WESTERN BIRDS

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PATTERNS OF DISTRIBUTION AND ABUNDANCE OF MIGRATORY SHOREBIRDS IN THE INTERMOUNTAIN WEST OF THE UNITED STATES

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ABSTRACT: From 1989 to 1995, we coordinated shorebird surveys in wetlands throughout the Intermountain West. Of 39 species, the American Avocet was the most numerous (280,000 in fall). Population estimates also exceeded 50,000 birds for the Black-necked Stilt (fall), American Avocet (spring), Western Sandpiper (fall and spring), and Long-billed Dowitcher (fall) and 10,000 for the Black-necked Stilt (spring), Marbled Godwit (fall and spring), Least Sandpiper (fall and spring), and Long-billed Dowitcher (spring). Great Salt Lake, Utah, held the greatest numbers of shorebirds (380,000 in fall) followed by the Salton Sea, California (88,000 in fall). Eight other sites held >10,000 shorebirds in spring or fall: Harney Basin, Summer Lake, and Lake Abert, Oregon; Lake Lowell, Idaho; Goose Lake, Oregon/California; Mono Lake, California; and Humboldt Wildlife Management Area and the Lahontan Valley, Nevada. An additional 29 sites held >1000. Shorebirds' distribution in the Intermountain West varied by subregions and habitats. Species also varied from being highly concentrated in large numbers at a few sites (e.g., Marbled Godwit) to being spread in small numbers among many sites (e.g., Killdeer). The single greatest threat to intermountain shorebirds is the scarcity of high-quality water for wetlands. The U.S. Shorebird Conservation Plan shows great promise, but it will require vigorous regional implementation to stem and reverse the continuing loss and degradation of wetland and upland habitats used by shorebirds.

Shorebirds are of great conservation concern because of population declines in many species linked to widespread and continuing habitat loss and alteration of the wetland and upland habitats on which they depend (Howe et al. 1989, Morrison et al. 1994, Page and Gill 1994). Efforts to reverse these trends include a system of voluntary reserves in North and South America, known as the Western Hemisphere Shorebird Reserve Network (Myers et al. 1987, Harrington and Perry 1995), and the U.S. Shorebird Conservation Plan (Brown et al. 2001). Still, a dearth of comprehensive information on shorebird distribution and abundance in North America limits these initiatives.

Prior studies of the distribution and abundance of shorebirds in the interior of the central and western United States have focused on intensive surveys of one or a few sites (Taylor et al. 1992, Neel and Henry 1997), on portions of large biogeographic regions (Warnock et al. 1998), on compilation of anecdotal information (Skagen and Knopf 1993, Skagen et al. 1999), or on single species (Jehl 1988). In 1988, Point Reyes Bird Observatory, now PRBO Conservation Science, initiated the Pacific Flyway Project to fill gaps in the knowledge of broad-scale patterns of shorebird use of wetlands in western North America. Results have been published for Baja California (Page et al. 1997), California's Central Valley (Shuford et al. 1998), and the Pacific coast of the contiguous United States (Page et al. 1999). Here we describe patterns of distribution and abundance of migratory shorebirds in wetlands in the arid intermountain western United States, highlight regional threats to shorebirds, and suggest approaches to conserving these populations.

STUDY AREA AND METHODS

Our study area, bounded on the west primarily by the axis of the Sierra Nevada and Cascade Range and on the east by the Rocky Mountains, encompasses all or parts of seven western states (Figure 1). This area corresponds closely with the Intermontane Plateaus, commonly known as the Intermountain West, consisting of the Columbia Plateaus, Basin and Range, and Colorado Plateau physiographic provinces (Fenneman 1946). Although they lie just west of the intermontane boundary, we included a few terminal lakes on the eastern coastal slope of southern California because of their greater affinity with the arid interior than the moister coast. We analyzed no data from western New Mexico.

To make broad geographic comparisons of relative abundance, we divided the survey area into three subregions. The western Great Basin included all sites in eastern Oregon, western Nevada, and eastern California south through Crowley Lake; the eastern Great Basin (and Columbia Plateaus) all sites in eastern Washington, Idaho, eastern Nevada, and Utah; the southern deserts all sites in southern California, southern Nevada, and Arizona (Figure 1).

We defined a "site" as an isolated wetland or a complex of wetlands lying within the same drainage basin. We treated these large wetland complexes as sites: Harney Basin of Malheur National Wildlife Refuge (NWR), Oregon (Stinking, Harney, Mud, and Malheur lakes); Warner Valley, Oregon (Coleman, Greaser, Pelican, N. Campbell, S. Campbell, Flagstaff, Mugwump, Swamp, Anderson, Hart, Alkali, and Crump lakes and MC Ranch); Klamath Basin, California (Lower Klamath and Tule Lake NWRs); Alkali Lakes, California (Upper, Middle, and Lower Alkali lakes); Long Valley, Nevada (Alkali, Calcutta, Crook's/New Year's, Fortynine, and Mud lakes); Lemmon Valley, Nevada (Lemmon Lake, Lemmon Valley sewage ponds, Lemmon Valley warehouse ponds, Silver Lake playa), Lahontan Valley, Nevada (Canvasback Club, Carson Lake, Fallon Tribal Wetland, various farms, Fernley Wildlife Management Area [WMA]/Fernley Sink, Harmon, Lahontan, Leter, Old River, Sheckler, and S-line reservoirs, Mahala and Massie sloughs, Soda Lakes, Stillwater Pond, Stillwater WMA); Ruby Valley,

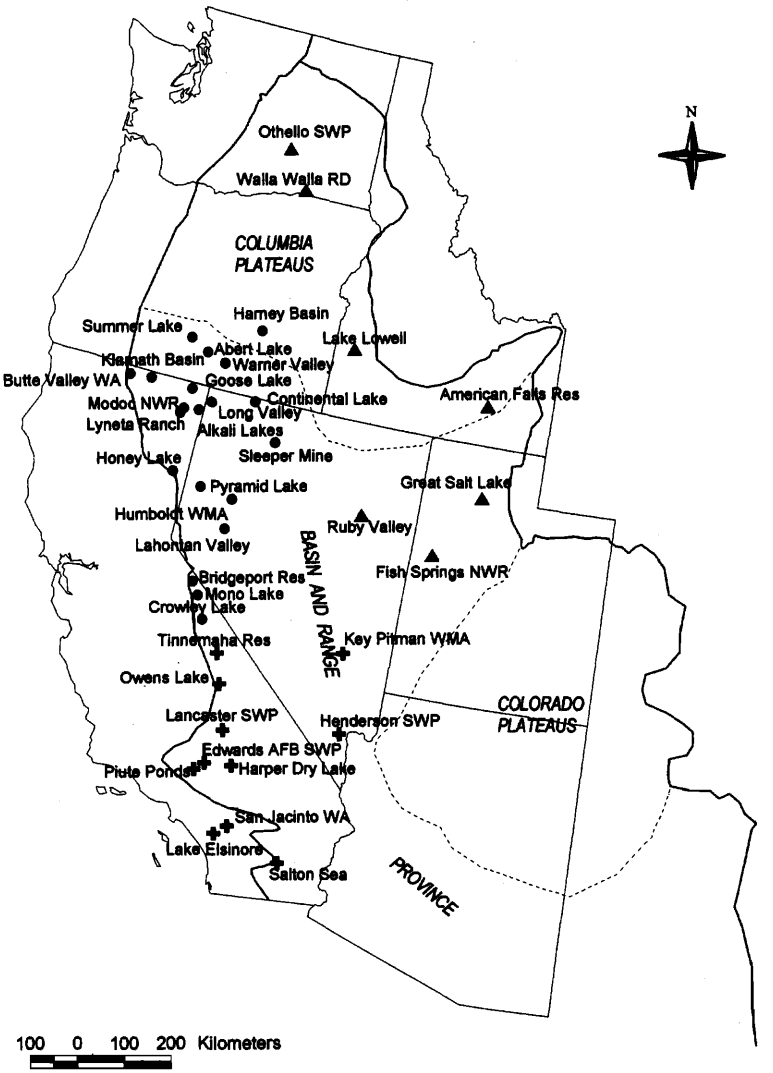

Figure 1. Locations of 38 sites that held >1000 shorebirds on at least one survey, 1989–1995. The Intermontane Plateaus (Intermountain West) study area is outlined by a solid dark line; the Columbia Plateaus, Colorado Plateaus, and Basin and Range physiographic province subregions (Fenneman 1946) are set off by dotted lines. Symbols for sites within three subregions used for analyses: circles, western Great Basin; triangles, eastern Great Basin and Columbia Plateaus; crosses, the southern deserts.

Nevada (Ruby Lake NWR, Franklin Lake WMA); and Lake Mead, Nevada (Lake Mead National Recreation Area [NRA] and Overton WMA).

Our surveys spanned April 1989 through August 1995. We initiated surveys primarily in California and expanded them to nearby states as we identified potential sites of importance to shorebirds and collaborating field observers. With these partners, we attempted to survey shorebirds in all wetlands or other shallow water bodies in the western United States thought, on the basis of published and unpublished literature, knowledge of local experts, and our personal experience, to hold 1000 shorebirds at one time during migration. To enable coverage of such a vast area, we emphasized the geographic extent of surveys at the expense of frequency of censuses. Hence, we tried to ensure coverage of all habitat and the counting of all shorebirds in each wetland annually during periods of one to two weeks each fall (Aug [mostly]-Sept) and one week each spring (late April-early May) for three to five years. We encouraged observers to count on designated weekends within each census period. Observers sometimes covered irrigated agricultural fields, such as those in the Imperial Valley adjacent to the Salton Sea.

PRBO staff and numerous professional and amateur field ornithologists conducted surveys. We provided all observers with a protocol for counting and estimating shorebird numbers under varying conditions. The number of observers needed to conduct a survey ranged from one individual at small sites to more than 10 in multiple teams at some large ones. At most sites observers surveyed on foot, with binoculars and spotting scopes, but at some larger ones they used airboats, fixed-wing aircraft, or a combination of the above. Methods sometimes varied among subareas of a wetland complex or among annual counts. Although there are biases to all methods, at most sites we did not find gross differences in counts using alternative methods. An exception was at Great Salt Lake. Here counts combining results from aerial, airboat, and ground teams conducted in April 1995 and, particularly, August 1994 and 1995 greatly exceeded those on prior counts taken only from the ground. Lower ground counts resulted from limited or no access to some key areas.

We instructed observers, when possible, to identify all shorebirds to species. Groups of unidentified shorebirds fell mostly into four categories: yellowlegs, either Greater or Lesser; small sandpipers of the genus *Calidris*, primarily Western Sandpipers, Least Sandpipers, or Dunlins; dowitchers, either Short-billed or Long-billed; and phalaropes, either Wilson's or Red-necked (see Appendix 1b for scientific names of all species). We assigned unidentified shorebirds to species by the methods described by Page et al. (1999), leaving some unidentified when the ratio of unidentified to identified was high. Our phalarope data in fall are weak, as, even after allocations, high proportions remained unidentified to species, and we generally scheduled our surveys two to three weeks later than the peak passage of the Wilson's Phalarope, an early migrant (Jehl 1988). For analyses, we grouped both identified and unidentified dowitchers as dowitcher spp. because of the difficulty of identifying most individuals to species on surveys of this scale. Still, the vast majority of these birds were likely Long-billed Dowitchers, and

we treat data for dowitcher spp. as pertaining to that species. The only interior site known to hold substantial numbers of the Short-billed in migration is the Salton Sea, though the Long-billed is still more numerous then (Patten et al. in press).

We surveyed 162 sites but set a threshold for inclusion of sites in analyses based on minimum coverage and number of birds detected. We used data from sites that in either season held ≥850 (a natural break in the data near 1000) shorebirds on at least one census or a mean of ≥100 birds on two or more censuses. The 74 sites that met the criteria for inclusion contributed 264 surveys at 63 sites in fall and 235 surveys at 54 sites in spring. The 74 sites accounted for 98% or more of the sum over all sites of both the mean and maximum counts of total shorebirds for fall and spring. From these, we further identified 38 "key" sites that held ≥1000 shorebirds in either fall or spring and were covered at least once in both seasons.

We calculated two abundance estimates of each species or species group at each of the 74 sites in fall and spring: (1) the median count, conditioned on the species' presence (nonzero median), or 0, if all counts were 0, and (2) the maximum count. Because of the large discrepancy among some counts at Great Salt Lake, we calculated medians from only the thorough surveys in August 1994 and 1995 and April 1995. The maxima there, however, are drawn from all seven fall and five spring surveys. Similarly, at the Salton Sea we used four spring and four fall surveys, 1989-1992, to calculate medians and seven spring and seven fall surveys, 1989-1995, to calculate maxima.

We estimated the abundance of shorebirds in the Intermountain West in fall and spring by summing the medians and maxima at all sites. We classified species or species groups with summed medians >10,000 in either season as abundant, those from 1000 to 10,000 as common, and those <1000 as uncommon to rare. We made similar estimates of shorebird abundance in each of the intermountain subregions, using summed medians and converting them to percentages for each subregion. We estimated the broad-scale dispersion of each species by calculating the percentage of total surveys on which each species occurred and counting the number of sites holding at least 1% of the species' median sums. We mapped the regional distribution and relative abundance of shorebirds on the basis of medians from the 38 key sites; abundance categories were based on natural breaks identified by MapInfo Professional 4.1. We categorized species by their breeding and wintering ranges to examine relationships between their abundance and range, modified from Boland (1988, 1991) as described by Page et al. (1999).

Precipitation patterns influencing the extent and availability of suitable shorebird habitat varied greatly during the study. We initiated our surveys in 1989, shortly after the start of a drought, which gripped most of the region through 1993–94, with a brief respite in 1992–93, followed by above-normal precipitation in 1994–95 (Figure 2). Although drought conditions generally reduced the extent of suitable shorebird habitat regionwide, this effect was not uniform across wetlands. Some playa lakes dried up for several years (e.g., Honey Lake, California; 1990–1992, 1994), greatly reducing their capacity to support shorebirds, except in adjacent artificially

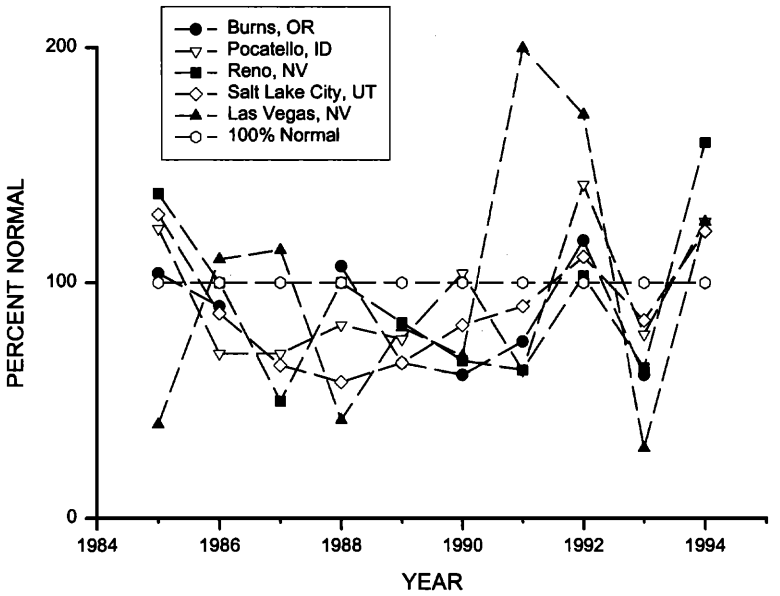

Figure 2. Annual precipitation for the climate year (1 July–30 June), 1985–86 to 1994–95, for five sites in the Intermountain West expressed as the deviation from mean conditions. Data from National Climatic Data Center (http:/www.ncdc.noaa.gov/pub/data/coop-precip/).

maintained wetlands. By contrast, dropping water levels at Goose Lake, Oregon/California, greatly increased the amount of mudflat available to shorebirds over that in wet periods, when water along much of the shoreline laps against low-lying vegetation or rocks.

RESULTS

Species Richness, Overall Abundance, and Seasonal Abundance Patterns

We tallied 39 species of shorebirds in wetlands of the Intermountain West. We recorded 34 species each in fall and in spring but only 28 in both seasons. In at least one season, the sum of medians calculated at all sites totaled >100,000 for the American Avocet, >10,000 to 100,000 for seven species or species groups, and >1000 to 10,000 for eight (Table 1). The summed maxima totaled >100,000 for five species or species groups, >10,000 to 100,000 for six, and >1000 to 10,000 for nine. Although our sum of medians at all sites in fall for the avocet was 280,000, we estimated over 250,000 at Great Salt Lake alone in August 1994 (Appendix 1a). Other species with sums of medians exceeding 50,000 were the Black-necked Stilt in fall, American Avocet in spring, Western Sandpiper in fall and

Table 1 Sum of Medians and Maxima and Percentage Occurrence of Shorebirds in the Intermountain West, 1989–1995[a]

Taxon	Range and (status)[b]	Fall			Spring		
		Median	Maximum	Percentage[c]	Median	Maximum	Percentage[c]
Black-bellied Plover	ab (id)	295	814	22.4 (8)	2570	3583	37.2 (7)
Snowy Plover	tn (sd)	666	1737	36.9 (14)	691	1514	38.5 (15)
Semipalmated Plover	ab (id)	298	575	47.5 (19)	1377	3029	56.8 (18)
Killdeer	tb (sd)	5329	11,750	94.3 (24)	1222	2833	89.3 (29)
Black-necked Stilt	tb (sd)	68,128	101,279	69.6 (4)	10,123	52,158	84.6 (9)
American Avocet	tn (sd)	280,084	391,851	79.5 (8)	58,792	98,065	94.0 (10)
Greater Yellowlegs	ab (id)	531	1210	68.1 (26)	280	935	53.4 (33)
Lesser Yellowlegs	ab (id)	817	2568	61.6 (20)	196	1712	37.2 (22)
yellowlegs spp.[d]	—	1542	4356	81.9 (21)	1240	2962	65.8 (13)
Solitary Sandpiper	as (id)	112	173	31.2 (30)	27	29	9.8 (17)
Willet	tb (sd)	1213	1853	40.3 (6)	5128	7161	68.0 (12)
Spotted Sandpiper	tb (id)	454	1071	66.9 (31)	266	618	48.3 (25)
Whimbrel	aab (id)	95	153	3.8 (7)	8880	11,549	10.7 (3)
Long-billed Curlew	tn (sd)	2180	8192	31.2 (5)	398	1143	48.7 (18)
Marbled Godwit	tn (sd)	15,926	20,699	39.2 (3)	13,402	20,617	29.5 (4)
Ruddy Turnstone	aab (id)	15	42	6.1 (8)	34	48	3.8 (3)
Red Knot	ab (id)	29	34	3.0 (5)	388	548	6.0 (3)
Sanderling	aab (id)	178	416	10.6 (13)	504	634	8.1 (5)
Semipalmated Sandpiper	as (id)	42	69	15.2 (22)	0	0	0.0 (0)
Western Sandpiper	ab (id)	67,849	142,186	81.0 (12)	84,548	188,997	75.6 (11)
Least Sandpiper	ab (id)	8176	24,758	79.1 (21)	13,290	70,555	79.9 (22)
Baird's Sandpiper	as (ld)	452	1127	37.3 (19)	63	210	15.4 (15)
Pectoral Sandpiper	as (ld)	70	130	10.6 (18)	12	12	1.3 (3)
Dunlin	an (id)	82	115	5.3 (11)	6195	22,756	58.1 (10)
Western/Least/ Dunlin[d]	—	103,492	222,974	93.2 (13)	112,719	314,704	95.3 (14)
Stilt Sandpiper	as (ld)	74	114	8.0 (12)	24	37	1.7 (3)
dowitcher spp.[d]	ab, an (id)	76,056	107,966	75.3 (6)	40,889	90,346	75.6 (10)
Common Snipe	tb (sd)	196	442	32.3 (18)	163	323	37.2 (24)
Wilson's Phalarope	ts (id)	19,242	111,918	69.2 (9)	1294	4988	63.7 (16)
Red-necked Phalarope	as (id)	19,993	60,760	51.3 (7)	1542	3169	18.4 (7)
phalarope spp.[d]	—	104,422	173,561	81.1 (5)	1845	7802	66.7 (18)
Total shorebirds	—	670,953	922,971	—	271,902	567,539	—

[a]Median counts conditioned on the species' presence (nonzero median), or 0, if all counts were 0. Based on surveys of 74 wetlands (63 fall, 54 spring). Summary statistics for some species or species groups may also have exceeded thresholds mentioned in the text, depending on the composition of unidentified but unallocated individuals.

[b]aaa, arctic breeder, Oceanic–Asiatic winterer; aab, arctic breeder, bicontinental/Oceanic–Asiatic winterer; ab, arctic breeder, bicontinental winterer; an, arctic breeder, northern winterer; as, arctic breeder, southern winterer; tb, temperate breeder, bicontinental winterer; tn, temperate breeder, northern winterer; ts, temperate breeder, southern winterer. Other shorebirds recorded were the American Golden-Plover (as), Pacific Golden-Plover (aab), Mountain Plover (tn), Wandering Tattler (aab), Hudsonian Godwit (as), Black Turnstone (an), Surfbird (ab), Curlew Sandpiper (aab), Ruff (aaa), and Red Phalarope (as). Migrational status: sd, short distance; id, intermediate distance; ld, long distance.

[c]Numbers in parentheses are the number, based on the sum of medians for all sites, of the 162 total sites holding ≥1% of the species' or species group's total population.

[d]Includes *all* identified and unidentified yellowlegs, *Calidris* sandpipers, Short-billed and (mostly) Long-billed dowitchers, and phalaropes, respectively.

spring, and Long-billed Dowitcher in fall. The Wilson's Phalarope would have exceeded 50,000 if we had surveyed in late July rather than in mid- to late August. Eight species occurred on ≥50% of all surveys in both fall and spring (Table 1), six others on ≥50% of all surveys in one season (3 in fall, 3 in spring). The Black-bellied Plover, Whimbrel, Long-billed Curlew, and Marbled Godwit were the only common to abundant species that did not occur on ≥50% of surveys in either season, whereas the Greater Yellowlegs, Lesser Yellowlegs, and Spotted Sandpiper were the only uncommon species that did.

Sums of medians for 7 of the 15 common to abundant species or species groups were ≥50% higher in fall than in spring (Table 1). Five of the seven (Killdeer, stilt, avocet, curlew, and Wilson's Phalarope) breed in the temperate zone, whereas the other two (dowitchers and Red-necked Phalarope) breed in the arctic. Sums of medians of 5 of the 15 species were ≥50% higher in spring than in fall. Four of the five (Black-bellied and Semipalmated plovers, Whimbrel, and Dunlin) are arctic breeders; the Willet is a temperate-zone breeder. Marbled Godwit totals were not strongly biased toward either season. The large number of unidentified *Calidris* in fall casts uncertainty on a seasonal difference for the Western and Least sandpipers.

Sums of medians for 6 of 11 of the uncommon to rare species were ≥50% higher in fall than in spring and for 3 were ≥50% higher in spring than in fall. The two short-distance migrants that breed in the temperate zone (Snowy Plover and Wilson's Snipe) had negligible seasonal differences (Table 1). The three arctic-breeding long-distance migrants (Baird's, Pectoral, and Stilt sandpipers) were most abundant in fall, as was the Spotted Sandpiper, an intermediate-distance migrant breeding in the temperate zone. Of seven arctic-breeding intermediate-distance migrants, two (Solitary and Semipalmated sandpipers) were most abundant in fall, three (Ruddy Turnstone, Red Knot, and Sanderling) in spring. Seasonal differences for the two yellowlegs species were uncertain because of the high proportion of unallocated individuals. An analogous comparison of sums of maxima yields the same result for the above 11 species, except that the Ruddy Turnstone was not among those with sums ≥50% higher in spring than in fall (Table 1).

Sites of Greatest Importance to Shorebirds

More sites held >10,000 shorebirds in fall than in spring. In fall, on the basis of medians, these included 10 sites: Harney Basin, Summer Lake, and Lake Abert, Oregon; Lake Lowell, Idaho; Goose Lake, Oregon/California; Mono Lake and the Salton Sea, California; Humboldt WMA and the Lahontan Valley, Nevada; and Great Salt Lake, Utah (Appendixes 1a–e). Of these, Great Salt Lake held >380,000 shorebirds and the Salton Sea >88,000. In spring only three sites held >10,000: the Lahontan Valley (42,000), Great Salt Lake (68,000), and the Salton Sea (83,000) (Appendixes 2a–d). Among the 38 sites with spring or fall medians of >1000 total shorebirds in at least one season and data for both seasons, 18 sites held ≥50% higher numbers in fall, 12 held ≥50% higher numbers in spring, and 8 held roughly comparable numbers in both seasons.

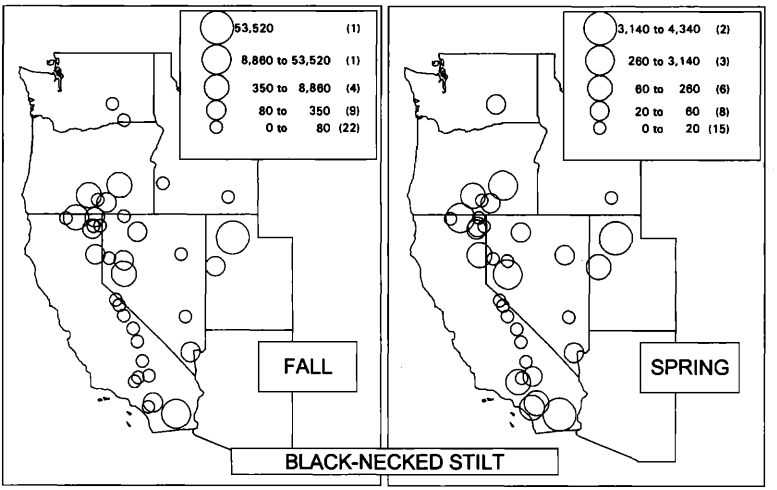

Figure 3. Distribution and abundance of the Black-necked Stilt at 38 key wetlands in the Intermountain West in fall and spring from median counts, 1989–1995.

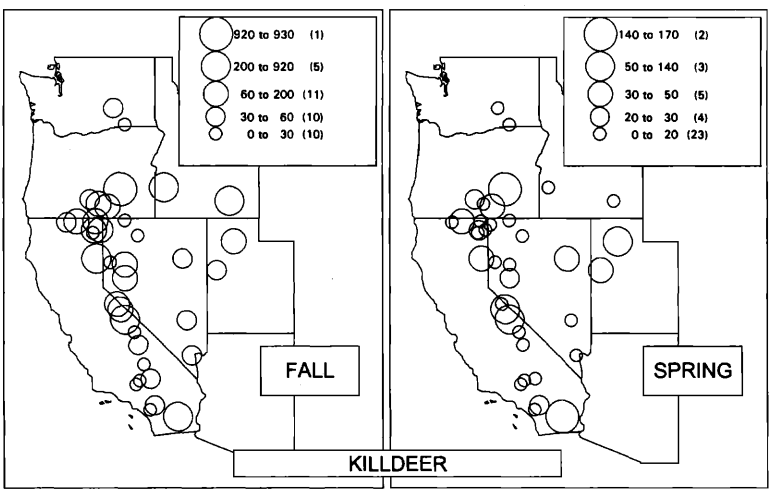

Figure 4. Distribution and abundance of the Killdeer at 38 key wetlands in the Intermountain West in fall and spring from median counts, 1989–1995.

Patterns of Distribution and Relative Abundance

Although most species were widely distributed across intermountain wetlands, they varied from being concentrated primarily in large numbers at a few sites (Table 1, Figure 3) to being spread in small numbers among many sites (Table 1, Figure 4). Eleven common to abundant species concentrated in either fall or spring at ≤10 sites that each held ≥1% of their numbers; five of these concentrated thus at both seasons (Table 1). Of other common to abundant species, only the Killdeer and Least Sandpiper (in both spring and fall) and yellowlegs (in fall) were spread among ≥20 sites that each held ≥1% of their numbers. Of the uncommon to rare species, seven concentrated in either fall or spring at ≤10 sites; the Ruddy Turnstone and Red Knot concentrated thus in both seasons. Six species uncommon to rare in either fall or spring were spread among ≥20 sites that each held ≥1% of their numbers (Table 1). Of these, the Greater and Lesser yellowlegs and Spotted Sandpiper were widely distributed in both seasons, the Solitary and Semipalmated sandpipers in fall, and Wilson's Snipe in spring (though not appreciably more so than in fall).

Shorebirds varied in their patterns of concentration. In fall, common to abundant species or species groups that concentrated particularly were the Black-necked Stilt (78% at Great Salt Lake, 13% at Salton Sea), American Avocet (79% at Great Salt Lake, 5% at Salton Sea), Willet, Whimbrel, and Long-billed Curlew (77%, 62%, 87%, respectively, at Salton Sea), Marbled Godwit (86% at Great Salt Lake), Baird's Sandpiper (25% at American Falls Reservoir, 13% at Lake Lowell), and dowitchers (39% at Great Salt Lake, 20% at Humboldt WMA, 17% at Lahontan Valley, and 13% at Salton Sea). Less numerous species that concentrated primarily at the Salton Sea were the Red Knot (76%), Sanderling (39%), and Stilt Sandpiper (65%).

In spring, common to abundant species or species groups that concentrated particularly were the Black-bellied Plover (68% at Great Salt Lake, 15% at Salton Sea), Black-necked Stilt (42% at Great Salt Lake, 31% at Salton Sea), American Avocet (60% at Great Salt Lake, 11% at Salton Sea), Willet (51% at Great Salt Lake), Whimbrel (88% at Salton Sea, primarily in the adjacent Imperial Valley, 10% at Lancaster sewage ponds in the Antelope Valley), Marbled Godwit (84% at Great Salt Lake, 6% at Salton Sea), small sandpipers (Western, Least, and Dunlin; 33% at Salton Sea, 21% at Lahontan Valley), and dowitchers (34% at Lahontan Valley, 33% at Salton Sea, and 17% at Great Salt Lake). Uncommon to rare species particularly concentrated at the Salton Sea were the Ruddy Turnstone (94%), Red Knot (94%), Sanderling (27%; 65% at Great Salt Lake), and Stilt Sandpiper (92%).

Shorebirds were distributed unevenly among the three subregions of the study area (Table 2). In fall, the eastern Great Basin held a high percentage of total shorebirds, primarily because of the very large numbers of Black-necked Stilts, American Avocets, dowitchers, Marbled Godwits, and phalaropes at Great Salt Lake (Table 2; Appendix 1a). Other uncommon to rare species that were proportionately more numerous in the eastern Great Basin than elsewhere were the Lesser Yellowlegs and Solitary, Semipalmated, and Baird's sandpipers; none of these was particularly numerous at

Table 2 Percentages of 31 Shorebird Species or Species Groups Attributed to Three Regions of the Intermountain West in Fall and Spring[a]

	Fall			Spring		
Taxon	W	E	S	W	E	S
Black-bellied Plover	10.4	19.7	69.9	14.2	68.8	17.0
Snowy Plover	32.9	40.8	26.4	38.5	25.4	36.1
Semipalmated Plover	45.1	15.8	39.0	52.7	1.8	45.6
Killdeer	53.3	29.3	17.4	52.5	23.2	24.3
Black-necked Stilt	6.2	79.7	14.1	17.6	45.3	37.2
American Avocet	15.2	78.8	6.0	25.0	61.4	13.6
Greater Yellowlegs[b]	36.4	32.7	30.9	61.3	9.2	29.4
Lesser Yellowlegs[b]	26.7	61.0	12.3	41.2	34.5	24.3
yellowlegs spp.[c]	27.6	53.9	18.6	18.4	70.2	11.3
Solitary Sandpiper	23.8	48.5	27.7	17.9	35.7	46.4
Willet	9.4	9.5	81.1	40.6	52.9	6.5
Spotted Sandpiper	38.1	36.0	25.9	67.0	13.1	19.8
Whimbrel	2.1	0.0	97.9	0.1	0.0	99.9
Long-billed Curlew	10.2	1.0	88.8	49.0	29.2	21.8
Marbled Godwit	3.8	86.0	10.2	8.7	85.2	6.1
Ruddy Turnstone	60.0	0.0	40.0	3.0	0.0	97.0
Red Knot	20.7	0.0	79.3	5.4	0.0	94.6
Sanderling	38.6	19.7	41.7	7.4	65.3	27.3
Semipalmated Sandpiper	13.8	64.4	21.8	0.0	0.0	0.0
Western Sandpiper[b]	27.7	17.5	54.8	32.3	2.1	65.6
Least Sandpiper[b]	44.0	8.1	47.9	66.5	4.6	28.9
Baird's Sandpiper	26.0	62.1	11.9	39.4	59.2	1.4
Pectoral Sandpiper	29.3	42.1	28.6	100.0	0.0	0.0
Dunlin[b]	71.8	2.3	25.9	93.5	2.0	4.4
Western/Least/Dunlin[c]	33.0	25.0	42.0	52.0	4.4	43.5
Stilt Sandpiper	4.1	25.2	70.8	0.0	0.0	100.0
dowitcher spp.	45.6	40.0	14.4	43.8	17.9	38.3
Wilson's Snipe	61.1	27.7	11.1	59.9	29.1	11.0
Wilson's Phalarope[b]	47.3	40.1	12.6	34.6	26.5	38.9
Red-necked Phalarope[b]	81.2	2.2	16.6	62.2	0.0	37.8
phalarope spp.[c]	36.6	55.8	7.6	48.6	18.8	32.6

[a]W, western Great Basin; E, eastern Great Basin and Columbia Plateaus; S, southern deserts (see Methods, Figure 1). Median sums used to calculate percentages presented in Table 1.

[b]True proportions for these species are uncertain because of the high numbers of unidentified yellowlegs, *Calidris* sandpipers, and phalaropes, respectively.

[c]Includes *all* identified and unidentified yellowlegs, *Calidris* sandpipers, and unidentified phalaropes, respectively.

Great Salt Lake. Of common to abundant species, only the Killdeer was particularly concentrated in the western Great Basin, although that region also held relatively large numbers of American Avocets, Western and Least sandpipers, dowitchers, and phalaropes. The southern deserts held relatively high numbers of Western and Least sandpipers, primarily at the Salton Sea. Many less numerous species also concentrated there, including the Black-bellied Plover, Willet, Whimbrel, Long-billed Curlew, Ruddy Turn-

stone, Red Knot, Sanderling, and Stilt Sandpiper. The relatively high numbers of certain species, such as the Willet, Long-billed Curlew, and Marbled Godwit, at the Salton Sea in fall or spring probably represent birds wintering there rather than migrating through.

In spring, the western Great Basin held a relatively high percentage of the totals of the Semipalmated Plover, Killdeer, Willet, Spotted Sandpiper, Long-billed Curlew, small sandpipers (especially Dunlin), dowitchers, Wilson's Snipe, and phalaropes (Table 2). The eastern Great Basin held high percentages of several common to abundant species, such as the Black-necked Stilt, American Avocet, Willet, and Marbled Godwit, and uncommon to rare species or species groups, such as the Black-bellied Plover, yellowlegs, Sanderling, and Baird's Sandpiper. The southern deserts, particularly the Salton Sea, held high percentages of several common to abundant species or species groups, such as the Semipalmated Plover, Black-necked Stilt, Whimbrel, Western and Least sandpipers, and dowitchers, and of several fairly common to uncommon species, such as the Ruddy Turnstone, Red Knot, and Stilt Sandpiper.

DISCUSSION

Patterns of Seasonal Abundance

Seasonal abundance patterns of shorebirds in the Intermountain West varied by species, as did their likely explanations. Of the seven common to abundant species with numbers higher in fall than in spring, the American Avocet and Wilson's and Red-necked phalaropes are especially adapted to exploit the brine shrimp (*Artemia* spp.) and brine flies (*Ephydra* spp.) so

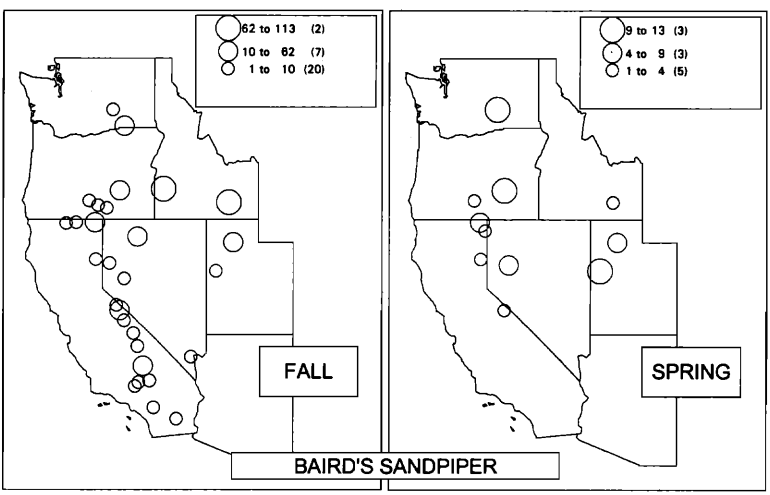

Figure 5. Distribution and abundance of the Baird's Sandpiper at 38 key wetlands in the Intermountain West in fall and spring from median counts, 1989–1995.

abundant in the region's hypersaline lakes in summer and fall (e.g., Jehl 1986, 1988, 1994). The Black-necked Stilt seems to have a secondary affinity for saline lakes, particularly those with adjacent freshwater wetlands, such as Great Salt Lake and the Salton Sea. The greater numbers of the Baird's Sandpiper in fall than in spring are explained by the broader and more westerly migratory pathway of juveniles in fall than of adults in fall and in spring (Figure 5; Jehl 1979); this likely also holds for the Lesser Yellowlegs and the rarer Solitary, Semipalmated, and Pectoral sandpipers, which, like the Baird's, move primarily southeast from arctic breeding grounds to winter in South America. All these species typically are more numerous east than west of the Rockies (Skagen et al. 1999) and were most numerous in the eastern portion of our study area (Table 2). The greater abundance of the Long-billed Curlew in fall than in spring is at first puzzling, as this species departs early from prairie and intermountain breeding grounds and builds to winter levels on the central California coast by late July (Shuford et al. 1989). Its high fall numbers in the Intermountain West reflect mainly the concentration at the Salton Sea (87% of fall numbers), where the species winters primarily in agricultural fields of the Imperial Valley. The greater fall than spring numbers of the Spotted Sandpiper appear to be in part an artifact of our census schedule. This species does not arrive in force in spring in the Great Basin of east-central California until early May (Gaines 1988), after our primary census period. We have no explanation for the greater abundance of the Killdeer and Greater Yellowlegs in fall.

Seasonal patterns of at least three of five common to abundant species most numerous in spring are explained by their patterns of migration. Of

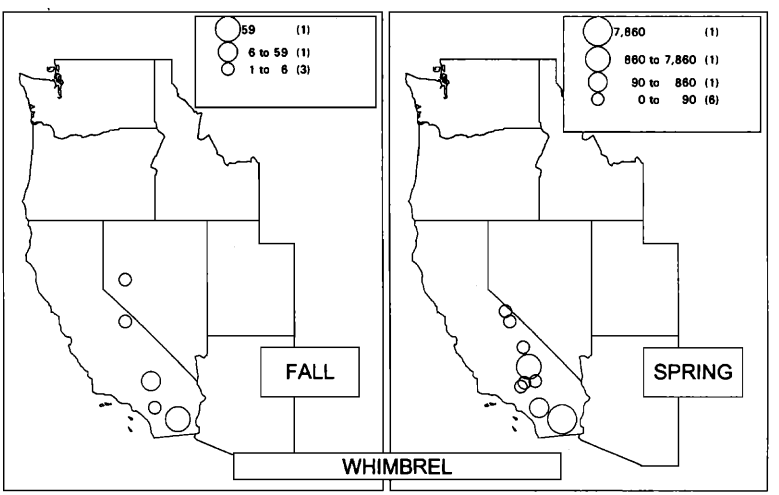

Figure 6. Distribution and abundance of the Whimbrel at 38 key wetlands in the Intermountain West in fall and spring from medians counts, 1989–1995.

these the Willet, like the curlew, departs from intermountain breeding grounds early and reaches winter numbers on the central California coast by late July (Shuford et al. 1989), before our fall inland surveys. The low numbers of the Dunlin in fall reflect that species' southward departure from the North American arctic being delayed until mid-September (Warnock and Gill 1996), after our census period; the species is not numerous in the Intermountain West even in October (e.g., Gaines 1988), perhaps in part because by then temperatures have dropped and food supplies have dwindled. The numbers of Whimbrels being much greater in spring than in fall reflects the species' passing through southern California deserts (Figure 6), particularly in agricultural fields of the Imperial Valley adjacent to the Salton Sea (Shuford et al. in press), on a flight line that leads them to California's Central Valley, where large numbers also occur in spring (Shuford et al. 1998). The numbers in these regions in fall being so low implies a coastal route then. The greater spring than fall numbers of the Black-bellied and Semipalmated plovers (and perhaps Western and Least sandpipers) may be explained by the rapid and concentrated passage of at least some of these arctic breeders in spring (see Iverson et al. 1996 for the Western Sandpiper). Two species rare in the Intermountain West—the Red Knot and Sanderling—are most numerous in spring when they move north from the Gulf of California to the Salton Sea.

For unknown reasons, two abundant species—the Marbled Godwit and Long-billed Dowitcher—and three uncommon to rare species—the Snowy Plover, Ruddy Turnstone, and Wilson's Snipe—occurred in intermountain wetlands in roughly similar numbers in fall and spring. The Snowy Plover was most numerous at alkali lakes, the Long-billed Dowitcher at extensive freshwater wetlands associated with saline lakes. We suspect the Marbled Godwit concentrated primarily at Great Salt Lake in both seasons because of abundant food supplies at a location allowing nonstop flights to both breeding and wintering areas.

The season at which key sites held the greatest numbers of shorebirds reflected in part the types and availability of habitat at each. Of 10 sites with >10,000 shorebirds (based on medians) at either season, 8 held ≥50% more in fall than spring. Of the eight, seven were saline lakes or saline lakes with associated freshwater wetlands; one was a reservoir. Of the four sites with the most striking contrast in seasonal numbers, three are hypersaline lakes—Great Salt, Abert, and Mono—that in fall attract large numbers of phalaropes or avocets. These lakes host abundant brine shrimp and brine flies, which are absent or scarce at the other wetlands (D. Herbst pers. comm.). Lake Lowell held many more shorebirds, particularly small sandpipers, in fall than in spring because very little mudflat is available there until the reservoir is drawn down in summer (Taylor and Trost 1992). Although the Lahontan Valley is a complex of saline and freshwater wetlands, our surveys found more shorebirds there in spring than in fall. This difference may have been an artifact of wetland variability related to climate, as shorebird numbers there subsequent to our survey have been greater in fall than in spring in five of six postdrought years, 1994-1999 (L. Neel and B. Henry unpubl. data); postdrought water availability was further augmented by newly acquired

water rights. Of sites with >10,000 shorebirds, the Salton Sea was unique in hosting roughly similar numbers in spring and fall. The sea is currently not saline enough to favor the brine shrimp and brine flies that would attract large numbers of phalaropes, has a hot climate conducive to invertebrates remaining active year round, and has associated agricultural fields that are particularly attractive to certain species such as the Whimbrel in spring. Other sites with <10,000 shorebirds and higher numbers in spring than in fall typically had more habitat available in spring because of desiccation over the summer or management practices that maintain high water levels in fall (e.g., Klamath Basin; D. Mauser pers. comm.).

Annual Variation in Abundance

Shorebird numbers varied considerably over the study. Numbers appeared to be greatly affected at some sites by fluctuations in available habitat resulting from the extremes of drought and flood. Total shorebird numbers in the Lahontan Valley, Nevada, generally tracked the extent of wetlands, which declined from 1989 to 1992 and increased thereafter, although shorebirds' response, particularly in spring, lagged behind the increasing acreage (Figure 7). Variation in shorebird numbers on individual wetlands likely also reflected census timing relative to pulses of shorebird movement, weather, broad-scale patterns of wetland availability in an arid environment, and variation in shorebirds' reproductive success and winter survival.

Numbers of certain species in the Intermountain West are particularly variable from year to year. Neel and Henry (1997) estimated 100,000 Long-

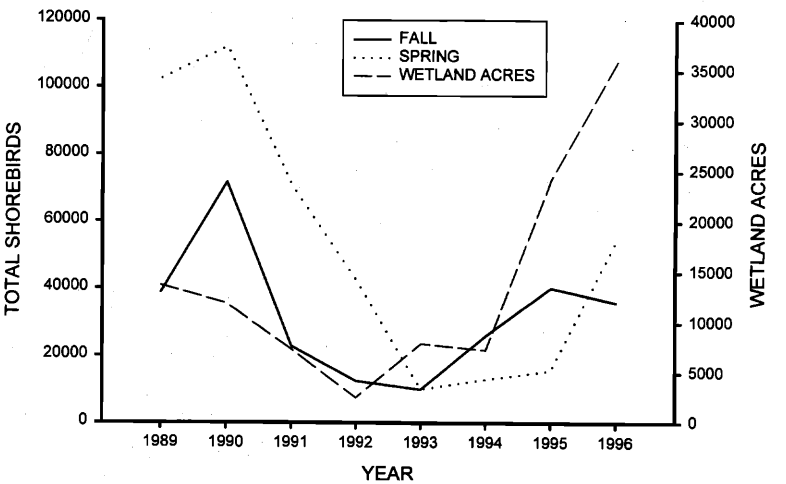

Figure 7. Relationship of annual minimum wetland acres (August) to spring and fall shorebird numbers in the Lahontan Valley, Nevada, 1989–1996. Data on wetland acres and shorebird numbers courtesy of Bill Henry, Stillwater National Wildlife Refuge, and Larry Neel, Nevada Dept. Wildlife, respectively.

billed Dowitchers in the Lahontan Valley in late April and early May in 1987 and 1990, but the median count in late April in other years 1989–2000 was 19,549 (range 2644–39,033; L. Neel, B. Henry unpubl. data). This period included extremes of flood and drought (Figure 7). It is unclear if extremely large numbers of dowitchers reflect very favorable wetland conditions or if large numbers may pass through quickly and be missed by single annual surveys. Similarly, prior estimates of Sanderling numbers at Great Salt Lake have reached 7000 birds in early May (Paton et al. 1992), but the maximum recorded on six Pacific Flyway Project censuses was 329. Paton et al. concluded the species passes through Utah quickly and is very localized there. Jehl (1999) also reported great variation in numbers of Wilson's Phalaropes staging at hypersaline lakes in the Great Basin in autumn (e.g., 67,000 and 7000 birds at Lake Abert in 1982 and 1983, respectively).

Geographic Affinities

Shorebirds using the Intermountain West come from diverse breeding and wintering areas. Among species numerous or widespread in the region in spring, the Snowy Plover, Killdeer, Black-necked Stilt, American Avocet, Willet, Spotted Sandpiper, Long-billed Curlew, Wilson's Snipe, and Wilson's Phalarope breed extensively there, sometimes concentrating at particular wetlands before dispersing more widely to breeding sites. Many others, such as the Western and Least sandpipers and Long-billed Dowitcher, use the area's wetlands as a migratory stopover en route to breeding areas in the western arctic or, in the case of the Marbled Godwit, the northern prairies. Numerous species in the Intermountain West in fall are primarily temperate and arctic breeders using these wetlands en route to northern or bicontinental wintering areas (Table 1). Notable exceptions are the Wilson's and Red-necked phalaropes; the former is a temperate breeder and southern winterer, the latter an arctic breeder that winters primarily offshore south of the Tropic of Cancer. Of the 20 most numerous species (summed maxima >1000), 12 are intermediate-distance migrants, 7 are short-distance migrants, and the Baird's Sandpiper is a long-distance migrant (classification of Skagen and Knopf 1993). These authors noted that large shorebirds and shorter-distance migrants dominate in the Intermountain West, small shorebirds and long-distance migrants in the Great Plains.

Sites of Importance

The Western Hemisphere Shorebird Reserve Network (WHSRN) identifies sites of importance to shorebirds in North America via criteria for three categories: 500,000 shorebirds annually and/or 30% of a species' flyway population (hemispheric), 100,000 and/or 15% (international), and 20,000 and/or 5% (regional). Applying these criteria can be difficult because few guidelines are available for interpreting data, census data often are short-term and do not reveal turnover rates, and data on the size of populations of most species by flyway are limited. Still, three WHSRN sites have been designated in the Intermountain West: Great Salt Lake (hemispheric), Lahontan Valley (hemispheric), and Mono Lake (international) (Harrington and Perry 1995). Many deserving sites have yet to be designated. Largely on

the basis of Pacific Flyway Project data, Harrington and Perry (1995) concluded the Salton Sea qualifies as a site of international importance, Summer Lake, Lake Abert, and Honey Lake as sites of regional importance. Warnock et al. (1998) evaluated Summer Lake, Lake Abert, and Goose Lake, and the WHSRN classification of these sites varied according to the authors' underlying, untested, assumptions.

We found >20,000 shorebirds on a single survey at seven sites not already designated by the WHSRN: Harney Basin, Summer Lake, and Lake Abert, Oregon; Goose Lake and Klamath Basin, Oregon/California; Humboldt WMA/Sink, Nevada; and Salton Sea, California (Appendixes 1a–e, 2a–d). Of these, Lake Abert and Salton Sea had median counts of >20,000 shorebirds, and the Salton Sea had single-day counts of >100,000 in both spring and fall. Solely on the basis of single-day counts, six of these qualify as WHSRN sites of regional importance, the Salton Sea as a site of international importance. The other 29 sites we identified that held >1000 shorebirds do not meet WHSRN criteria, but their importance still should be recognized at some level. Although some other sites in the Intermountain West may have >1000 shorebirds, we suspect these are few and used by such numbers only irregularly. Most large wetlands in the region derive their water from snowmelt from the large mountain ranges—Sierra Nevada, Cascades, Wasatch—at the rim of the Great Basin (Engilis and Reid 1997), where we focused our efforts.

Assessing which wetlands hold high proportions of populations of migratory shorebirds highlights these sites' importance and the species that rely on them particularly. In at least one season Great Salt Lake held >30% of the populations of the American Avocet, Black-necked Stilt, dowitchers, and Marbled Godwit and >5% for the Long-billed Curlew and small sandpipers (mostly Western and Least). Our data are inadequate to reveal the proportion of the populations of phalaropes passing through Great Salt Lake, but this number is likely high. Great Salt Lake was the only wetland that consistently held thousands of Marbled Godwits. Peak counts at Bear River Migratory Bird Refuge (unpubl. data; 7- to 10-day survey intervals, 1992–2000) ranged from 7820 to 35,500 (median 16,913) in fall and from 150 to 26,858 (median 6000) in spring. The Salton Sea held >30% of the populations of the Black-necked Stilt, dowitchers, Long-billed Curlew, Whimbrel, Willet, and small sandpipers and >5% of those of the American Avocet and Marbled Godwit. The Lahontan Valley held >30% of dowitchers, >15% of small sandpipers, and >5% of American Avocets and Long-billed Curlews. Humboldt WMA/Sink held >15% of dowitchers, and Harney Basin, Summer Lake, Lake Abert, Warner Valley, Klamath Basin, Goose Lake, the Alkali Lakes, Lake Lowell, Ruby Valley, Mono Lake, and Lancaster sewage ponds each held >5% of the population of at least one species. Of intermountain wetlands, Great Salt Lake, Lake Abert, and Mono Lake are the most important sites for the Wilson's Phalarope (Jehl 1988).

Beyond their value to particular species, certain sites may be of greater importance than others to particular age or sex classes (see Jehl 1988 for Wilson's Phalarope). Also, regional movements of avocets among sites in the western Great Basin emphasize wetland connectivity and suggest that

complexes of wetlands are of more value than the sum of their parts (Plissner et al. 2000).

WHSRN criteria are based on a "staging paradigm," emphasizing sites hosting large numbers of migratory birds (Robinson and Warnock 1997). Thus sites critical to breeding or wintering birds, supporting species that do not concentrate in large numbers, or are important irregularly during climatic extremes may be overlooked. Relatively numerous yet widely dispersed species in the Intermountain West not likely to be conserved solely by the protection of a few sites are the Snowy Plover, Killdeer, Semipalmated Plover, Greater and Lesser yellowlegs, Willet, Spotted Sandpiper, Long-billed Curlew, and Wilson's Snipe.

Threats to Shorebird Habitats

The greatest threat to shorebird habitat in the Intermountain West is the scarcity of high-quality fresh water (Engilis and Reed 1997, Oring et al. 2000). Water diversions for agricultural and urban uses have greatly reduced the region's historic wetlands, and future demands will increase to meet the needs of an expanding human population. Water diversions also lead to effluent from agriculture or mining entering wetlands, which can degrade water quality by concentrating salts, trace minerals, and nutrients, potentially affecting shorebirds or their prey. Contaminants are of concern at many sites (e.g., Lahontan Valley, Salton Sea), but more needs to be known about their effects on shorebirds. Other known or potential risks facing shorebirds are urban encroachment, human-induced increases in predation rates, harvest of brine shrimp, degradation of breeding habitat from grazing, and agricultural practices that concentrate breeding shorebirds, leaving them vulnerable to predation and being killed by hay-cutting machinery (Reed et al. 1997, Oring et al. 2000).

The future for shorebirds in the Intermountain West is uncertain. Jehl (1994) assessed how changes at eight saline and alkaline lakes in western North America may have affected their ability to support breeding and migratory birds. Of these, Winnemucca Lake, Nevada, has been lost and Owens Lake, California, is seriously degraded. Jehl concluded that Great Salt Lake, Pyramid Lake, and Mono Lake are the only ones likely to remain largely unchanged in their future ability to support current populations of migratory birds. Great Salt Lake, though, is the most modified of all the large salt lakes, and current proposals to create a large freshwater impoundment in the lake, if implemented, could have major effects on the productivity of the south arm. Great concern has recently been expressed about the health of the Salton Sea ecosystem because of potential harm from increasing salinity, mass mortality from diseases and unknown causes, and contaminants (Shuford et al. 2002). Projected increases in salinity there within one to two decades could convert the ecosystem to one dominated by brine shrimp and brine flies. Such a change likely would favor salt-adapted species, such as phalaropes and avocets, but its overall effect on shorebirds is unknown. Proposals to divert additional water flowing to Lake Abert to create marshland and increase irrigation, if implemented, may have a significant adverse effect if diversions exceed 4400 acre-feet/year (Keister

1992). Recent events have begun to reverse decades of wetland degradation in the Lahontan Valley (Neel in Oring et al. 2000). Legislation in 1990 that enabled the purchase of water rights is expected to increase wetland habitat and reduce salinities and concentrations of trace elements if water is managed properly; concerns for mercury contamination are not likely to be mitigated. At Owens Lake, there is cautious optimism as Los Angeles seeks to comply with regulations by pumping ground water to inundate portions of the lakebed to reduce dust storms (Prather in Oring et al. 2000). Although shallow flooding during pilot projects has attracted shorebirds, there is concern over the possible effect of pumping on ground-water levels and spring flow; plans to plant saltgrass (*Distichlis* spp.) may ultimately reduce the amount of water needed for dust abatement.

There is also concern for shorebirds at many of the region's freshwater wetlands. A 1995 federal solicitor's opinion on the Klamath (reclamation) Project increases water priority for endangered species and lowers it for Lower Klamath NWR (USBR 1998). Severe effects are expected, particularly from reduction of the refuge's water supplies in summer and fall; the refuge also suffers from excessive nutrients from agricultural runoff (D. Mauser pers. comm). The spread of perennial pepperweed (*Lepidium latifolium*) on the refuge is reducing the suitability of upland nesting habitat for curlews and Willets and replacing low-growing saltgrass on islands used by nesting stilts and avocets.

The greatest challenge for shorebird conservation in the Intermountain West is to stem the tide of wetland loss. Though the rate of loss in the conterminous United States has slowed substantially, net annual loss from 1985 to 1995 still averaged 47,370 ha (Dahl et al. 1997). Even if these trends are halted or reversed, existing wetlands will need to be managed more intensively to provide for shorebirds. Wetland restoration and enhancement projects will likely be most successful if they restore or at least mimic natural hydrologic function and if wetlands are replaced with ecologic equivalents at the scale of a landscape rather than an individual project (Bedford 1996). Hence, we caution that lost playa lakes not be replaced solely with freshwater ponds.

The U.S. Shorebird Conservation Plan (Brown et al. 2001) shows promise for shorebird conservation by conducting sound research and monitoring, integrating shorebird needs into multispecies management strategies, and increasing public awareness of wetlands and shorebirds. Although the national framework is crucial, its application in the Intermountain West will require local implementation of the regional plan via partnerships with government agencies, nonprofit organizations, and private landowners (Oring et al. 2000). Long-term success will hinge on creative and energetic pursuit of the plan's goals and priorities, particularly via habitat acquisition, protection, and enhancement.

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Appendix 1a Numbers of Shorebirds[a] at Sites in Washington, Idaho, and Utah Holding at Least 1000 Individuals on at Least One Survey in Fall[b]

	Washington		Idaho			Utah	
Species	Othello sewage ponds (5)	Walla Walla R. delta (5)	Lake Lowell (3)	American Falls (6)	Great Salt Lake (7)[c]	Fish Springs (2)	Utah Lake (1)
Black-bellied Plover	0	0	4 (0–4)	1 (0–3)	28 (3–210)	20 (0–20)	0
Snowy Plover	0	0	0	0	221 (58–627)	21 (5–37)	0
Semipalmated Plover	2 (0–2)	2 (0–3)	12 (0–12)	4 (0–13)	2 (0–25)	10 (0–10)	3
Killdeer	30 (17–83)	25 (2–25)	200 (56–855)	238 (95–739)	166 (133–651)	45 (11–79)	555
Black-necked Stilt	8 (0–58)	12 (0–12)	47 (0–47)	18 (0–109)	53520 (2904–65570)	246 (0–246)	400
American Avocet	15 (7–42)	8 (0–13)	30 (27–106)	324 (21–2246)	220272 (25785–252358)	12 (10–15)	56
Greater Yellowlegs	8 (1–11)	2 (0–5)	8 (0–8)	18 (3–122)	47 (3–107)	22 (0–22)	0
Lesser Yellowlegs	34 (8–183)	5 (0–28)	16 (0–16)	184 (12–705)	78 (5–232)	53 (0–53)	10
yellowlegs spp.	42 (10–192)	6 (0–33)	24 (0–24)	210 (18–827)	322 (158–496)	38 (22–53)	10
Solitary Sandpiper	1 (0–1)	4 (0–6)	0	4 (0–6)	3 (0–10)	3 (0–3)	3
Willet	0	0	0	9 (0–30)	94 (3–162)	1 (0–1)	0
Spotted Sandpiper	3 (2–13)	2 (0–2)	21 (0–37)	12 (2–44)	22 (7–52)	10 (0–10)	6
Whimbrel	0	0	0	0	0 (0–1)	0	0
Long-billed Curlew	0	0	1 (0–1)	2 (0–2)	5 (0–8)	0	0
Marbled Godwit	0	1 (0–1)	4 (0–5)	35 (0–144)	13647 (113–16315)	1 (0–1)	0
Ruddy Turnstone	0	0	0	0	0 (0–1)	0	0
Red Knot	0	0	0	0	0 (0–4)	0	0
Sanderling	0	2 (0–2)	0	13 (0–18)	0 (0–92)	5 (0–5)	0
Semipalmated Sandpiper	1 (0–1)	3 (0–3)	2 (0–3)	3 (0–15)	4 (0–5)	0	0
Western Sandpiper	56 (2–593)	285 (110–2750)	2050 (1572–11200)	952 (218–2181)	522 (75–3942)	1168 (154–2181)	320
Least Sandpiper	40 (5–53)	40 (0–55)	8 (1–74)	19 (2–51)	6 (3–710)	24 (12–35)	1
Baird's Sandpiper	4 (0–30)	10 (0–15)	62 (0–88)	112 (22–263)	24 (3–206)	3 (0–3)	0
Pectoral Sandpiper	5 (0–9)	2 (0–2)	0	16 (0–18)	0 (0–5)	0	0
Dunlin	0	0	2 (0–2)	0	0	0	0

rn/Least/							
ılin	97 (7–837)	285 (135–2805)	9746 (2051–11210)	984 (220–2217)	11855 (817–21447)	1191 (189–2193)	321
andpiper	1 (0–1)	1 (0–1)	0	6 (0–6)	0 (0–2)	0	0
ther spp.	17 (4–141)	28 (27–45)	66 (0–66)	183 (0–752)	30032 (3510–31940)	18 (0–18)	0
ı's Snipe	7 (0–7)	3 (0–3)	1 (0–1)	2 (0–3)	0 (0–2)	2 (2–2)	0
ı's Phalarope	15 (0–38)	0	14 (0–14)	21 (10–324)	7220 (45–41664)	120 (2–238)	0
ecked							
larope	70 (11–557)	22 (0–43)	18 (0–34)	11 (0–103)	119 (0–3550)	0	0
ope spp.	119 (11–595)	22 (0–43)	26 (0–48)	32 (16–427)	57740 (575–66062)	120 (2–238)	0
species	0	1 (0-1)[d]	0	2 (0–2)[e]	1 (0–1)[f]	0	0
shorebirds	348 (139–1425)	314 (238–2886)	11027 (2181–11457)	3114 (491–5780)	387953 (55125–435743)	1588 (269–2906)	1354
er of taxa	17	20	19	24	28	19	9

essed as median and (minimum–maximum).

ber of surveys per site listed in parentheses.

ero median based on two censuses, minimum–maximum on seven censuses (see Methods).

(*Philomachus pugnax*).

onian Godwit (*Limosa haemastica*).

r Golden-Plover (*Pluvialis dominica/P. fulva*).

Appendix 1b Numbers of Shorebirds[a] at Sites in Oregon Holding at Least 1000 Individuals on at Least One Survey in Fall[b]

Species	Harney Basin (6)	Summer Lake (6)	Lake Abert (6)	Warner Valley (6)
Black-bellied Plover *Pluvialis squatarola*	1 (0–7)	4 (0–4)	2 (0–2)	0
Snowy Plover *Charadrius alexandrinus*	14 (0–25)	8 (0–29)	20 (7–99)	0
Semipalmated Plover *C. semipalmatus*	3 (0–15)	25 (0–59)	5 (0–9)	25 (0–25)
Killdeer *C. vociferus*	922 (171–1828)	48 (4–219)	69 (42–148)	122 (27–831)
Black-necked Stilt *Himantopus himantopus*	1353 (1–2436)	353 (163–1546)	49 (0–473)	97 (0–166)
American Avocet *Recurvirostra americana*	1026 (683–2482)	8064 (580–15917)	6684 (1051–34819)	755 (0–2040)
Greater Yellowlegs *Tringa melanoleuca*	38 (2–65)	20 (0–74)	2 (0–3)	6 (0–6)
Lesser Yellowlegs *T. flavipes*	67 (1–197)	17 (2–80)	6 (0–8)	5 (0–9)
yellowlegs spp.	127 (8–254)	44 (23–154)	10 (2–319)	10 (0–124)
Solitary Sandpiper *T. solitaria*	4 (0–4)	2 (0–2)	1 (0–1)	0
Willet *Catoptrophorus semipalmatus*	15 (1–162)	7 (0–12)	4 (0–13)	16 (0–20)
Spotted Sandpiper *Actitis macularia*	23 (0–153)	5 (0–16)	18 (0–22)	24 (0–107)
Whimbrel *Numenius phaeopus*	0	0	0	0
Long-billed Curlew *N. americanus*	28 (1–169)	9 (0–17)	2 (0–7)	21 (0–30)
Marbled Godwit *Limosa fedoa*	9 (0–23)	4 (0–9)	4 (0–6)	20 (0–20)
Ruddy Turnstone *Arenaria interpres*	1 (0–1)	1 (0–1)	4 (0–4)	0
Red Knot *Calidris canutus*	0	0	0	0
Sanderling *C. alba*	9 (0–132)	0	24 (0–39)	6 (0–6)
Semipalmated Sandpiper *C. pusilla*	0	0	0	0
Western Sandpiper *C. mauri*	1790 (1065–8329)	58 (0–6482)	4945 (0–6080)	252 (0–1666)
Least Sandpiper *C. minutilla*	316 (197–815)	78 (2–1464)	320 (0–479)	229 (0–4124)
Baird's Sandpiper *C. bairdii*	14 (0–95)	4 (0–21)	4 (0–6)	6 (0–6)
Pectoral Sandpiper *C. melanotos*	1 (0–46)	8 (0–10)	1 (0–1)	0
Dunlin *C. alpina*	3 (0–3)	25 (0–25)	0	12 (0–12)
Western/Least/Dunlin	3709 (1639–8937)	5276 (3673–7946)	6626 (1385–19313)	501 (16–5802)

Stilt Sandpiper *C. himantopus*	2 (0–2)	0	0	0
dowitcher spp.				
Limnodromus griseus/scolopaceus	2305 (555–5258)	1157 (89–2154)	73 (0–163)	567 (0–625)
Wilson's Snipe *Gallinago delicata*	2 (0–15)	2 (0–4)	1 (0–1)	29 (0–52)
Wilson's Phalarope *Phalaropus tricolor*	430 (0–1739)	190 (2–654)	1918 (0–2500)	65 (0–1260)
Red-necked Phalarope *P. lobatus*	275 (0–996)	64 (20–220)	6590 (0–15630)	256 (0–459)
phalarope spp.	850 (11–1975)	458 (253–680)	12140 (4050–27600)	524 (0–1312)
Other species	0	0	1 (0–1)[c]	0
Total shorebirds	10706 (4611–19980)	16274 (9366–25378)	36399 (6844–75818)	2180 (60–8609)
Number of taxa	24	23	24	19

[a]Expressed as median and (minimum–maximum).

[b]Number of surveys per site listed in parentheses.

[c]Wandering Tattler (*Heteroscelus incanus*).

Appendix 1c Numbers of Shorebirds[a] at Sites in Northern California Holding at Least 1000 Individuals on at Least One Survey in Fall[b]

Species	Butte Valley WA (6)	Klamath Basin (6)	Goose Lake (5)	Modoc NWR (6)
Black-bellied Plover	0	3 (0–4)	5 (0–10)	0
Snowy Plover	0	2 (0–2)	38 (0–43)	0
Semipalmated Plover	5 (0–6)	2 (0–24)	25 (0–40)	2 (0–4)
Killdeer	33 (0–103)	146 (84–221)	96 (2–299)	73 (46–165)
Black-necked Stilt	26 (0–197)	373 (37–645)	127 (22–358)	53 (0–210)
American Avocet	55 (0–296)	74 (4–768)	3473 (1081–10310)	11 (0–41)
Greater Yellowlegs	5 (0–41)	18 (3–33)	5 (0–7)	24 (0–29)
Lesser Yellowlegs	3 (0–17)	2 (0–11)	6 (0–7)	4 (0–68)
yellowlegs spp.	8 (0–44)	22 (3–37)	11 (0–14)	24 (7–97)
Solitary Sandpiper	1 (0–1)	0	0	2 (0–2)
Willet	1 (0–1)	6 (0–12)	33 (1–115)	2 (0–3)
Spotted Sandpiper	2 (0–2)	6 (0–20)	11 (0–54)	4 (0–8)
Whimbrel	0	0	0	0
Long-billed Curlew	0	34 (0–36)	48 (0–95)	1 (0–1)
Marbled Godwit	3 (0–3)	1 (0–1)	14 (0–52)	2 (0–2)
Ruddy Turnstone	0	0	2 (0–2)	0
Red Knot	0	0	2 (0–2)	0
Sanderling	0	0	2 (0–2)	0
Semipalmated Sandpiper	0	0	1 (0–1)	0
Western Sandpiper	24 (0–1246)	176 (30–641)	5621 (0–16853)	53 (0–185)
Least Sandpiper	92 (0–196)	68 (14–157)	894 (0–1480)	15 (0–119)
Baird's Sandpiper	2 (0–2)	4 (0–5)	27 (0–36)	0
Pectoral Sandpiper	0	3 (0–3)	0	0
Dunlin	0	0	0	0
Western/Least/Dunlin	276 (4–1442)	282 (60–798)	6515 (1006–18333)	65 (0–304)
Stilt Sandpiper	0	0	0	0
dowitcher spp.	25 (0–256)	633 (20–978)	131 (0–326)	331 (136–1675)
Wilson's Snipe	0	1 (0–3)	4 (0–4)	32 (0–64)
Wilson's Phalarope	10 (0–34)	44 (1–283)	14 (0–453)	9 (1–254)
Red-necked Phalarope	11 (0–11)	110 (0–159)	263 (0–506)	0
phalarope spp.	11 (0–34)	103 (41–345)	45 (2–959)	9 (1–254)
Total shorebirds	452 (30–2277)	2021 (325–2622)	17065 (2198–23399)	614 (294–1907)
Number of taxa	16	19	23	16

[a]Expressed as median and (minimum–maximum).

[b]Number of surveys per site listed in parentheses.

Lyneta Ranch (4)	Alkali Lakes (1)	Honey Lake (6)	Bridgeport Res. (5)
3 (0–3)	0	1 (0–1)	1 (0–1)
0	28	5 (0–8)	4 (0–4)
0	0	8 (0–8)	2 (0–7)
22 (4–42)	140	224 (23–462)	85 (50–554)
82 (1–337)	9	232 (5–504)	9 (0–69)
45 (0–63)	4607	200 (76–994)	140 (42–310)
8 (0–42)	0	10 (1–44)	18 (13–29)
51 (0–83)	0	5 (0–16)	2 (0–52)
27 (0–125)	0	14 (1–44)	20 (13–81)
2 (0–2)	0	2 (0–2)	2 (0–2)
0	1	2 (0–9)	3 (0–5)
0	0	6 (0–13)	4 (0–15)
0	0	0	0
0	0	2 (0–7)	1 (0–1)
0	0	8 (0–41)	5 (0–8)
0	0	0	0
0	0	1 (0–1)	0
0	0	19 (0–19)	1 (0–1)
0	0	1 (0–1)	1 (0–1)
25 (4–100)	45	66 (11–154)	150 (21–547)
36 (1–52)	0	108 (6–522)	196 (22–790)
0	0	7 (0–7)	6 (0–10)
2 (0–2)	0	0	0
0	0	9 (0–9)	0
52 (26–150)	229	220 (53–626)	346 (43–1038)
0	0	0	1 (0–1)
485 (0–558)	50	158 (24–284)	87 (9–247)
2 (0–8)	0	6 (0–7)	4 (0–10)
164 (0–217)	0	67 (8–363)	15 (5–756)
82 (0–155)	0	46 (6–1686)	61 (10–264)
172 (0–372)	5	124 (47–1711)	73 (15–941)
615 (85–1577)	5069	1570 (415–3203)	1603 (224–2006)
14	8	24	23

Appendix 1d Numbers of Shorebirds[a] at Sites in Central and Southern California Holding at Least 1000 Individuals on at Least One Survey in Fall[b]

Species	Mono Lake (7)	Crowley Lake (6)	Owens Lake (7)
Black-bellied Plover	8 (0–50)	2 (0–2)	0
Snowy Plover	49 (7–216)	4 (0–7)	4 (1–17)
Semipalmated Plover	12 (0–30)	1 (0–14)	4 (1–10)
Killdeer	66 (30–202)	255 (0–420)	51 (7–72)
Black-necked Stilt	36 (0–133)	39 (0–108)	13 (3–31)
American Avocet	7652 (2191–10999)	67 (0–173)	467 (236–1007)
Greater Yellowlegs	4 (1–16)	8 (0–38)	10 (1–22)
Lesser Yellowlegs	9 (1–15)	4 (0–6)	5 (0–10)
yellowlegs spp.	13 (2–31)	8 (0–43)	11 (6–27)
Solitary Sandpiper	2 (0–4)	2 (0–2)	3 (0–13)
Willet	11 (4–35)	8 (0–16)	2 (0–6)
Spotted Sandpiper	34 (0–53)	3 (0–11)	5 (0–10)
Whimbrel	0	1 (0–1)	0
Long-billed Curlew	19 (1–43)	1 (0–1)	11 (7–17)
Marbled Godwit	5 (1–124)	2 (0–16)	3 (0–12)
Ruddy Turnstone	2 (0–2)	0	1 (0–1)
Red Knot	3 (0–4)	0	0
Sanderling	3 (0–6)	0	1 (0–1)
Semipalmated Sandpiper	1 (0–1)	0	3 (0–3)
Western Sandpiper	810 (272–4043)	129 (0–206)	846 (38–2717)
Least Sandpiper	305 (24–1408)	162 (0–1288)	485 (250–728)
Baird's Sandpiper	19 (2–31)	4 (0–4)	6 (0–8)
Pectoral Sandpiper	2 (0–2)	0	2 (0–2)
Dunlin	6 (0–12)	0	10 (0–10)
Western/Least/ Dunlin	1069 (514–5451)	368 (0–1450)	2042 (810–3445)
Stilt Sandpiper	0	0	0
dowitcher spp.	27 (4–46)	27 (0–148)	23 (9–87)
Wilson's Snipe	2 (0–7)	11 (0–14)	8 (0–12)
Wilson's Phalarope	5478 (552–46792)	28 (1–961)	14 (0–245)
Red-necked Phalarope	7296 (75–19000)	10 (0–14)	57 (7–131)
phalarope spp.	21520 (6591–46872)	30 (1–975)	133 (57–287)
Other species	4 (0–5)[d]	0	0
Total shorebirds	31432 (13091-50916)	907 (7-1963)	2811 (1314-4225)
Number of taxa	28	21	24

[a]Expressed as median and (minimum–maximum).

[b]The following sites in southern California that held at least 1000 shorebirds in spring did not do so in fall: Tinnemaha Res. (6 counts, 994 maximum), Lancaster sewage ponds (4, 463), Harper Dry Lake (4, 446), Lake Elsinore (1, 322). Number of surveys per site listed in parentheses.

[c]Nonzero median based on four censuses, minimum–maximum on seven censuses (see Methods).

[d]Mountain Plover (*Charadrius montanus*) and Red Phalarope (*Phalaropus fulicarius*).

[e]Mountain Plover, Wandering Tattler (*Heteroscelus incanus*), and Black Turnstone (*Arenaria melanocephala*).

Edwards AFB sewage ponds (2)	Piute Ponds (7)	San Jacinto WA (5)	Salton Sea (7)[c]
1 (1–1)	1 (0-1)	0	202 (98–478)
6 (6–6)	2 (0–3)	6 (0–6)	114 (72–389)
2 (1–4)	3 (1–5)	8 (0–14)	78 (38–131)
11 (2–20)	19 (3–31)	35 (9–134)	421 (132–777)
52 (4–100)	65 (6–214)	90 (39–315)	8861 (2341–19255)
45 (30–60)	365 (100–785)	220 (55–250)	15333 (4291–19382)
5 (2–8)	10 (0–22)	32 (0–61)	46 (39–122)
5 (2–8)	4 (0–32)	8 (0–9)	36 (0–157)
10 (10–10)	14 (1–54)	35 (0–70)	77 (41–230)
0	1 (0–3)	0	0
1 (0–1)	2 (0–3)	0	937 (52–1147)
4 (0–4)	2 (0–8)	2 (0–3)	26 (7–82)
0	0	2 (0–2)	59 (0–116)
0	1 (0–3)	5 (0–8)	1900 (243–7476)
3 (2–4)	18 (0–31)	0	1568 (371–3190)
0	0	0	4 (0–29)
0	0	0	22 (0–22)
0	0	0	70 (0–70)
0	1 (0–1)	1 (0–1)	0
425 (200–650)	160 (55–1080)	62 (27–340)	35307 (9336–54374)
110 (40–180)	70 (40–135)	232 (12–815)	2355 (422–4149)
9 (8–10)	2 (0–10)	7 (0–10)	6 (0–23)
0	0	0	0
0	0	0	8 (0–14)
535 (240–830)	240 (108–1215)	325 (74–984)	39166 (10490–54797)
0	0	1 (0–1)	48 (0–85)
26 (0–26)	125 (76–628)	569 (15–805)	10012 (5939–15566)
0	2 (0–2)	1 (0–1)	0
14 (6–22)	18 (0–100)	18 (0–65)	1674 (664–7577)
175 (100–250)	67 (0–170)	1 (0–1)	2744 (150–12265)
189 (106–272)	33 (0–225)	18 (0–65)	6540 (1192–13083)
0	0	0	1 (0–5)[e]
879 (511-1247)	1048 (622-2237)	1406 (345-2163)	88267 (43635-105570)
17	21	19	26

Appendix 1e Numbers of Shorebirds[a] at Sites in Nevada Holding at Least 1000 Individuals on at Least One Survey in Fall[b]

Species	Long Valley (2)	Continental Lake (2)	Sleeper Mine (3)	Pyramid Lake (3)
Black-bellied Plover	0	0	0	0
Snowy Plover	0	0	6 (0–6)	6 (0–8)
Semipalmated Plover	0	0	0	3 (3–12)
Killdeer	0	2 (0–2)	11 (8–18)	20 (14–25)
Black-necked Stilt	0	2 (0–2)	84 (10–94)	5 (0–5)
American Avocet	784 (55–1514)	20 (13–26)	26 (17–125)	1 (0–1)
Greater Yellowlegs	0	0	2 (0–2)	0
Lesser Yellowlegs	0	0	2 (0–3)	0
yellowlegs spp.	0	0	3 (0–3)	0
Solitary Sandpiper	0	0	0	1 (0–1)
Willet	0	0	0	0
Spotted Sandpiper	0	0	6 (3–10)	3 (0–3)
Whimbrel	0	0	0	0
Long-billed Curlew	0	0	11 (0–21)	4 (0–4)
Marbled Godwit	0	0	4 (0–8)	2 (0–2)
Sanderling	0	0	0	2 (0–2)
Semipalmated Sandpiper	0	0	0	0
Western Sandpiper	0	0	164 (0–237)	108 (90–1200)
Least Sandpiper	0	0	27 (14–52)	40 (18–400)
Baird's Sandpiper	0	0	11 (0–11)	3 (0–4)
Pectoral Sandpiper	0	0	0	1 (0–1)
Dunlin	0	0	0	0
Western/Least/Dunlin	0	1380 (0–1380)	119 (49–289)	148 (108–1600)
Stilt Sandpiper	0	0	0	0
dowitcher spp.	0	25 (0–25)	254 (36–570)	2 (1–2)
Wilson's Snipe	0	0	2 (0–2)	0
Wilson's Phalarope	0	0	25 (18–119)	4 (0–4)
Red-necked Phalarope	0	0	39 (39–346)	0
phalarope spp.	0	58 (2–115)	58 (57–465)	4 (0–4)
Total shorebirds	784 (55–1514)	782 (17–1548)	815 (270–1280)	203 (129–1647)
Number of taxa	1	6	16	16

[a]Expressed as median and (minimum–maximum).

[b]Number of surveys per site listed in parentheses.

Humboldt WMA (2)	Lahontan Valley (7)	Ruby Valley (5)	Key Pitman WMA (4)	Henderson sewage ponds (5)
0	1 (0–5)	0	0	1 (0–1)
4	13 (0–28)	0	0	2 (0–3)
0	6 (0–34)	4 (0–4)	2 (0–2)	2 (0–5)
100	93 (20–244)	54 (34–145)	45 (25–80)	40 (30–122)
235	960 (394–5814)	23 (4–446)	25 (0–70)	85 (30–173)
2355 (500–4210)	5826 (845–23711)	47 (7–504)	8 (1–16)	78 (0–161)
0	19 (0–47)	0	11 (0–16)	3 (2–9)
0	12 (1–101)	8 (0–15)	4 (0–7)	12 (0–32)
0	66 (32–280)	10 (1–18)	12 (0–23)	16 (2–35)
2	1 (0–3)	0	1 (1–16)	1 (0–1)
0	3 (0–17)	10 (4–35)	2 (0–2)	1 (0–1)
0	8 (2–15)	14 (0–35)	22 (17–29)	6 (0–7)
0	1 (0–1)	0	0	0
0	56 (0–195)	15 (0–21)	1 (0–1)	0
385	106 (44–226)	4 (0–4)	1 (0–1)	1 (0–1)
2	0	0	0	0
0	2 (0–2)	0	0	1 (0–1)
3267	996 (304–2080)	70 (0–70)	42 (21–2262)	12 (0–669)
363	221 (60–1551)	0	11 (0–18)	41 (0–170)
0	2 (0–8)	0	0	2 (0–2)
0	2 (0–5)	0	0	0
0	1 (0–23)	0	0	0
3630	2397 (412–13245)	93 (15–300)	54 (35–2280)	67 (9–839)
0	0	0	2 (0–2)	0
15000	13204 (4541–28906)	46 (0–72)	24 (0–24)	19 (9–56)
2	6 (0–8)	23 (0–135)	1 (0–1)	0
130	396 (2–2876)	288 (0–616)	55 (0–273)	220 (120–250)
40	1001 (216–2897)	23 (0–23)	0	29 (0–29)
170	1569 (1104–4532)	50 (23–616)	55 (0–273)	225 (120–250)
12120 (500–23740)	25753 (10193–72452)	724 (245–2036)	226 (83–2757)	516 (256–1633)
13	23	14	17	19

Appendix 2a Numbers of Shorebirds[a] at Sites in Oregon and Utah Holding at Least 1000 Individuals on at Least One Survey in Spring[b]

	Oregon				Utah
Species	Harney Basin (6)	Summer Lake (6)	Lake Abert (6)	Warner Valley (6)	Great Salt Lake (5)[c]
Black-bellied Plover	4 (1–22)	11(0–36)	0	0	1752 (32–1752)
Snowy Plover	8 (4–107)	4 (2–22)	43 (0–114)	2 (0–2)	110 (98–414)
Semipalmated Plover	7 (0–73)	56 (4–78)	29 (0–34)	12 (0–12)	0 (0–35)
Killdeer	148 (73–223)	21 (6–35)	16 (0–49)	41 (27–118)	90 (90–252)
Black-necked Stilt	268 (31–1660)	62 (19–232)	10 (0–21)	31 (0–37)	4334 (2651–34567)
American Avocet	1243 (192–3368)	1195 (426–2794)	1120 (320–1670)	254 (65–1012)	35462 (7439–39681)
Greater Yellowlegs	7 (0–11)	7 (0–11)	0	12 (0–15)	0 (0–338)
Lesser Yellowlegs	17 (0–71)	2 (0–2)	0	0	9 (9–1281)
yellowlegs spp.	19 (7–80)	6 (0–13)	2 (0–3)	15 (0–19)	826 (73–1885)
Solitary Sandpiper	1 (0–1)	0	0	0	8 (0–8)
Willet	451 (166–782)	214 (39–465)	52 (22–85)	154 (69–232)	2636 (393–2636)
Spotted Sandpiper	16 (0–24)	3 (0–9)	2 (0–2)	10 (0–11)	1 (0–35)
Whimbrel	0	0	0	0	0
Long-billed Curlew	20 (7–32)	18 (5–44)	12 (4–46)	34 (9–443)	38 (38–196)
Marbled Godwit	30 (0–59)	8 (0–86)	0	6 (0–6)	11292 (1889–15302)
Ruddy Turnstone	1 (0–1)	0	0	0	0
Sanderling	1 (0–1)	0	6 (0–6)	0	329 (0–329)
Western Sandpiper	1106 (177–9908)	1602 (0–4056)	113 (0–129)	59 (0–220)	1372 (132–5047)
Least Sandpiper	665 (62–2592)	298 (0–5125)	280 (0–515)	36 (0–1020)	0 (0–168)
Baird's Sandpiper	10 (1–37)	3 (0–3)	0	0	5 (5–88)
Pectoral Sandpiper	9 (0–9)	0	0	0	0
Dunlin	146 (0–220)	345 (0–1053)	199 (0–200)	22 (0–53)	1 (0–2)
Western/Least/Dunlin	3864 (480–12720)	3827 (1265–8806)	1284 (113–11030)	241 (28–1293)	3964 (251–5151)

dowitcher spp.	1244 (318–3140)	164 (86–695)	49 (0–70)	26 (0–64)	7024 (852–7024)
Wilson's Snipe	0	2 (0–2)	0	6 (0–7)	0 (0–7)
Wilson's Phalarope	31 (0–216)	7 (0–17)	5 (0–36)	3 (0–3)	126 (22–505)
Red-necked Phalarope	3 (0–3)	0	0	0	0 (0–21)
phalarope spp.	31 (0–216)	7 (0–17)	20 (0–135)	3 (0–3)	126 (22–505)
Total shorebirds	7135 (2948–20889)	5849 (2114–12791)	2138 (1151–12867)	830 (263–3104)	67997 (16142–101923)
Number of taxa	23	19	15	16	22

[a]Expressed as median and (minimum–maximum).

[b]The following sites in Washington, Utah, and Idaho that held at least 1000 shorebirds in fall did not do so in spring. Washington: Othello sewage ponds (5 surveys, max. count 268), Walla Walla River delta (4, 93); Utah: Fish Springs NWR (1, 851); Idaho: Lake Lowell (1, 70), American Falls Res. (5, 333). Number of surveys per site listed in parentheses.

[c]Nonzero median based on one census, minimum–maximum on five censuses (see Methods).

Appendix 2b Numbers of Shorebirds[a] at Sites in Northern California Holding at Least 1000 Individuals on at Least One Survey in Spring[b]

Species	Butte Valley WA (5)	Klamath Basin (6)	Goose Lake (5)	Lyneta Ranch (4)
Black-bellied Plover	5 (0–8)	76 (2–238)	42 (4–241)	2 (0–8)
Snowy Plover	0	1 (0–1)	34 (16–42)	0
Semipalmated Plover	12 (0–22)	20 (5–80)	35 (2–79)	10 (0–20)
Killdeer	6 (2–8)	30 (22–60)	8 (6–76)	18 (14–32)
Black-necked Stilt	4 (1–9)	588 (325–971)	17 (0–68)	32 (14–58)
American Avocet	279 (49–411)	726 (447–1447)	584 (288–2170)	82 (32–166)
Greater Yellowlegs	3 (1–12)	33 (13–49)	2 (0–2)	10 (1–83)
Lesser Yellowlegs	6 (0–8)	6 (1–12)	0	6 (0–9)
yellowlegs spp.	15 (3–98)	40 (14–65)	2 (0–2)	13 (4–89)
Solitary Sandpiper	0	0	0	0
Willet	30 (10–191)	65 (31–90)	322 (198–676)	32 (20–53)
Spotted Sandpiper	0	4 (0–8)	7 (0–7)	2 (0–2)
Whimbrel	0	0	0	0
Long-billed Curlew	0	14 (0–21)	4 (3–58)	16 (0–16)
Marbled Godwit	3 (0–3)	38 (0–121)	52 (0-153)	95 (0–95)
Red Knot	0	0	2 (0–2)	0
Sanderling	0	0	1 (0–1)	0
Western Sandpiper	637 (0–637)	532 (146–12765)	2271 (778–14605)	64 (21–2354)
Least Sandpiper	76 (0–76)	830 (532–8564)	1233 (72–5111)	51 (8–1820)
Baird's Sandpiper	0	0	4 (1–16)	0
Dunlin	45 (0–45)	1046 (73–2454)	581 (57–1567)	24 (1–112)
Western/Least/ Dunlin	290 (10–2000)	3844 (1478–23783)	6773 (3008–17729)	139 (30–4286)
dowitcher spp.	14 (0–42)	522 (129–2326)	91 (22–511)	589 (0–1143)
Wilson's Snipe	0	4 (0–7)	9 (0–16)	2 (0–2)
Wilson's Phalarope	0	12 (2–24)	7 (2–57)	3 (0–28)
Red-necked Phalarope	230 (0–230)	35 (0–35)	1 (0–1)	0
phalarope spp.	230 (0–230)	13 (2–55)	8 (2–57)	3 (0–28)
Total shorebirds	858 (199–2630)	6616 (2906–28367)	8799 (4806–19190)	746 (269–5674)
Number of taxa	14	18	21	17

[a]Expressed as median and (minimum–maximum).

[b]The following sites in northern California that held at least 1000 shorebirds in fall did not do so in spring: Modoc NWR (5 counts, 561 maximum) and Bridgeport Res. (3, 901). Number of surveys per site listed in parentheses.

Alkali Lakes (6)	Honey Lake (6)	Mono Lake (7)	Crowley Lake (4)
4 (0–16)	26 (2–208)	11 (0–49)	2 (0–2)
19 (9–46)	13 (0–31)	81 (23–135)	2 (0–20)
23 (3–97)	20 (0–179)	159 (70–286)	36 (7–60)
13 (5–29)	48 (10–100)	64 (23–97)	58 (30–124)
7 (0–46)	88 (3–192)	14 (0–82)	7 (0–17)
1124 (38–2464)	556 (334–3318)	425 (15–1564)	82 (17–124)
2 (0–2)	6 (2–19)	4 (0–10)	2 (0–2)
8 (0–8)	1 (0–1)	1 (0–1)	1 (0–1)
2 (0–10)	6 (2–20)	3 (1–10)	2 (0–3)
0	0	1 (0–1)	0
278 (114–602)	116 (58–144)	6 (0–50)	14 (0–32)
1 (0–1)	1 (0–3)	4 (1–209)	115 (0–115)
0	0	2 (0–4)	9 (0–9)
6 (0–8)	8 (0–20)	2 (0–2)	0
44 (0–79)	20 (0–89)	28 (0–36)	1 (0–1)
4 (0–4)	1 (0–1)	3 (0–3)	11 (0–11)
1 (0–1)	0	14 (0–14)	1 (0–1)
1200 (36–2714)	104 (11–2613)	4939 (1570–19107)	614 (255–850)
386 (72-1539)	526 (79–3475)	1178 (148–4810)	186 (28–750)
1(0–10)	2 (0–3)	3(0–3)	0
56 (2–297)	16 (3–643)	313 (88–725)	59 (2–90)
2975 (422–7745)	2330 (684–13709)	6723 (2007–24347)	758 (538–1640)
146 (1–612)	110 (26–818)	22 (8–297)	19 (12–640)
4 (0–11)	1 (0–15)	5 (3–22)	14 (0–14)
10 (0–264)	2 (0–55)	61 (7–1341)	8 (2–514)
9 (0–10)	15 (0–18)	64 (0–227)	573 (0–573)
26 (0–264)	19 (0–70)	190 (7–1568)	8 (2–1087)
4748 (1618–10288)	4071 (1551–17884)	7792 (2683–25616)	1573 (1054–2271)
21	21	24	21

Appendix 2c Numbers of Shorebirds[a] at Sites in Southern California Holding at Least 1000 Individuals on at Least One Survey in Spring[b]

Species name	Tinnemaha Res. (6)	Owens Lake (7)	Lancaster sewage ponds (3)	Piute Ponds (6)
Black-bellied Plover	2 (0–3)	2 (0–3)	1 (0–1)	42 (0–42)
Snowy Plover	2 (0–2)	6 (0–30)	1 (0–1)	2 (0–3)
Semipalmated Plover	32 (0–42)	7 (0–81)	2 (0–2)	23 (3–40)
Killdeer	1 (0–4)	3 (0–6)	0	5 (3–8)
Black-necked Stilt	11 (0–18)	5 (0–45)	5 (1–55)	124 (55–452)
American Avocet	38 (1–124)	668 (442–918)	15 (0–15)	242 (163–500)
Greater Yellowlegs	1 (0–1)	4 (0–10)	0	3 (1–15)
Lesser Yellowlegs	8 (0–12)	2 (0–2)	0	2 (0–5)
yellowlegs spp.	5 (0–12)	4 (0–11)	0	6 (1–16)
Solitary Sandpiper	3 (0–3)	2 (0–3)	0	1 (0–1)
Willet	2 (0–6)	2 (0–4)	0	1 (0–2)
Spotted Sandpiper	1 (0–1)	3 (0–3)	2 (0–2)	3 (0–6)
Whimbrel	0	6 (0–6)	868 (160–1300)	20 (0–60)
Long-billed Curlew	2 (0–2)	2 (0–3)	4 (2–8)	2 (0–2)
Marbled Godwit	0	1 (0–1)	0	3 (0–7)
Ruddy Turnstone	0	0	0	0
Red Knot	0	0	0	1 (0–1)
Sanderling	0	0	0	1 (0–1)
Western Sandpiper	209 (0–610)	396 (76–3317)	100 (55–360)	3755 (1960–12323)
Least Sandpiper	172 (0–434)	824 (273–1649)	22 (0–35)	180 (77–800)
Dunlin	3 (0–11)	2 (1–6)	6 (0–6)	100 (41–300)
Western/Least/Dunlin	483 (0–744)	2904 (901–7525)	106 (90–370)	4322 (2171–12441)
Stilt Sandpiper	0	0	0	0
dowitcher spp.	41 (0–60)	29 (11–74)	0	580 (167–1125)
Wilson's Snipe	1 (0–1)	1 (0–3)	0	2 (0–2)
Wilson's Phalarope	24 (0–46)	8 (0–31)	0	3 (0–20)
Red-necked Phalarope	2 (0–3)	7 (0–14)	0	116 (0–125)
phalarope spp.	2 (0–49)	8 (2–34)	0	20 (0–127)
Other species	0	0	0	1 (0–1)[d]
Total shorebirds	360 (7–1048)	3601 (1505–8497)	1303 (290–1397)	5320 (3096–14429)
Number of taxa	19	21	11	24

[a]Expressed as median and (minimum–maximum).

[b]The following site in southern California that held at least 1000 shorebirds in fall did not do so in spring: Edwards AFB sewage ponds (3 counts, maximum 901). Number of surveys per site listed in parentheses.

[c]Nonzero median based on four censuses, minimum–maximum on seven censuses (see Methods).

[d]Ruff (*Philomachus pugnax*).

[e]Pacific Golden-Plover (*Pluvialis fulva*), Black Turnstone (*Arenaria melanocephala*), Surfbird (*Aphriza virgata*), Curlew Sandpiper (*Calidris ferruginea*), and Red Phalarope (*Phalaropus fulicarius*). See Howell and Pyle (1997) for details of Curlew Sandpiper at Whitewater River mouth, Salton Sea, 16–26 April 1994.

Piute Ponds (6)	Harper Dry Lake (7)	San Jacinto WA (4)	Lake Elsinore (1)	Salton Sea (7)[c]
42 (0–42)	2 (0–3)	1 (0–1)	0	376 (147–579)
2 (0–3)	20 (0–30)	0	0	220 (72–312)
23 (3–40)	12 (0–16)	10 (0–12)	4	545 (105–811)
5 (3–8)	16 (10–53)	22 (6–41)	18	163 (130–717)
124 (55–452)	28 (14–100)	193 (59–315)	144	3149 (1171–10467)
242 (163–500)	86 (18–210)	152 (65–366)	192	6489 (3111–14356)
3 (1–15)	3 (0–7)	5 (0–21)	3	27 (9–102)
2 (0–5)	1 (0–3)	1 (0–1)	0	5 (0–28)
6 (1–16)	2 (0–8)	4 (3–21)	3	42 (11–102)
1 (0–1)	1 (0–1)	0	0	0
1 (0–2)	97 (0–97)	0	3	202 (17–337)
3 (0–6)	1 (0–7)	1 (0–1)	0	7 (4–17)
20 (0–60)	3 (0–10)	98 (0–300)	0	7860 (0–9837)
2 (0–2)	1 (0–1)	17 (0–17)	0	41 (0–102)
3 (0–7)	0	0	8	754 (73–3170)
0	0	0	0	32 (7–46)
1 (0–1)	0	0	0	366 (37–502)
1 (0–1)	0	0	0	135 (0–265)
3755 (1960–12323)	650 (40–1200)	1200 (141–1928)	216	48334 (24474–67343)
180 (77–800)	225 (16–620)	430 (0–825)	47	1684 (197–3476)
100 (41–300)	4 (0–392)	7 (0–13)	12	132 (0–2258)
4322 (2171–12441)	805 (58–1828)	1260 (176–2747)	275	50148 (25555–73077)
0	0	1 (0–1)	0	22 (0–35)
580 (167–1125)	37 (3–170)	809 (380–2154)	580	13366 (8993–26443)
2 (0–2)	3 (1–15)	1 (0–1)	0	3 (0–7)
3 (0–20)	6 (0–19)	1 (0–1)	0	234 (0–416)
116 (0–125)	1 (0–2)	0	0	428 (0–1816)
20 (0–127)	6 (0–19)	1 (0–1)	0	802 (0–1899)
1 (0–1)[d]	0	0	0	6 (0–10)[e]
5320 (3096–14429)	1028 (163–2114)	2374 (1146–5771)	1227	83532 (52559–129538)
24	20	17	11	28

Appendix 2d Numbers of Shorebirds[a] at Sites in Nevada Holding at Least 1000 Individuals on at Least One Survey in Spring[b]

Species	Continental Lake (2)	Humboldt WMA (3)	Lahontan Valley (7)	Ruby Valley (5)
Black-bellied Plover	0	0	166 (0–323)	2 (0–2)
Snowy Plover	6 (0–6)	14 (0–28)	8 (0–62)	0
Semipalmated Plover	6 (0–6)	27 (0–27)	97 (20–658)	0
Killdeer	6 (0–6)	2 (0–2)	18 (5–99)	38 (10–65)
Black-necked Stilt	0	16 (11–152)	286 (156–1261)	24 (12–69)
American Avocet	1554 (519–2588)	180 (69–1754)	4190 (355–12459)	166 (23–1249)
Greater Yellowlegs	0	4 (0–4)	27 (0–48)	7 (0–9)
Lesser Yellowlegs	0	0	2 (1–7)	0
yellowlegs spp.	0	4 (0–4)	28 (3–55)	8 (0–13)
Solitary Sandpiper	0	0	1 (0–1)	0
Willet	26 (12–41)	2 (0–2)	7 (3–15)	43 (38–54)
Spotted Sandpiper	0	0	4 (0–10)	8 (2–44)
Long-billed Curlew	4 (4–5)	0	31 (7–54)	37 (4–50)
Marbled Godwit	71 (0–71)	8 (0–8)	255 (2–518)	5 (0–5)
Sanderling	0	0	1 (0–1)	0
Western Sandpiper	20 (0–20)	2534 (0–5000)	4349 (1949–18002)	0
Least Sandpiper	31 (0–31)	220 (0–255)	1532 (294–22722)	80 (0–125)
Baird's Sandpiper	0	4 (0–6)	0	0
Pectoral Sandpiper	0	1 (0–1)	2 (0–2)	0
Dunlin	0	96 (0–123)	2755 (161–11794)	5 (0–5)
Western/Least/Dunlin	28 (5–51)	323 (115–5378)	23388 (2702–68658)	66 (0–210)
dowitcher spp.	0	498 (0–920)	13944 (2666–39153)	19 (7–213)
Wilson's Snipe	0	0	4 (0–4)	17 (0–30)
Wilson's Phalarope	0	8 (0–8)	84 (2–300)	24 (7–39)
Red-necked Phalarope	0	10 (0–10)	10 (0–30)	0
phalarope spp.	0	9 (0–10)	124 (2–299)	24 (7–39)
Total shorebirds	1657 (547–2767)	411 (398–8285)	42576 (10576–112185)	628 (295–1585)
Number of taxa	9	16	21	14

[a]Expressed as median and (minimum–maximum).

[b]The following sites in Nevada that held at least 1000 shorebirds in fall did not do so in spring: Sleeper Mine wetland (1 count, maximum 355), Pyramid Lake (3, 264), Franklin Lake (5, 332), Key Pitman WMA (3, 29), Henderson sewage ponds (5, 583), Long Valley (1,529). Number of surveys per site listed in parentheses.

Appendix 3. Sites surveyed for shorebirds not included in Appendixes 1a–e and 2a–d. Sites listed alphabetically by state, county, and within counties. Number of counts at each season and maximum count listed in parentheses (fall, spring; maximum with season indicated: F, fall; S, spring).

Averaged >100 shorebirds for at least two counts in a single season or >850 shorebirds on one count in a single season

Arizona

Cochise: Wilcox Playa area (1, 4; 371S).
La Paz: Cibola NWR (1, 3; 259S).
La Paz and Yuma (part Imperial Co., Calif.): Imperial NWR (3, 3; 258F).
Mohave: Havasu NWR (4, 4; 210F).

California

Imperial and Riverside: Palo Verde Valley agricultural fields (3, 2; 298F).
Kern: China Lake sewage ponds (6, 7; 971F), Lake Isabella (6, 4; 389F).
Lassen: Madeline Plains (0, 3; 132S), Willow Creek Wildlife Area (WA) (4, 5; 952S).
Modoc: Clear Lake (2, 1; 431F).
Plumas and Sierra: Sierra Valley (5, 6; 552S).
Shasta: Fall River Valley (0, 2; 525S).

Idaho

Ada: Indian Creek Reservoir (1, 2; 219F).

Nevada

Clark: Overton WMA/Lake Mead NRA (4, 5; 460S).
Elko: Blue Lakes (3, 3; 633F), Dake Reservoir (1, 3; 193S), Jake's Creek Reservoir (2, 2; 291F), Jiggs Reservoir (3, 2; 511F), Snow Water Lake (0, 2; 744S), South Forks Reservoir (2, 3; 550S).
Humboldt: Summit Lake (0, 2; 488S).
Humboldt and Washoe: Sheldon NWR (1, 1; 983F).
Lincoln: Pahranagat NWR (4, 3; 621F).
Nye: Ash Meadows NWR (3, 3; 230F).
Lyon: Mason Valley (5, 5; 760S)
Washoe: Gridley Lake (2, 2; 777S), Massacre Lake (2, 2; 511S), Lemmon Valley (4, 4; 638F), Washoe Lake wetlands (2, 3; 229F).

Washington

Adam and Grant: Columbia NWR (5, 5; 577F).
Benton: Yakima River delta (4, 1; 539F).
Grant: Crab Creek/Hwy 26 Saline Ponds (5, 5; 467F), Potholes Reservoir area (4, 1; 206F), Soap Lake (2, 1; 241F).
Lincoln Co.: Reardon Ponds, (2, 0; 346F).

Averaged <100 shorebirds for at least two counts or had <2 counts in any season

Arizona

Cochise: San Bernardino NWR (0, 1; 1S).
Pima: Buenos Aires NWR (0, 2; 43S).

California

Lassen: Dillon Lake (0, 1; 19S), Said Valley Res. (0, 2; 33S), Silva Flat Res. (0, 2; 69S).
Lassen and Modoc: Ash Creek WA (5, 6; 104S).
Modoc: Big Sage Res. (0, 1; 13S), Donovan Res. (2, 1; 83F), Jesse Valley marshes (0, 1; 13S), Mud Lake (0, 1; 6S), West Valley Res. (0, 1; 32S).
Mono: alkali ponds N of Crowley L. (1, 1; 450S), Hot Creek Gorge (0, 1; 9S), June

Lake sewage ponds (0, 1; 9S), Little Hot Creek (0, 1; 12S), Topaz Lake (0, 1; 23S).
Plumas: pastures northwest shore Lake Almanor (0, 1; 319S).
San Bernardino: East Cronese Dry Lake (1, 0; 756F).

Idaho

Ada: Blacks Creek Res. (1, 1; 124F), Hubbard Res. (0, 1; 25S).
Bingham, Bonneville, and Caribou: Grays Lake NWR (0, 1; 10S).
Bonneville: flooded field W of Idaho Falls (1, 0; 54F).
Camas: Camas Prairie Centennial Marsh WMA (0, 1; 18S), Mormon Res. (0, 1; 14S).
Canyon: Boise River Rd. SW of Notus (1, 1; 79F), Dry Lakes nr. Nampa (2, 1; 85F), Fort Boise WMA (1, 1; 65S), Gem State Academy sewage ponds (0, 1; 17S), Wilson Drainage Pond (0, 1; 76S).
Clearwater: Tolo Lake (0, 1; 9S).
Elmore: Little Camas Res. (0, 1; 23S), Mt. Home Res. (1, 2; 133S).
Franklin: Oxford Slough (0, 1; 48S).
Jefferson: Market Lake (1, 0; 291F), Mud Lake WMA (0, 1; 17S).
Nez Pierce: Clearwater River (1, 0; 21F), Mann Lake (5, 5; 243F).
Owyhee: Bruneau Sand Dunes State Park (0, 1; 26S).
Power: Minidoka NWR (0, 1; 24S).

Nevada

Clark: Glendale Pond (2, 2; 16F), Las Vegas sewage ponds (0, 1; 20S), Logendale (Bowman) Res. (5, 3; 108F).
Douglas: Mud Lake (1, 2; 79S), Settelmeyer Ranches (0, 1; 340S).
Elko: Crintendon Res. (2, 1; 115F), Goshute Lake/marsh (0, 1; 53S), Mary's River (0, 1; 98S), 21 Mile Res. (0, 1; 34S), S. Fork Humboldt River SRA (1, 1; 527F), Wildhorse Res. SRA (2, 0; 179F), Wilson Res. SRA (1, 0; 170F).
Eureka: Diamond Valley (Playa Wells) (1, 0; 22F).
Humboldt: Deer Creek Res. (0, 1; 74S), Hog John Slough at Quinn Lakes (1, 0; 149F), Mud Meadow Res.(1, 1; 47F), Soldier Meadows (0, 1; 1S).
Lyon: Artesia Lake (1, 1; 254S), Wabuska Marshes (1, 2; 60F).
Pershing and Washoe: Winnemucca Lake (0, 1; 46S).
Washoe: Cold Springs Playa (1, 1; 66S), Crooks/New Years Lake (1, 0; 1F), Duck Flat (1, 1; 82S), Parker Res. (0, 1; 178S), Smoke Creek Desert (1, 1; 462F).
White Pine: Bassett Lake and Slough (1, 1; 215F), Comins Lake area (0, 1; 269S), Illipah Res. (0, 2; 25S), Long Valley Slough (0, 1; 18S), Newark Valley (1, 4; 86S), Warm Springs Res. (0, 1; 28S).

Oregon

Harney: Burns sewage ponds (1, 0; 88F).
Lake: Alkali Lake (1, 0; 64F).
Malheur: Antelope Res. (1, 0; 212F), Bully Creek Res. (1, 0; 494F), Cow Lakes (1, 0; 540F), Little Valley Res. (1, 0; 89F), Malheur Res. (1, 0; 249F), Warm Springs Res. (1, 0; 47F).

Utah

Cache: The Barrens (1, 1; 237S).

Washington

Asotin: Anatone Ponds (0, 2; 5S), Savage Rd. pond (2, 1; 35F), Snake River (5, 1; 34F).
Benton: Byron Ponds, Sunnyside WA (1, 1; 106F).
Benton, Franklin, Grant, Yakima: Hanford Reach (0, 1; 47S).
Franklin: Kahlotus Lake (1, 0; 689F).
Grant: wasteways along Dodson Rd. (0, 1; 65S), Saddle Mountain NWR (1, 0; 22F).
Yakima: Priest Rapids Lake (0, 1; 7S).