



AVIAN MONITORING ON PRIVATE LANDS

Measuring Bird Response to Easement, Restoration, and Incentive Programs in the Central Valley

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Background and Introduction

Approximately 90% of the Central Valley's historic wetlands have been lost due to anthropogenic causes, such as conversion to agriculture and flood control projects (Frayer et al. 1989, Kempka et al. 1991). Despite extensive habitat loss and degradation, the managed wetlands, flooded agricultural fields, and evaporation ponds that replaced the natural habitat support an abundance of bird populations. Wetland habitats of California's Central Valley support a large diversity of aquatic and terrestrial wildlife (Knopf et al. 1988). The Central Valley is recognized internationally as one of the most important wintering areas for waterfowl in North America (USFWS and CWS 1986). For numerous non-waterfowl species it is similarly important yet less well recognized. In winter and spring, the Central Valley supports more shorebirds than any other inland site, and in winter is one of only two inland sites that support tens of thousands of shorebirds (Shuford et al. 1998). Likewise, valley riparian forest is known to support a diverse and concentrated population of neotropical song birds (Gaines 1977).

In California, riparian areas have been identified as the most important habitat for the protection and conservation of songbirds (Manly and Davidson 1993, Davidson 1995), yet they have declined dramatically over the past 150 years (RHJV 2004). While no estimates exist for the total historical extent of riparian habitat in California, there were at least 60,000 miles of streams in the state that were capable of supporting this type of vegetation (Warner and Hendrix 1984). Current estimates of remaining riparian habitat in the state range from 2% to 7% for the Central Valley (Katibah 1984, Dawdy 1989). The loss of riparian habitats may be the most important cause of population decline among land bird species in western North America (DeSante and George 1994).

It is estimated that historically almost 8 million acres of grassland carpeted California, most of it concentrated in the Central Valley. Current estimates put the amount of grassland remaining at about 36% of historic amounts (CPIF 2000). Grasslands around the Central Valley are becoming increasingly fragmented by urbanization and, in some

areas, by encroaching woody vegetation (Fredrickson and Laubhan 1995). This has an unknown but potentially negative impact on native grassland bird species.

Overall in the Central Valley, approximately 94% of land is under private ownership, including nearly all of the Valley's important wildlife habitats: managed wetlands (68%), riparian (80%), and grasslands (90%). Public agencies and private organizations are investing millions of dollars in habitat restoration and enhancement, with thousands of acres slated for restoration on private lands through programs such as the U.S. Department of Agriculture - Natural Resource Conservation Service's (NRCS) Wetlands Reserve Program, U.S. Fish and Wildlife Service's (USFWS) Partners for Fish and Wildlife, and California Department of Fish and Games's (CDFG) Waterfowl Habitat Program and Landowner Incentive Program.

We conducted the first year of a 3-year project designed to assess the value of the above four programs to landbird, waterbird, and shorebird populations in the Central Valley, California. This project will include 3 years of shorebird, waterbird, and landbird monitoring during spring/summer in grassland, riparian, and semi-permanent wetland habitats throughout the Central Valley and 2 years of shorebird and waterbird monitoring in post-harvest flooded agricultural lands in the San Joaquin and Tulare basins.

The biological and habitat information gained from this project will be used to actively guide effective restoration, enhancement, and management on program and partner sites. Study results and recommendations will be published in reports, bird conservation plans, web based databases, and the scientific literature. Results of this monitoring and assessment project also will contribute to regional conservation efforts by providing information to California Partners in Flight, the Riparian Habitat Joint Venture, and the Central Valley Joint Venture.

Study Areas

The Central Valley is surrounded by mountains, except for its western drainage into San Francisco Bay, and averages about 644 km (400 mi) long and 64 km (40 mi) wide. It is divided into the Sacramento Valley, draining southward, the San Joaquin Valley, draining northward, the Sacramento-San Joaquin River Delta (hereafter Delta), where these rivers converge, and Suisun Marsh, where land-locked wetlands merge with tidal habitats of the San Francisco Bay estuary.

Total precipitation in the Central Valley was just below normal in the winter prior to our surveys and was well below average in the spring of 2004. Precipitation for the climate year (1 July-30 June) 2003-2004 was 33.5 and 15.0 cm (13.2 and 5.9 in) in the Sacramento and San Joaquin drainage divisions, respectively. These figures represent 89% and 75%, respectively, of the long-term averages (n = 109 yrs) for these areas (Western Regional Climate Center; <http://www.wrcc.dri.edu/divisional.html>). Precipitation for late spring (1 April-31 May) 2004 for these regions was 1.9 and 0.4 cm (0.7 and 0.2 in), respectively, and amounted to 44% and 17% of the long-term averages at that season (n = 110 yrs).

We conducted surveys on privately owned land in seven counties across the Central Valley, California from April through July, 2004. Study sites were located in the Sacramento Valley, the San Joaquin River Basin including the Grasslands Ecological Area, and the Tulare Basin. Cooperation with landowners was essential and sites were pre-screened based on level of interest of landowners.

We surveyed a diversity of habitat types including mature Valley Oak forest, flooded willow forest, seasonal and semi-permanent wetlands, grazed riparian, newly planted grassland and riparian, as well as areas scheduled for future restoration activities. All wetland sites were levee-impounded and were flooded before surveys began in April. In general, seasonal wetlands dried up over the survey period and semi-permanent wetlands remained wet longer, until mid July.

Methods

Terrestrial habitats:

Point counts, designed to assess passerine occurrence and abundance, were used in riparian and other un-flooded habitats. Point count routes were designed to be representative of the existing habitat. We established the maximum number of point count locations on most properties. On two especially large properties, we established enough points to sample different habitats but did not cover the entire properties.

Standardized 5-minute point count surveys were conducted using distance estimation to each detection (Ralph et al. 1995). All transects were surveyed twice and two transects were surveyed a third time to determine whether certain species were potentially breeding at the sites. Surveys were completed by experienced observers able to identify all birds by sight or sound. Surveys were conducted between 9 April and 21 June and visits were at least 3 weeks apart. Surveys were completed within 4 hours of sunrise and all birds seen or heard were recorded. Distances to all birds within 100 meters were determined using range finders. Birds flying over the count circle were noted separately. Only birds detected within 50 meters of the point are included in the data summary. Evidence of breeding (e.g. observations of nest building, completed nests, food for nestlings, fledglings) also was documented.

At each point count location vegetation parameters were recorded using the releve method (Ralph et al. 1993). We estimated percent cover of each vegetation class (trees, shrubs, and herbaceous plants) over a 50-meter radius circle. Vegetation classes were defined by height (tree>5 meters, shrub=50 centimeters to 5 meters, and herbaceous <50 centimeters), and all plant species within each class were recorded. Vegetation measurements were completed in June and July. Vegetation variables were not analyzed here, but may be analyzed in the 3-year summary report for this project.

Wetlands:

Area surveys were conducted at both semi-permanent and seasonal wetlands; although only data from semi-permanent wetlands is presented here. Counts were conducted at all times of the day between 7 April and 30 July. All bird species seen or heard using the wetland, including those aerial feeding, were recorded. Birds flying over but not actively using the wetland were not recorded. Wetlands were surveyed approximately every 3 weeks. Evidence of breeding was noted. All broods were counted and the development stage of the young noted. Wetlands were visually scanned from as many points as necessary to count all birds present. Survey times thus varied according to number of birds and size of wetland. Abundance of secretive marsh birds (i.e. rail species) was not estimated adequately by this method.

For each wetland survey we recorded a set of habitat conditions including the percent vegetative cover (including tall and short emergents), shallow and deep water, bare ground and mud. The number of islands was noted as well as the surrounding land use. Several of the study sites underwent some type of significant maintenance which included a dry period when water levels were not maintained. Restoration ages and vegetative conditions varied considerably. Multiple wetlands were surveyed on a single property whenever possible.

Analysis

Terrestrial habitats:

Point count analysis was conducted for two different suites of bird species. First we examined the group of bird species known to currently breed in Central Valley riparian habitat (PRBO unpubl. data), and then we examined all bird species detected. Some species may not be well sampled using the point count method (e.g. waterbirds, ducks, and raptors). Results using all birds should not be compared to data from other studies looking solely at riparian breeders.

For both suites of bird species we calculated abundance, species richness, and species diversity, averaged across visits and survey points so comparisons could be made among routes consisting of different numbers of points. Bird abundance is the mean number of birds recorded per station per visit and species richness is the total number of species detected. Species diversity is the number of species detected weighted by the number of individuals of each species. Known as the Shannon-Weiner index, this widely used diversity index reflects both the species richness as well as the evenness of distribution among species (Nur et al 1999). We averaged restoration age across each transect which may have masked relevant age effects.

Wetlands:

Wetland data was summarized by site for 12 guilds of birds (Table 2). Species within these guilds share certain behavioral traits and have similar environmental requirements. Since tall vegetation affects bird use as well as our ability to count all birds present, we grouped sites into three categories depending on the amount of open water (0 to 33%, 34-67% and 68-100%). An additional category was established for sites that were dry at least two thirds of the season; these sites varied in their percent vegetative cover. Fourteen Tulare Basin sites were surveyed twice to get baseline information for comparison with future years when they, or surrounding similar sites, would be actively managed as semi-permanent wetlands. Only 4 of those 14 sites were flooded during the 2004 summer.

Results and Discussion

Terrestrial Habitats:

Abundance, species richness, and species diversity are summarized for each transect surveyed in 2004 (Table 1). SAN-C1, SAN-E1, SAC-F1, and SAN-A1 had the highest riparian breeding bird and total species diversities. All these sites contained forested areas of Valley Oak, willow, Oregon Ash, Black Cottonwood, and other riparian forest species. Riparian bird abundance was highest at SAN-D1 and SAC-C2, largely because of numbers of blackbirds and swallows present.

Grouping detections across all survey routes, the most abundant species was Red-winged Blackbird, accounting for almost 25% of all individuals counted. It was also the most abundant species on 7 of 13 transects and was present on all but two routes. On the remaining six transects, the most abundant species were American Goldfinch, Brown-headed Cowbird, Cliff Swallow, House Wren, Song Sparrow, and Western Kingbird. Nine of 17 CalPIF Riparian Plan focal species were detected and all but 3 transects supported one or more focal species (RHJV 2004). Song Sparrow was the most common focal species, accounting for almost 5% of all birds detected on transects. The Brown-headed Cowbird, a known nest parasite, was one of the top two most abundant species on five of the nine routes where it was detected. Overall they were the third most common species comprising over 6% of detections.

Over half (8) of the sites surveyed this year were in the early stages of restoration and their relatively low diversity reflected this (Table 1). We plotted species abundance against the averaged age of restoration for survey sites to examine this relationship (Figure 1); however, it may be more informative to examine these data by age of restoration at each point if more precise age information can be obtained. We expect species diversity will increase as the restorations mature and shrub layers and tree cavities develop. Cavity nesting birds such as wrens and woodpeckers, which require decaying trees, generally will not be found in younger restorations. Some species, such as Song Sparrow and Blue Grosbeak, prefer more open habitat and may decrease as tree canopy increases (DiGaudio 2003). This highlights the need to create diverse restorations both in age and vegetative structure.

Wetlands:

Overall species occurrence and abundance

We examined 62 semi-permanent and 13 seasonal wetlands. On the semi-permanent wetlands (excluding non-flooded Tulare Basin sites), a total of 33,820 individuals of 106 species were counted on 297 surveys. Twenty-two of the 106 species accounted for at least 1% of the total number of individuals of all species counted. Only three species -

the Black-necked Stilt (10%), Mallard (14%), and Red-winged Blackbird (20%) - accounted for at least 10% of the individuals counted (Appendix A). The most frequently encountered species was Marsh Wren, documented on 67% of all surveys. Mallard (60%), Red-winged Blackbird (60%), and Song Sparrow (52%) were observed on more than half of the surveys and Pied-billed Grebe (29%), American Coot (27%), Killdeer (40%), Great Egret (40%), Snowy Egret (26%), Western Meadowlark (28%), Great Blue Heron (34%), Gadwall (37%), and Cinnamon Teal (32%) were encountered on at least one quarter of the surveys (Appendix A).

Species composition of guilds

Breeding Aerial Feeders

The Black Tern, occurring on only two surveys, was the only waterbird among the 10 species included in this guild (Appendix A). Those guild members occurring on the most surveys were the Western Kingbird, Black Phoebe, and three species of swallows; the same five species were encountered at the most sites (Appendix A). Definite evidence of breeding was documented for Tree Swallow and Western Kingbird at one site each.

Colonial Breeding Ciconiformes

Among the seven species within this guild, Great Egrets, Great Blue Heron, and Snowy Egret occurred on the most surveys and at the most sites. The next most commonly occurring species, White-faced Ibis and Black-crowned Night Heron, were seen on at least 18% and 13% of the surveys, and at 53% and 38% of the sites, respectively.

Breeding Diving Feeders

Five species were included in this guild. Pied-billed Grebe was encountered at more than twice as many sites and on three times as many surveys than the other species. Double-crested Cormorant and Ruddy Duck were the next most commonly encountered species (Appendix A). Definite evidence of breeding was documented at four sites.

Breeding Marsh Birds

The Red-winged Blackbird was the most abundant of the nine species in this guild but Marsh Wren occurred at as many sites and on more surveys (Appendix A). American Coot, Common Moorhen, Common Yellowthroats, and American Bittern were encountered at 33% or more of the sites. Definite evidence of marsh birds breeding was documented at 22 sites.

Breeding Shorebirds

This guild included only three species of which the Killdeer occurred at the most sites and on the most surveys, but the Black-necked Stilt was by far the most abundant species. American Avocets were the lowest in all categories among the three species (Appendix A). Definite evidence of shorebird breeding was documented at 15 wetland sites, but three of these cases were Killdeer nesting in gravelly areas such as roads and parking lots. The other 12 wetlands where breeding was observed held water throughout the breeding season and had some semi-permanent habitat component.

Breeding Dabbling Ducks

Of the nine species in this guild, Mallard was the most abundant in total numbers, number of surveys, and number of sites. Cinnamon Teal and Gadwall were fairly equal in occurrence across all three categories (Appendix A). Northern Shoveler, Green-winged Teal, Wood Duck, and Northern Pintail were also relatively abundant. Definite evidence of breeding was documented at two sites.

Geese

None of the three species within this guild was encountered on many surveys or sites. Canada Goose was the only species found at more than one site (Appendix A). Definite evidence of breeding was documented at one site.

Gulls and Terns

The four species in this guild were only encountered on one to seven surveys and one to six locations. Encounter rates were highest for Ring-billed Gull, Forster's Tern, and Caspian Tern, respectively. Definite evidence of breeding was documented at one site.

Migratory Diving Feeders

Only American White Pelican and Ring-necked Duck fell into this category. White Pelicans were encountered much more frequently than Ring-necked Ducks (Appendix A).

Migratory Shorebirds

This guild, with 13 species, included more species than any other waterbird guild. It was only outnumbered by the diverse set of species included in the upland bird guild. Top ranked in abundance in the shorebird guild were the Long-billed Dowitcher, Western Sandpiper, Dunlin, and Least Sandpiper. Species found at the most sites were Least Sandpiper, Greater Yellowlegs, and Western Sandpiper.

Raptors and Shrikes

Northern Harrier occurred on more than twice as many surveys and sites than the other six species encountered in this guild (Appendix A). Loggerhead Shrikes, four hawks and the Great-horned Owl were the other species within the guild. Definite evidence of Loggerhead Shrike breeding was documented at one site.

Upland Species

This group includes a diverse assemblage of 34 species (Appendix A). Within it, the most abundant species were the Song Sparrow, Brown-headed Cowbird, Western Meadowlark, and Brewer's Blackbird (Appendix A). Species occurring at the most sites were Song Sparrow, Western Meadowlark, Brown-headed Cowbird, and Ring-necked Pheasant. Definite evidence of upland species breeding was documented at 10 sites.

Guild occurrence on semi-permanent wetlands flooded throughout the survey period

Among the 12 guilds of species documented at the semi-permanent wetlands, breeding marsh birds, upland species, breeding dabbling ducks, and colonial breeding ciconiformes occurred at over 80% of the sites regardless of extent of vegetation and open water (Table 2). In contrast, the goose guild, and gull and tern guild were encountered at only 0-17% of the sites (Table 2). Comparing wetland types, the greatest difference in the percent of sites in which one or more species in a guild were encountered occurred for breeding diving feeders (50-89%), and migratory shorebirds guild (40-78%; Table 2). As expected, migratory shorebirds were less frequently encountered (40%) at mostly vegetated sites than at less vegetated sites (78% and 58%; Table 2). There was a similar pattern for breeding diving feeders and migratory diving feeders.

Most species in most guilds were encountered at the three types of wetlands – for example, breeding diving feeders; colonial breeding ciconiformes; breeding marsh birds; breeding shorebirds; breeding dabbling ducks; and migratory diving feeders. Species occurrence within guilds varied from 25-100% across wetland types for the gull and terns guild; 31-85% for migratory shorebirds; 60-80% for breeding aerial feeders; 56-79% for upland species; and 29-71% for raptors and shrikes (Table 2).

For 7 of the 12 guilds, the maximum number of individuals counted occurred at the 0-33% open water sites. The maximum for breeding diving feeders and migratory shorebirds occurred on sites with intermediate amounts of open water. Sites with the highest percent open water had slightly higher maximum individual counts than intermediate sites for raptors and shrikes, upland species, and geese.

Guild occurrence on semi-permanent wetlands flooded during only two of the three survey periods

Twelve semi-permanent wetlands were only flooded during two of the three survey periods. Of these, seven were in the 0-33% open water category, four in the 34-67% open water category, and one in the 68-100% open water category (Appendix E).

Breeding aerial feeders, breeding marsh birds, breeding shorebirds, migratory shorebirds, and upland species were documented at all sites and colonial breeding ciconiformes, and breeding dabbling ducks at all but one site (Appendix E). Breeding diving feeders were found at 6 and migratory diving feeders at 5 of the 12 sites.

Future Studies

While it is premature to draw major conclusions from the data collected during this initial year of study, we have shown that the restorations, implemented on private lands with federal and state conservation funding, provide habitat for many duck, waterbird, songbird, and raptor species. During 2005, we plan to survey as many as possible of the riparian and wetland sites covered in 2004.

As additional years of data are collected, riparian analyses will focus on the comparative contributions private land program sites make relative to natural, and publicly-managed riparian habitat. From multiple years of surveys in private land program riparian habitat, we will be able to assess how avian use changes as the age of restoration increases. Also, vegetation will be examined along with bird occurrence to pinpoint the important habitat features for different bird species.

A future step for the wetland analysis is to obtain the size of each survey site and convert bird abundance into densities. Using acreage data we can attempt to determine minimum size for effective restorations. From the multiple years of data we will assess the variability in avian guild use of the semi-permanent wetland restoration sites. Additionally, we will compare avian use of these semi-permanent wetlands with approximately 15 new permanent wetlands to be included in the project in 2005.

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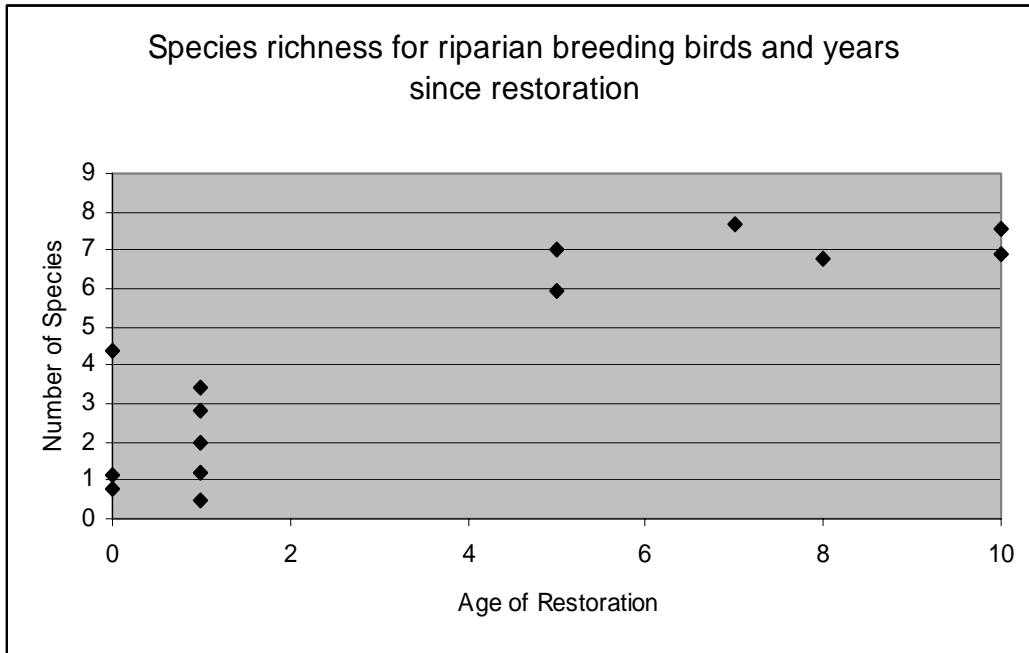


Figure 1. Species richness as determined by point count surveys for riparian breeding birds versus years age of restoration at the site.

Table 1. Species diversity, species richness, and abundance for species breeding in Central Valley riparian habitat, and for all species detected on point count surveys presented by site code.

Region and Site Name	California Wildlife Habitat Relationship	Age of Restoration	# Stations	Central Valley Riparian Bird Species			All Bird Species		
				Species Diversity (SW)	Species Richness	Abundance	Species Diversity (SW)	Species Richness	Abundance
<u>Sacramento Valley</u>									
SAC-A1	VOW	0	9	0.78	0.78	0.44	0.78	0.78	0.44
SAC-B1	AGS	1	4	0.47	0.50	0.38	2.11	2.67	6.67
SAC-C1	AGS	1	8	1.45	2.00	5.75	2.81	14.38	7.19
SAC-C2	VRI	1	5	1.97	2.80	13.00	2.79	5.00	14.50
SAC-D1	VRI	1	5	2.82	3.40	3.20	3.57	4.20	3.70
SAC-E1	VRI	5	15	4.75	5.93	7.50	5.92	7.53	8.67
SAC-F1	VRI	7	3	6.25	7.67	9.67	8.11	10.00	11.33
SAC-G1	VOW, VRI	8	25	5.50	6.76	8.88	6.83	8.56	10.64
<u>San Joaquin</u>									
SAN-A1	VOW	5	9	5.66	7.00	8.00	6.37	7.89	9.00
SAN-B1	AGS	1	19	1.08	1.21	1.87	1.88	2.21	3.55
SAN-C1	FEW, VRI	10	7	6.51	7.57	8.29	7.48	8.71	9.14
SAN-D1	VRI	0	10	2.35	4.40	15.45	3.96	7.40	21.85
SAN-E1	VRI	10	10	5.80	6.90	8.70	6.77	8.10	9.05
<u>Tulare</u>									
TUL-A1	AGS, FEW	0	26	0.99	1.12	1.71	2.51	3.00	3.79

CWHR Habitat Types: AGS=Annual Grassland, FEW=Fresh Emergent Wetland, VOW=Valley Oak Woodland, VRI=Valley Foothill Riparian

Table 2. Species occurrence (maximum individuals counted, percent of species observed, and percent of sites with one or more species in the guild) in three wetland types. Number in () after name of guild is total number of species in that guild. Maximum number refers to maximum individuals of that guild found at any wetland of that particular type. Site specific information can be found in Appendices (C-G).

Guild	0-33% open water (20 sites)			34-67% open water (9 sites)			68-100% open water (12 sites)			Overall (41 sites)	
	Max #	% species	% sites	Max #	% species	% sites	Max #	% species	% sites	Max #	% sites
Breeding Aerial Feeders (10)	80	60%	70%	27	70%	56%	27	80%	67%	80	66%
Breeding Diving Feeders (5)	17	80%	50%	23	80%	89%	16	80%	83%	17	68%
Colonial Breeding Ciconiformes (7)	628	100%	90%	130	86%	100%	43	86%	83%	628	90%
Breeding Marsh Birds (9)	1033	100%	100%	88	100%	100%	92	89%	92%	1033	98%
Breeding Shorebirds (3)	1144	100%	65%	140	100%	89%	12	100%	62%	1144	71%
Breeding Dabbling Ducks (9)	383	100%	95%	212	100%	100%	354	100%	83%	383	93%
Gulls and Terns* (4)	11	100%	15%	1	25%	11%	2	50%	17%	11	15%
Migratory Diving Feeders (2)	550	100%	15%	13	100%	33%	22	100%	33%	550	24%
Migratory Shorebirds (13)	204	85%	40%	649	77%	78%	10	31%	58%	204	54%
Raptors and Shrikes (7)	2	57%	55%	2	29%	56%	3	71%	33%	3	49%
Upland Species (34)	47	59%	100%	43	56%	100%	49	79%	83%	49	95%
Geese (3)	0	0%	0%	1	33%	11%	5	67%	17%	5	7%

Appendix A. Total individuals counted, number of surveys (out of 297) and sites (out of 53) on which each species occurred, and status for species occurring on semi-permanent wetland surveys (except for Tulare Basin sites).

Guild	Scientific Name	Total Counted	# surveys	# sites	Status
Breeding Aerial Feeders					
Black Tern	<i>Sterna anaethetus</i>	4	2	1	BSoSC
Western Wood Peewee	<i>Contopus sordidulus</i>	1	1	1	
Pacific Slope Flycatcher	<i>Empidonax difficilis</i>	1	1	1	
Black Phoebe	<i>Sayornis nigricans</i>	43	36	27	
Ash-throated Flycatcher	<i>Myiarchus cinerascens</i>	7	5	5	CalPIF
Western Kingbird	<i>Tyrannus verticalis</i>	147	62	24	
Northern Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>	8	2	2	
Tree Swallow	<i>Tachycineta bicolor</i>	220	21	13	
Cliff Swallow	<i>Petrochelidon pyrrhonota</i>	393	26	17	
Barn Swallow	<i>Hirundo rustica</i>	64	16	11	
Colonial Breeding Ciconiformes					
Great Blue Heron	<i>Ardea herodias</i>	174	101	40	
Great Egret	<i>Ardea alba</i>	614	117	45	
Snowy Egret	<i>Egretta thula</i>	514	76	38	
Cattle Egret	<i>Bubulcus ibis</i>	30	5	5	
Green Heron	<i>Butorides virescens</i>	5	3	3	
Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	129	40	20	
White-faced Ibis	<i>Plegadis chihi</i>	1894	54	28	

Guild	Scientific Name	Total Counted	# surveys	# sites	Status
Breeding Diving Feeders					
Double-crested Cormorant	<i>Phalacrocorax auritus</i>	60	22	12	
Pied-billed Grebe	<i>Podilymbus podiceps</i>	289	86	30	
Redhead	<i>Aythya americana</i>	13	5	4	BSoSC
Ruddy Duck	<i>Oxyura jamaicensis</i>	80	22	8	
Belted Kingfisher	<i>Ceryle alcyon</i>	8	7	5	
Breeding Marsh Birds					
American Bittern	<i>Botaurus lentiginosus</i>	57	35	18	BSoSC
American Coot	<i>Fulica americana</i>	615	80	32	
Common Moorhen	<i>Gallinula chloropus</i>	106	43	21	
Common Yellowthroat	<i>Geothlypis trichas</i>	68	45	21	CalPIF
Marsh Wren	<i>Cistothorus palustris</i>	1234	199	48	
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	6798	177	47	
Tri-colored Blackbird	<i>Agelaius tricolor</i>	311	13	9	BSoSC
Yellow-headed Blackbird	<i>Xanthocephalus xanthocephalus</i>	32	17	11	BSoSC
Virginia Rail	<i>Rallus limicola</i>	3	3	3	
Breeding Shorebirds					
American Avocet	<i>Recurvirostra americana</i>	381	42	19	
Black-necked Stilt	<i>Himantopus mexicanus</i>	3256	64	28	
Killdeer	<i>Charadrius vociferus</i>	436	118	39	

Guild	Scientific Name	Total Counted	# surveys	# sites	Status
Breeding Dabbling Ducks					
American Widgeon	<i>Anas americana</i>	20	8	4	
Blue-winged Teal	<i>Anas discors</i>	25	9	6	
Cinnamon Teal	<i>Anas cyanoptera</i>	1080	94	32	
Gadwall	<i>Anas strepera</i>	1006	109	35	
Green-winged Teal	<i>Anas crecca</i>	120	18	13	
Mallard	<i>Anas platyrhynchos</i>	4731	179	49	
Northern Pintail	<i>Anas acuta</i>	53	22	13	
Northern Shoveler	<i>Anas clypeata</i>	219	25	15	
Wood Duck	<i>Aix sponsa</i>	52	26	11	CalPIF
Geese					
Canada Goose	<i>Branta Canadensis</i>	34	5	4	
Greater White-fronted Goose	<i>Anser albifrons</i>	3	3	1	
Snow Goose	<i>Chen caerulescens</i>	1	1	1	
Gulls and Terns					
California Gull	<i>Larus californicus</i>	1	1	1	
Ring-billed Gull	<i>Larus delawarensis</i>	28	7	6	
Caspian tern	<i>Sterna caspia</i>	9	5	3	
Forster's Tern	<i>Sterna forsteri</i>	13	6	4	
Migratory Diving Feeders					
American White Pelican	<i>Pelecanus erythrorhynchos</i>	1046	25	15	BSoSC
Ring-necked Duck	<i>Aythya collaris</i>	11	5	4	

Guild	Scientific Name	Total Counted	# surveys	# sites	Status
Migratory Shorebirds					
Black-bellied Plover	<i>Pluvialis squatarola</i>	14	4	4	
Wilson's Snipe	<i>Gallinago delicata</i>	9	4	4	
Dunlin	<i>Calidris alpina</i>	736	6	6	
Greater Yellowlegs	<i>Tringa melanoleuca</i>	213	37	23	
Long-billed Curlew	<i>Numenius americanus</i>	134	10	8	USFWS, USSCP
Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>	1148	25	18	
Least Sandpiper	<i>Calidris minutilla</i>	662	32	26	
Lesser Yellowlegs	<i>Tringa flavipes</i>	5	2	2	
Semipalmated Plover	<i>Charadrius semipalmatus</i>	6	3	3	
Spotted Sandpiper	<i>Actitis macularia</i>	2	2	2	
Western Sandpiper	<i>Calidris mauri</i>	769	17	14	
Whimbrel	<i>Numenius phaeopus</i>	24	9	7	
Wilson's Phalarope	<i>Phalaropus tricolor</i>	16	5	4	
Raptors and Shrikes					
Northern Harrier	<i>Circus cyaneus</i>	29	26	17	BSoSC, CalPIF
White-tailed Kite	<i>Elanus leucurus</i>	2	1	1	CalPIF
Red-shouldered Hawk	<i>Buteo lineatus</i>	3	3	3	CalPIF
Red-tailed Hawk	<i>Buteo jamaicensis</i>	5	4	3	
American Kestrel	<i>Falco sparverius</i>	1	1	1	
Great-horned Owl	<i>Bubo virginianus</i>	4	3	3	
Loggerhead Shrike	<i>Lanius ludovicianus</i>	13	9	6	

Guild	Scientific Name	Total Counted	# surveys	# sites	Status
Upland Species					
American Goldfinch	<i>Carduelis tristis</i>	41	17	14	
American Pipit	<i>Anthus rubescens</i>	27	8	8	
American Robin	<i>Turdus migratorius</i>	9	6	3	
Bewick's Wren	<i>Thryomanes bewickii</i>	1	1	1	CalPIF
Brown-headed Cowbird	<i>Molothrus ater</i>	164	63	30	
Black-headed Grosbeak	<i>Pheucticus melanocephalus</i>	6	5	4	CalPIF
Blue Grosbeak	<i>Guiraca caerulea</i>	13	9	8	CalPIF
Brewer's Blackbird	<i>Euphagus cyanocephalus</i>	146	19	14	
Bullock's Oriole	<i>Icterus bullockii</i>	17	10	6	
Bushtit	<i>Psaltriparus minimus</i>	28	6	3	
California Towhee	<i>Pipilo crissalis</i>	4	3	3	CalPIF
California Quail	<i>Callipepla californica</i>	6	4	3	CalPIF
Common Raven	<i>Corvus corax</i>	3	3	3	
European Starling	<i>Sturnus vulgaris</i>	5	3	3	CalPIF
Great-tailed Grackle	<i>Quiscalus mexicanus</i>	12	7	5	
House Finch	<i>Carpodacus mexicanus</i>	65	12	7	
Horned Lark	<i>Eremophila alpestris</i>	13	4	4	
House Sparrow	<i>Passer domesticus</i>	11	2	1	
House Wren	<i>Troglodytes aedon</i>	3	3	3	
Lark Sparrow	<i>Chondestes grammacus</i>	25	5	1	CalPIF
Lesser Goldfinch	<i>Carduelis psaltria</i>	18	2	2	
Mourning Dove	<i>Zenaida macroura</i>	71	25	11	
Northern Mockingbird	<i>Mimus polyglottos</i>	9	8	6	

Guild	Scientific Name	Total Counted	# surveys	# sites	Status
Upland Species continued					
Nuttal's Woodpecker	<i>Picoides nuttallii</i>	2	2	1	CalPIF
Ring-necked Pheasant	<i>Phasianus colchicus</i>	96	45	27	
Savannah Sparrow	<i>Passerculus sandwichensis</i>	84	15	13	CalPIF
Song Sparrow	<i>Melospiza melodia</i>	674	153	43	CalPIF
Spotted Towhee	<i>Pipilo maculatus</i>	1	1	1	
Vesper Sparrow	<i>Pooecetes gramineus</i>	1	1	1	
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>	1	1	1	
Western Meadowlark	<i>Sturnella neglecta</i>	160	82	31	CalPIF
Western Scrub-Jay	<i>Aphelocoma californica</i>	5	4	2	CalPIF
Yellow-billed Magpie	<i>Pica nuttalli</i>	47	6	3	CalPIF
Turkey Vulture	<i>Cathartes aura</i>	16	3	3	

BSoSC = Draft California Bird Species of Special Concern listed species (CDFG and PRBO 2001).

CalPIF = California Partners in Flight Focal Species from Riparian (RHJV 2004), Grassland (CPIF 2000), and Oak Woodland (CalPIF 2002) bird conservation plans.

Appendix B. Guild abundance (maximum number) in each wetland with 0-33% open water.

Wetland Site	Breeding Aerial Feeders	Breeding Diving Feeders	Colonial Breeding Ciconiformes	Breeding Marsh Birds	Breeding Shorebirds	Breeding Dabbling Ducks	Gulls and Terns*	Migratory Diving Feeders	Migratory Shorebirds	Raptors and Shrikes	Upland Species
SAN-U1				1033						2	9
SAN-P1			54	85	17	141			11	1	7
SAN-P2	1			2		2				2	6
SAC-H6	1	1	4	12		5					17
SAN-G1	2	17	628	40		39	2	550	1		6
SAN-L1		1	28	14	3	54			25		1
SAN-I1	80		11	102		40				1	42
TUL-D2	1		11	9	3	6					9
TUL-04	3		6	5	26	2					7
SAN-F2	7		63	300	140	298				1	18
SAN-F1		6	198	107	1144	383	11	89	204	2	12
SAC-L2	60	2	29	149	49	182			153	1	10
SAC-L1	3		55	78	28	312	1	2	117	1	17
SAC-J2			1	26		2					2
SAC-J3	12	1	16	38	3	30					4
SAC-J1	3	3	87	170	2	14			21	1	6
SAN-N1			6	27	2	15					7
SAC-K1	13	4	52	35	3	19			15	1	6
SAN-Q1	1	2	31	76	1	26					47
SAN-J1	1	3	15	6		2				1	11
Maximum	80	17	628	1033	1144	383	11	550	204	2	47

Appendix C. Guild abundance (maximum number) in each wetland with 34-67% open water.

Wetland Site	Breeding Aerial Feeders	Breeding Diving Feeders	Colonial Breeding Ciconiformes	Breeding Marsh Birds	Breeding Shorebirds	Breeding Dabbling Ducks	Gulls and Terns*	Migratory Diving Feeders	Migratory Shorebirds	Raptors and Shrikes	Upland Species
SAC-H5	3	2	11	12		11					6
SAN-K1		23	16	88	10	168	1	13	6	2	14
SAN-R1	2	4	42	34	10	212			2		7
TUL-D1		1	35	26	140	97			649		7
TUL-D3			7	18	94	85			104	1	19
SAN-M1	27	6	130	58	16	42			13	1	43
SAN-O1	5	9	44	21	66	148		13	110	1	11
SAN-C2		11	16	29	2	39		8			7
SAN-H1	1	9	11	63	4	50			1	2	10
Maximum	27	23	130	88	140	212	1	13	649	2	43

Appendix D. Guild abundance (maximum number) in each wetland with 68-100% open water.

	Breeding Aerial Feeders	Breeding Diving Feeders	Colonial Breeding Ciconiformes	Breeding Marsh Birds	Breeding Shorebirds	Breeding Dabbling Ducks	Gulls and Terns*	Migratory Diving Feeders	Migratory Shorebirds	Raptors and Shrikes	Upland Species
Wetland Site											
SAN-T1	1	14	25	16	4	354		22	7	1	27
SAN-T2	27	6	11	43	8	222	2	1	4		15
SAC-H1											
SAN-C5	4	1	4	25	12	5		1	10	3	26
SAC-C3	2	1	1	15					6		1
SAC-C4				4			2		3		3
SAC-C5				6	3	1					
SAC-C6		5	2	10	1	8			1		2
SAN-C4	15	16	43	5	12	3		16			11
SAC-E6	11	9	4	92		13				2	49
SAN-C3		1	2			5					
SAC-G2	5	5	3	11	1	6					6
Maximum	27	16	43	92	12	354	2	22	10	3	49

Appendix E. Guild abundance (maximum number) in each wetland with varying amount of open water, but dry at least 2/3 of the survey period. Wetland sites grouped by proportion of site with open water.

	Breeding Aerial Feeders	Breeding Diving Feeders	Colonial Breeding Ciconiformes	Breeding Marsh Birds	Breeding Shorebirds	Breeding Dabbling Ducks	Gulls and Terns*	Migratory Diving Feeders	Migratory Shorebirds	Raptors and Shrikes	Upland Species
Wetland Site											
0-33% open water											
SAC-B4	30	4	184	98	45	21		8	23		30
SAC-B5	4	12	8	83	64	68		14	179	1	11
SAC-B3	1		5	30	15	9		9	7		6
SAC-B2	4		6	24	14	27			35	1	3
SAN-S1	1		32	20	8	35			95		10
SAC-I1	60	10	20	499	38	462	8	91	913	1	44
SAC-M1	73		45	81	1	174	3	5	9		34
34-67% open water											
SAC-I3	47	3	88	280	31	41			63		10
SAC-D2	43	1	3	853	25	16	5		312	1	32
SAC-E3	2	4	38	3	3	1			5		2
SAC-E5	3			9	9				6		4
68-100% open water											
SAC-I2	12		53	74	136	384	3		89	3	12
Maximum	73	12	184	853	136	462	8	91	913	3	44

Appendix F. Guild abundance (maximum number) in each Tulare site, only four* of which were flooded for any portion of the season.

Wetland Site	Breeding Aerial Feeders	Breeding Diving Feeders	Colonial Breeding Ciconiformes	Breeding Marsh Birds	Breeding Shorebirds	Breeding Dabbling Ducks	Gulls and Terns*	Migratory Diving Feeders	Migratory Shorebirds	Raptors and Shrikes	Upland Species
TUL-D2*	1		11	9	3	6					9
TUL-D1*		1	35	26	140	97			649		7
TUL-D3*			7	18	94	85			104	1	19
TUL-D4*	3		6	5	26	2					7
TUL-F1				5		2				2	10
TUL-C1	2		1	66	2	1				1	11
TUL-C2				47		2				6	13
TUL-B1				1						1	2
TUL-G1	1					6					2
TUL-H1				1							4
TUL-I1											5
TUL-E1	1			13	1	3				1	21
TUL-E2	2										3
TUL-E3										1	13
Maximum	3	1	35	66	140	97	0	0	649	6	21