

Status of breeding and wintering Snowy Plovers in San Diego County, California, 1994–1999

Abby N. Powell,¹ Christine L. Fritz,² Bonnie L. Peterson, and Jill M. Terp³

U.S. Geological Survey, Western Ecological Research Center, Department of Biology, San Diego State University, San Diego, California 92182-4614 USA

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ABSTRACT. We conducted intensive surveys of breeding and wintering Snowy Plovers (*Charadrius alexandrinus nivosus*) in San Diego County from 1994 through the winter of 1999. We found Snowy Plovers using 11 sites within the study area for nesting and at least 18 sites were used during winter months. Estimated breeding populations of Snowy Plovers within San Diego County fluctuated among years, and males always outnumbered females; fewer than 325 Snowy Plovers were present during any breeding season. Two sites consistently supported 65% of nesting pairs during this study, both at military installations. Nesting sites with fewer than five breeding pairs were unlikely to produce fledglings. Nest success over the entire area ranged from 50–58% and reproductive success was on average fewer than 0.5 fledglings produced per adult plover. Approximately 227–367 Snowy Plovers wintered within San Diego County from 1995–1999, which is within the range of winter population estimates from the mid-1980s. Neither breeding nor wintering numbers of plovers in San Diego County have increased since the 1980s, and it is unlikely that populations can increase given the low rates of reproduction. In addition, the concentration of most nesting pairs at a few sites makes this population more vulnerable to local extirpation.

SINOPSIS. **Estatus de individuos reproductivos e invernales de *Charadrius alexandrinus* en el condado de San Diego, California, 1994–1999**

Llevamos a cabo un estudio intensivo del estatus de individuos reproductivos e invernales de playeritos (*Charadrius alexandrinus*) en el Condado de San Diego en California de 1994 hasta el invierno de 1999. Dentro del área de estudio, encontramos playeritos utilizando once (11) localidades para anidar y al menos otras dieciochos (18) durante los meses de invierno. El estimado de la población reproductiva de playeritos en el Condado de San Diego, fluctuó entre años. Los machos siempre estuvieron en mayor número que las hembras y durante cualquier época reproductiva nunca hubo menos de 325 playeritos. El 65% de las parejas nidificantes se encontraron en dos localidades, ambas instalaciones militares. Localidades con menos de cinco (5) parejas reproductivas tuvieron baja probabilidad de producir pichones. El éxito de anidamiento en toda el área varió de 50%–58% y el éxito reproductivo fue en promedio menos de 0.5 volantones producidos por adultos. Entre 1995–1999, entre 227 y 367 playeritos pasaron el invierno en el Condado de San Diego. Estos estimados poblacionales caen dentro del rango para las poblaciones invernales estimadas en la misma localidad para mediados de 1980. Desde esta fecha ni las parejas anidantes o el número de aves invernales han incrementado en el Condado de San Diego y es poco probable que la población aumente dado la baja tasa de reproducción. La concentración de la mayoría de las aves reproductoras en dos localidades hacen muy vulnerable a esta población a la extinción local.

Key words: *Charadrius alexandrinus nivosus*, nest success, populations, southern California, Threatened and Endangered Species

Snowy Plovers (*Charadrius alexandrinus nivosus*) use wide, sparsely vegetated beaches, dredge spoils, salt pans, and levees around salt evaporation ponds for nesting and wintering

and as migratory stopover sites (Page et al. 1995a). Loss of these habitats due to urbanization and heavy recreational use has been severe in southern California, particularly along beachfronts (Page and Stenzel 1981). The changes along the Pacific Coast have resulted in considerable loss of suitable habitat for Snowy Plovers (Page et al. 1995a). As a result, the Pacific Coast population has declined over the past 20 yr and was federally listed as Threatened in 1993 (Federal Register 1993; Powell 1998).

Researchers from Point Reyes Bird Observatory (PRBO) conducted extensive state-wide

¹ Corresponding author. Current address: Alaska Cooperative Fish and Wildlife Research Unit, University of Alaska Fairbanks, Fairbanks, Alaska 99775-7020 USA. Email: <ffanp@uaf.edu>

² Current address: California Department of Fish and Game, 4949 Viewridge Avenue, San Diego, California 92123 USA.

³ Current address: U.S. Fish and Wildlife Service, Carlsbad Field Office, 2730 Loker Avenue West, Carlsbad, California 92008 USA.

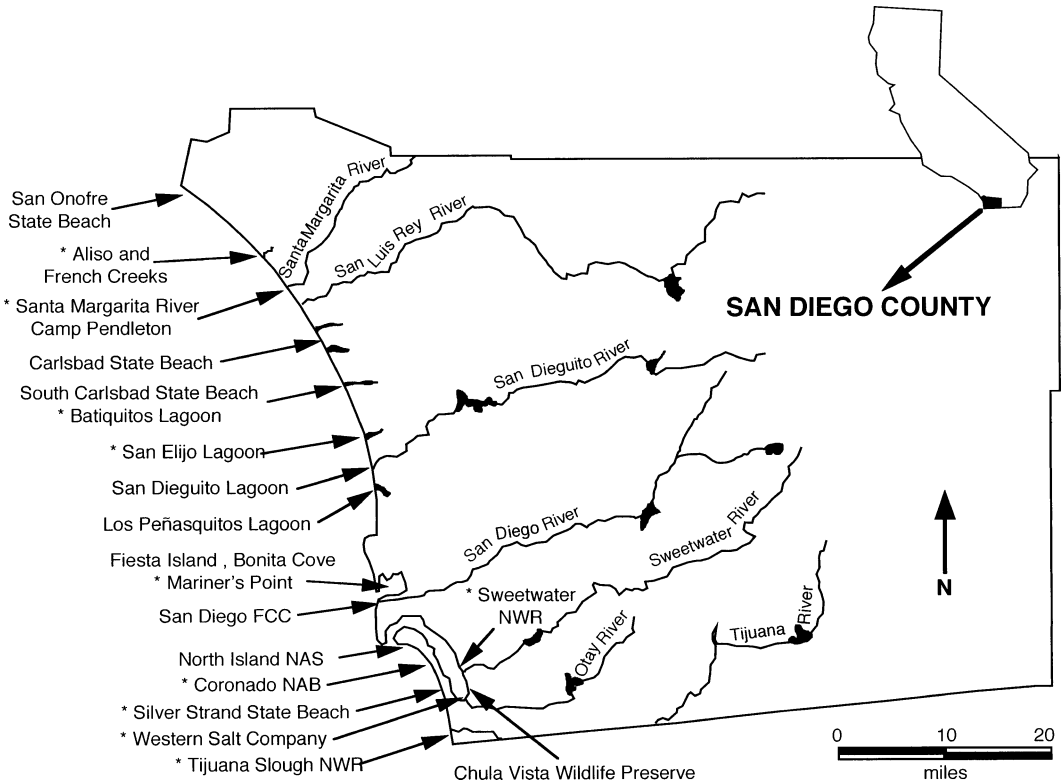


Fig. 1. Sites surveyed for breeding and wintering Snowy Plovers in San Diego County, California, 1994–1999. Asterisks indicate breeding areas.

surveys of wintering and breeding Snowy Plovers in California in the 1970s and 1980s, including San Diego County (Page and Stenzel 1981; Page et al. 1986, 1991). Historically, several coastal lagoons in the county supported breeding Snowy Plovers, but habitat loss and alteration of water flows have caused these sites to be degraded. In recent years only a few lagoons have sporadically supported breeding pairs (Page and Stenzel 1981; California State Coastal Conservancy 1989). Snowy Plovers have also lost considerable beach nesting habitat. As of 1989, Snowy Plovers no longer bred in Los Angeles County and only one nesting area, Bolsa Chica Lagoon, remained in Orange County (Page et al. 1991). As a result, San Diego County now supports most of the breeding Snowy Plover population in the region. In San Diego County there are more sites that support wintering plovers than breeding plovers. Therefore, San Diego County also provides more wintering habitat than elsewhere in the region

(Page et al. 1986). This paper summarizes results of intensive surveys of breeding and wintering Snowy Plovers in San Diego County from 1994 to 1999. We monitored Snowy Plover habitat to estimate: (1) use of sites within the county by breeding, migrating, and wintering plovers, (2) number of resident Snowy Plovers in the county, and (3) annual variation in site use and reproductive success.

STUDY AREA AND METHODS

We surveyed all potential breeding sites within San Diego County for Snowy Plover nesting activity throughout the breeding season (1 March–31 August) in 1994–1998 (Fig. 1). Data on early nests were missing for 1994 because we did not begin our surveys until April that year. Locations of potential breeding sites ranged approximately 125 km along the coast from San Onofre State Beach in the north (33°23'00") to Tijuana Slough in the south

(32°33'00"). Breeding sites were managed by federal agencies (U.S. Department of Defense—Camp Pendleton Marine Corps Base (MCB), North Island Naval Air Station (NAS), Coronado Naval Air Base (NAB), Naval Coronado Radio Receiving Facility (NRRF), and U.S. Fish and Wildlife Service—Sweetwater Marsh National Wildlife Refuge (NWR), Tijuana Slough (NWR)), state agencies (California State Parks—Silver Strand State Beach and California Department of Fish and Game—Batiqitos Lagoon, Tijuana Slough), and private landowners (Western Salt Company). All of these areas, with the exception of Sweetwater Marsh NWR, Batiqitos Lagoon (after 1994), and Western Salt Company, consisted of sandy beach or salt pan habitats. The nesting area at Sweetwater Marsh consisted of dredged material, and Western Salt Company habitat was made up of dikes.

We conducted intensive nest searches by foot and marked nests found with numbered tongue depressors 1 m to the west of each nest. We revisited plover nests 1–3 times per week from initiation or date first found until they hatched (or failed) to determine clutch size, hatch success, or cause of nest failure. We also received information on nests between our visits from people monitoring California Least Tern (*Sterna antillarum browni*) nests, resulting in a range of observation frequencies of daily to three times a week per nest. We did not examine contents of nests if we observed adults incubating. If we thought that nests might not be attended because the eggs were cold, we did not observe adults in the area, or there were no plover footprints around the nest, we moved an egg so that the smaller end was pointed up. If the egg remained in this position the next time we checked, the nest was considered abandoned. Likewise, if eggs were gone from a nest before it was expected to hatch, we examined the area surrounding the nest for evidence of predation or hatching. Signs of predation included footprints or other sign, broken eggshells, or punctured eggs. Signs of hatching included observations of the adults nearby with chicks or intense distraction displays and observations of clean eggshell caps with loose and clean membranes in or near the nest (Maybee 1997). We trapped adult plovers using open-bottomed Potter traps or noose mats and banded individuals with unique color combinations and stan-

dard aluminum bands. Chicks were banded at hatching with unique color combinations.

Nest success was estimated using the Mayfield method (Mayfield 1961, 1975) and is reported with 95% confidence limits. We then estimated the total number of nests by dividing the number of successful nests (in which ≥ 1 egg hatched) by the Mayfield estimate of nest success (Johnson and Shaffer 1990). Percent of nests we did not find was estimated by dividing the number of found nests by the number of estimated total nests and subtracting from 100. We compared categories of nest outcome for failed nests (abandoned, flooded, depredated, unknown) among years with a chi-square test. We estimated fledging success as the number of fledglings produced per nest attempt and compared fledging success among years with analysis of variance. Finally, we estimated the number of fledglings produced per male and female plover using a modification of the method used by Page et al. (1983).

Snowy Plovers have multiple nests within a given breeding season, and all adult plovers were not banded. We therefore calculated the number of known nesting attempts for each banded individual to estimate mean numbers of nests per year for males and females. To estimate breeding populations, we assumed that all successful nests were found, hence that plover numbers could be estimated by dividing numbers of successful nests (N_s) by products of Mayfield estimates (\hat{S}) and by mean numbers of nests initiated by individual plovers (\hat{i}). We used quantiles of 1000 bootstrap replicates to estimate approximate 95% confidence limits for plover numbers. During bootstrapping, we resampled nests to generate replicates of \hat{S} and plovers to generate replicates of \hat{i} , but treated N_s as a constant.

We conducted winter surveys along the coast of San Diego County including all of the breeding areas mentioned above. In addition, we surveyed San Onofre, Carlsbad, and South Carlsbad State Beaches; San Dieguito, San Elijo, and Los Peñasquitos Lagoons; San Diego Flood Control Channel (FCC), South Mission Beach, Mission Bay (Fiesta Island and Bonita Cove), and South Bay Marine Reserve for wintering plovers (Fig. 1). We did not survey Western Salt Company because it was privately owned and the U.S. Fish and Wildlife Service (USFWS) was conducting surveys there. Each site was sur-

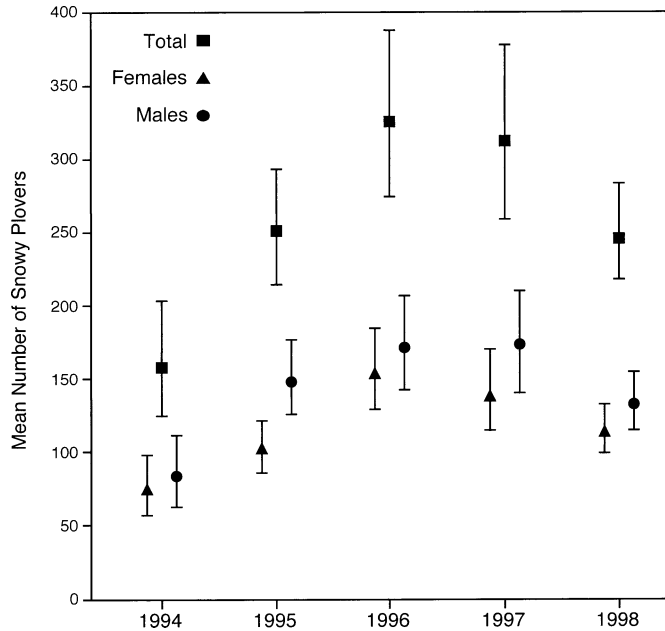


Fig. 2. Population estimates of Snowy Plovers breeding in San Diego County, 1994–1998.

veyed 1–2 d per month September through February, 1995–1999, but not all sites were surveyed in every year. Surveys for all sites were usually conducted within a 2-d window to minimize variations in weather and plover movements. We slowly walked or drove along the beaches and counted plovers through binoculars or spotting scopes. If individual plovers moved during our census, we watched where they went to avoid double-counting them. Plovers generally did not move from where they were resting or foraging during the non-breeding months. We recorded color-band combinations, sex and age of individuals, and size of flocks. To distinguish migrating from overwintering birds, we defined fall as 1 September through 31 October, and winter as 1 November through 28 February (Page et al. 1986; Warriener et al. 1986). We report numbers of plovers per season as means \pm SE.

RESULTS

Breeding population. We found Snowy Plovers nesting at 11 sites within San Diego County during 1994–1998, including two major areas within Camp Pendleton MCB: Aliso Creek/French Creek area and the Santa Margarita River mouth. Two coastal lagoons, Bati-

quitos and San Elijo, supported breeding plovers, while Mariner's Point was the only site within Mission Bay used for nesting and only in 1995. The remaining eight sites were located around San Diego Bay: Coronado NAB, which included both Delta Beach along the bay and the ocean beach to the west; Silver Strand State Beach, Coronado NRRF, Sweetwater Marsh NWR, Chula Vista Wildlife Preserve (CVWP), Western Salt Company, and Tijuana Slough NWR (Fig. 1).

The estimated breeding population of Snowy Plovers in San Diego County ranged from 158–325 individuals, but estimates for 1994 were lower because no plovers were banded at the start of this study and monitoring began at a later date than in other years (Fig. 2). In general, there were more males than females present during the breeding season each year (Fig. 2). For all years, Camp Pendleton MCB consistently supported more Snowy Plover nests (49%) than any other site. Coronado NAB (16%) and Batiquitos Lagoon (16%) supported similar percentages of nests, with use of both sites increasing over the five years of our study (Table 1).

The earliest nest in San Diego County was initiated on 10 March, but most nests were ini-

Table 1. Location (listed from north to south) of Snowy Plover nesting areas, number of apparent nests, and fledglings per nest in San Diego County, California, 1994–1998.

Location	1994 ^a			1995			1996			1997			1998		
	No. nests	Fledglings \bar{x}	SE	No. nests	Fledglings \bar{x}	SE	No. nests	Fledglings \bar{x}	SE	No. nests	Fledglings \bar{x}	SE	No. nests	Fledglings \bar{x}	SE
Camp Pendleton MCB															
Aliso-French Creeks	10	0.90	0.35	6	0.50	0.22	6	0	0	8	0.13	0.13	7	0.86	0.34
Santa Margarita River	43	0.19	0.06	88	0.18	0.52	81	0.24	0.07	67	0.42	0.09	72	0.47	0.10
Batiquitos Lagoon	5	0.40	0.25	15	1.40	0.32	40	0.50	0.12	40	0.30	0.09	29	0.28	0.09
San Elijo Lagoon	5	0	—	0	—	—	0	—	—	0	—	—	0	—	—
Mariner's Point	0	—	—	1	0	—	0	—	—	0	—	—	0	—	—
Coronado NAB															
Ocean Bay	9	1.56	0.38	17	1.00	0.21	23	0.48	0.17	38	0.71	0.17	27	0.78	0.15
Silver Strand State Beach	2	0	—	0	—	—	3	0.67	0.67	5	1.60	0.68	7	0.29	0.29
Coronado NRRF	—	—	—	4	0.75	0.48	7	0	—	8	0.38	0.18	10	0.40	0.22
Sweetwater Marsh NWR	1	0	—	0	—	—	2	0	—	1	3	—	0	—	—
Western Salt Company	9	0.44	0.24	13	0.31	0.13	7	0.57	0.37	12	0.42	0.19	2	0.50	0.50
Chula Vista Wildlife Preserve	1	0	—	—	—	—	1	0	—	4	0.25	0.25	3	0.33	0.33
Tijuana Slough NWR	0	—	—	0	—	—	0	—	—	0	—	—	1	0	—
Total, San Diego County	4	0	—	11	0.46	0.28	17	0.35	0.19	14	0.43	0.18	13	0.23	0.12
	89	0.42	0.81	155	0.45	0.06	187	0.33	0.05	197	0.48	0.06	173	0.46	0.06

^a Effort of surveys in 1994 was not complete; thus, the number of nests was underestimated.

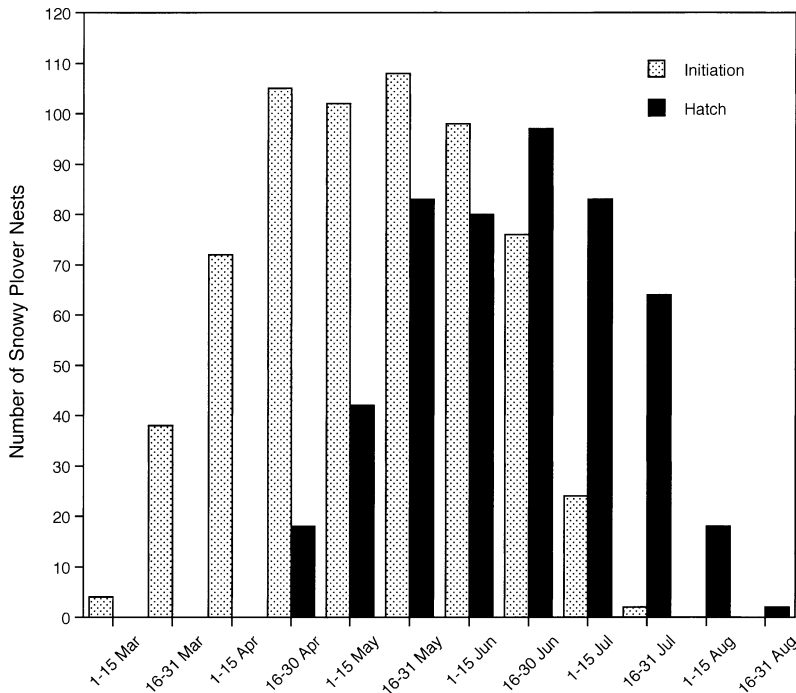


Fig. 3. Nest initiation and hatch dates for Snowy Plovers breeding in San Diego County, 1994–1998.

tiated from early April through mid-June (Fig. 3). Based on banded adults, we found that 35% of Snowy Plovers nested two or more times in a given breeding season. Nests initiated after 15 May were, therefore, probably second or third nesting attempts (Warriner et al. 1986). Snowy Plover nests hatched in the county from mid-April through August (Fig. 3).

Reproductive success. We estimated that we found between 83% (in 1994) and 93% (in 1995) of Snowy Plover nests in 1994–1998. Estimated nest success in San Diego County ranged from a low of 43% (36–53%) in 1997 to a high of 68% (60–77%) in 1998. Estimated nest success was 51% (39–66%) in 1994, 64% (56–74%) in 1995, 46% (39–55%) in 1996, and 54% (50–58%) for the five years combined. Causes of nest failure varied by year ($\chi^2_{12} = 36.1$, $P < 0.001$). Predation accounted for most nest failure in 1994, 1996, and 1997 (Fig. 4). Documented egg predators included Common Ravens (*Corvus corax*), American Crows (*C. brachyrhynchos*), coyotes (*Canis latrans*), Argentine ants (*Iridomyrmex humilis*) and gulls. Flooding of Snowy Plover nests occurred during extreme high tides, both in salt pan habitats

and on sandy beaches, and had the highest impact in 1995 (Fig. 4).

Mean fledging success for the county did not vary among years ($F_4 = 1.16$, $P = 0.32$) and was always less than 0.5 fledglings produced per nest. In general, sites with fewer than five nests rarely produced fledglings (Table 1), and fewer fledglings were produced per male than per female. Females produced, on average, <0.5 fledglings each year (0.29 in 1994, 0.37 in 1995, 0.19 in 1996, 0.40 in 1997, 0.50 in 1998), whereas males produced <0.45 fledglings per year (0.26 in 1994 and 1995, 0.15 in 1996, 0.30 in 1997, 0.44 in 1998).

Unlike with egg loss, causes of chick mortality were difficult to determine. However, we documented plover chicks being caught in the mesh of fences erected around Least Tern colonies at Camp Pendleton MCB in 1995. In 1997, a chick at Camp Pendleton was killed by a Great Horned Owl (*Bubo virginianus*) and another died after its leg was caught in a stick. At Tijuana Slough NWR, a Burrowing Owl (*Athene cunicularia*) killed a plover chick in 1997; its aluminum band was found in the owl's burrow (R. Patton, pers. comm.). Two fledglings from

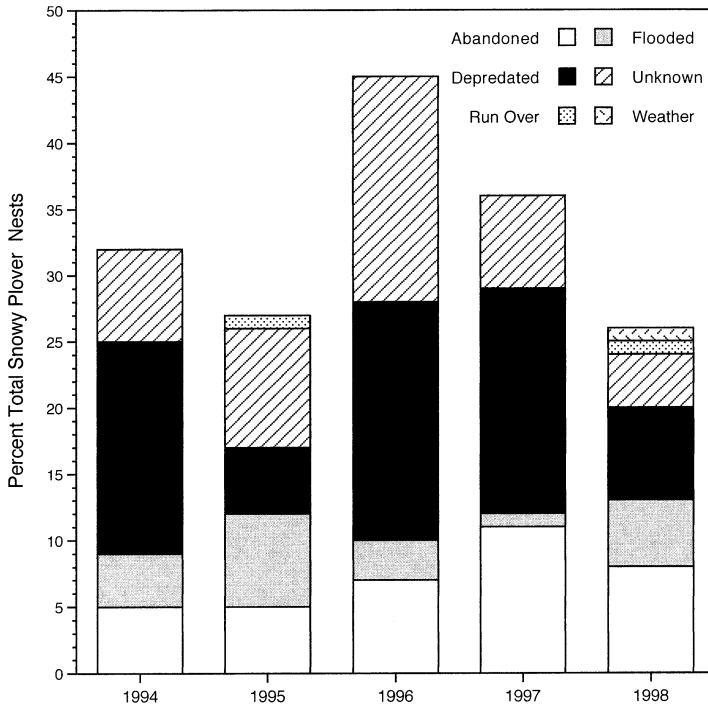


Fig. 4. Causes of nest failure for Snowy Plovers breeding in San Diego County, 1994–1998.

Sweetwater Marsh NWR were found dead in 1997, apparently killed by an American Kestrel (*Falco sparverius*).

Winter population. A minimum of 18 sites in San Diego County supported migrating and wintering Snowy Plovers. These included all 11 breeding sites in the county as well as many sandy beaches with heavy recreational use, including San Onofre and Carlsbad State Beaches, Fiesta Island, Bonita Cove, and South Mission Beach (Table 2). Coastal lagoons also supported plovers during the non-breeding seasons, as did San Diego River FCC. Some locations within the county supported more plovers during fall migration than during winter, including San Diego River FCC and Tijuana Slough. Although the San Diego River mouth was channelized, both it and the Tijuana River provided foraging habitat for Snowy Plovers during low tides. In contrast, Sweetwater Marsh NWR supported more plovers in winter than during fall migration, probably because plovers overwintering around the general vicinity of San Diego Bay used Sweetwater's extensive mudflats during low tides and congregated there to forage.

Based on our winter surveys (excluding Western Salt Company), we found a range of 227–367 Snowy Plovers wintering within San Diego County from 1995–1999. Winter numbers were within the range estimated for the county by PRBO in 1984 (257 plovers) and 1986 (346 plovers), which also did not include Western Salt Company (Page et al. 1986). Although we found numbers of breeding and wintering plovers in the county to be similar, they were not the same individuals. We found that in a given year, 15–27% of plovers banded in San Diego overwintered at or near their corresponding nesting site. For example, overwintering plovers that nested at Camp Pendleton stayed at the mouth of the Santa Margarita River, and those that bred at Batiquitos Lagoon stayed at the lagoon or South Carlsbad State Beach. In contrast, plovers that nested at sites around San Diego Bay were observed using multiple sites around the bay during winter.

Snowy Plovers banded within San Diego County but that migrated elsewhere for winter have been observed at San Clemente Island, Crystal Cove State Beach, Morro Strand, Piedras Blancas, Arroyo Laguna Creek, and Van-

Table 2. Numbers of Snowy Plovers observed in San Diego County in fall (1 September–31 October) and winter (1 November–28 February), 1995–1999.

	Fall				Winter			
	Counts ^a	\bar{x}	SE	Range	Counts ^a	\bar{x}	SE	Range
San Onofre State Beach	2	13.5	4.5	9–18	5	9.6	3.5	0–18
Aliso-French Creeks	11	9.7	1.6	0–17	20	12.1	1.5	0–26
Los Flores Creek	8	19.9	4.0	6–39	9	21.7	4.8	1–42
Santa Margarita River Estuary	16	36.4	3.4	17–63	28	37.5	2.1	19–66
Batiquitos Lagoon	10	18.7	5.7	0–61	11	4.8	2.5	0–27
Carlsbad State Beach	10	22.3	4.9	0–44	21	12.9	2.9	0–42
San Elijo Lagoon	12	2.2	1.2	0–12	22	0.7	0.4	0–7
San Dieguito Lagoon	11	0.0	0.0	0–0	24	0.1	0.1	0–1
Los Penasquitos Lagoon	12	7.7	2.1	0–23	25	12.8	1.6	0–25
Fiesta Island	14	7.3	1.4	0–16	26	9.5	1.3	0–22
Bonita Cove	13	4.8	4.3	0–56	27	33.7	6.0	0–83
San Diego River FCC	14	16.4	7.9	0–80	26	9.2	3.7	0–73
South Mission Beach	10	29.9	8.5	0–62	19	24.7	5.7	0–70
North Island NAS	4	25.0	2.9	18–31	8	15.5	2.0	7–21
Coronado Beach (NAB)	15	37.5	5.9	2–74	27	30.7	5.9	0–97
Delta Beach (NAB)	12	6.4	2.1	0–18	27	9.2	2.2	0–35
Silver Strand State Beach	15	34.3	4.6	3–61	27	10.9	3.8	0–74
NRRF	5	8.6	3.1	1–19	11	3.5	1.5	0–13
Sweetwater Marsh NWR	12	5.8	2.5	0–26	24	25.1	8.2	0–177
South Bay Biological Station	14	5.9	2.7	0–36	26	5.2	2.3	0–54
Tijuana River Estuary	12	54.2	8.0	28–121	26	11.1	2.0	0–35

^a Number of surveys from 1995–1999.

denberg Air Force Base in California. San Diego plovers have also been documented in Baja California, Mexico, during winter at Estero Punta Banda, Playa Misión, and Laguna Ojo de Liebre (Scammon's Lagoon). We observed banded Snowy Plovers from Monterey, Santa Cruz, and Santa Barbara counties, California, using wintering sites within San Diego County.

DISCUSSION

Page and Stenzel (1981) estimated 257 breeding plovers in 1978 and 115 in 1989 at 10 sites throughout San Diego County (Page et al. 1991). Our five-year mean was 243 individuals, but discrepancies in survey results were most likely due to the difference in intensity of survey effort and the changes in certain sites, particularly coastal lagoons, due to human use. Page and Stenzel's (1981) extensive surveys included the entire coast of California, with each site surveyed on one day during the breeding season by one or two people. Our study was more intensive in scope and included banding, nest searches, and weekly counts at each site conducted by several people throughout the

breeding season. It is misleading, therefore, to compare the numbers of plovers we found to the population estimates made by PRBO (Page and Stenzel 1981; Page et al. 1991). We expected, however, that our intensive surveys would result in greater numbers of breeding pairs. The estimated number of breeding pairs found by both methods was similar, however, despite the facts that we found additional breeding sites and closely monitored the area over extended periods of time each year. This may be strong evidence that the southern California population of Western Snowy Plovers has continued to decline significantly.

Our intensive surveys also documented use of areas not identified by the extensive statewide surveys conducted by PRBO. These included Mission Bay and Chula Vista Wildlife Preserve (both used once in the five years of our study), North Island NAS, Silver Strand State Beach, and Coronado NRRF. We also documented shifts in habitat use with regard to coastal lagoons in the county. Snowy Plovers no longer use lagoons that have become degraded due to loss of tidal influence (San Elijo, San Dieguito) and heavy recreational use or dredging (Agua

Hedionda). Use of Batiquitos Lagoon increased only after restoration of tidal flow and creation of new nesting areas during the mid-1990s. Finally, only two sites (Camp Pendleton MCB and Coronado NAS) supported an average 65% of the total Snowy Plover nests in the county. The fact that only two sites consistently supported over 60% of all Snowy Plover nests in the county suggests a need for greater protection and enhancement of the nesting areas that are not managed by military installations.

We also observed a shift in habitat use by breeding Snowy Plovers in San Diego County over the past 20 yr. In the late 1970s Page and Stenzel (1981) found Snowy Plovers breeding in large numbers in the county's coastal lagoons. For example, they estimated 27 pairs at Agua Hedionda Lagoon and 12 pairs at San Elijo Lagoon in 1979. Although Page et al. (1991) found a 55% decline in breeding plovers in northern San Diego County 10 yr later, they did not specify any habitat changes that might have accounted for the decline. We found five nests at San Elijo Lagoon in 1994 and none thereafter. Nesting habitat was not available at San Elijo Lagoon because a culvert was blocked from 1995 to 1998, which flooded the eastern salt pan during breeding season. In addition, we found no breeding plovers at Agua Hedionda Lagoon during our study. Agua Hedionda was used heavily for recreation, including jet-ski rental and a YMCA day camp, and has undergone extensive dredging to maintain cooling for intake pipes at the power plant. Batiquitos Lagoon was an exception, however, because nesting by plovers increased from 1994 to 1998. In 1994, five pairs of Snowy Plovers nested along the narrow perimeter of salt pan on the northeastern shore of the lagoon. Dredge-spoil islands were created in the lagoon from 1994 to 1996, and the lagoon's mouth was restored to tidal flushing 1997 (Powell and Collier 2000). Although the salt pan habitat historically used for nesting was no longer available, the number of nesting plovers increased to a high of 40 nests in 1996 and 1997 after new nesting areas were created.

Another shift in breeding habitat use may have occurred in south San Diego Bay. Page and Stenzel (1981) found 16 breeding pairs at the Western Salt Works, but we documented only 1–2 pairs. We did not intensively survey this site, however. Populations of several species

of colonial waterbirds including the California Least Tern, Caspian Tern (*Sterna caspia*), Royal Tern (*S. maxima*), Elegant Tern (*S. elegans*), Forster's Tern (*S. forsteri*), Black Skimmer (*Rynchops niger*), and Gull-billed Tern (*S. nilotica*) have increased over the past 30 yr (D. Stadlander, pers. comm.). Competition for limited nesting space along the tops of dikes may be limiting use by Snowy Plovers. We found more breeding Snowy Plovers during our study than PRBO on the sandy beaches of Camp Pendleton MCB and Coronado NAB. Both are U.S. military installations that have protected California Least Tern nesting colonies using predator control and restrictions on civilian and military activities since the mid-1980s. These two areas combined accounted for approximately 65% of Snowy Plover nesting attempts within San Diego County during this study.

In addition to loss of breeding pairs, reproductive success in San Diego County was lower than in coastal northern California over the same years (G. Page, pers. comm.). The reasons for this difference are still unclear, and we suspect that higher levels of human disturbance may be a factor. Female Snowy Plovers typically leave their clutches at or soon after hatching, leaving the male parent to rear the brood alone (Warriner et al. 1986). Broods are mobile and often the single male parent cannot attend all the chicks simultaneously. Long distances are often traveled by newly hatched chicks, and they can get separated from their parent and succumb to hypothermia or starvation. Separation of chicks from their parents can be caused by human disturbance, the presence of predators, and domestic pets. Disturbance has been documented to increase both egg and chick mortality in Snowy and Piping Plovers (*Charadrius melodus*; Warriner et al. 1986; Flemming et al. 1988; Melvin et al. 1994; Staine and Burger 1994). We believed at least one chick died of exhaustion in 1997, after we observed it repeatedly trying to climb deep ruts left by heavy tracked vehicles at Camp Pendleton MCB. The reduced number of breeding pairs combined with the low reproductive rates we found in San Diego County further indicates that this population continues to be at high risk of decline and perhaps local extinction.

The numbers of Snowy Plovers we found

wintering within San Diego County were not different than those found by surveys conducted by PRBO. Sites used by migrating and wintering plovers within the county are not only important to local birds, but also to plovers from other populations. We documented few plovers during winter that were banded at breeding areas outside of San Diego County, so we still do not know the origin of the majority of winter birds. We suspect that Snowy Plovers nesting in Santa Barbara County, including the Channel Islands, may be using San Diego sites. Unfortunately, there are few color-banded plovers from that area. Snowy Plovers that nest at interior sites in Oregon and California also use sites along the coast of southern California for wintering and migration (Page et al. 1995b). Protection of coastal habitats in San Diego County is critical for both inland and coastal populations of western Snowy Plovers.

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