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DIFFERENCES IN WINTERING AREAS OF SNOWY PLOVERS FROM INLAND BREEDING SITES IN WESTERN NORTH AMERICA[1]

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West of the Rocky Mountain/Sierra Madre Cordillera, Snowy Plovers (*Charadrius alexandrinus*) breed along the Pacific coast from southern Washington to southern Baja California and inland from eastern Oregon and northern Utah south into the interior of Mexico (AOU 1983, Page et al. 1991, Howell and Webb 1994). Except for agricultural evaporation ponds in the southern San Joaquin Valley and a few locations in the deserts of southern California (particularly the Salton Sea), inland areas in the western United States are abandoned for the winter (Page et al. 1986). Wintering areas of the inland breeders should lie within the species' western winter range which extends primarily along the Pacific coast from northern Oregon to southern Mexico, where the species is common, and south to Panama, where it is reportedly uncommon (AOU 1983, Castro and Myers 1988). Evidence of the movement of color-banded Snowy Plovers from one inland breeding location, Mono Lake, to wintering locations along the Pacific coast of California and Baja California is documented in Page et al. (1986).

During the late 1980s and early 1990s several hundred Snowy Plovers were banded at three inland breeding sites in western North America. Enough of these plovers have been located on the wintering grounds to test whether birds from different inland breeding localities segregate geographically on the wintering grounds. Sufficient numbers of breeding birds from one site were also located to test whether birds of differing age or gender also varied in choice of wintering areas.

STUDY AREAS AND METHODS

During the period 1988–1992 a total of 522 adult and 506 chick or juvenile (hereafter immature) Snowy Plovers were color banded at three interior breeding sites in western North America (Table 1). Marked birds included adults and immatures at two Great Basin sites (Lake Abert, Oregon and Great Salt Lake, Utah). Only immature birds were banded at the third location, a number of agricultural waste water ponds in the southern San Joaquin Valley of California. At the two Great Basin sites adults were marked with unique combinations of 3–4 color bands. Immature birds were banded similarly, except for the color coding, which was usually by brood rather than by individual. All chicks from the San Joaquin Valley were marked with a single white color band on one leg.

Searches were conducted for these birds by a network of volunteers that visited coastal California beaches and salt ponds as frequently as once a month from August to April to count plovers and look for marked birds. The proportion of these coastal wintering areas covered by the volunteer network during five consecutive winters, from 1988 to 1992, ranged from 52–67% ($\bar{x}$ = 59%, SD = 7) of the 141 potential sites identified since 1979 (PRBO, unpubl. data). Cumulatively, about 80% of all sites were covered over the five-winter period. While this survey did not extend into Baja California, one of us searched for marked plovers on beaches at La Mission and Bahia San Quintin, and on tidal flats at Ojo de Liebre on the west Baja coast from 4–9 January 1991; at four beaches between Loreto and Mulege on the east coast from 20–21 January 1992; and at nine beaches from Las Barrancas to La Salina on the west coast from 19–28 January 1992. P. Ashfield and M. Jungers searched 11 beaches on the west Baja coast between the United States/Mexico border and Bahia San Quintin from January to February 1989. Other persons studying shorebirds in Baja between 1989 and 1993 were also alerted to look for color-banded plovers. The only other Mexican locations searched by one of us were beaches in the Puerto Penasco and El Gulfo de Santa Clara regions of Sonora State, in March, September and December 1991, and December 1992. The Oregon coast was surveyed at least once annually during winter by workers of the Oregon Department of Fish and Wildlife.

Any marked Snowy Plover located on the coast between 15 October and 10 March was considered to be at its wintering area. Any sighted between 1 July and 14 October was considered a potential fall migrant and any between 11 March and 30 April a potential spring migrant.

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RESULTS

During the study 20.5% of 166 marked adults from Lake Abert were located during winter. This was a significantly larger proportion than the 0.6% of 356 marked adults located from Great Salt Lake (Table 1, $\chi^2 = 69.96$, $P < 0.0001$). The proportion of immature birds found during winter was also much greater for the Lake Abert than the Great Salt Lake cohort (Table 1), but we did not test the difference because of the potential confounding effect of fledgling survival rates, which may vary considerably among locations (PRBO, unpubl. data).

All 54 marked birds from Lake Abert, found during winter, were on either the coast of California or the west coast of Baja California (Fig. 1, Table 2). In contrast, no birds from Great Salt Lake were found in California and only one was located on the Pacific coast of Baja. The remaining three birds from Great Salt Lake were found in the Gulf of California (Fig. 1, Table 2). There were no sightings of additional Great Salt Lake birds during migration.

During the study 16.4% of the males, 23.7% of the females and 9.8% of the immatures banded at Lake Abert were located in winter. Detection rates of males and females were not significantly different ($\chi^2 = 1.3$, $P = 0.25$). Nor did the latitudes of wintering areas differ significantly with age or gender (Fig. 1, Kruskal-Wallis Test, $P = 0.71$). The most northerly wintering areas of each age and sex class were all in California and the most southerly areas in southern California or Baja California (Fig. 1). The straight line distance between the most northerly and southerly wintering areas of the Lake Abert birds was 1,970 km. Median wintering locations for each sex and age class all fell within the 80-km distance between Toro Creek, San Luis Obispo County and the Santa Ynez River mouth, Santa Barbara County, California. Of the Lake Abert birds whose wintering areas were discovered, 67% of the males, 73% of the females and 60% of the immatures were seen at their winter locations in at least two years, and 33% of the males, 32% of the females, and 35% of the immatures for at least three years.

In addition to the 54 Lake Abert birds located during winter, there were nine (three immature, three male, three female) Lake Abert birds that may have been migrating when sighted. One was reported from the Oregon coast, seven from the California or Baja coasts within the range reported for wintering birds, and one, identified as a female, was located south of all other Lake Abert birds at Bahia Santa Maria, Baja Sur (Fig. 1). One additional bird, an immature from Lake Abert, was seen on the California coast at Monterey Bay, on 4 June 1990, at a time when most plovers are breeding. This bird, identified as a male, was only seen once in an area that was monitored closely for breeding Snowy Plovers. There was no indication it attempted to breed there.

The five immatures banded in the San Joaquin Valley were all in coastal California in winter (Table 2). In contrast to the birds banded at all the other breeding areas, three of five San Joaquin Valley birds wintered north of their natal areas (Fig. 1).

Banding data from two other inland breeding sites indicate movement of Snowy Plovers to the coast for

TABLE 1. Summary information for Snowy Plovers that nested inland and wintered on the coast of western North America.

	Age/Sex	Location				
		Lake Abert	Great Salt Lake	San Joaquin Valley[1]	Mono Lake	Honey Lake[2]
Breeding area						
Lat., Long.		42.5°, 120°	41°, 112°	35–36°, 119–120°	38°, 119°	40°, 120°
Banding years		1988–1989	1990–1992	1989	1978–1981	1992
No. banded (found in winter)	Male	73 (12)	162 (1)		44 (0)	4 (0)
	Female	93 (22)	194 (1)		86 (6)	7 (2)
	Imm.[3]	204 (20)	139 (2)	163 (5)	237 (5)	17 (0)
Range of wintering area latitudes	Male	41°0′–27°40′	31°18′			
	Female	39°29′–32°38′	27°40′		36°36′–32°50′	36°45′–34°24′
	Imm.	40°35′–30°39′	31°18′–24°30′	39°29′–36°46′	35°23′–24°42′	
Breeding to wintering areas (km)	Male	874 (373–1,781)	1,104			
	Female	904 (468–1,161)	1,513		435 (300–578)	537 (415–659)
Median (range)	Imm.	826 (409–1,422)	1,486 (1,104–1,867)	282 (110–582)	397 (343–1,635)	

[1] Birds from nine locations that were not distinguished by color combination.
[2] Source L. Oring (pers. comm.).
[3] Immature (e.g., chicks and juveniles).

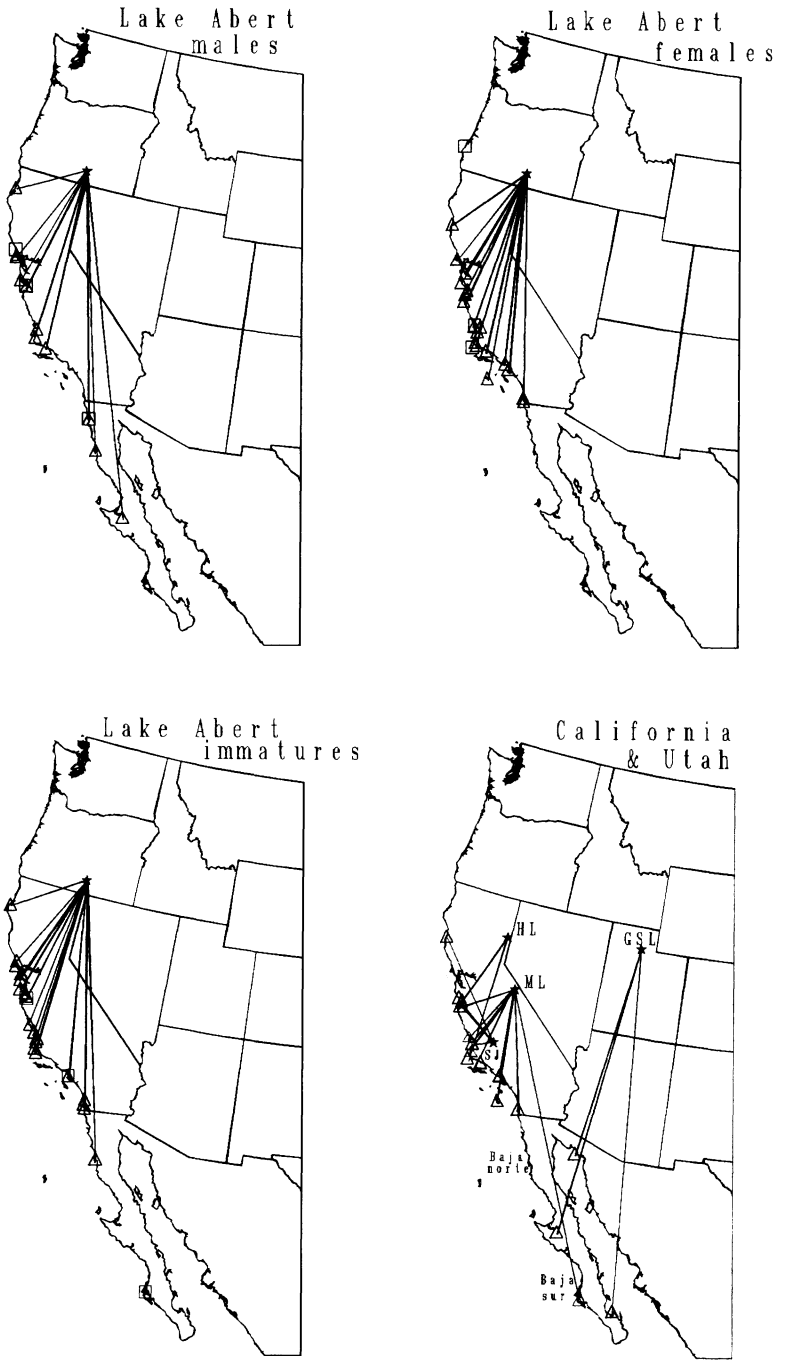

FIGURE 1. Winter locations of Snowy Plovers banded during summer at three inland study sites in western North America: Lake Abert, Oregon; Great Salt Lake, Utah (GSL); and the San Joaquin Valley, California (SJ). Triangles are for plovers seen in winter, and squares for birds seen during migration. Also included are records of birds from other studies: ML for Mono Lake, California (Page et al. 1986) and HL for Honey Lake, California (L. Oring, pers. comm.).

TABLE 2. Winter locations of Snowy Plovers from inland breeding areas in western North America.

Breeding site	Wintering site	Male	Female	Immature	Approximate distance moved (km)
Great Salt Lake, Utah	Puerto Penasco, Mexico	1		1	1,100
Great Salt Lake, Utah	Guerrero Negro, Baja Sur, Mexico		1		1,510
Great Salt Lake, Utah	Isla Espirito Santo, Baja Sur, Mexico			1	1,870
Lake Abert, Oregon	Bandon Beach, Oregon		1		350
Lake Abert, Oregon	Eel River, California	1		1	373
Lake Abert, Oregon	MacKerricher Beach, California		1		470
Lake Abert, Oregon	Doran Beach, California	1			550
Lake Abert, Oregon	Point Reyes, California	2	1	2	570
Lake Abert, Oregon	San Francisco Bay, California		1	1	610
Lake Abert, Oregon	Santa Cruz County, California	3	1	4	660
Lake Abert, Oregon	Monterey County, California		5	1	690
Lake Abert, Oregon	Arroyo Laguna, California			1	800
Lake Abert, Oregon	Morro Bay, California		2	2	830
Lake Abert, Oregon	Pt. San Luis-Pt. Sal, California	1	1	2	850
Lake Abert, Oregon	Pt. Sal-Pt. Conception, California	1	2	2	890
Lake Abert, Oregon	Devereaux Slough, California	1	3	1	930
Lake Abert, Oregon	Malibu, California		1		980
Lake Abert, Oregon	Hermosa Beach, California		1	2	1,000
Lake Abert, Oregon	San Nicolas Island, California		2		1,065
Lake Abert, Oregon	San Diego County, California		2	3	1,150
Lake Abert, Oregon	Estero Beach, Baja Norte, Mexico	2			1,270
Lake Abert, Oregon	San Quintin Bay, Baja Norte,Mexico	2		1	1,429
Lake Abert, Oregon	Guerrero Negro, Baja Sur, Mexico	1			1,781
Lake Abert, Oregon	Bahia Santa Maria, Baja Sur, Mexico			1	2,100
San Joaquin Valley, California	MacKerricher Beach, California			1	580
San Joaquin Valley, California	Wilder Beach, California			1	282
San Joaquin Valley, California	Sunset Beach, California			1	260
San Joaquin Valley, California	Pt. San Luis-Pt. Sal, California			1	110
San Joaquin Valley, California	San Diego County, California			1	370
Mono Lake, California	Del Monte Beach, California			1	300
Mono Lake, California	Atascadero Beach, California			1	340
Mono Lake, California	Pt. San Luis-Pt. Sal, California			1	360
Mono Lake, California	Pt. Sal-Pt. Conception, California			2	400
Mono Lake, California	Devereaux Beach, California		2		420
Mono Lake, California	Malibu Lagoon, California		2		450
Mono Lake, California	San Clemente Island, California		1		580
Mono Lake, California	Magdalena Bay, Baja Sur, Mexico			1	1,635
Honey Lake, California	Elkhorn Slough, California		1		415
Honey Lake, California	Santa Barbara Harbor, California		1		660

winter. Birds banded at Mono Lake, California were located between southern Monterey Bay, California and Magdalena Bay, Baja Sur, Mexico (Fig. 1, Table 2, Page et al. 1986). We also found two Snowy Plovers banded at Honey Lake, California by L. Oring (pers. comm.) on the California coast (Fig. 1, Table 2).

DISCUSSION

Our study did not reveal any significant differences in wintering areas related to age or gender. There was no evidence that males and females from Lake Abert wintered in separate areas. Although the probability of sighting males and females from Mono Lake during the winter appeared to be different (Table 1, $P = 0.08$, Fisher Exact Test), the small number of wintering birds that were located limited the power of the statistical test; this made it impossible to draw a meaningful biological conclusion concerning the geographic separation of males and females from Mono Lake in winter.

We found that Snowy Plovers from breeding areas in the interior of western North America winter along the Pacific coast and in the Gulf of California. Birds from Lake Abert, Oregon were found in winter months along the Pacific coast from northern California south to Guerrero Negro, Baja Sur, Mexico. In contrast, no adult or immature birds banded at Great Salt Lake, Utah were located in California or in Baja Norte despite an extensive search effort. Our limited data suggest the Gulf of California coastline and the west coast of Baja Sur are the primary wintering areas for birds breeding in northern Utah.

We cannot explain the absence of birds from Great

Salt Lake along the California coast during winter. Distance is eliminated as a factor. It is about 970 km from Great Salt Lake to the central California coast (San Francisco Bay) and 1,100 km to the southern California coast (Santa Barbara) whereas the closest documented wintering area of a Great Salt Lake breeder was 1,104 km away (Table 1).

Only 20% of the breeding birds banded at Lake Abert were located on the heavily-searched coastline of California and on the reasonably well surveyed coast of Baja Norte. However, some wintering birds from Lake Abert were undoubtedly missed in California and western Baja, as corroborated by the sighting of nine birds only during migration periods. While no breeding birds from Lake Abert were located on either coast of the Gulf of California (Fig. 1), some may winter there. We surveyed a very limited amount of the potential wintering habitat in the Gulf of California. If distance were a primary factor in selection of wintering areas, the winter range we report for birds from western Great Basin breeding sites would be the most logical since it is further to the closest Gulf of California wintering area (Lake Abert, 1,269 km; Honey Lake, 1,060 km; Mono Lake, 800 km) than to coastal wintering locations in California (Table 2).

Snowy Plovers also breed inland east of the Rocky Mountains on the southern Great Plains (AOU 1983). Little is known about the wintering range of these birds. Two banded plovers from Kansas have been sighted on the Texas coast in winter (R. Boyd, pers. comm.); however, it is not known whether some breeders from the southern Great Plains also migrate to the Gulf of California or Pacific coast for winter. Further investigation of banded or radio-tagged birds will also be necessary to determine if birds from inland breeding sites west of the Rocky Mountains move as far east as the Gulf of Mexico coast for winter.

We thank the many people who searched for color-banded Snowy Plovers during winter and Frances Bidstrup for coordinating their efforts. L. Oring kindly provided information on Snowy Plovers from Honey Lake. L. Stenzel assisted with statistical analysis. The Utah Division of Wildlife Resources, Native Wildlife Section, provided funding for Peter Paton's fieldwork. Funding for work in Oregon was provided by the Oregon Department of Fish and Wildlife Nongame Program and the Bureau of Land Management, Lakeview District.

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