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DISTRIBUTION AND ABUNDANCE OF THE SNOWY PLOVER ON ITS WESTERN NORTH AMERICAN BREEDING GROUNDS

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Abstract.—State-wide surveys between 1977 and 1980 indicated up to 10,200 breeding Snowy Plovers (*Charadrius alexandrinus*) in Washington, California, Oregon and Nevada. Recent surveys of these states (and also Utah) in 1988 and 1989 provided further information on the species' distribution and abundance and showed a possible decline in numbers. In kern North America, the Snowy Plover **breeds** at various sites on either side of the Great Basin; in the San Joaquin Valley, Mojave Desert and Salton Sea regions of California; in Arizona and New Mexico; and along the Pacific Coast from southern Washington into Mexico. Along the United States coast plovers are most numerous from San Francisco Bay south. In 1988 and 1989, the breeding population size in Washington, Oregon, California, and Nevada was estimated to be about 7900 birds, and in Utah **about** 1700. **Most** plovers (about 7700) were at interior sites, **some** (about 1900) were coastal. The estimated population size in 1988–1989 for Washington, California, Oregon and Nevada was about 20% lower than for 1977-1980. Numbers have declined on the Oregon coast since 1979. Several interior sites also had fewer birds in 1988-1989. Often these declines were associated with changes in habitat availability. Since 1978 plover numbers in the San Joaquin Valley have increased sharply at newly constructed agricultural waste water ponds. No surveys have been made in Mexico, Idaho, Arizona, or New Mexico.

DISTRIBUCIÓN Y ABUNDANCIA DE ***CHARADRIUS ALEXANDRINUS EN*** LAS **ÁREAS REPRODUCTIVAS** DE LA PARTE OCCIDENTAL DE **NORTE** AMÉRICA

Sinopsis.—Un estudio que se llevó a cabo entre 1977 y 1980, a lo largo de varios estados, permitió estimar el número de playeros (*Charadrius alexandrinus*) en Washington, California, Oregón y Nevada, en unos 10,200 individuos. Un **trabajo** más reciente (1988 y 1989) en estos estados (incluyendo a Utah) proveyó información adicional sobre la distribución y abundancia de la especie y mostró una posible reducción en el número de aves. En la parte occidental de Norte América, el pájaro se reproduce en varias localidades a ambos lados de la Gran Cuenca; en regiones del Valle de San Joaquin, Desierto de Mojave y Salton Sea en California; en Arizona y Nuevo México; y a lo largo de la costa del Pacífico desde Washington hasta México. A lo largo de la costa **de** los Estados Unidos, estos playeros son más numerosos desde la Bahia de San Francisco hacia el sur de ésta. En 1988 y 1989 el tamaño de la población reproductiva en Washington, Oregon, California y Nevada fue estimada en unos 7900 aves y la de Utah en 1700. La mayoria de los playeros fueron encontrados en localidades del interior (cerca de 7700) mientras que un grupo pequeño (cerca **de** 1900) habit6 lugares costaneros. El estimado poblacional en 1988-1989 para los estados mencionados (excluyendo a Utah) fue 20% menor que el estimado entre 1977-1980. En las costas de Oregón las aves se han ido reduciendo en números desde el 1979. Entre 1988–1989 algunas Iocalidades del interior tambiin mostraron una reducción en el número

de individuos. La merma poblacional se asoció comunmente a cambios en la disponibilidad de habitat. Desde el 1978 el número de playeros en el Valle de San Joaquin ha aumentado dristicamente en áreas en donde se han construido fosas de sedimentación de origen agrícola. No se han hecho estudios similares en México, Idaho, Arizona y Nuevo México.

The Snowy Plover nests on coastal sandy beaches, at salt evaporation ponds and on the margins of alkaline lakes and ponds in western North America (American Ornithologists' Union 1983, Herman et al. 1988, Page and Stenzel 1981). By the 1980s it had disappeared from many former breeding sites along the coast (Page and Stenzel 1981). Growing recreational use and urban development are damaging and destroying much of the remaining coastal breeding habitat.

Detailed knowledge of distribution and abundance is fundamental for protection of every threatened species. Base-line surveys for nesting Snowy Plovers in Washington, Oregon, Nevada and California between 1977 and 1980 (Herman et al. 1988, Page and Stenzel 1981, Widrig 1980, Wilson- Jacobs and Meslow 1984) provided the first population size estimate of about 10,000 birds breeding in the region (Page et al. 1986). Surveys continued in Oregon through the 1980s, but no further surveys were undertaken in Nevada until 1987, nor in California until 1988 and 1989. In 1988 and 1989 all these states and Utah were surveyed by a consortium of organizations and agencies. Small breeding populations were surveyed on the Washington coast in the 1980s, but no effort was made to cover the Washington interior. No survey data are available from Arizona, New Mexico, Idaho or Mexico. In this paper, we use all available surveys and other reports (from American Birds) to update knowledge of the species' breeding distribution and abundance in western North America.

METHODS

Survey methods varied from state to state. Suitable habitat was traversed by observers on foot, but at some locations in Nevada and Utah in 1988 observers rode on slow-moving all-terrain vehicles. Survey dates varied from site to site from 1 May to 29 July. More than two people seldom covered most California sites, whereas groups of up to 14 people covered interior sites in other states. The lengths of most coastal beaches were searched on foot by one or two people. In the interior, searches were concentrated around water, as dry playa sometimes extended several kilometers in all directions and was too extensive to cover completely. Observers attempted to determine the sex of each plover only in California. Juveniles were distinguished from adults except in Oregon.

We measured our ability to detect plovers on three California beaches by recording color-banded birds on surveys. At Point Reyes and on Monterey Bay, where most plovers were banded, someone not on the survey team checked frequently for plovers several weeks before and after the survey; thus, we knew how many birds should have been present on the survey dates. At Morro Bay two counts conducted over a 3-d period gave an estimate of the expected number of marked birds; the second count

was used as the survey. For each area we then estimated the detection rate for each sex.

We used detection rates to extrapolate numbers of the breeding population from survey totals. For the coast, we used the average of three 1989 detection rates for both sexes to extrapolate a population for California and Oregon combined as $100/D \times S$, where D is the detection rate and S is the number of plovers on the survey. We added 20 additional birds as a best guess for Washington. Based on Mono Lake data, Page et al. (1986) estimated the size of the interior plover population as 2.4N, where $T = N/3.010 + 1.4N/1.643$, T is the number of plovers tallied on surveys, N is the size of the female population, and 1.4N the size of the male population. The assumptions used in the equation are that detection rates for males (61%) and females (33%) at Mono Lake are representative for interior sites and that the overall male to female ratio of the population is 1.4: 1.

Sightings reported in American Birds regional reports are cited in the text as AB volume:page.

RESULTS

On the coast Snowy Plovers nest from southern Washington to Mexico (American Ornithologists' Union 1983) with largest numbers occurring from San Francisco Bay south (Fig. 1). Many plovers probably breed in Mexico where no surveys have been undertaken. Inland in western North America the Snowy Plover breeds on the western side of the Great Basin, from southern Oregon to central California, and into the Mojave and Colorado deserts (Fig. 1). Fewer sites have been found on the eastern side of the Basin in Utah. Several hundred plovers nest at agricultural waste water ponds in California's San Joaquin Valley. Small numbers have been recorded nesting in Arizona (Davis and Russell 1984, Monson and Phillips 1981). In New Mexico, where no surveys have been undertaken, five playas on the east side of the Rocky Mountains probably support hundreds of breeding plovers (J. Hubbard and S. 0. Williams, III, pers. comm.).

Coast.-Small numbers of Snowy Plovers nest at two locations on the Washington coast. At Damon Point, Grays Harbor, up to 8 pairs bred between 1979 and 1989 (AB 33:891, 34:808, 35:854, 36:1009, 37:1020, 38:949, 38:1054; Anthony 1987; E. Cummins, pers. comm.). At Leadbetter Point, Willapa Bay, 10 pairs were recorded in 1978, 5 pairs in 1979 and 1980, 10–11 pairs in 1981 and 1982, 7-12 pairs from 1985 to 1987, and 4 pairs in 1988 and 1989 (AB 35:854, 36:1009; Widrig 1980; J. Atkinson, pers. comm.).

Summer surveys on the Oregon coast over 12 yr tallied 46-139 adult-sized plovers (Table 1). Numbers declined from 1978 to 1989 (Spearman Rank Correlation, $r = 0.65$, df = 10, $P = 0.022$). The Heceta Head to Cape Blanco regions of the southern Oregon coast consistently held at least 65% of the birds (Table 1).

Counts of Snowy Plovers on the California coast in 1989 totaled only

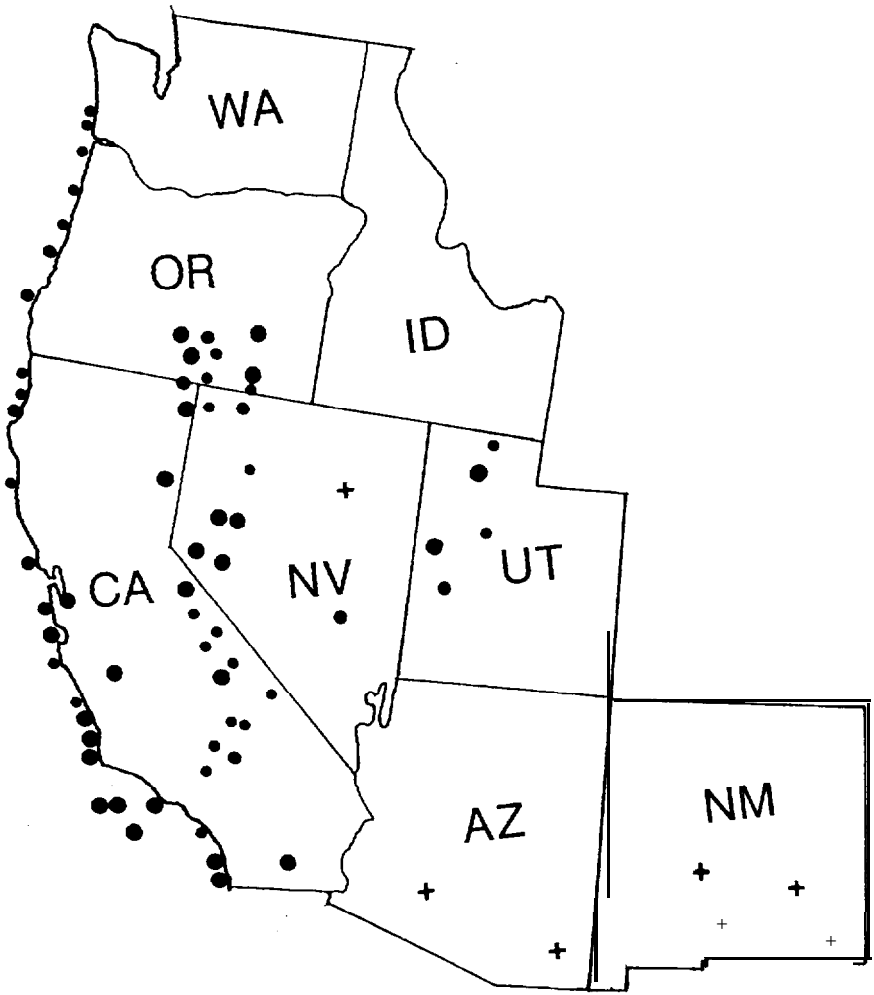

FIGURE 1. Map of documented breeding locations of Snowy Plovers in the western United States. Largest numbers recorded for each region are shown by three sizes of dots following Page et al. (1986): smallest 1-27 birds, medium 28-81 birds and largest 82 or more birds. A plus sign indicates a known breeding area that has not been surveyed.

89% of the comparable counts in 1977-1980 (Table 2); few data are available for the interim. Numbers in 1989 were notably lower at Humboldt Bay (49% of the 1977-1980 totals), Mendocino County (13%), San Francisco Bay (64%), San Miguel Island (43%), San Nicolas Island (68%), northern San Diego County (45%) and San Diego Bay area (59%). Numbers were higher at Morro Bay (149%), Callendar to Mussel Rock Dunes (273%), Oxnard Lowland (129%) and Santa Rosa Island (212%).

TABLE 1. Numbers of adult-sized Snowy Plovers on the Oregon coast.

Region	1978[1]	1979[1]	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Columbia River to Tillamook Head	4	4	2	11	10	16	1	—	0	0	0	0
Nehalem Bay to Cascade Head	26	10	15	15	13	2	14	7	3	8	10	12
Cascade Head to Heceta Head	2	3	5	0	o	-	0	o	-	0	0	0
Heceta Head to Cape Arago	32	60	37	86	48	20	18	25	43	41	31	27
Cape Arago to Cape Blanco	29	23	21	27	7	14	13	16	27	12	12	19
Cape Blanco to California border	0	0	0	0	0	0	0	0	0	0	0	0
Total	93	100	80	139	78	52	46	48	73	61	53	58

[1] From Wilson- Jacobs and Meslow 1984

In 1984 C. Swarth counted 270 adult plovers in South San Francisco Bay during a May-June survey (Point Reyes Bird Observatory, unpubl. data); this count is consistent with a decline from 1978 to 1989. National Park Service surveys of San Miguel Island tallied 68 adult plovers in May 1987, 65 in June 1987 and 60 in May 1988; we found only 36 adults in June 1989. On the two California surveys 92-95% of the plovers were located from San Francisco Bay south.

Interior.-Since 1986 numbers in the Oregon interior have been 53–81% of the 1980 total (Table 3), but the disappearance of birds from Harney Lake Basin due to inundation of most nesting habitat (Herman et al. 1988) is largely responsible for the difference. Other sites showed year-to-year variation in numbers but no consistent decrease since 1980.

Counts in western Nevada in 1988 totalled only 71% as many birds as in 1980 despite a net increase in the number of areas surveyed (Table 4). Lower 1988 numbers in the Lahonton Valley, in the Fernley Sink and at Artesia Lake may have been due to much drier conditions, resulting in a decreased amount of suitable feeding habitat. (Feeding Snowy Plovers at inland sites usually concentrate at areas of shallow saline water.) In 1987 the 650 adult-sized Snowy Plovers counted in the Lahonton Valley (AB 41:1468) were comparable to the 671 in 1980 but nearly twice the number in 1988, possibly because of reduced amounts of shallow water feeding habitat in 1988. Less than 0.5% of the Artesia Lake playa was moist or held shallow standing water in 1988 and there were only 54% of the number of plovers as in 1980 when the playa was 60% flooded (Herman et al. 1988). The larger number of plovers at Walker Lake in 1988 was likely due to low lake levels and the concomitant increase in suitable nesting habitat, which is limited at higher lake levels by surrounding vegetation. Although eastern Nevada has not been systematically surveyed, about 40 plovers were recorded in the Diamond Valley, Eureka County, on 22 June 1980 (Alcorn 1988) and 37 in the Railroad Valley Wildlife Management Area in 1988 (Table 4).

The total for the California interior in 1988 was 95% of that in 1978 (Table 5). Lower numbers at the Salton Sea (88% of the 1978 total), Koehn Lake (42%), Owens Lake (39%), Mono Lake (89%), Honey Lake

TABLE 2. Numbers of adult Snowy Plovers on the California coast in 1977-1980 and in 1989.

Region	1977–1980[1]			1989		
	Males	Females	Total	Males	Females	Total
N Del Norte Co	4	6	11	5	2	8
N Humboldt Co	4	8	13	6	6	12
Humboldt Bay area	19	18	41	10	10	20
Mendocino Co	7	8	15	1	1	2
Bodega & Pt Reyes area	17	13	40	25	9	34
San Francisco Bay	102	89	351	114	94	226
San Mateo & N Sta Cruz Co	11	12	29	18	9	27
Monterey Bay	19	22	146	90	56	146
Pt Sur area	0	2	3	2	2	4
N San Luis Obispo Co	0	0	0	4	3	7
Morro Bay area	24	27	80	72	47	119
Callendar-Mussel Rck Dns	12	20	45	65	54	123
Pt Sal-Pt Conception	31	39	119	70	44	116
Oxnard Lowland	64	39	136	117	54	175
Santa Rosa Island		—	43	55	33	91
San Miguel Island			84	19	14	36
San Nicolas Island		—	133	49	35	90
Orange County	8	8	19	14	5	21
N San Diego County	34	21	160	44	24	72
San Diego Bay area	33	30	97	32	21	57
Total	389	362	1565	812	523	1386

[1] From Page and Stenzel 1981.

(75%) and Goose Lake (12%) were almost completely offset by the 138% increase at the Alkali Lakes and the 8033% increase in the San Joaquin Valley. A decrease in suitable nesting habitat due to high water levels was the probable reason for the lower 1988 numbers at the Salton Sea and Goose Lake, and no water other than a saturated brine solution for the lower numbers at Searles Lake. More complete coverage in 1988 found more birds at the Alkali Lakes but fewer at Honey Lake (Table 5). In 1988 in the San Joaquin Valley, Snowy Plovers nested around 2870 ha of agricultural waste-water evaporation ponds; however, only 230 ha of evaporators had been created by 1978 (J. Skorupa, pers. comm.). The 230 ha of evaporators, not surveyed in 1978, probably held fewer than 50 plovers, based on data from 1987 to 1989 (J. Skorupa, pers. comm.). At least 126 adult-sized plovers were using the evaporators by 1982 (Ivey 1984). The 1988 total for the San Joaquin Valley was probably low relative to other areas because the counts from some evaporators were obtained during multi-species surveys. Intensive surveys by J. Skorupa, D. Barnum and colleagues solely for plovers in 1989 found 189 adults at six evaporators on which only 9 1 had been recorded in 1988. Barnum and Skorupa (in litt.) believe plover numbers there had been quite stable between 1987 and 1989, and that 339 would be a better estimate for the

TABLE 3. Numbers of adult-sized Snowy Plovers in interior Oregon.

Region	1980[1]	1985	1986	1987	1988
Harney Lake basin	436	—[2]	27	28	38
Alkali Lake	6	51	38	24	24
Summer Lake basin	193	210	236	261	213
Bluejoint Lake	0	—	—	3	3
Abert Lake	345	194	247	344	237
Alvord Lake basin	67		51	171	34
Coleman Lake	0	—		19	3
Pueblo Slough	—	—	3	—	—
Total	1047	455	602	850	552

[1] From Herman et al. 1988.
[2] Area lacked suitable habitat.

San Joaquin Valley than the 241 in Table 5, thus increasing the 1988 total for the California interior to 1843 birds, identical to the 1978 total.

In Utah in 1988, the first systematic surveys for Snowy Plovers located 487 adults in the northwestern region (Table 6). In 1989 expanded surveys, including the 1988 survey region, produced 849 adults with Great Salt Lake and Fish Springs National Wildlife Refuge holding the largest concentrations. Additional potential Snowy Plover habitat that remains unsurveyed includes the west shore of Great Salt Lake and the area of Extensive salt flats west of the lake, including the basin into which water was recently pumped from the lake. Two other possible breeding sites where Snowy Plovers were sighted in 1989 (M. Halpin, pers. comm.) are the Gandy Salt Marsh area and Clear Lake in Millard County.

In Arizona a few pairs have nested at several ponds and a former lake near Willcox in the 1970s and 1980s (AB 40:1237, 42:470; Davis and Russell 1984; Monson and Phillips 1981). The only other breeding records for the state are from Painted Rock Reservoir, Maricopa County in 1974 and in 1980, when three pairs were reported in June and many

TABLE 4. Numbers of adult-sized Snowy Plovers in Nevada.

Region	1980[1]	1988
Long Valley	5	18
Gridley Lake	—	31
Lower Pitt-Taylor Reservoir	12	—
Lahonton Valley	671	342
Fernley Sink	126	85
Artesia Lake	112	61
Walker Lake	43	117
Railroad Valley WMA	—	3 7
Total	969	691

[1] From Herman et al. 1988.

TABLE 5. Numbers of adult Snowy Plovers in the interior of California in 1978 and 1988.

Region	1978[1]			1988		
	Males	Females	Total	Males	Females	Total
Goose Lake	18	8	33	1	1	4
Alkali Lakes	80	52	358	304	62	494
Honey Lake	81	33	208	103	43	155
Mono Lake	181	139	384	223	101	342
Crowley Lake			—	5	3	8
Deep Springs Lake	6	5	13	3	1	7
Tinemaha Res	1	1	2	0	0	0
Salt Lake	0	1	1			
Owens Lake	115	81	499	112	51	195
Tecopa Marsh	4	3	7	3	4	8
San Joaquin Vly	0	2	3	134	79	241
Searles Lake	4	4	16	0	0	0
China Lake				3	3	6
Koehn Lake	10	8	26	6	3	11
Harper Lake	14	8	61	34	19	61
Rosamond Lake	4	2	6	10	4	15
Salton Sea	79	86	226	102	73	198
Total	597	433	1843	1043	447	1745

[1] From Page and Stenzel 1981.

pairs with downy young were reported in July (AB 34:919, Monson and Phillips 1981). May or June observations of one to two birds at Many Farms Lake, Apache County (AB 35:850, 38:943); near Holbrook, Navajo County (AB 35:850); and at Lees Ferry, Coconino County (AB 36:1004) suggest small numbers may breed irregularly elsewhere in the state.

Although Snowy Plovers are known to nest on the east side of the Rocky Mountains in New Mexico, systematic surveys have not been conducted there. Known breeding areas include Bitter Lake National Wildlife Refuge and vicinity including nearby Bottomless Lakes State Park, Chaves County, where over 300 have been reported during summer (AB 39:950) and nesting is recorded regularly; Laguna Grande, Eddy County, where over 50 were seen and breeding was noted on 18 May 1975; the Alamogordo-White Sands-Holloman Lakes area, Otero County, where up to 26 have been counted between May and July and flightless young have been recorded; Bosque del Apache National Wildlife Refuge, Socorro County, where up to 15 plovers including a flightless young were found on 19 July 1980 (AB 34:919); and probably Laguna del Perro, Torrance County (S. 0. Williams, III, pers. comm.).

Mexico.-Snowy Plovers are fairly common but local breeders along the Pacific coast of Baja California south at least to Laguna Ojo de Liebre and possibly San Ignacio Lagoon (Bancroft 1927; E. Palacios Castro, pers. comm.). Elsewhere in Mexico they may breed locally from Sonora to Colima. They definitely breed at Laguna Superior, Oaxaca, the southernmost known breeding location on the Pacific Slope (Binford 1989).

TABLE 6. Numbers of adult Snowy Plovers counted in Utah in 1988 and 1989.

Region	1988[1]	1989
Amalga Barrens	17	5
Great Salt Lake	444	590
Utah Valley	13	26
Fish Springs NWR	I3	174
Sevier Desert	—	54
Total	487	849

[1] From Halpin and Paul 1989.

On the Atlantic coast they breed from Tamaulipas to northern Veracruz (Coffey 1961) and along the north coast of the Yucatan Peninsula (S. N. G. Howell, pers. comm.). In the interior, they breed locally at salt flats in the central volcanic belt at least in the states of Mexico and Puebla and territorial pairs have been seen at other lakes on the Mexican plateau (S. N. G. Howell, pers. comm.).

Detection rates.-We measured our count accuracy at three California coastal sites with color-banded plovers. At Point Reyes the beach was littered with driftwood and *Vellela vellela* and we located only 67% of 18 males and 36% of 14 females known to be present (K. Wilson, pers. comm.). Beaches of Monterey and Morro bays were relatively devoid of litter at the time of our surveys. At the former we detected 91% of 68 marked males and 87% of 45 marked females; however, we counted 8 of 62 marked males and 1 of 39 females twice. We determined that 87 males and 63 females were present on Monterey Bay at the time of our survey, whereas our count, including duplicates, totalled 90 males and 56 females (Table 2). On the first of two counts at Morro Bay spit, we recorded 88% of the marked males and 78% of the females detected on either count; on the second, we detected 81% of the males and 83% of the females.

Sex ratios.-Warriner et al. (1986) reported 1.4 males per female in the Snowy Plover population. Because males were more readily detected at Mono Lake, on a typical survey 2.6 males were recorded per female. In 1988 we observed a male to female ratio of 2.2:1 at Mono Lake; however, at 11 other interior sites in California and Nevada the ratio varied from 1.4:1 (Salton Sea and Walker Lake) to 6:1 :1 (Lower Alkali Lake, California). The median rate for the 12 sites was 2.1: 1. Site-to-site variation in the sex ratio of the birds or the observers' abilities to detect each sex were responsible for the variability.

DISCUSSION

We estimated the number of breeding Snowy Plovers in 1988-1989 for Washington, Oregon, California and Nevada combined to be roughly 7900 birds. This compares to an estimate of roughly 10,200 birds in the 1977-1980 period. (The population estimate in Page et al. (1986) of 10,126 was calculated using an erroneous figure for Oregon. That error

is corrected here.) For the coast we estimated about 1900 birds in the 1988-l 989 period compared to 2300 for 1977–1980. Comparable figures for the interior are 6100 plovers for 1988-1989 and 7800 for 1977–1980. Observed and estimated numbers for these states, then, were about 20% lower in 198881989 than during the former survey period. We extrapolated an additional 1700 plovers for Utah based on the 1989 count.

The results are consistent with a decline in the population size of Snowy Plovers in the western United States and point to locations of potential concern. Yearly surveys demonstrate a decline on the Oregon coast (Table 1). Regions of potential decline on the California coast include the Humboldt Bay area, Mendocino County, San Francisco Bay, San Nicolas Island, San Miguel Island and San Diego County. Fluctuations in availability of habitat from year to year in the interior due to changing water levels make the results of two surveys more difficult to interpret for the interior than the coast. Numbers in the Harney Lake Basin declined markedly after the nesting habitat was inundated by high water (Herman et al. 1988) and have yet to recover; there is no evidence the displaced plovers colonized other areas in Oregon. However, they may have moved to other states. The difference in numbers between 1980 and 1988 in Nevada is difficult to interpret due to fluctuating water levels. In 1988, 342 plovers were counted in the Lahonton Valley (AB 41: 1468) compared to 650 in 1987, and 671 in 1980. Fewer plovers in 1988 than in 1980 in the Lahonton Valley, the Fernley Sink and Artesia Lake (Table 4) possibly reflected temporary loss of suitable habitat due to dry conditions rather than a declining population. There was no overall difference for the California interior because increased numbers at the Alkali Lakes and in the San Joaquin Valley in 1988 offset lower numbers elsewhere (Table 5). The decline in numbers at Owens Lake was substantial and may signal a problem. Otherwise, decreased numbers at California interior sites paralleled obvious changes in habitat availability (Goose and Searles lakes, and the Salton Sea), involved small groups of birds (Deep Springs and Koehn lakes), or were moderately low (Honey and Mono lakes).

Information on abundance and distribution of Snowy Plovers in western North America has improved substantially as a result of the surveys. Increased geographical coverage and coordination in timing between different regions would improve the value of future surveys. Data taken should include age and sex of birds so that surveys from each state are better comparable. Surveys are needed in Arizona, New Mexico and Mexico to complete the distributional map. Data also are needed on the movements of New Mexico and Arizona birds to determine if they ever mingle with plovers from the other western states. Birds from interior California, Nevada, Oregon and probably Utah, migrate to the coasts of California and Mexico for the winter (Page et al. 1986; G. W. Page and M. A. Stern, unpubl. data). It takes several years of surveys before any trend in population size becomes evident. Enough is now known about abundance and distribution that population monitoring could be accomplished by covering selected sites annually, augmented by less frequent,

range-wide surveys. More data on observer detection rates of birds would improve the size estimate of the breeding population.

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