DISTRIBUTION AND ABUNDANCE OF SNOWY PLOVERS WINTERING IN THE INTERIOR OF CALIFORNIA AND ADJACENT STATES

W. DAVID SHUFORD, GARY W. PAGE, and CATHERINE M. HICKEY, Point Reyes Bird Observatory, 4990 Shoreline Highway, Stinson Beach, California 94970

Since the late 1970s, broad-scale surveys for the Snowy Plover (*Charadrius alexandrinus*) have been conducted in many western states (Page and Stenzel 1981, Wilson-Jacobs and Meslow 1984, Page et al. 1986, Herman et al. 1988, Halpin and Paul 1989, Page et al. 1991). In California, surveys of the breeding population have covered the entire state (Page and Stenzel 1981, Page et al. 1991), whereas surveys of the wintering population have focused mostly on the coast (Page et al. 1986). Knowledge of the status of the species in the interior in winter is therefore fragmentary (Page et al. 1986). Here we report the migration schedule, distribution, abundance, and habitat use of Snowy Plovers wintering in the interior of California based on the first comprehensive surveys of key wintering areas in the San Joaquin Valley and the Mojave and Colorado deserts. We also summarize records of plovers from other sites where they infrequently winter in the interior of California and other western states.

METHODS

As part of Point Reyes Bird Observatory's (PRBO) Pacific Flyway Project, we organized winter surveys of all shorebirds using most open shallow-water habitats in California's Central Valley, Mojave and Colorado deserts, and southern Great Basin desert. On the basis of prior knowledge (H. Coe, R. Marsh in litt.) and our initial surveys, we determined that 19 sets of agricultural evaporation ponds (totaling about 2576 hectares) were the primary wintering area for Snowy Plovers in the southern San Joaquin Valley (Figure 1). We surveyed these ponds at least once during each of the periods 6 November–1 December 1991, 15–31 January 1992, 18–30 November 1992, 23 January–5 February 1993, 9–29 November 1993, 15 January–1 February 1994, 9–22 November 1994, and 28 January–22 February 1995. Observers drove or walked impoundment dikes and carefully scanned suitable plover habitat with binoculars and spotting scopes. Roster et al. (1992) described the physical and biological characteristics of these highly productive saline impoundments.

Our standard multi-species shorebird surveys of the Salton Sea, Riverside and Imperial counties (21–22 November 1992, 6 February 1993, 21–22 January 1994), proved inadequate to detect many of these cryptic plovers on the broad beaches of the sea's vast shoreline. Hence, from 3 to 8 December 1993 and 1 to 9 December 1994 we made thorough specific searches for plovers in all areas of the Salton Sea with suitable habitat. Once to twice per winter from November 1991 to February 1995 we also surveyed most other areas possibly important to Snowy Plovers in the San Joaquin Valley and the southern Great Basin, Mojave, and Colorado deserts

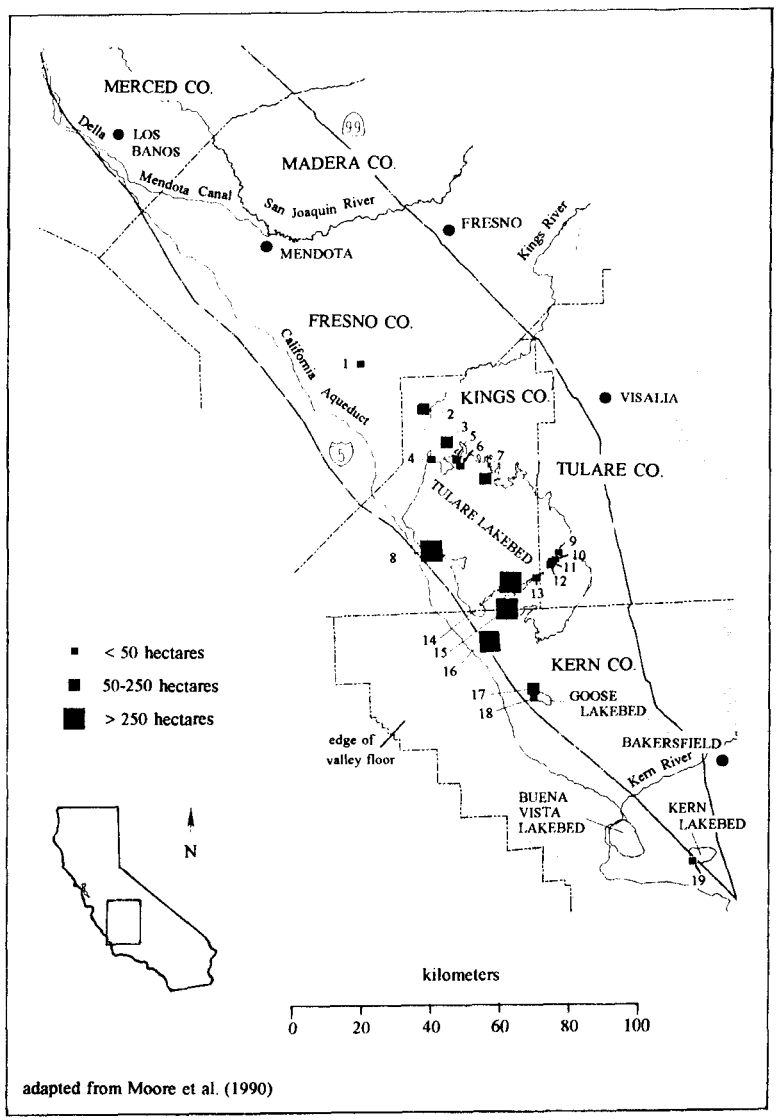

Figure 1. Agricultural evaporation ponds in the Tulare Basin of the San Joaquin Valley, California. 1, Britz Five Points; 2, Stone Land Co.; 3, Westlake Farms North; 4, Fabry Farms; 5, Meyers Ranch; 6, Barbizon Farms; 7, Tulare Lake Drainage District (TLDD) North; 8, Westlake Farms South; 9, Pryse Farms; 10, Bowman Farms; 11, Morris Farms; 12, Martin Farms; 13, 4-J Corp.; 14, TLDD Hacienda; 15, TLDD South; 16, Lost Hills Water District; 17, Carmel Ranch; 18, Lost Hills Ranch; 19, Rainbow Ranch.

of California (Appendix 1). Although we tried to make exhaustive surveys for plovers at all sites, we probably detected a higher percentage of plovers at the smaller, more contained sites, such as diked evaporation ponds, than at larger sites with long broad beaches or expansive alkali flats, such as the Salton Sea or Owens Lake. Lacking a color-banded population, we were unable to estimate detection rates for wintering plovers as Page et al. (1986, 1991) did for breeding plovers.

For additional winter records of Snowy Plovers from the interior of the western U.S., we searched the published literature, including the seasonal reports and Christmas Bird Counts (CBCs) in *Audubon Field Notes* (AFN), *American Birds* (AB), and *National Audubon Society Field Notes* (NASFN), and contacted regional and local experts in California, Washington, Oregon, Nevada, Arizona, and New Mexico. These sources helped us to characterize the seasonal limits of the Snowy Plover's period of winter residency.

RESULTS

Period of Winter Residency

For the interior of the West, the period of winter residency for Snowy Plovers is primarily November through February (Page et al. 1986). Fall departure from breeding sites varies regionally. In southern New Mexico, most fall migrants leave by early to mid-October but some linger into early November [e.g., up to 20 at Bitter Lake National Wildlife Refuge (NWR), Chaves County, on 2 November 1973; AB 28:88]. Along the lower Colorado River, Snowy Plovers are rare and irregular after September (Rosenberg et al. 1991) but may remain in fall until mid-November (Phillips et al. 1964). In the southern California deserts away from regular wintering sites, Snowy Plovers typically stay only until mid- to late September (T. and J. Heindel, J. Tarble in litt.). In Nevada, Snowy Plovers occasionally linger in fall into November (Alcorn 1988).

At colder sites in the wintering range, such as Harper Dry Lake and the Lancaster sewage ponds in the Mojave Desert of California, numbers of Snowy Plovers appear to dwindle over the winter (K. Garrett, E. Cardiff pers. comm.). By contrast, in areas of milder winters, such as the Salton Sea and San Joaquin Valley, plover numbers appear to remain fairly constant throughout the winter (see below).

The timing of the first influx of spring migrants to interior breeding areas generally ranges from early to late March. In southern New Mexico, early arrivals in spring have ranged from 8 to 17 March (AB 25:609, 26:639, 28:607, 39:336, 46:460), and large numbers have been detected as early as 22 March (1974, 124 at Bitter Lake NWR; AB 28:674). Late February records for New Mexico (see below) are problematic and may represent either wintering birds or very early spring migrants. Along the lower Colorado River, Snowy Plovers may arrive in spring by late March (Phillips et al. 1964, Rosenberg at al. 1991). They have arrived in the southern California deserts as early as 13 March (1974, Tecopa, Inyo County; J. Tarble in litt.) and build up rapidly thereafter (e.g., 24 at Edwards Air Force

Base, Kern County, on 24 March 1990; AB 44:496). In Nevada, Snowy Plovers arrive as early as 22 March (Alcorn 1988).

Wintering Status

In the interior of the West most wintering Snowy Plovers were found at evaporation ponds in the San Joaquin Valley and at the Salton Sea. The remaining plovers were found primarily at alkali lakes in the southern deserts.

San Joaquin Valley. The vast majority of the wintering Snowy Plovers on our surveys of the San Joaquin Valley were in evaporation ponds created to dispose of the salt-laden subsurface drain waters from irrigated fields (Table 1, Figure 1). Snowy Plovers were found on 10 of 19 evaporation-pond systems surveyed. Over four winters, totals for these ponds ranged from 79 to 185 [mean 135.2, standard error (SE) 18.8] plovers in November and from 53 to 174 (mean 101.0, SE 23.8) in January. The Westlake Farms North and Tulare Lake Drainage District's (TLDD) Hacienda Ranch ponds usually held the most plovers, except in November 1993 and 1994, when TLDD South held 95 and 68 birds, respectively (Table 1). Plover numbers at individual pond systems varied over the course of a winter, as demonstrated by nine counts from 15 November 1993 to 25 February 1994 at the Westlake North and Westlake South ponds, where totals ranged from 21 to 61 (mean 39.3, SE 3.5) and 3 to 31 (mean 12.3, SE 3.4), respectively (J. Seay in litt.). Other Snowy Plovers encountered on our surveys of the San Joaquin Valley were found on managed duck clubs in the

Table 1 Number of Snowy Plovers Counted at Agricultural Evaporation Ponds in the Southern San Joaquin Valley, California, in the Winters from 1991–92 to 1994–95

	1991–92		1992–93		1993–94		1994–95	
Pond System Name[a]	Nov	Jan	Nov	Jan	Nov	Jan	Nov	Feb
Jack Stone Land Co.	0	17	0	0	0	0	8	0
Westlake Farms North	77	5	48	47	48	35	19	0
Westlake Farms South	2	1	9	36	3	3	12	15
Bowman Farms	0	9	D[b]	D	D	D	D	D
Morris Farms	0	1	0	1	0	D	D	D
Martin Farms	0	0	0	2	0	0	D	D
TLDD Hacienda	0	13	79	80	35	62	25	34
TLDD South	0	5	4	2	95	11	68	10
Lost Hills Ranch	0	2	D	0	D	D	D	D
Rainbow Ranch	0	0	0	6	4	1	5	6
Totals	79	53	140	174	185	112	137	65

[a]No plovers were detected at 9 other sets of evaporation basins also surveyed during the same time periods in 1991-92 to 1994-95 (see Methods and Figure 1).

[b]D, evaporation basin dry at time of survey.

Grasslands wetlands complex near Los Banos, Merced County, at alkali ponds, or at sewage ponds (Appendix 1).

Page et al. (1986) listed the few records of Snowy Plovers wintering in the San Joaquin Valley before 1985. Subsequent winter records for the San Joaquin Valley, beyond ours for the Tulare Basin, are cited in Appendix 2.

Salton Sea. On multi-species shorebird surveys of varying amounts of the Salton Sea shoreline, not specially aimed at Snowy Plovers, observers tallied 112 plovers on 23 November 1991, 48 on 21 and 22 November 1992, 66 on 3 February 1993, and 40 on 21 and 22 January 1994. Our complete surveys of the Salton Sea, 3–8 December 1993 and 1–9 December 1994, which emphasized a thorough count of Snowy Plovers, yielded totals of 285 and 214, respectively (Table 2). The December totals were similar to or surpassed the breeding-season totals of 226 in May 1978 and 198 in May 1988 (Table 2). The distribution of wintering Snowy Plovers in 1993 and 1994 was generally similar to that of breeding birds, with the majority found along the western and southeastern shorelines (Table 2, Figure 2); wintering birds were, however, more clumped at roosting sites or favored feeding areas than were breeding birds. In 1993 two areas of concentration stood out: 46 birds were roosting at one site between Salton

Table 2 Number of Snowy Plovers Counted in Winter along Various Segments of the Salton Sea, California (see Figure 2), with Comparisons to Prior Breeding Seasons

Shoreline Segment	4–12 May 1978[a]	4–14 May 1988[b]	3–8 Dec 1993	1–9 Dec 1994
(1) Whitewater R. delta	2	4	14	3
(2) Whitewater R.–Desert Shores	0	0	10	0
(3) Desert Shores–Salton Sea Beach	12	8	0	1
(4) Salton Sea Beach–Lido Palms	7	14	46	16
(5) Lido Palms–Iberia Wash	32	18	21	9
(6) Iberia Wash–Naval Test Base	38	14	102	31
(7) Naval Test Base	0	24	17	16
(8) San Felipe Creek delta	29	38	26	18
(9) San Felipe Creek–Barth Rd.	3	3	0	7
(10) Poe Road	0	0	15	3
(11) Near New River jetty	2	0	0	0
(12) Salton Sea NWR	0	7	3	0
(13) McDonald Rd.–Wister Unit	16	17	10	89
(14) Imperial Wildlife Area (Wister Unit) ponds	5	13	3	9
(15) North Wister–Niland Marina	33	11	0	0
(16) Niland Marina–Bombay Beach	29	26	13	7
(17) Bombay Beach	4	1	0	1
(18) near Bob's Playa Riviera	6	0	0	0
(19) Salt Creek Beach	6	0	0	0
(20) Desert Beach	2	0	5	4
Totals	226	198	285	214

[a]Data from Henderson and Page (1979).

[b]PRBO unpublished data summarized by Page et al. (1991).

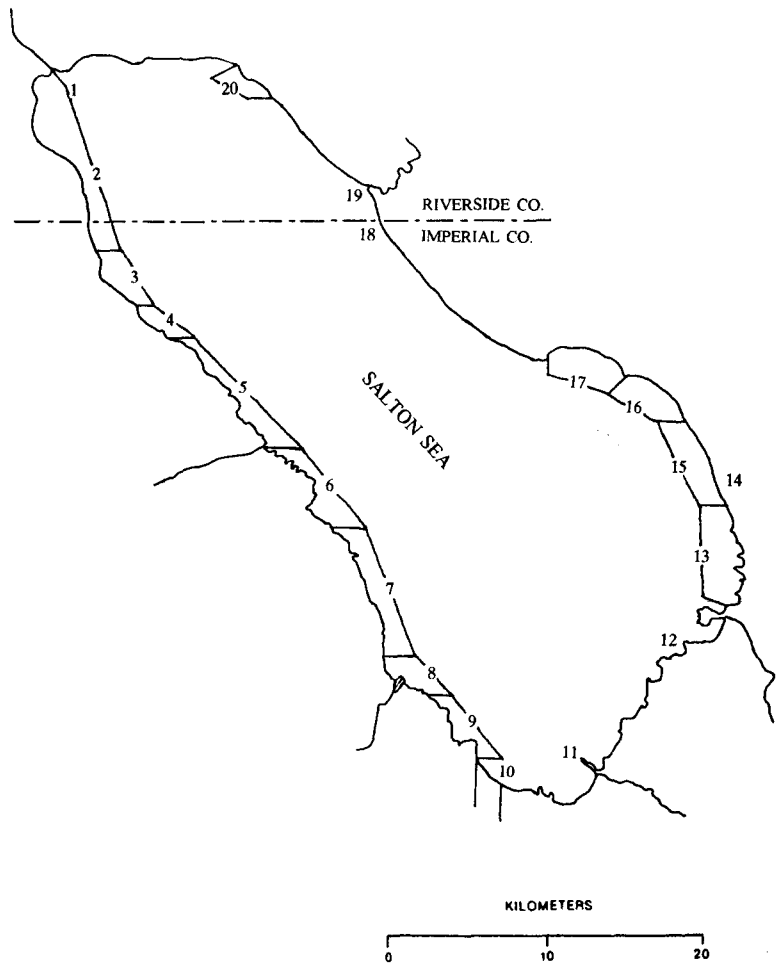

Figure 2. Salton Sea, California. Numbered sites or segments of the shoreline: 1, Whitewater R. delta; 2, Whitewater R.–Desert Shores; 3, Desert Shores–Salton Sea Beach; 4, Salton Sea Beach–Lido Palms; 5, Lido Palms–Iberia Wash; 6, Iberia Wash–Naval Test Base; 7, Naval Test Base; 8, San Felipe Creek delta; 9, San Felipe Creek–Barth Rd.; 10, Poe Road; 11, near New River jetty; 12, Salton Sea NWR; 13, McDonald Rd.–Wister Unit; 14, Imperial Wildlife Area (Wister Unit) ponds; 15, north Wister–Niland Marina; 16, Niland Marina–Bombay Beach; 17, Bombay Beach; 18, near Bob's Playa Riviera; 19, Salt Creek Beach; 20, Desert Beach.

Sea Beach and Lido Palms (area 4, Figure 2), and 102 were scattered along a 8-km stretch of beach between Iberia Wash and the north boundary of the Salton Sea Naval Test Base (area 6, Figure 2). In 1994 the highest single concentration of 89 plovers was scattered along a 8-km segment of the southeastern shoreline from the Wister Unit of Imperial Wildlife Area south to McDonald Road (area 13, Figure 2).

Other southern California sites. During surveys in the winters of 1992–93, 1993–94, and 1994–95 small numbers of Snowy Plovers were found at three sites in the Mojave Desert and at Lake Elsinore, Riverside County (Appendix 1).

A large number of other winter records of Snowy Plovers in southern California have now accumulated; most are from alkali lakes and sewage ponds in the southern Great Basin, Mojave, and Colorado deserts (Appendix 2).

Northern California. The only Snowy Plover found on our surveys in the Sacramento Valley was a single bird in a flooded fallow agricultural field about 8 km northwest of Colusa, Colusa County, on 25 January 1995 (C. Hickey). We know of no other winter records of Snowy Plovers from the Sacramento Valley. The latest records for the Sierra Nevada and Great Basin Desert, respectively, are of one at the south end of Lake Tahoe, El Dorado County, on 11 November 1961 (G. McCaskie in Page et al. 1986) and one or two at Mono Lake, Mono County, on 6 November 1990 (J. R. Jehl, Jr., pers. comm.). These November records probably represent late migrants rather than true winterers; the winter climate of both locations is typically too severe for overwintering plovers.

Arizona and New Mexico. Snowy Plovers winter infrequently in these states. We have found only nine winter records for Arizona, four from the Colorado River, the remaining five from scattered localities, Prescott being the northernmost (Appendix 2). For New Mexico we found five records, excluding the one of 9 at Laguna Grande, Eddy County, on 27 February 1993 (AB 47:287), thought to represent early spring migrants (AB 47:287). Four of the records are from playa lakes in the southeastern corner of the state.

Oregon, Nevada, and Washington. Three Snowy Plovers at Harney Lake, Malheur NWR, Harney County, on 27 February 1968 have been considered early spring migrants (Page et al. 1986, Littlefield 1990), but this seems extremely early given the average arrival date of 26 April at Malheur (Littlefield 1990) and the typical late March arrival of plovers inland in southern California and Nevada (see above). This undocumented record is also anomalous since there are no mid-winter records from the interior of California north of the Sacramento and Owens valleys and no winter records at all from elsewhere in the interior of Oregon (J. Gilligan in litt.), Nevada (Alcorn 1988, V. Mowbray pers. comm.), or Washington (B. Tweit pers. comm.).

Size of the Interior Wintering Population

Our surveys were most complete in November and December 1993 and 1994 when 499 and 283 Snowy Plovers, respectively, were located

wintering in the interior of California: Salton Sea (285, 214), evaporation ponds in San Joaquin Valley (185, 65), Lancaster sewage ponds (17, 2; on CBC), Harper Dry Lake (9, 0), and Grasslands (3, 2). We would likely have found a few more plovers in the interior in 1993 and 1994 if we had surveyed a few other sites in southern California and all suitable habitat in southern Arizona and New Mexico.

Habitat Use

Snowy Plovers wintering in the San Joaquin Valley were found primarily in evaporation ponds where shallow water was bordered with extensive alkali flats. They tended to forage on the moist alkali flats near the water's edge and to roost in depressions in raised areas of bumpy encrusted alkali. At the Salton Sea, foraging plovers were most frequent on moist flat beaches >20 m wide. They concentrated particularly on the margins of shallow receding lagoons perched on the beach slope above the main shoreline, often found on the broad deltas of creeks or washes. Plovers tended to roost on encrusted alkali near lagoons or on the barnacle- and driftwood-strewn berms of beaches. We also found plovers at five sets of sewage ponds, but they occurred more or less regularly only at the Lancaster sewage ponds in the Mojave Desert. There they roosted on the gravel- or rock-lined dikes, but it is unclear if they use these sewage ponds extensively for foraging. The five sewage ponds used by plovers are within a few kilometers of either alkaline wetlands (Los Banos sewage ponds), evaporation ponds (Lemoore Naval Air Station sewage ponds), or a playa lake (Edwards Air Force Base, China Lake, and Lancaster sewage ponds), habitats that the birds may use as primary or supplementary foraging areas. The bird seen on the 29 December 1985 Creighton Ranch–Corcoran CBC in the southern San Joaquin Valley was on exposed mudflats in a shallowly flooded fallow field (R. Hansen pers. comm.), as was the bird near Colusa in the Sacramento Valley on 25 January 1995 (C. Hickey pers. obs.). Rosenberg et al. (1991) reported that in the lower Colorado River Valley Snowy Plovers are "most frequently observed in plowed agricultural fields," presumably during migration, but this habitat appears to be very rarely used in winter anywhere in the West.

DISCUSSION

San Joaquin Valley

Our surveys establish that the Snowy Plover currently winters regularly in modest numbers at agricultural evaporation ponds in the southern San Joaquin Valley of California. Most of these ponds were built from the late 1970s to the mid-1980s (Moore et al. 1990) and were rapidly colonized by breeding (Ivey 1984) and wintering (Page et al. 1986) Snowy Plovers. Earlier winter counts of Snowy Plovers at the TLDD Hacienda and TLDD South evaporation ponds combined ranged from 4 to 36 (mean 19.7, SE 4.0) on 7 surveys from 7 November 1983 to 3 January 1984 and from 1 to 7 (mean 3.7, SE 0.6) on 11 surveys from 13 January to 29 February 1984 (H. Coe in litt.). Although the variation in numbers among the four years of our study (Table 1) precludes valid comparisons to the prior single-year

survey, it is clear that the Snowy Plover was well established in winter at least by 1983, five years after the TLDD ponds were built in 1978 (Moore et al. 1990). Surveys of 16 sets of evaporation ponds totaling about 2517 hectares in the winter of 1989–90 yielded totals of 42 birds in early November, 57 in early December, and 73 in early February (R. Marsh in litt.). These counts fall within the range of variation of our 1991–92 to 1994–95 counts (Table 1).

These data suggest that the wintering population of plovers on the evaporation ponds is generally smaller than the breeding population. Roster et al. (1992) counted a maximum of 181 adult-sized plovers on 12 sets of evaporation ponds in the breeding season of 1987. Because they did not differentiate between adults and full-grown juveniles and because their counts increased steadily over the breeding season, at a time when young would be fledging continually, their total likely overestimates the adult breeding population that year. Page et al. (1991) reported a raw count of 241 adult plovers on a survey of all evaporation ponds in 1988, but estimated a total of 339, on the basis of suspected low totals from ponds where Snowy Plovers were counted during multi-species surveys. J. Skorupa and D. Barnum (in Page et al. 1991) found 189 adult plovers at six sets of ponds in 1989. The average of our November and January counts (Table 1) implies that the wintering population on these ponds was about 66 in 1991–92, 157 in 1992–93, 148 in 1993–94, and 88 in 1994–95. Because of this variation, a survey of plover numbers over several consecutive breeding and winter seasons would be desirable to better establish the relative size of the breeding versus the wintering population.

The breeding grounds of the plovers wintering in the interior are unknown. Five Snowy Plovers color-banded as chicks at evaporation ponds in the San Joaquin Valley in 1989 wintered on the California coast in 1989–90 (Page et al. 1995, PRBO unpubl. data). Also, single color-banded birds sighted on 14 February 1990 at both the TLDD Hacienda and TLDD South evaporation ponds had been banded as young on these ponds in summer 1989 (J. Skorupa in litt.). They may have wintered on these ponds or may have wintered on the coast, returning early to set up for breeding in the San Joaquin Valley. More color-banding would be useful, to determine if some plovers hatched on the evaporation ponds are resident and, if so, what proportion of the population is resident and what proportion migrates to the coast or elsewhere.

Very limited information is available on the historical breeding status of the Snowy Plover in the San Joaquin Valley (Page and Stenzel 1981), and even less is known of the species' former status there in winter (Page et al. 1986). The Tulare Basin historically held the largest single block of wetland habitat in California, primarily in the form of shallow lakes and associated marshes (USFWS 1990). These playa lakes, in a region of high soil alkalinity (Preston 1981), must have provided ideal habitat for both breeding and wintering Snowy Plovers. The plover's use of these lakes went largely undocumented before they were drained. Because of the vast extent of former habitat, we suspect that plover numbers in the Tulare Basin may have rivaled or exceeded those in any other region in the interior of California.

Salton Sea

The largest population of Snowy Plovers wintering in the interior of the West is found at the Salton Sea. Lack of prior thorough surveys led Garrett and Dunn (1981) to conclude that the Snowy Plover "rarely" remains at the Salton Sea through winter (K. Garrett pers. comm.) and left Page et al. (1986) unable to estimate the size of the winter population there. Given that the Salton Sea is among the Snowy Plover's most important breeding areas in the interior of California (Page and Stenzel 1981, Page et al. 1991), that it has long been occupied by breeding birds (Page and Stenzel 1981), and that it has mild winters, it also seems likely that for decades since its creation in the early 1900s it has held a substantial wintering population of plovers. Page et al. (1986) speculated that the wintering population of plovers at the Salton Sea is smaller than the breeding population, but our surveys suggest that the wintering population is similar to or greater than the breeding population. Surveys at both seasons over several years are needed to assess this accurately.

Our total of 499 Snowy Plovers in the interior of California in the early winter of 1993 is about 200 more than the estimate by Page et al. (1986) of at most 300. By contrast, our total in 1994 was only 283. Our 1993 total is also about 20% of the 2500 that Page et al. (1986) estimated were wintering along the California coast. Doubtless the interior wintering population fluctuates as climatic conditions and management practices that affect habitat conditions for the plovers vary. For instance, November counts at two of the three sets of evaporation ponds that held the most birds during our study ranged from 0 to 79 and 0 to 95 over the four years. Our highest count of 95 plovers at the TLDD South evaporation ponds in late November 1993 was at a time when the ponds were drawn down for structural alterations, thereby exposing extensive alkali flats (J. Wilson pers. comm.). It would be desirable to improve the estimates of the year-to-year variation in the size of the interior wintering population of Snowy Plovers by conducting more winter counts and by measuring detection rates to account for plovers missed on surveys.

Root (1988), using Christmas Bird Count data, mapped the winter distribution of the Snowy Plover in North America and concluded that all populations were in areas that average warmer than 30° F (-1° C) in January. We plotted our more extensive record for the interior of the West on Root's (1988) contour map of average minimum January temperatures and found that plovers winter at many sites with average minimum January temperatures *lower* than 30° F (Figure 3). An average minimum January temperature of 20° F (-6° C) is a better temperature threshold, but Snowy Plovers nevertheless do not winter in an extensive area of lowland northern California warmer than this. Knowing that inland plovers concentrate on alkaline soil near saline water, we thought that some measure of aridity might also be helpful in predicting Snowy Plover distribution. This led us to plot winter records of Snowy Plovers in relation to both temperature and general humidity (as measured by pan evaporation rates). The best fit of our data was to an average minimum January temperature warmer than 20° F (-6° C) combined with an average annual pan evaporation rate greater than

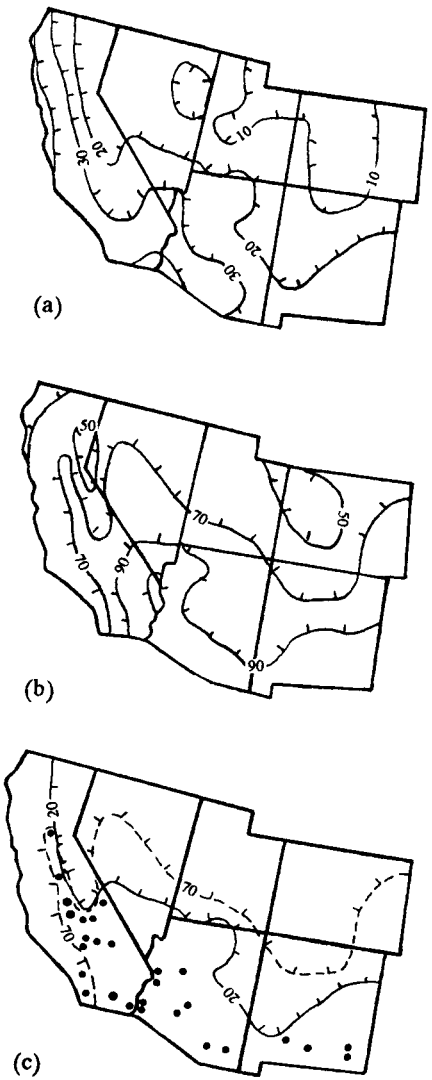

Figure 3. (a) Average minimum January temperatures with 10° F (5° C) contour intervals; tick marks point toward lower temperatures (from Root 1988). (b) Average annual general humidity, as measured by pan evaporation, with 20-inch evaporation contour intervals; tick marks point toward smaller values (from Root 1988). (c) Winter (15 Nov–15 Feb) records of Snowy Plovers in the interior of the West plotted relative to the isolines of 20° F average minimum January temperature and 70 inches average annual pan evaporation (general humidity) (adapted from Root 1988). Large dots, sites of regular wintering; small dots, sites of erratic wintering.

70 inches (Figure 3c). Thus aridity as well as warmth favors Snowy Plovers.

Although the increasing concentration of salts and trace elements, particularly selenium, in the San Joaquin Valley (e.g., Skorupa and Ohlendorf 1991, Ohlendorf et al. 1993) and at the Salton Sea (e.g., Schroeder et al. 1993, Setmire et al. 1993) has impaired the reproduction of some species of birds, to date the risk of toxicity to Snowy Plovers has been low (J. Skorupa pers. comm.). Ironically, Snowy Plovers may face habitat loss as pond owners seek means to reduce the toxicity risk to wildlife using these habitats (see Moore et al. 1990). Methods suggested to reduce bird use of contaminated ponds in the San Joaquin Valley include hazing, altering the pond's physical structure, and creating nearby uncontaminated wetlands as alternative habitat (Steele and Bradford 1991, Bradford 1992). While some such wetlands have already been constructed, both the total amount of alternative habitat and the proportion of freshwater and saline wetlands in it have yet to be decided (C. Taylor pers. comm.). Monitoring to determine the effect of these actions on the health and size of populations of the Snowy Plover and other species will be needed.

SUMMARY

Surveys over four years reveal that most Snowy Plovers wintering in the interior of the West concentrate in California at agricultural evaporation ponds in the southern San Joaquin Valley and at the Salton Sea. Small numbers of plovers also winter irregularly in deserts elsewhere in southern California, Arizona, and New Mexico, primarily at playa lakes. Surveys in 1993 found 499 Snowy Plovers wintering in the interior of California, about 200 more than had been estimated from prior partial surveys. The wintering population at the Salton Sea appears to be greater than or equal to the breeding population, but the converse appears to be true at evaporation ponds in the San Joaquin Valley. The inland distribution of wintering plovers in the West corresponds to arid climates (average annual evaporation >70 inches) and mild (average January temperature >–6° C) winters. Changes in management practices at the evaporation ponds designed to reduce the toxic effects of selenium on wildlife using the ponds may in the near future affect the amount and quality of habitat for plovers and other shorebirds.

ACKNOWLEDGMENTS

Major funding for the Pacific Flyway Project was provided by the Bay Foundation of Morro Bay, the Bradford Foundation, the Bureau of Reclamation, the Central Valley Habitat Joint Venture, Chevron USA Inc., the Dakin Foundation, the David and Lucille Packard Foundation, the Dean Witter Foundation, Ducks Unlimited, Genentech, the Walter and Elise Hass Fund, the Marin, Morro Coast, and Stockton chapters of the National Audubon Society, the National Fish and Wildlife Foundation, the San Francisco Foundation, the Strong Foundation, and the True North Foundation.

The Pacific Flyway Project has become a cooperative venture on a grand scale, and we are grateful to all who have supported our work in any way. At the risk of

inadvertently leaving out important contributors, we particularly thank the following groups and individuals that helped organize shorebird counts in the San Joaquin Valley and southern California deserts, which provided data on the status of wintering Snowy Plovers in these regions: San Joaquin Valley—Bob Barnes, Doug Barnum, John Beam, Calif. Dept. Fish and Game (CDFG), Steve Clay, Mark Chichester, Joe Engler, Sam Fitton, Greg Gerstenberg, Ron Gerstenberg, Grasslands Water District, Rob Hansen, H. T Harvey and Assoc., Greg and Karen Kirkpatrick, Tim Kroeker, Mike Peters, Tim Poole, Gary Potter, Martin Potter, Harold Reeve, Jeff Seay, Mark Stacy, Charles Stearns, U. S. Fish and Wildlife Service (USFWS) at San Luis NWR complex and Kern NWR, Bruce Williford, John Wilson, Dennis Woolington, and Gary Zahm; southern California deserts—Bert Anderson, David Blue, Eugene Cardiff, Barbara Carlson, Dave Feliz, Kimball Garrett, Matt Heindel, Tom and Joe Heindel, Robert McKernan, Susan Nash, Michael Patten, Michael Prather, and USFWS at Salton Sea NWR. We would particularly like to thank the numerous landowners and land managers that have graciously allowed access to their lands, without which our studies would not have been possible.

The following individuals and organizations kindly shared their unpublished records of Snowy Plovers: CDFG, Eugene Cardiff, Rob Hansen, Matt Heindel, Tom and Jo Heindel, H. T. Harvey and Assoc., Gale Monson, Jan Tarble, Rex Marsh, Terry Salmom, and Todd Sloat. Brett Hoover of the National Biological Survey promptly provided computerized CBC data for the western states. Doug Barnum, Fred Heath, Kimball Garrett, Jeff Gilligan, Vince Mowbray, Michael Patten, Philip Unitt, Bill Tweit, and Sartor O. Williams III freely shared their knowledge of Snowy Plovers. Helen Green provided Snowy Plover records from the files of the editors of the Middle Pacific Coast Region of *American Birds* on file at Golden Gate Audubon Society in Berkeley. Janet Kjelmyr summarized Snowy Plover data from PRBO's Pacific Flyway Project surveys. Peter Paton and Philip Unitt provided very helpful reviews of an earlier draft of the manuscript. This is Contribution No. 641 of PRBO.

LITERATURE CITED

Alcorn, J. R. 1988. The Birds of Nevada. Fairview West, Fallon, NV.

Bradford, D. F. 1992. Potential sites and mechanisms for creating wetland habitat in the southern San Joaquin Valley. Final Report for Calif. Dept. Water Resources, 1025 P St., Sacramento, CA 94236.

Fisher, A. K. 1893. Report on the ornithology of the Death Valley expedition of 1891, comprising notes on the birds observed in southern California, southern Nevada, and parts of Arizona and Utah. N. Am. Fauna 7.

Garrett, K., and Dunn, J. 1981. Birds of Southern California: Status and Distribution. Los Angeles Audubon Soc., Los Angeles.

Halpin, M., and Paul, D. 1989. Survey of Snowy Plovers in northern Utah—1988. Utah Birds 5:21–32.

Henderson, R. P., and Page, G. W. 1979. Part III: The California interior, in The breeding status of the Snowy Plover in California (G. W. Page and L. E. Stenzel, eds.), pp. III-1 to III-41. Nongame Wildlife Invest. Rep., Calif. Dept. Fish Game, Sacramento.

Herman, S. G., Bulger, J. B., and Buchanan, J. B. 1988. The Snowy Plover in southeastern Oregon and western Nevada. J. Field Ornithol. 59:13–21.

Ivey, G. L. 1984. Some recent nesting records for the Snowy Plover in the San Joaquin Valley, California. W. Birds 15:189.

Littlefield, C. D. 1990. Birds of Malheur National Wildlife Refuge, Oregon. Ore. State Univ. Press, Corvallis.

Monson, G., and Phillips, A. R. 1981. Annotated Checklist of the Birds of Arizona, 2nd ed. Univ. Ariz. Press, Tucson.

Moore, S. B., Winckel, J., Detwiler, S. J., Klasing, S. A., Gaul, P. A., Kanim, N. R., Kesser, B. E., DeBevec, A. B., Beardsley, K., and Puckett, L. K. 1990. Fish and wildlife resources and agricultural drainage in the San Joaquin Valley, California. Report of the San Joaquin Valley Drainage Program, 2800 Cottage Way, Rm. W-2143, Sacramento, CA 95825-1898.

Ohlendorf, H. M., Skorupa, J. P., Saiki, M. K., and Barnum, D. A. 1993. Food-chain transfer of trace elements to wildlife, in Management of Irrigation and Drainage Systems: Integrated Perspectives (R. G. Allen and C. M. U. Neale, eds.), pp. 596–603. Proceedings of the 1993 National Conference on Irrigation and Drainage Engineering, Park City, Utah; July 21–23, 1993. Am. Soc. Civil Engineers, 345 East 47th St., New York, NY 10017-2398.

Page, G. W., Bidstrup, F. C., Ramer, R. J., and Stenzel, L. E. 1986. Distribution of wintering Snowy Plovers in California and adjacent states. W. Birds 17:145–170.

Page, G. W., and Stenzel, L. E., eds. 1981. The breeding status of the Snowy Plover in California. W. Birds 12:1–40.

Page, G. W., Stenzel, L. E., Shuford, W. D., and Bruce, C. R. 1991. Distribution and abundance of the Snowy Plover on its western North American breeding grounds. J. Field Ornithol. 62:245–255.

Page, G. W., Stern, M. A., and Paton, P. W. C. 1995. Differences in wintering areas of Snowy Plovers from inland breeding sites in western North America. Condor 97:258–262.

Phillips, A., Marshall, J., and Monson, G. 1964. The Birds of Arizona. Univ. Ariz. Press, Tucson.

Preston, W. L. 1981. Vanishing Landscapes: Land and Life in the Tulare Lake Basin. Univ. Calif. Press, Berkeley.

Root, T. 1988. Atlas of Wintering North American Birds: An Analysis of Christmas Bird Count Data. Univ. Chicago Press, Chicago.

Rosenberg, K. V., Ohmart, R. D., Hunter, W. C., and Anderson, B. W. 1991. Birds of the Lower Colorado River Valley. Univ. Ariz. Press, Tucson.

Roster, D. L., Hohman, W. L., and Barnum, D. A. 1992. Use of agricultural drainwater impoundments by Snowy Plovers (*Charadrius alexandrinus nivosus*) in the southern San Joaquin Valley, California, in Endangered and sensitive species of the San Joaquin Valley, California: Their biology, management, and conservation (D. F. Williams, S. Byrne, and T. A. Rado, eds.), pp. 229–235. Calif. Energy Comm., 1516 Ninth St., Sacramento, CA 95814.

Schroeder, R. A., Rivera, M., Redfield, B. J., Densmore, J. N., Michel, R. L., Norton, D. R., Audet, D. J., Setmire, J. G., and Goodbred, S. L. 1993. Physical, chemical, and biological data for detailed study of irrigation drainage in the Salton Sea area, California, 1988–90. U. S. Geol. Surv. Open-File Rep. 93-83. U. S. Geol. Surv., Federal Bldg., Rm. W-2233, 2800 Cottage Way, Sacramento, CA 95825.

Setmire, J. G., Schroeder, R. A., Densmore, J. N., Goodbred, S. L., Audet, D. J., and Radke, W. R. 1993. Detailed study of water quality, bottom sediment, and biota associated with irrigation drainage in the Salton Sea area, California,

1988-90. U. S. Geol. Surv. Water-Resources Invest. Rep. 93-4014. U. S. Geol. Surv., Federal Bldg., Rm. W-2233, 2800 Cottage Way, Sacramento, CA 95825.

Skorupa, J. P., and H. M. Ohlendorf. 1991. Contaminants in drainage water and avian risk thresholds, in The Economics and Management of Water and Drainage in Agriculture (A. Dinar and D. Zilberman, eds.), pp. 345–368. Kluwer Academic, Norwell, MA.

Steele, N. L. C., and D. F. Bradford. 1991. Habitats, siting, and management of potential wetlands in the southern San Joaquin Valley, California. ESE Rep. 91-07, Calif. Dept. Water Resources, 1025 P St., Sacramento, CA 94236.

U. S. Fish and Wildlife Service. 1990. Central Valley Habitat Joint Venture Implementation Plan: A Component of the North American Waterfowl Management Plan. U. S. Fish and Wildlife Serv., 2233 Watt Ave., Suite 375, Sacramento, CA 95825-0509.

Wilson-Jacobs, R., and Meslow, E. C. 1984. Distribution, abundance and nesting characteristics of Snowy Plovers on the Oregon coast. Northwest Sci. 58:40–48.

APPENDIX 1 Inland Winter Records of Snowy Plovers in California from This Study, 1991–92 to 1994–95, Other Than From Evaporation Ponds in the San Joaquin Valley (Table 1) or the Salton Sea (Table 2).

Survey Sites and Frequency

Sites in the San Joaquin Valley surveyed in January 1992, 1993, and 1994, January to February 1995, and November 1993 and 1994: the Grasslands wetlands complex of public wildlife refuges [San Luis NWR, Kesterson NWR, Merced NWR, Arena Plains NWR, Volta Wildlife Area (WA), Los Banos WA, Mud Slough WA, Salt Slough WA, China Island WA] and private duck clubs (two-thirds of the wetland area of the Grasslands) surrounding Los Banos, Merced Co.; Mendota WA, Fresno Co.; Pixley NWR, Tulare Co.; Kern NWR, Kern Co.; South Wilbur Flood Area, Kings Co.; and most sets of municipal sewage ponds and irrigation district ponds from Modesto, Stanislaus Co., south to Bakersfield, Kern Co.

Sites in the deserts of southern California surveyed in the winters of 1992–93, 1993–94, and 1994–95: Tinnemaha Reservoir, Inyo Co. (2 Dec 1994, 29 Jan 1995), Owens Lake, Inyo Co. (4 Dec 1993, 29 Jan 1994, 3 Dec 1994, 28 Jan 1995), China Lake sewage ponds, Kern Co. (2 Nov 1992, 23 Jan 1993, 3 Dec 1993, 2 Dec 1994, 28 Jan 1995), Edwards Air Force Base sewage ponds, Kern Co. (27 Nov 1992, 1 Feb 1995), Piute Ponds, Los Angeles Co. (23 Nov 1992, 2 Feb 1993, 3 Dec 1993, 30 Jan 1994), Lancaster sewage ponds, Los Angeles Co. (20 Nov 1992, 2 Feb 1993, 3 Dec 1993, 30 Jan 1994), Harper Dry Lake, San Bernardino Co. (6 Dec 1992, 1 Feb 1993, 5 Dec 1993, 12 Feb 1993, 11 Dec 1994), San Jacinto Valley, Riverside Co. (20 Nov 1992, 30 Nov 1993, 29 Jan 1994, 3 Dec 1994, 29 Jan 1995), Lake Elsinore, Riverside Co. (10 Dec 1993, 6 Feb 1994, 3 Dec 1994, 28 Jan 1995), and agricultural lands south of Blythe, Riverside Co. (8 Dec 1993).

Snowy Plover Records

Merced Co.: Duck clubs in Grasslands wetlands complex surrounding Los Banos, 3, 20 Nov 1993 (D. Shuford, C. Hickey); 5, 20 Jan 1991 (G. Page); 23, 8 & 11 Feb 1995 (C. Alexander, C. Hickey, H. Reeve, D. Shuford). Los Banos sewage ponds, 2, 9 Nov 1994 (D. Shuford).

Kings Co.: Small alkali ponds near Corcoran Irrigation District reservoir, Corcoran, 1, 28 Jan 1992 (J. Kjelmyr). Westlake Farms section 16 mitigation wetlands, 2.5 km E of Kettleman City, 2, 16 Feb 1995 (J. Seay). Lemoore Naval Air Station sewage ponds (formerly Carlton Duty evaporation ponds), 11, 14 Nov 1994; 9, 31 Jan 1994 (both T. Kroeker).

Kern Co.: Edwards Air Force Base sewage ponds, 1, 27 Nov 1992 (M. Heindel).

Los Angeles Co.: Lancaster sewage ponds, 20, 20 Nov 1992 (D. Shuford); 3, 3 Dec 1993 (K. Garrett); 9, 2 Feb 1993 (K. Garrett).

San Bernardino Co.: Harper Dry Lake, 9, 5 Dec 1993; 6, 6 Dec 1992 (E. Cardiff).

Riverside Co.: Lake Elsinore, 1, 6 Feb 1994 (M. A. Patten).

APPENDIX 2 Inland Winter Records of the Snowy Plover Other Than Those Generated by This Study

California

Merced Co.: Los Banos sewage ponds, 1, 26 and 27 Dec 1986 (AB 41:324); 2, 28 Dec 1992 (AB 47:949).

Kern Co.: Lake Isabella, 1, 25 Jan 1985 (AB 39:210). Carmel Ranch evaporation ponds (Figure 1), 5, 24 Nov 1990 (M. Heindel). China Lake sewage ponds, 1, 21 Dec 1990 (D. Blue). Edwards Air Force Base sewage ponds, 1, 23 Nov 1991; 5, 22 Dec 1990; 6, 30 Dec 1989; 8, 4 Jan 1989 (all M. Heindel).

Inyo Co. (all Owens Lake): "Northwest Seep," 1, 15 Dec 1984 (AB 39:785, D. Gaines); 9, 20 Dec 1986 (AB 41:1270). Keeler saltworks, 1, 20 Dec 1993 (NASFN 48:248); 2, 11 Jan 1976; 11, 28 Jan 1993; 3, 2 Feb 1993 (all T. & J. Heindel). Cottonwood Marsh, 16 km SSE of Lone Pine, 4, 23 Dec 1992 (M. Heindel, T. & J. Heindel). Exact location not recorded, 1, 27 Dec 1890 (Fisher 1893). Dirty Sock Springs, 2, 3 Jan 1975 (AB 29:742).

Los Angeles Co.: Lancaster sewage ponds, 10, 14 Dec 1991 (AB 46:977); 2, 17 Dec 1994 (*fide* Fred Heath); 17, 18 Dec 1993 (NASFN 48:833); 6, 19 Dec 1992 (AB 47:948). Rosamond Lake, 1, at least Dec 1981 through Feb 1982 (AB 36:331); 2, 15 Dec 1984 (AB 39:785); 26, 17 Dec 1983 (AB 38:789).

San Bernardino Co.: Harper Dry Lake, 4, 21 Nov 1988; 6, 23 Nov 1987; 5, 10 Dec 1988; 4, 27 Feb 1988 (all E. Cardiff). East Cronese Lake near Baker, 1, 19 Nov 1978 (AB 33:213).

Riverside Co.: Lake Elsinore, 6, 11 Dec 1981 (Page et al. 1986); 10, 30 Jan 1982 (AB 36:331).

San Diego Co.: Lake Henshaw, 1, 5 Nov 1978 (AB 33:213). Lake Hodges, 2–3, during winter 1979–80 (Garrett and Dunn 1981); 2, 6 Nov 1982 (Page et al. 1986).

Imperial Co.: West Pond, below Imperial Dam, 4, 23 Dec 1961 (W. C. Royall, Jr. and L. Olver *fide* G. Monson).

We have rejected the following records for lack of sufficient documentation: Los Angeles Co., "at reservoir" on the Pasadena–San Gabriel Valley CBC, 6, 29 Dec 1964 (AFN 19:331); Orange Co., Irvine Lake on the Orange Co. (northeastern) CBC, 20, 4 Jan 1981 (AB 35:721).

Arizona

Mohave Co.: Lake Havasu, 1, 20 Jan 1982 (AB 36:318).

Mohave and La Paz counties: Bill Williams R. delta, 2, 20 Oct 1952 to 7 Mar 1953 (G. Monson).

Yuma Co.: Martinez Lake, 1, 2 Feb 1977 (S. Furniss, USFWS, *fide* G. Monson). 1.5–3 km north of Imperial Dam, 1–2, 4 Nov 1960 to 1 Feb 1961 (G. Monson).

Yavapai Co.: Willow Lake, Prescott, 1, 24 Nov 1985 (AB 40:151).

Maricopa Co.: Phoenix, 1, 28 Dec 1963 (AFN 18:295, Monson and Phillips 1981). Near Gila Bend on Gila River, 7, 15 Jan 1974 (AB 28:674).

Pima Co.: Tucson, 1–2, 11 Oct to 3 Dec 1971 (AB 26:101).

Cochise Co.: Willcox, 1, 31 Dec 1976 (AB 31:359).

New Mexico

Sierra Co.: Elephant Butte Lake, 1, 14 Jan 1990 (P. Steel *fide* N. M. Ornithol. Soc. Field Notes 29:6).

Otero Co.: Holloman Lakes, 1, 23 Feb 1985 (AB 39:198).

Eddy Co.: Laguna Grande, 1, 28 Dec 1976 (AB 31:359); 1, 4 Jan 1987 (AB 41:315). Vicinity of Salt Lake, east of Loving, 1–2, 9–27 Jan 1975 (AB 29:725).

Accepted 23 March 1995

NOTES

BREEDING BIRDS OF ESTEROS TÓBARI AND SAN JOSÉ, SOUTHERN SONORA

EDUARDO PALACIOS and ERIC MELLINK, Centro de Investigación Científica y Educación Superior de Ensenada, Apdo. Postal 2732, Ensenada, Baja California, Mexico *or* P. O. Box 434844, San Diego, California 92143

Although the ornithofauna of Sonora has been studied since, at least, the 19th century (van Rossem 1945), it is still rather poorly known. This is particularly true for its southern coastal area. Van Rossem and Hachisuka (1937) provided an extensive list of water birds from Estero Tóbari but found little evidence of local breeding for most species. In 1971 and 1972, Knoder et al. (1980) made aerial surveys of water birds and wetlands along the coasts of Baja California and the west coast of mainland Mexico, from the delta of the Rio Colorado to San Blas, Nayarit, but did not include Estero Tóbari as one of their intensively surveyed sites.

Here we report on the breeding birds that we recorded on a trip to esteros Tóbari (including Isla Huivulai) and San José on 14 May 1994 (Figure 1). In Estero Tóbari, we surveyed the north and south mouths of the bay, two islets outside the north mouth, and two heronries on the southeast and northwest sides of Isla Huivulai. San José is a small fishermen's town 8 km northwest of the north mouth of Estero Tóbari, with an estero and a large saltflat nearby, both of which we surveyed. We visited also an abandoned shrimp farm at the north end of Estero Tóbari. The main purpose of our trip was to search for Least Tern breeding colonies.

Great Blue Heron (*Ardea herodias*). A heronry in NE Isla Huivulai contained eight nests, one with two half-grown chicks. On the west coast of mainland México, Great Blue Herons breed from the delta of the Rio Colorado (Palacios and Mellink 1993) south to, at least, San Blas, Nayarit (Knoder et al. 1980). Griffing Bancroft (unpublished field notes) had found this species as a breeder at Estero Tóbari in 1930, and van Rossem and Hachisuka (1937) collected a specimen in breeding condition from there.

Great Egret (*Casmerodius albus*). Two heronries in SE and NE Huivulai had about 15 pairs with nests each. Van Rossem and Hachisuka (1937) had recorded this species as a breeder from the area.

Snowy Egret (*Egretta thula*). There were 20 pairs in the SE heronry and about the same number in the NE heronry on Isla Huivulai. The Snowy Egret is reported as occurring along the Pacific coast of Mexico from Puerto Peñasco south to the Istmo de Tehuantepec (Knoder et al. 1980) and being a resident from Guaymas south (van Rossem 1945), but no previous breeding records exist for southern Sonora.

Little Blue Heron (*Egretta caerulea*). We found three pairs with nests in each heronry on Isla Huivulai. This species is known to occur from Punta Sargento south to the Istmo de Tehuantepec (Knoder et al. 1980) and to be a summer resident of the mangrove association of southern Sonora (van Rossem 1945), but no particular breeding locations had been published.

Tricolored Heron (*Egretta tricolor*). We saw five adults feeding on the mudflat in front of the heronry in NE Isla Huivulai; we presume nesting. Like previous species, this heron has been noted from Guaymas south to Tehuantepec (Knoder et al. 1980) and to be a resident of coastal lagoons in southern Sonora (van Rossem 1945), but no specific breeding locations had been provided.