-throated Gray Warbler	*Setophaga nigrescens*								x	x
Townsend's Warbler	*Setophaga townsendi*								x	x
Wilson's Warbler[b]	*Cardellina pusilla*	x						x	x	x
Yellow-breasted Chat[a,b]	*Icteria virens*	b								
Spotted Towhee	*Pipilo maculatus*	b	b					b	b	
California Towhee	*Melozone crissalis*	B	b	B				p	b	p
Rufous-crowned Sparrow	*Aimophila ruficeps*			p						
Chipping Sparrow	*Spizella passerina*	p								
Lark Sparrow	*Chondestes grammacus*	b								
Savannah Sparrow	*Passerculus sandwichensis*						x			
Song Sparrow[b]	*Melospiza melodia*						B		b	p
Golden-crowned Sparrow	*Zonotrichia atricapilla*			x						
Western Tanager	*Piranga ludoviciana*	x		x					x	x
Black-headed Grosbeak[b]	*Pheucticus melanocephalus*	b	b						p	b
Blue Grosbeak[b]	*Passerina caerulea*						b			p
Lazuli Bunting	*Passerina amoena*	b	p				x		p	
Red-winged Blackbird	*Agelaius phoeniceus*	x				x	B		B	
Tricolored Blackbird[a.b]	*Agelaius tricolor*						x			
Western Meadowlark	*Sturnella neglecta*	b		b	b	b	b		p	
Brewer's Blackbird	*Euphagus cyanocephalus*	B		B	x	x	B	p	p	
Great-tailed Grackle	*Quiscalus mexicanus*							x	x	

Common Name	Scientific Name	Site 1	Site 1 ref.	Site 2	Site 3	Site 3 r ef.	Site 4	Site 5	Site 5 ref.	Site 6
Brown-headed Cowbird	*Molothrus ater*	b	b	b		p	B	b	b	b
Bullock's Oriole	*Icterus bullockii*	b		b	b	b	b	b	b	B
House Finch	*Carpodacus mexicanus*	b		B	p	b	b	b	B	b
Lesser Goldfinch	*Spinus psaltria*	b	p	b	p	b		p	b	b
Lawrence's Goldfinch[a]	*Spinus lawrencei*	b								b
American Goldfinch	*Spinus tristis*	p		p	p	p	p	p	p	p
House Sparrow	*Passer domesticus*			p				p		B

Appendix B. Species detected on riparian LIP sites in 2009 and 2010 with status designations of conservation concern from various state, regional, continental, and global assessments.

Common Name	BSSC 2006[a]	T & E[b]	USFWS 2008[c]	IUCN 2006[d]
Bald Eagle		SE	R, 32	
Northern Harrier	3			
Swainson's Hawk		ST		
Whimbrel			R, 32	
Long-billed Curlew			R, 32	NT
Nuttall's Woodpecker			32	
Willow Flycatcher		SE	R	
Loggerhead Shrike	2		R, 32	
Yellow-billed Magpie			R, 32	
Oak Titmouse			R, 32	
Yellow Warbler	2		R, 32	
Yellow-breasted Chat	3			
Tricolored Blackbird	1		R, 32	EN
Lawrence's Goldfinch			R, 32	

[a]Species, subspecies, and distinct populations on the 2006 list of California Bird Species of Special Concern (Shuford and Gardali 2008) that occur in the Central Valley. Numbered designations indicate priority levels within the list (1, 2, or 3; highest to lowest).

[b]Species listed as threatened or endangered by state or federal law. ST, state threatened; SE, state endangered; FT, federally threatened; FE, federally endangered (CDFG 2009).

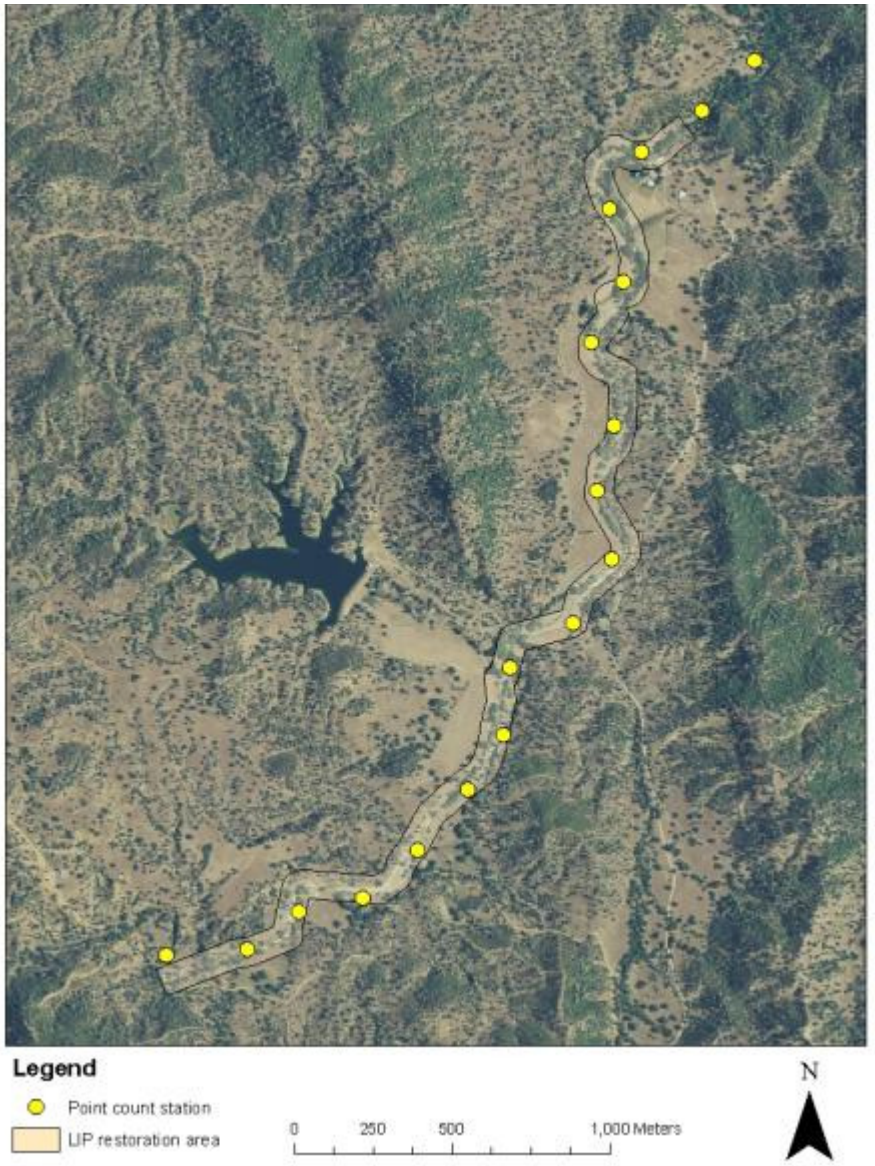
[c]Species or subspecies on the USFWS list of Birds of Conservation Concern 2008 (USFWS 2008); includes taxa of lesser concern than those listed as Federally threatened or endangered (see footnote [c] above). R, USFWS Region 8 (states of CA, NV, and the Klamath Basin of OR). The number 32 refers to Bird Conservation Region 32 (Coastal California), which includes the Central Valley.

[d]Species with IUCN Red List global conservation status ranks (listed here in descending order of conservation concern): CR, critically endangered; EN, endangered; VU, vulnerable; and NT, near threatened (IUCN 2006).

Appendix C. Site maps showing location of PRBO point count stations within each LIP riparian restoration plot.

Site 4

Site 1



Appendix C. continued.

Site 3

Site 2

Appendix C. continued.

Site 5

Site 6