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THE BREEDING STATUS OF THE SNOWY PLOVER IN CALIFORNIA

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The western race of the Snowy Plover (*Charadrius alexandrinus nivosus*) breeds on the Pacific coast from southern Washington to southern Baja California, inland in Oregon, California, Nevada, Utah, Colorado, New Mexico, Kansas, Oklahoma and Texas, and along the coasts of Texas and northeastern Mexico (AOU 1957). For many years ornithologists believed that the number of Snowy Plovers breeding along the Pacific coast was declining as development destroyed suitable habitat. In May, June and July, from 1977 to 1980, Point Reyes Bird Observatory (PRBO) biologists and volunteers conducted surveys of potential breeding habitat throughout California to gather information on the distribution and abundance of Snowy Plovers. This paper summarizes the results of those surveys and the available data on the species' past abundance and distribution. We attempt to define suitable breeding habitat and to describe the effects of human activities on it. Detailed studies of marked birds undertaken by John and Jane Warriner at Pajaro Dunes on Monterey Bay have been very helpful in interpreting the survey results. Their information on migration periods, mid-breeding season movements and the detection rate of birds on censuses is summarized in this paper. Detailed information on the occurrence of birds at specific sites is available in a report (Page and Stenzel 1979) on file with the California Department of Fish and Game in Sacramento. If readers have information indicating greater breeding numbers or know of breeding sites not mentioned here, we and the Department of Fish and Game encourage them to contact us.

METHODS

The breeding survey covered the coast between the Golden Gate and the Oregon border in 1977, the remainder of the California coast and interior in 1978, and the Channel Islands from 1978 to 1980. A list of all sites surveyed on the mainland can be derived from Appendices 1 and 2.

Susan Peaslee and Gary Page, with occasional help from others, covered the coast from the Golden Gate to the Oregon border between 16 May and 11 June 1977. From USGS topographical maps they located beaches ap-

pearing to have sand or pebble habitat above the high water mark. They surveyed these beaches, starting in Marin County and proceeding north to Del Norte County. Additional censuses to recheck certain beaches during the last 3 days were taken in Humboldt County. On every beach all open habitat was checked and heavily vegetated or littered areas were sampled. Physical characteristics, vegetation, debris cover, evidence of nest predators, and level of human disturbance were recorded. The age and sex of Snowy Plovers were determined when possible. Adult males were distinguished by their black forehead, cheek and shoulder plumage; some males also had a distinctive rusty cap which females lacked. Adult females were recognized by browner feathering in these regions, and juveniles by distinctive pale edgings on wing coverts. We attempted to find the nests of all birds whose behavior suggested they might be incubating. Descriptions of each nest included the presence or absence of nearby objects, substrate type, distance from water and openness of habitat within a 10 m radius. Broods of chicks also were located and the size and number of young recorded.

In some areas it was impossible to detect all plovers, and estimates were made to partially correct for missed birds. We used four methods to estimate the number of breeding pairs: 1) total adults divided by 2; 2) total pairs seen; 3) total single females or males with nests or broods; and 4) total pairs seen plus single adults with nests or broods. For each area the method resulting in the highest number of pairs was used.

From 8 May to 26 June and on 9 July 1978 Lynne Stenzel and Susan Peaslee made censuses or spot checks of beaches, lagoons, river mouths and bars, bay shores, salt pans and saltworks along the coast between Border Field, San Diego County, and the Golden Gate. Suitable areas for censuses were selected from USGS topographical maps, references in the literature, and many unpublished field observations. Only in Los Angeles County, where we assumed beach grooming activities precluded the possiblity of nesting, did we knowingly exclude some sand beach from our survey. Our findings on the similarly groomed beaches of Orange County and a description of how grooming makes plover nesting virtually impossible are reported in the results. Although the survey progressed from south to north, there was some back-tracking or skipping ahead so that censuses could be made at heavily used areas on weekdays and at restricted access areas on weekends.

Survey methods were similar to those used in 1977 except that nest descriptions were more detailed and included information on the topographic relief within 1 and 10 m. A search was made for nests and broods to establish evidence of breeding in each locality, but to minimize survey time and disturbance, particularly in Least Tern (*Sterna albifrons*) nesting areas, no attempt was made to locate all nests.

The interior survey lasted from 26 April until 13 July 1978. Philip Henderson first checked areas in the San Joaquin Valley and around the Salton Sea. He then generally moved northward, working alone until 1 June when Gary Page joined him in Inyo County. Potential breeding areas were selected from USGS topographical maps, from ornithological literature and from discussions with persons familiar with the distribution of California birds. Alkaline lakes particularly were sought out, but if these lacked standing water they were not surveyed because plovers were assumed to be absent.

Survey methods varied according to each area's physical characteristics and accessibility by car. At each area we took many photographs and notes on vegetation and physical characteristics. We recorded the age and sex of plovers whenever possible although sometimes glaring, midday lighting or the large number of plovers encountered at one time made this task impossible. We attempted to find some nests or broods in each area and described nests similarly to those on the coast.

Nancy Spear conducted surveys of the breeding populations on four of the Channel Islands. On 25 and 26 April 1978 she searched beaches on San Clemente Island and between 19 and 21 May 1978, with Hal Spear and Bob Jackman, beaches on San Nicolas Island. From 13 to 18 July 1979 the Spears and Mike Hill covered most of San Miguel Island's beaches, and on 22 July Bud Antonelis surveyed five additional ones. From 4 to 7 June 1980 the Spears surveyed beaches on the east end of Santa Rosa Island. On all surveys they recorded the number and location of all plovers and whenever possible, their age and sex.

The historical status of breeding Snowy Plovers throughout the state was inferred from breeding records in the literature, from unpublished field notes, and from egg and nest collection records and summarized in Appendix 1. Sources of unpublished records are listed in Appendix 3.

RESULTS

I. CHANNEL ISLANDS

NANCY L. SPEAR

Based on my surveys, at least 130 pairs of Snowy Plovers breed on San Nicolas, San Miguel and Santa Rosa islands (Table 1). The species also may breed on Santa Cruz Island, although the lack of nest records from earlier in the century when the island was regularly visited by egg collectors (Kiff pers. comm.), as well as the low number of wide sandy beaches, does not attest well to the species' presence there. The remaining islands probably are not used by breeding plovers. As the following accounts illustrate, habitat availability rather than human disturbance appears to be the major factor limiting breeding distribution on the Channel Islands.

San Clemente Island. This 34 km long, narrow island lies 69 km south-southwest of Point Fermin. Sandy beaches, once reported as common along the west and north sides, now exist only on the north; beach areas to the south, once reportedly sandy, are now primarily covered with rocks. The Navy maintains a small base on the island and infrequently conducts large-scale maneuvers covering the island and using beaches as entry points.

Snowy Plovers probably do not breed on this island. Howell (1917) reported a few birds in fall 1907, but there have been no reports during the breeding season. I surveyed 40% of the coastline by foot and observed from a distance another 40%. I found no Snowy Plovers, nor much appropriate breeding habitat. That habitat which did exist is at Northwest Harbor, a beach used for recreational purposes as well as for minor military maneuvers. Island Foxes (*Urocyon littoralis clementae*) and Common Ravens (*Corvus corax*) occur but I doubt that their presence is a major reason for the absence of plovers.

Santa Catalina Island. The 30 km long Santa Catalina Island is rugged, mountainous and has precipitous shores with few sandy beaches. It is heavily used by the public for boating and other recreation. Although Meadows (1934) reported Snowy Plovers as common on the beach at Howland's Landing, it is now generally agreed that they do not breed regularly there (Jones pers. comm.).

San Nicolas Island. San Nicolas, the Channel Island farthest from the mainland, lies 98 km south-southwest of Point Mugu. It is 13 km long and 5 km wide. The Navy maintains a base with an airstrip on the northeast side. Sandy beaches are common along the perimeter and are backed by dunes, bluffs and sandstone rock.

Snowy Plovers are regular breeders; evidence dates back to the early 1900s when Willett (1912) found them "fairly common" and Howell (1917) reported their breeding. Reports from 1976 and 1977 indicated breeding activity with Jones (pers.comm.) describing them as "a widespread breeder every year," and Schroeder (pers. comm.) reporting them to be common and breeding in 1977 on the five beaches he surveyed monthly for bird carcasses. On my 1978 survey of 24 beaches, 133 adult, 2 juvenile and 9 chick (4 broods) Snowy Plovers were found. Adding estimates for three additional beaches surveyed by telescope from nearby bluffs, I estimate 74 breeding pairs (Table 1). No scrapes or nests were found mainly because there was little time to look for them.

Although plovers were found around all the island, the heaviest concentrations occurred on the northwest edge at Red Eye Beach, on the sandspit at the east end, and from just west of Dutch Harbor to Daytona Beach. Competition for space may occur on southwest side beaches, which support seal

Table 1. Number of Snowy Plover pairs on the Channel Islands. Sources are discussed in the text.

ISLAND	ESTIMATED PAIRS
From 1978 Survey	
San Clemente	0
San Nicolas	74
From 1979 Survey	
San Miguel	35
From 1980 Survey	
Santa Rosa	21
Estimates Based on Other Sources	
Santa Catalina	0
Santa Barbara	0
Anacapa	0
Santa Cruz	—
TOTAL OBSERVED	130

and sea lion rookeries. Although a few adults and chicks were reported on one of these beaches in 1977, we found none during the 1978 survey. Island Foxes, Common Ravens and feral cats are present but not abundant, suggesting a low threat from predators.

The birds did not appear to be disturbed by human activity, but increased naval operations, with an expected increase in personnel are proposed for the near future. This almost certainly will increase beach use and breeding activity may be affected.

Santa Barbara and Anacapa Islands. Santa Barbara and Anacapa are the smallest islands. Their shores are bold and almost perpendicular. As there are no beaches, Snowy Plovers cannot breed on either island (pers. obs., Jones pers. comm.).

Santa Cruz Island. Santa Cruz, the largest Channel Island, is 34 km long and is located 27 km west-southwest of Port Hueneme. Beaches around the island are interspersed with steep cliffs rising directly from the water; the larger beaches are on the east and west ends. A dozen anchorages around the island are heavily used during late spring and summer by cruising yachtsmen. Although access is by permit only and restricted to hiking, beaches near popular anchorages probably receive heavy use, which could deter Snowy Plovers from nesting.

The Snowy Plover's breeding status on Santa Cruz is uncertain. Howell (1917) reported the birds to be "fairly common during the late fall of 1907." Observers conducting bird carcass censuses found a few Snowy Plovers using eight beaches during August 1976 and from January to March 1977, but none from April to June, suggesting the species winters but does not breed on the island.

Santa Rosa Island. Lying 39 km southwest of Goleta Point, Santa Rosa is 24 km long and 16 km wide. Precipitous rocky shorelines constitute the north and south sides, while the east and west coasts consist of many sandy beaches.

At least 43 Snowy Plovers breed there. Between March and September, 1968 to 1976, from 2 to 40 birds have been found on the island (Collins pers. comm.). During my survey, which included all beach between Skunk and East points on the east end of the island, 43 adult and 2 juvenile Snowy Plovers were found. It is highly probable that a similar number of plovers occur on unsurveyed beaches between Cluster and Sandy points on the southwest side of the island.

Santa Rosa's beaches are privately owned and receive little human disturbance. A potential predator on plover eggs and chicks is the Island Fox, whose tracks were found on most beaches.

San Miguel Island. The westernmost island of the northern group, San Miguel lies 37 km southeast of Point Conception. The shores vary from bold, rocky cliffs to stretches of beach. Willett (1912) reported Snowy Plovers there in summer. Recent observers reported sightings in May and June 1977 and believed the species probably bred in restricted localities every year (Jones, Collins and Kelly pers. comm.).

During our 1979 survey 84 adult, 8 juvenile and 4 chick Snowy Plovers were found. As this species begins autumn migration in July, all birds seen were not necessarily breeding on San Miguel. Most birds were found singly or

in small groups but one flock of 10 may have been migrants and hence have not been included in the estimated total of 35 breeding pairs (Table 1).

Except for Cuyler Harbor, beaches on San Miguel suffer little human disturbance; however plans are currently being considered to open the island to increased public use. Island Foxes are abundant and may destroy some nests. We found fairly fresh fox tracks on most beaches.

II. MAINLAND COAST

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Survey Census Results

During the 1977 and 1978 breeding surveys 954 adults, representing an estimated 498 pairs of Snowy Plovers, were found on the mainland coast (Table 2). They occurred in 45 locations and in all but 4 either nests or chicks were found. In the remaining four areas, all in San Diego County, another observer found nests or chicks either later in the season or the following year. Breeding plovers were located in all coastal counties except Los Angeles and San Francisco. Accounts for each county, starting at the Mexican and ending at the Oregon border, follow.

SAN DIEGO COUNTY, with 26% of the estimated pairs on the coast, supported the most birds. We found breeding plovers on spits and alkali flats at the Tijuana River mouth, on salt evaporators, bay fill and beaches around San Diego Bay, on the northern lagoons, and on spits and alkali flats at the Santa Margarita River mouth (Table 2). When surveyed, Batiquitos Lagoon, flooded from winter and spring rains, had only a narrow ring of potential habitat. Later, dropping water levels exposed additional suitable nesting flats. A count of 39 adults made by others later in 1978 and, in other recent years, of 75 adults (Appendix 1), probably are more representative of plover numbers at Batiquitos than our count of 6 adults. Although we found no positive evidence of breeding at the Sweetwater River mouth, Silver Strand bay shore or Batiquitos Lagoon, nesting at these sites was confirmed later in 1978 by Parker as well as by several observers in other years (Appendix 1). We found three plovers, which showed no signs of nesting, at French Creek mouth. No subsequent visits were made that season, but in July 1979 Parker found a chick there. At Penasquitos Lagoon in 1978 he found four adults he suspected were nesting and, in 1979, a pair with a nest where we had found no plovers in 1978.

San Diego County has historical records of breeding plovers for a number of coastal sites (Appendix 1). Imperial Beach and Coronado beachfronts, Ocean Beach, Mission Bay beachfront, Pacific Beach, Del Mar Beach, Buena Vista Lagoon and the Oceanside beachfront, all former nesting sites, have been so altered in recent years by development, erosion or human use, that habitat no longer exists for nesting Snowy Plovers. Conversely, a major breeding site in the San Diego Bay area was created with the construction of the Western Salt Works where a number of plovers nest undisturbed on levees.

ORANGE COUNTY once supported substantial numbers of nesting Snowy Plovers (Appendix 1) but during our survey held only 2% of the pairs on the mainland coast; all were at the Bolsa Chica Oil Fields (Table 2). These

oil fields, on disused salt evaporators in Bolsa Chica Bay, offer relatively undisturbed alkali flats for nesting. Bay fill near Sunset Aquatic Park constitutes the only other recently used nesting area in Orange County. Nests were collected from beaches in Orange County until 1940. By 1947 Cogswell (1947) noted that formerly good beach nesting habitat had deteriorated due to increased human use. Because of raking and heavy human use, beach nesting habitat is no longer suitable for Snowy Plovers. Beaches are now raked regularly from Newport Bay north to Sunset Beach. Newport Bay spit and Sunset Beach have some unraked, vegetated portions of upper beach, but Bolsa Chica and Huntington state beaches are completely raked and denuded of vegetation. Although we found no plovers at the fenced-off Least Tern nesting site at the Santa Ana River mouth on the south end of Huntington State Beach, we suspect one or two plover pairs could nest at this small, undisturbed oasis.

Although no plovers were found during our survey, LOS ANGELES COUNTY once supported many breeding pairs. Records of nests on beaches adjacent to metropolitan Los Angeles, at Redondo and Ballona, are all prior to 1908 (Appendix 1), although a plover incubating a nest amid many human bathers was photographed on Manhattan Beach in 1947 (Cogswell 1947). In 1903 one egg collector reported counting 50 pairs of plovers along a 2 mile stretch of beach between Ballona and Santa Monica (NMNH egg set 31481). In 1938 a set of eggs was collected from a beach where six plover nests were said to be present among those of Least Terns 8 km north of Malibu (WFVZ egg set 3497). We have been unable to find records of nesting on beaches in Los Angeles County since 1949, when one incubating adult was reported from Malibu Beach (Stager 1949). The frequent raking of all county beaches now precludes the possibility of Snowy Plover nesting.

In VENTURA COUNTY beaches and river bars from Mugu Lagoon to the Santa Clara River mouth supported 14% of the plover pairs on the coast. Sixty percent of the Ventura County birds were found on the relatively undisturbed spits of Mugu Lagoon at Pt. Mugu Naval Air Station which is off-limits to the public. On Ormond Beach, adjacent to Mugu Lagoon and extending northwest to Hueneme, plovers were found on pond margins that are a continuation of the Mugu Lagoon wetlands. Except at Mugu Lagoon and McGrath State Beach, where we found the remaining Snowy Plovers, beach habitat in Ventura County is mostly raked, residentially developed or heavily disturbed by off-road vehicles. While records from museum egg collections suggest that plovers once nested along most of the beach from Mugu Lagoon to the city of Ventura, on our survey plovers were absent from the most disturbed sections (Appendix 1).

SANTA BARBARA COUNTY held the second highest number of coastal breeding Snowy Plovers, with 16% of the estimated pairs. The most striking change that has occurred in this county is the disappearance of the species from breeding grounds southeast of Point Conception (Appendix 1). At El Estero spits (Carpinteria and Sandyland), Santa Barbara Beach and Goleta, where at least 58 clutches were collected between 1891 and 1948, we were unable to find suitably wide or untrampled beach habitat (less than 100% covered by human footprints). In 1927 one collector counted 24 pairs at Goleta (WFVZ egg set 31500) where we found no plovers on the small,

heavily used public beach. On small beaches west of Goleta we found some suitable habitat but no plovers. Apparently erosion of habitat has been a major factor eliminating Snowy Plovers from southeastern Santa Barbara County. We discovered large numbers of plovers on the beaches and river mouths of northern Santa Barbara County, primarily on Vandenberg Air Force Base's Purisima Point beach, which is off-limits to the public.

SAN LUIS OBISPO COUNTY, with 9% of the coastal breeders, has only two large, potential nesting areas, the northern section of the Nipomo Dunes (extending from the Santa Maria River north to Pismo Beach) and Morro Bay spit (Table 2). At the Nipomo Dunes few plovers were found away from the Santa Maria River. Two nests at Pismo Beach in 1965 are the only previously reported nests on this section of the coast, which seemed to be suitable breeding habitat. Heavy human use, including intensive vehicle traffic, probably results in the paucity of nesting plovers away from the Santa Maria River mouth. Plovers were dispersed along the entire length of Morro Bay spit, which appeared to be lightly used by humans. Documentation for nesting in the Morro Bay area extends back to 1926.

MONTEREY COUNTY held 12% of the coast's and over two-thirds of Monterey Bay's sizable Snowy Plover population. Plovers occurred primarily from Marina Beach to Moss Landing's Western Salt Works. While increased human disturbance has probably reduced the number of plovers that now breed on the accessible beaches north of the Salinas River mouth, the loss has probably been partially compensated for by the development of relatively undisturbed nesting habitat at the Moss Landing salt evaporators. Where plovers once nested from Pacific Grove to Marina Beach (Appendix 1), they no longer do so since high tides now wash to the base of high wave-cut dunes.

SANTA CRUZ COUNTY supported 5% of the coastal breeding plovers, all in two locations (Table 2). At the Pajaro River mouth plovers nested on the beach and on open alkali flats in a salt marsh behind the housing development north of the river. Wilder Beach, known as a nesting area since 1922, held an unusually high number of plovers for its small (0.5 km long) size. Egg records from Palm Beach and the mouths of Moore, Four-Mile and Scott creeks indicate that in the past other small pocket beaches on north Monterey Bay supported nesting plovers (Appendix 1). In 1979 Vollmer (pers. comm.) found three adults and a brood at the Laguna Creek mouth, and Metropulos (pers. comm.) found eight adults and at least two broods at the mouth of Waddell Creek. Apparently the species still breeds sporadically on some of these publicly-used pocket beaches.

In SAN MATEO COUNTY, which supported just over 1% of the coastal birds, breeding Snowy Plovers were found on the little disturbed beach at Año Nuevo State Reserve and on the beach and sand flats at Pescadero Creek mouth. Nesting records from Año Nuevo are very recent but Pescadero has been a known nesting area since 1927 (Appendix 1). The beach at Franklin Point, just north of Año Nuevo, where eggs were collected early in the century, has eroded to a narrow terrace backed by dunes perched on a 1-3 m high bank. At the time of our survey it was an unsuitable nesting site.

It is understandable that the heavily eroded and intensively used beaches of SAN FRANCISCO COUNTY currently provide no habitat for nesting Snowy Plovers, but it is interesting that no historical records of breeding could be found. Probably they nested on the dune-backed Ocean Beach before urban development spread to the shoreline.

The plovers found in MARIN COUNTY represented 4% of the coastal population. All but one pair were found on the beaches of the Point Reyes National Seashore; the remaining pair was on the Bolinas Lagoon spit. Although there appeared to be suitable habitat at Dillon Beach, at the mouth of Tomales Bay, no plovers were found. Historical records in Marin County are limited to a single nest found on Point Reyes Beach in 1926 (Booth 1926) and a few unpublished observations of nests or broods at Limantour Estero and Bolinas Lagoon by PRBO personnel in the 1970s.

Beaches near Bodega Bay in SONOMA COUNTY are only occasionally used by small numbers of nesting plovers. Although we found no plovers during the 1977 survey, a nest was found in late April on Salmon Creek Beach in 1978 (Appendix 1). The nest and incubating adult disappeared within two days. Snowy Plovers probably bred regularly on the spit of Bodega Harbor but, since the area has been developed and become heavily used for recreation, breeding is now probably irregular at best.

MENDOCINO COUNTY'S share of the coastal population, 2%, was located on 7.4 km dune-backed MacKerricher Beach. We found no previous county breeding records, but suspect a lack of observers is responsible for the absence of previous records.

HUMBOLDT COUNTY, with 6% of the coastal plovers, held more birds than any county north of Monterey Bay. This undoubtedly was related to the extensive amount of potential habitat, consisting of 115 km of sand beach backed by dunes or wetlands (Anon. 1971). Records of nesting in the Humboldt Bay area extend back to 1899 (Appendix 1) but are lacking for beaches to the north where we found breeding birds (Table 2). Absence of past records for the northern area probably is related to a lack of observers. We cannot explain the absence of nesting Snowy Plovers south of Humboldt Bay, at the north and south spits of the Eel River and at McNutt Beach.

DEL NORTE COUNTY held just over 1% of the coastal population with nesting birds on the beach at Lake Talawa and the Smith River spit. Yocom and Harris (1975) suspected breeding in the Lake Talawa area but no definite records were reported until Widrig (pers. comm.) found them nesting there in May 1977. Lack of observer coverage is undoubtedly responsible for the paucity of historical records for this county.

Coastal Habitat

Coastal habitats were grouped into six types: 1) bluff-backed beach: beach backed by cliffs, bluffs or other non-dune, non-wetland habitat; 2) dune-backed beach: may be interrupted by a river, creek, pond, lagoon or salt flat; 3) small pocket beach: short beach at the mouth of a river, creek or lagoon and delimited and dominated by bluffs or rocky points; 4) spit: a sand spit or bar separating the ocean from a coastal wetland; 5) estuarine margin: disturbed or naturally open area in or at the margin of an estuary or a lagoon (often a salt flat); 6) salt evaporator.

Table 2. Numbers of Snowy Plovers breeding in coastal California. San Diego County to San Mateo County from 1978 survey; Marin County to Del Norte County from 1977 survey. Area types are explained in the coastal habitat section of text.

	Area Type	Est. Pairs	Total Adults	Known Males	Known Females	Juve-niles	Broods	Nests
San Diego County		131	257					
Tijuana R Mouth	4	19	37	16	8	1	1	1
Silver Strand Beach	4	3	5	1	2		1	
Silver Strand Bay Shore	4	3	6	1	2			
Western Salt Works	6	16	31	12	12	1	3	2
Sweetwater R Mouth	5	9	18	3	6			
San Elijo Lagoon	5	12	23	6	4		1	
Batiquitos Lagoon	5	3	6	3				
Agua Hedionda Lagoon	5	27	54				6	2
Sta Margarita R Mouth	4	37	74	23	16			1
French, Aliso Cr Mouths	3	2	3	2	1			
Orange County		10	19					
Bolsa Chica Oil Fields	5	10	19	8	8			2
Ventura County		71	136					
Mugu Lagoon Spits	4	41	82	36	27	2	6	2
Ormond Beach	2	14	25	14	6	1	1	
McGrath State Beach	2	3	4	2	1	1	2	
Santa Clara R Mouth	2	13	25	12	5	1	1	
Santa Barbara County		82	158					
Santa Ynez R Mouth	2	5	10	1	1			2
Purisima Point Beach	2	55	109	30	38	2	6	6
So. Nipomo Dunes	2	4	4		4			2
Santa Maria R Mouth	2	18	35	10	13	2	1	
San Luis Obispo County		43	86					
No. Nipomo Dunes	2	3	6	2	3			1
Morro Bay Spit	4	40	80	24	27	13	4	5
Monterey County		60	115					
Point Sur Beach	2	2	3		2		2	
Marina Beach	2	12	23	8	9			1
Salinas R Spit	4	16	31				2	1
Salinas R State Beach	2	4	7	3	4			2
Western Salt Works	6	24	47	7	7		2	8
Moss Lndng.-Zmudowski	2	2	4	1	2		2	
Santa Cruz County		25	50					
Pajaro R Spit	4	17	34				8	5
Wilder Cr Beach	3	8	16	5	6		3	
San Mateo County		7	13					
Año Nuevo Beach	2	5	9	4	4			1
Pescadero Cr Spit	4	2	4	2	2			1

Table 2 (Cont.)

	Area Type	Est. Pairs	Total Adults	Known Males	Known Females	Juve-niles	Broods	Nests
Marin County		21	40					
Bolinas Lagoon Spit	4	1	1	1			1	
Limantour Estero Spit	4	4	8	3	3			2
Drakes Beach Spit	4	1	2	1	1			
Point Reyes Beach	2	15	29	12	9			1
Mendocino County		9	15					
MacKerricher Beach	2	9	15	7	8			5
Humboldt County		32	54					
So. Humboldt Bay Spit	4	4	7	3	2			1
No. Humboldt Bay Spit	4	6	11	5	5			3
Elk R Spit	4	1	1		1			1
Lanphere Dunes Beach	2	2	3	1	2			2
Mad R Spit	4	10	17	9	7		2	5
Clam Beach	2	1	2	1	1			1
Big Lagoon Bar	4	8	13	4	8	1	2	5
Del Norte County		7	11					
Lake Talawa Beach	2	3	5	2	2			1
Smith R Spit	4	4	6	2	4			2
TOTALS		498	954	287	275	25	57	72

Small pocket beaches are sometimes similar to spits but are distinguished by several characteristics. Because pocket beaches are short and usually span less than 1.5 km of coastline, they are almost always dominated by delimiting cliffs or bluffs. Significant vegetated dune or hummock development behind the beach is usually lacking. Spits may be delimited at either end by cliffs, bluffs, dunes or lowlands but, because of their length and the presence of fairly extensive low wetlands behind them, they are not dominated by towering topographic features. They usually have well developed dune or hummock structures between the beach and the wetland.

The six habitats differed in importance to nesting Snowy Plovers. The habitat type for each area supporting plovers on the survey is designated in Table 2.

None of the many bluff-backed beaches surveyed held nesting Snowy Plovers; most were low and narrow, offering little habitat free from periodic tidal inundation. One exception, the privately owned isolated 5.8 km McNutt Beach in Humboldt County, was backed by a stretch of upper beach over 100 m wide above the high tide line but, like other bluff-backed beaches, held no plovers. No obvious reason for their absence there was apparent.

Dune-backed beaches supported 34% of the pairs on the coast; all except Point Sur, Dillon Beach and Lanphere Beach were interrupted at least once by river mouths, creek mouths, ponds or lagoons. Although these wetlands

spanned only 7% of the 112 km of dune-backed beaches that supported plovers, 46% of the 170 pairs on these beaches were near these wetlands. Densities of plovers along dune-backed beaches were not particularly high compared to those along spits except at Purisima Point and Año Nuevo State Reserve (Table 3).

Small pocket beaches proved to be generally poor nesting locations, collectively holding only 2% of the estimated pairs; we found plovers on only 2 of 25 with potential nesting habitat. At one of these, French Creek mouth on Camp Pendleton, we found three adults that showed no signs of nesting. The other site, Wilder Beach, Santa Cruz County, was unusual among small pocket beaches, having a small but well developed terrace of vegetated sand hummocks on its upper beach. French and Wilder creek mouths share two important characteristics: both are off-limits to the public and both are near other major nesting areas; French Creek is 3.4 km north of the Santa Margarita River mouth and Wilder Creek is on the north side of Monterey Bay. Other Santa Cruz County pocket beaches occasionally hold plovers such as in 1979 when nesting birds were found at Laguna and Waddell creek mouths. Usually, however, small pocket beaches provide the only beaches along long stretches of bluff-backed coast, are consequently heavily trampled by bathers, and therefore are difficult places for plovers to nest safely.

Some of the highest densities of plovers were on spits (Table 3). Sand spit habitat, which held 43% of the pairs along the coast, was undoubtedly enhanced by the fairly extensive bordering wetlands. Tidal flats and other open areas in marshes afforded alternate, often productive feeding areas, and a refuge from human disturbance on the beaches. At the Tijuana River, Santa Margarita River, Mugu Lagoon and Pajaro River spits, salt pans in adjacent marshes were also used for nesting. Snowy Plovers often were seen moving between salt pans, tidal flats, and beaches, indicating these areas function together in providing habitat. Supplemental feeding and nesting areas provided by wetlands and salt flats caused plover densities (measured along the length of the spits) to be higher than they might otherwise have been. For example, spits at the Tijuana River and nearby Silver Strand beach in San Diego County both receive heavy human use. However, the spit at the Tijuana River adjoins a salt marsh with extensive salt flats which the plovers use, while Silver Strand beach is separated from the few remaining undeveloped portions of the bay shore by a major roadway. The density of plovers along the Silver Strand spit was less than a tenth that along the Tijuana River spits and was noticably lower than that on other spits (Table 3). Spits that supported nesting plovers varied in topography, vegetation and composition of the adjacent wetlands. South of Point Conception, Santa Barbara County, most spits were covered by low, vegetated mounds, but to the north they were often covered by extensive vegetated dunes, sometimes over 30 m high.

Open areas around estuaries, which held 12% of the coastal pairs, include lagoon margins, disturbed areas (salt pans) in salt marshes, and bay fill. All of these areas were usually level, with topographic relief exceeding 50 cm only at San Diego Bay fill sites, which were 2 to 3 m above the bay margin, and at Bolsa Chica Oil Fields, where roadways were built 2 m above the marsh. Substrate was always at least lightly compacted and debris usually covered

less than 1% of the area. Marsh salt pan also occurred behind the spits at the Tijuana and Pajaro river mouths, at Mugu Lagoon and at the Moss Landing Salt Works but, because salt pans functioned as part of a broader habitat system at these areas, they are considered as subareas of the spits or salt works rather than separately as open areas in estuaries.

Salt evaporators, which supported 8% of the pairs on the coast, afforded Snowy Plovers a man-made habitat at estuaries. Plovers nested on low dikes separating evaporator ponds and on floors of dried evaporators. They fed on the abundant brine flies (Ephydridae) at pond margins. Dikes varied in height from less than 1 m to 2 m above the water surface. We found most plovers on unvegetated portions of the lower dikes, except where Western Gulls (*Larus occidentalis*), Caspian Terns (*Sterna caspia*), Forster's Terns (*S. forsteri*) or Black Skimmers (*Rynchops niger*) were nesting.

In general the density of nesting plovers decreased from south to north (Table 4), indicating that when human disturbance was not overwhelming, southern rather than northern beaches provided the best habitat.

Table 3. Densities of Snowy Plover pairs estimated from census totals in May and June 1978 in four of six habitat types surveyed in southern and central California.

	Kilometers of Coastline*	Hectares of Open Area	Pairs per Km or Ha
Small Pocket Beaches			
French Cr Mouth	0.5		4.0
Wilder Cr Beach	0.5		16.0
Dune-backed Beaches			
Ormond to Ventura Beach	12.5		1.9
Santa Ynez R Beach	2.3		2.2
Purisima Point Beach	9.2		6.0
Nipomo Dunes Beach	20.9		1.2
Point Sur Beach	0.9		2.2
Marina Beach	5.6		2.1
Salinas R to Pajaro R	10.1		0.6
Año Nuevo State Reserve	1.1		4.6
Spits			
Tijuana R Mouth	3.7	(15)	5.1
Silver Strand	13.4		0.4
Santa Margarita R Mouth	1.9	(52)	19.5
Mugu Lagoon Spits	8.6	(12)	4.8
Morro Bay Spit	8.0		5.0
Salinas R Spit	2.0		8.0
Pajaro R Spit	2.6	(3)	6.5
Pescadero Cr Spit	1.0		2.0
Estuarine Margins			
Sweetwater R Mouth		17.5	0.5
San Elijo Lagoon		63	0.2
Batiquitos Lagoon		1.5	2.0
Agua Hedionda Lagoon		20	1.4
Bolsa Chica Oil Fields		68	0.1

*Does not include riprapped, urban developed or bluff-backed shoreline.

Table 4. Densities of Snowy Plovers along sand beaches in coastal California counties. Lengths of sand beach in each county from Anon. (1971).

County	Kilometers of Sand Beach	Estimated Pairs on Beaches & Associated Flats†	Estimated Pairs per Kilometer of Beach†	Estimated Pairs in Coastal Habitat§	Estimated Pairs per Kilometer of Beach§
San Diego	36.7	73	2.0	131	3.6
Orange	41.4	0	0.0	10	0.2
Los Angeles	70.8	0	0.0	0	0.0
Ventura	29.0	71	2.4	71	2.4
Santa Barbara	27.7	82	3.0	82	3.0
San Luis Obispo	41.7	43	1.0	43	1.0
Monterey	33.5	36	1.1	60	1.8
Santa Cruz	19.6	25	1.3	25	1.3
San Mateo	12.4	7	0.6	7	0.6
San Francisco	4.0	0	0.0	0	0.0
Marin	35.1	21	0.6	21	0.6
Sonoma	17.4	1	0.1	1	0.1
Mendocino	12.4	9	0.7	9	0.7
Humboldt	115.4	32	0.3	32	0.3
Del Norte	19.8	7	0.4	7	0.4

† Omits birds at salt works, oil fields and northern San Diego County coastal lagoons.
§ Includes all estimated pairs from along the coast.

Generally nests were located in flat open areas devoid of, or sparsely covered with, vegetation or driftwood. On beaches in particular, nests were often placed next to some object such as a piece of driftwood, kelp or plastic. Sites were usually within 100 m of water but occasionally were several hundred meters away when there was not a formidable barrier of vegetation between the nest and the water. The absence of such a barrier is probably important so that newly-hatched chicks may have easy access to the shore. Broods generally were located feeding near water, but when disturbed would retreat to the upper beach where the chicks would crouch by driftwood or run into vegetation to avoid being seen.

Disturbance to Coastal Habitat

Several factors affect the quality of breeding habitat. Humans have a considerable impact through their recreational activities and by physically altering areas with residential, industrial and recreational development. Other agents of disturbance identified in other studies (Page unpubl. data) are high winds, high water levels and nest predators.

The intensity and type of human activity varied considerably among sites. Some activities precluded the use of beaches for nesting. In all of Los Angeles County and parts of Orange County, entire beaches are groomed with large rakes with tines 5 to 8 cm apart. These rakes are dragged behind motorized vehicles from the waterline to pavement or the low retaining wall bordering the beaches. Since this is done once a week or more often, no nest could survive even if human use were not as intensive as it is. Other activities, such as the driving of public off-road and military all-terrain vehicles, while causing considerable disturbance and sometimes nest destruction, do not always prevent plovers from nesting.

To measure the effect of human activity on the density of nesting plovers we had hoped to find physically similar segments of coastline that received different intensities of human use. We found only one place where reasonably similar areas could be compared. In Santa Barbara and San Luis Obispo counties there are two fairly long neighboring stretches of dune-backed beach, the dunes north of Purisima Point on Vandenberg Air Force Base and the vast Nipomo Dunes System (Santa Maria River dunes) farther north. They differ primarily in the extent of associated wetlands; Purisima Point dunes are interrupted by one creek mouth and the Nipomo Dunes by a river and two creeks. However, the human use that these beaches receive is quite dissimilar, with the Purisima area receiving almost none and the Nipomo area receiving a lot, including extensive off-road vehicle traffic. The density of nesting plovers along Nipomo Dunes beach is less than a fifth of that along Purisima Point beach, despite the fact that the Nipomo system has more wetland habitat. In addition, nesting plovers are dispersed along much of the Purisima coast, whereas 78% of the plovers on Nipomo Dunes beach were concentrated around the mouth of the Santa Maria River. Although a more thorough population and habitat study would be necessary to assess the causes of these disparate densities, they do suggest that human activities can severely depress the number of nesting plovers.

The introduction of Marram Grass (*Ammophila arenaria*) to stabilize coastal dunes has altered the physical structure of beaches and has almost certainly detrimentally affected nesting Snowy Plovers. We found Marram Grass from Ventura County north; it was well established in many areas north of Point Conception. The formation of the foredune parallel to the shoreline typically built by the sand-binding roots of Marram Grass decreases open, unvegetated areas above the tidelines and therefore the amount of potential nesting habitat. Vegetated dunes of beaches dominated by the native dunegrass (*Elymus mollis*) are usually perpendicular to the shoreline and are often separated by expanses of fairly flat sand that extend back from the upper beach and are favored plover nesting sites. Barbour et al. (1976) found that *Ammophila*-dominated beach held about half the number of plant species, had less open area and had steeper slopes than adjacent beach dominated by *Elymus*. Slobodchikoff and Doyen (1977) found that *Ammophila* markedly depressed the abundance and diversity of sand dune arthropods in California. Since Snowy Plovers often feed on insects well above the high tide line, their food supply may be detrimentally affected by the presence of *Ammophila*. The Piping Plover (*Charadrius melodus*), a bird

with similar habits, declined in numbers on a New York State beach after *Ammophila* was planted in its nesting area (Wilcox 1959).

Among non-human related factors, predators, which on the coast appear to be mainly corvids, are known to have a marked effect on plover nesting success (Page unpubl. data and Wilson pers. comm.). Ravens were seen at only 6 and crows at 4 of 107 sites surveyed south of the Golden Gate. This spotty corvid distribution contrasts with the north coast, where ravens were seen on 34 and crows at 10 of the 41 sites surveyed. We believe that nesting plovers south of the Golden Gate may suffer less from corvid nest predation than those to the north.

Strong winds and high water are the other factors affecting breeding success. At Pajaro Dunes, Santa Cruz County, strong winds were found to be a major cause of nest loss (Warriner and Warriner unpubl. data). Extremely high tides, especially spring tides in June and July, washed away nests at Limantour spit, Marin County (Page unpubl. data). Egg collectors noted that high tides washed away a nest in San Diego County (WFVZ egg set 91,240) and nearly inundated one in Santa Barbara County (CMNH egg set 1192). Although it is impossible to reach any valid conclusion about the effect of high winds on Snowy Plovers during this survey, we can comment on the probable effects of high water. The winter of 1977-78 was unusually stormy and high waves severely eroded beaches in southern and central California. By early May, when we started the survey of the south coast, many eroded beaches had not yet recovered their normal sand loads. One employee at Silver Strand State Beach, San Diego County, told us that 45 m of the normal 100 to 130 m of beach width had been removed by storms the previous winter. We also found that several coastal lagoons, whose level sandy margins previously provided nesting habitat, were flooded by winter rains up to the vegetated edges or steep banks and therefore lacked suitable breeding habitat at that time. Later in the season water levels dropped in most lagoons, which then were used by nesting plovers. Because much of the flooded and eroded coastal habitat eventually was restored, nesting areas appeared or increased in size in some locations after our survey. These habitat alterations undoubtedly were responsible for some shifting of nesting birds between locations during the summer.

III. SAN FRANCISCO BAY AND THE INTERIOR

R. PHILIP HENDERSON and GARY W. PAGE

San Francisco Bay

Having habitat affinities with the interior and being somewhat isolated from the open coast, San Francisco Bay falls into an intermediate category between the coast and the interior and therefore is considered separately. During the survey 351 adult plovers were found in the bay with 90.6% of these in ALAMEDA COUNTY, 5.4% in SAN MATEO COUNTY, and 4.0% in SANTA CLARA COUNTY (Table 5); they occurred at functioning and abandoned salt evaporators south of the San Mateo Bridge. The majority were on the east side of the bay, on levees surrounding evaporators brimming with water and on levees and flats in partly dry evaporators. Their

distribution on levees was patchy and their absence from some was inexplicable, although when found, birds were almost always on levees separating one evaporator from another and seldom on levees separating evaporators from the bay or the land. Nests were located on levees around filled or partly dry evaporators or on dry flats in partly empty or disused evaporators.

Snowy Plovers bred at salt evaporators in South San Francisco Bay as early as 1918; Grinnell et al. (1918) noted that "a great many pairs nested on dikes separating salt ponds on the east side of the bay, at the Alvarado salt works, and that workmen had reported having broken many eggs with wheelbarrows," As one nest was collected 15 May 1919 on a levee near Redwood City, they also nested on the west side of the bay early in this century. Subsequent scattered breeding records at the Hayward salt ponds, near the Dumbarton Bridge, near Alviso and near Belmont are summarized in Appendix 1; we found birds in all these areas. We found none on sand fill at the end of the main runway at Oakland International Airport where Manolis (pers. comm.) found a few adults in 1977, and Feeney (pers. comm.) saw five adults in 1979, nor did we have any reports of breeding on the south shore of Alameda where there have been occasional recent records (Appendix 1).

In summer, 1971, during an extensive survey of the breeding birds of South San Francisco Bay, Gill (1972) found 15 Snowy Plover nests at two locations, on the Knapp Gun Club property 4 km northwest of Alviso, and on levees at the east end of the Dumbarton Bridge. He concluded that "breeding populations of Snowy Plovers within the study area would approximate . . . 150 pairs. This would include nesting actually observed during 1971 plus observation of other adult birds within the major nesting areas and sightings of additional birds in areas with suitable nesting habitat such as Bair Island, Moffett Field, and the Drawbridge-Coyote Creek areas."

We found plovers breeding in both areas where Gill found them breeding but at one, the Knapp Gun Club property, they were much less numerous during our survey. At Bair Island, the Moffett Field area and the Drawbridge-Coyote Creek area where Gill found birds but no nests, we found neither nests nor birds. At most only 199 of the plovers we counted were within the area Gill estimated held 150 pairs in 1971. Because of the patchiness of the plovers' distribution in South San Francisco Bay, Gill may have overestimated numbers, so that the two sets of data should not be construed as indicating a decline. At best the data indicate that since at least 1971 the man-made salt evaporators of South San Francisco Bay have been one of the most important breeding areas in the state.

Although Gill (pers. comm.) found three pairs nesting on a salt evaporator levee in July 1975 at Little Island, NAPA COUNTY, our search of this and many other levees in North San Francisco Bay failed to turn up a single Snowy Plover in 1978. The levee at Little Island was covered with 600 nesting Caspian Terns, several hundred roosting California Gulls (*Larus californicus*) and 80 roosting White Pelicans (*Pelecanus erythrorhynchos*). Since this crowded levee seemed to be the only suitable nesting area, we believe that the breeding of small numbers of plovers at salt evaporators in North San Francisco Bay is probably irregular.

Table 5. Number of Snowy Plovers in San Francisco Bay during June 1978 survey.

	Total Adults	Known Males	Known Females	Juveniles	Broods	Nests
San Mateo County	19	10	2	2	3	
Santa Clara County	14	7	4	3	2	1
Alameda County	318	85	83	3	50	35
TOTALS	351	102	89	8	55	36

Table 6. Numbers of Snowy Plovers found in 1978 in the California interior. Asterisks (*) indicate first reported breeding records.

	Total Adults	Known Males	Known Females	Juveniles	Broods	Nests
Imperial County	*216*					
Salton Sea	216	78	82		7	10
Riverside County	*10*					
Salton Sea	10	1	4			
San Bernardino County	*77*					
Harper Lake	61	14	8		1	1
* Searles Lake	16	4	4	2	9	
Kern County	*34*					
Rosamond Lake	6	4	2			
* Koehn Lake	26	10	8		2	1
Goose Lake	2		1			
Kings County	*1*					
Corcoran Reservoir	1		1			
Inyo County	*522*					
* Tecopa Marsh	7	4	3		1	
Owens Lake	499	115	81	4	35	21
Salt Lake	1		1			
* Tinemaha Reservoir	2	1	1			1
Deep Springs Lake	13	6	5		3	
Mono County	*384*					
Mono Lake	384	181	139			31
Lassen County	*208*					
* Honey Lake	208	81	33	28	20	4
Modoc County	*391*					
* Lower Alkali Lake	92	22	11	8	11	10
* Middle Alkali Lake	36	13	3	13	5	
* Upper Alkali Lake	230	45	38	51	42	11
Goose Lake	33	18	8	4	11	
TOTALS	1843	597	433	110	147	90

The Interior

During the 1978 survey we found 1843 adult Snowy Plovers at 18 interior locations; nests or chicks were found at all except 4 (Table 6). At 2 of those 4 locations, Rosamond Lake and Goose Lake in Kern County, the presence of suitable nesting habitat suggested probable breeding.

The male to female ratio was unbalanced at 10 males to 8 females, probably because females incubate for most of the daylight hours and were more difficult to find on their scattered nests than males, which concentrated at feeding places by water. Unfavorable lighting conditions or large numbers of birds often prevented us from determining the sex of some birds. Because of these factors, we have used the total number of adults rather than the estimated number of pairs as a measure of population size in the interior.

The Salton Sea in IMPERIAL and RIVERSIDE COUNTIES accounted for 12.3% of the adults found in the interior. This percentage might have been slightly higher had we not accidentally omitted the Lupine Wash area in Imperial County. Of the 226 adults found, 96% were in IMPERIAL COUNTY and 4% were in RIVERSIDE COUNTY. Although they occurred around the entire Salton Sea perimeter, the major concentrations were on the west side from Desert Shores to the north half of the Salton Sea Naval Test Base and at the mouth of San Felipe Creek, and on the east side from Bombay Creek to the Wister Unit of Imperial Wildlife Area and on beaches south of the Wister Unit. They occurred along open, gently sloping shorelines and in the region of washes. A few were found on flats inside diked reservoirs but none on diked or densely vegetated shoreline. Although most plovers were located in areas with little human disturbance, some were found between Desert Shores and Salton City, at Desert Beach and at Bombay Beach, three areas heavily used by people.

The Salton Sea formed from 1905 to 1907 when structural flaws in a canal system allowed water from the Colorado River to flow unchecked into the Whitewater River Basin. Since then agricultural runoff has maintained and even caused a rise in water levels. We found no information suggesting that Snowy Plovers bred in the Whitewater River Basin prior to 1905; a nest taken in 1929 is the earliest known breeding record. This and other reports (Appendix 1) indicate that Snowy Plovers have been breeding at the Salton Sea for at least 50 years. Our survey results indicate that it is currently one of the most important breeding sites in the state (Table 6).

The only other known breeding location in RIVERSIDE COUNTY is Lake Elsinore. Records date from a nest found in 1939 to the sighting of three "juveniles" (possibly chicks?) in April 1974 (Appendix 1). At the time of our 1978 survey high lake levels flooded into surrounding vegetation, leaving no suitable habitat for nesting plovers and none were found.

SAN BERNARDINO COUNTY held 4.2% of the interior plover population at two sites, Harper and Searles lakes. Harper Lake, an alkali sink with some marsh and open standing water, accounted for 79.2% of the plovers in the county. They were found on the southwest margin of the lakebed in three separate areas with 37 birds at the central, 15 at the southeast, and 9 at the northwesternmost site. Since water is pumped to at least two of these areas after it has been used for irrigation in nearby alfalfa fields, the birds' habitat is

largely under human control. Snowy Plovers were first known to be breeding at Harper Lake in 1977 when Henderson found at least 67 adults, 3 broods and one nest. The lack of earlier records is probably due to the absence of observers.

The first reported breeding record at Searles Lake occurred during our 1978 survey with the discovery of 16 adults and 9 broods. Since all birds were feeding around standing water leaking from a pipe at the west facility of the Kerr-McGee Chemical Corporation plant, plover breeding at this heavily industrialized location may have been unusual. The only other standing water on the alkali lakebed was a concentrated brine solution in solar evaporation ponds and an effluent smelling of sulfur from the chemical plants.

Three locations, Rosamond Lake, Koehn Lake and Goose Lake in KERN COUNTY, collectively held 1.8% of the interior population. Although Rosamond Lake is usually dry, 25% of the lakebed was flooded by fresh-tasting, silt-laden water when surveyed. On the unvegetated east shoreline the six plovers seen were believed to be breeding although no nests or broods were found. Two small bodies of water lay on the otherwise dry alkali flats at Koehn Lake. By the larger, 25 ha body on the west edge of the lakebed, 25 adults, 2 broods and 1 nest were found. One additional adult was seen by a 5 ha body of water near the old Saltdale saltworks. At Koehn Lake strong winds hampered surveying so that our population estimate is probably low. We found no previous summer records for either Koehn or Rosamond lakes.

Agricultural practices have changed the landscape of the Sacramento and San Joaquin valleys considerably during past decades. Most alkaline lakes which provided good nesting habitat have disappeared. The only such areas we found were in the San Joaquin Valley on the Kern National Wildlife Refuge and at Goose Lake in KERN COUNTY. The only plovers found were two birds believed to be nesting at Goose Lake and a probable migrant at Corcoran Reservoir, and an area lacking suitable breeding habitat, in KINGS COUNTY.

Historically the Sacramento Valley probably was not a major nesting area and we therefore omitted it from the survey. The only three documented breeding records were an adult with young at both the Woodland Sewage Ponds and the Davis Sewage Ponds in YOLO COUNTY, and a nest that was collected in 1913 near Reigo in BUTTE COUNTY (Appendix 1).

Historically the San Joaquin Valley was probably more important as a breeding area than the Sacramento Valley. There are several breeding records from near Los Banos in MERCED COUNTY (Appendix 1); one that was particularly well documented (Unglish 1938), notes that 5 miles north of Los Banos a 5 acre pond with a few small islands held 11 Snowy Plovers and at least 4 nests in 1937. It was the first time Unglish "in fifteen years of field work in the Los Banos area" and only the second time his companion Tyler, "in forty years in this section," had ever recorded Snowy Plovers. Dawson (1923) mentions that plovers were breeding near Los Banos as early as 1912. Other records for the San Joaquin Valley include a pair that was "probably preparing to nest" just east of Firebaugh in MADERA COUNTY (Tyler 1916) and records from Buena Vista Lake in KERN COUNTY. Judging from the accounts of Linton (1908) and Lamb and Howell (1913) signifi-

cant numbers may have once bred at Buena Vista Lake. Both accounts report plovers in June, and Linton reported a two egg clutch on 2 June 1907. Linton's description of the lake indicated ideal breeding habitat. Today Snowy Plovers rarely breed in the San Joaquin Valley.

INYO COUNTY held the largest number of plovers with 28.3% of the interior population. At Tecopa Marsh, where the meandering Amargosa River created some marsh and open standing water on an old lakebed, Henderson found seven adults and one brood of chicks for the first definite breeding record. However, the species was reported in small numbers during past breeding seasons by Tarble (pers. comm.); the highest number she saw was 12 birds on 18 June 1975. Undoubtedly some were breeding.

Owens Lake, with 499 birds, held more Snowy Plovers than any other location in the state. While we were there, water from Cartago, Ash, Cottonwood and Carroll creeks bypassed the Los Angeles Aqueduct and flowed onto the alkaline lakebed where it formed a shallow body of water on the west side. Water also seeped onto the lakebed at several locations at its north, south and east sides. Most birds were found around water, especially along creeks, at creek mouths and at seeps. Ponds adjacent to the south end of the lake also held some plovers. Areas we were able to reach along the margins of the main body of the lake held no birds except near creek mouths. Most nests were found on the west side but broods were found almost everywhere where adults were near water. At Owens Lake in 1891 Fisher (1893) found the Snowy Plover "near Keeler, May 30 to June 4, where it was common in small flocks of five to ten on the alkaline flats which border the lake." He believed "the species was evidently breeding at the time, but no eggs or young were found." The only published information we found verifying nesting at Owens Lake was Heindel's observation in July 1975 of 130 adult-sized plovers accompanied by downy young at Dirty Socks (McCaskie 1975) at the south end of the lake.

Although Henderson found one Snowy Plover at Salt Lake in Saline Valley in May 1978 and two in June 1977, he found no evidence of breeding. Since the birds may have been transients or summering nonbreeders and since there are no past breeding records, the plovers breeding status at Salt Lake remains uncertain.

A pair of nesting plovers found by Henderson in June 1978 at the Los Angeles Department of Water and Power's freshwater Tinemaha Reservoir represents the first breeding record for this location. An employee of LADWP indicated the flat on which the plover nested would soon be flooded by rising water so the nest may have been destroyed; normally the area may not be a nesting site.

The final INYO COUNTY site with Snowy Plovers was the alkaline Deep Springs Lake, where 13 adults and 3 broods were found, mostly near a small seep on the northwest margin of the lakebed. LeValley (pers. comm.) reported seeing about 30 plovers on the lake on 29 and 30 May 1971, a time when migrants should have been absent. Two nests found in 1964 (McCaskie and Pugh 1964) are the only previous nesting records.

Mono Lake accounted for 20.8% of the adults in the interior and all of the Snowy Plovers in MONO COUNTY. The lake's 384 birds represented the state's second largest concentration. Birds were found from Navy Beach on

the south side counterclockwise along the shoreline to Black Point on the north side. A small, isolated pocket of birds also occurred at Mono County Park on the northwest side of the lake. Nests were on unvegetated gravel and sand ridges up to 1.5 km from water and on dry alkali flats as close as 100 m to the receding water line. In all, 128 nests were located in 1978 (Page et al. 1979).

No one reported nesting Snowy Plovers at Mono Lake before 1976 when Winkler et al. (1977) found 3 nests, at least 6 broods and, on 14 September, had a high count of 100 adult-sized birds on a census of the entire lake. Page and Peaslee visited the area for 2 days in mid-June 1977 and found 90 adults and 8 nests along part of the shoreline.

Snowy Plovers occurred at one location in LASSEN COUNTY, Honey Lake, where 208 birds made up 11.3% of those in the interior. Most birds were found along the southeast side of the lake from just south of Wendel to the base of a broad peninsula that bisects the south shore, along the west side of that peninsula, and along the north shore of the lake, especially in the vicinity of Hartson Reservoir. Because we did not cover the shoreline from 3 km east of Hartson Reservoir to 0.8 km south of Wendel, we may have missed some birds. The only nests founds were in clumps of *Distichlis* near Hartson Reservoir but we suspect birds also nested on dried, cracked mud several hundred meters from water on the east side of the lake. We found broods in all areas where there were adults. Prior to our survey the only record for the Honey Lake area was an observation of two pairs on the floor of Hartson Reservoir on 11 June 1977 (Gaines fide Jurek pers. comm.).

Four sites, Lower Alkali Lake, Middle Alkali Lake, Upper Alkali Lake and Goose Lake, in MODOC COUNTY held 391 birds or 21.2% of those in the interior. By the time we reached this area in early July the alkali lakes had evaporated considerably, exposing wide expanses of lakebed. On Lower Alkali Lake, where water covered about 50% of the lakebed, all plovers were found at the northeast end where open standing water abutted a marsh. Ten nests were found in the same area but several hundred meters from the water on a low plateau bordering the lakebed. Middle Alkali Lake was nearly dry but we found some plovers with broods by open water adjoining marsh near the north end of the lakebed. Plovers were found along the east side of Upper Alkali Lake where 75% of the lakebed was still covered by water; there was no suitable open habitat on the west side. Some nests at Upper Alkali Lake were near the edge of the lakebed on alkali flat as far as 2-3 km from water; other nests were much closer to water. Broods were found by water mostly at the northeast end of the lake. Ours are the first breeding records for all of the Alkali Lakes.

The 33 adults and 11 broods near water on alkali flats at the southwest end of Goose Lake, MODOC COUNTY, were the last plovers we found on the interior survey. Dawson (1923) reported breeding plovers here in June 1912, providing the only other record.

Since there was a breeding record in the Tule-Lower Klamath Lakes region of SISKIYOU COUNTY in 1957 (Giles and Crabb 1958), we visited this area but found no plovers. It is unlikely that the species breeds regularly there, except perhaps at White Lake just across the border in Oregon where we saw a few plovers. James Hainline, a biologist at Klamath Lake National

Wildlife Refuge, told us he had seen 8 adults and 5 chicks at White Lake a few days before our visit in early July but that he had not seen Snowy Plovers on the California side of the refuge.

Inland Habitat

Breeding habitat consisted primarily of shallow lakes bordered by unvegetated or sparsely vegetated flats. Inhabited lakes were distributed over the length of the state, mainly in the Upper and Lower Sonoran Life Zones (Grinnell 1915); most were alkaline.

Nests were generally located in flat, open areas, although many were partly concealed by microhabitat features. Of 45 nests at the Salton Sea, Owens Lake, Honey Lake and the Alkali Lakes, 40% were within 15 cm of something such as a stick, rock or clump of vegetation, even though these were usually scarce in the general area. Except for 11% of the nests that were in flat (topographic relief within a 1 m radius less than 5 cm) areas away from vegetation or other surface irregularities, the remaining nests were on substrate with enough topographic relief or disruptive coloration (sand-pebble substrate) to provide some concealment for the eggs and in many cases the incubating bird.

At inland lakes we usually saw broods feeding within a few meters of the water. When disturbed they often ran across dry open flats to avoid us. Chicks readily hid in available marsh vegetation, particularly at the Alkali Lakes in Modoc County.

Disturbance to Nesting Habitat

Except at Rosamond Lake, habitat at each breeding site had apparently been altered by human activities over the past 200 years. In the Central Valley agricultural development has confined wetlands to such an extent that suitable breeding habitat is largely depleted. The only historical nesting site of any size we were able to identify, Buena Vista Lake in Kern County, has disappeared. At several breeding sites in the Mohave Desert and the Great Basin, agricultural or municipal water demands have altered habitat. The most striking examples, Owens Lake which has almost completely dried up, and Mono Lake whose levels are rapidly dropping, held the largest concentrations of birds. Because much habitat remains in these areas and practically nothing is known about breeding numbers prior to the 1970s, we refrain from assessing the effect of these changes on the plover. Man's intervention at the Salton Sea has produced breeding habitat for a substantial number of plovers. Whether the additional habitat offsets the loss at other locations remains unanswered.

We saw nest predators, particularly Common Ravens, at almost all locations surveyed. One raven was seen taking the eggs of a plover and those of several American Avocets (*Recurvirostra americana*) at Owens Lake. At Mono Lake California Gulls, ravens and Coyotes (*Canis latrans*) destroyed many plover nests (Page et al. 1979).

IV. SEASONAL VARIATION IN PLOVER NUMBERS

JOHN S. WARRINER and JANE C. WARRINER

To help interpret the results of the statewide surveys we studied breeding Snowy Plovers at Pajaro Dunes on Monterey Bay, measuring the degree to which observers could detect birds on censuses and defining the species' migration periods. Pajaro Dunes is a beachfront housing development at the Pajaro River mouth in extreme southwestern Santa Cruz County. Plovers breed on either side of the river mouth and on a small unvegetated flat in salt marsh 1 km away. During 1977 and 1978 we tried to find all nests, and at approximately 7 day intervals count all birds in the area. Just prior to nesting in March 1978, 25 adults were individually color banded by placing two strips of differently colored plastic tape on each of two aluminum bands, one on each leg. Additional birds were later captured on their nests and similarly marked. From the time of marking onwards counts of marked and unmarked birds enabled us to use the Lincoln Index [P = (T × M)/ N, where P = total number of plovers in area, T = total number of birds seen on census, M =

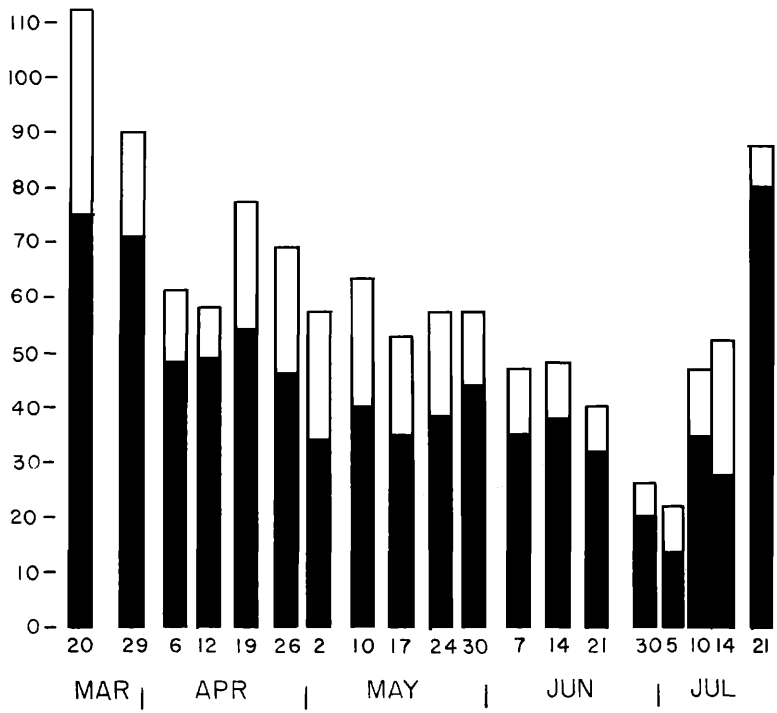

Figure 1a. Number of adult Snowy Plovers counted (solid bar) and estimated (open bar) at Pajaro Dunes in the 1978 breeding season.

number of marked birds known to be in the area and N = number of marked birds on census] to estimate the total number of plovers in the area.

Experienced observers conducted 19 censuses of plovers in the Pajaro study area between March and July 1978. The number of marked plovers sighted varied between 54% and 91% and averaged 72% (s = 9.1%) of those assumed to be present because they were sighted before and after the census (Figure 1a). Pajaro Dunes was a difficult area to survey because plovers moved between three separate areas. Due to the more difficult than average census conditions at Pajaro, Page and Stenzel (pers. comm.) believe that on the coastal survey as a whole it was possible to detect at least 72% of the plovers present. The detection rate for interior sites may be lower since nesting areas, up to 3 km wide, were difficult for two people to cover (Page pers comm.).

It appears that most spring migrants and wintering birds left Pajaro Dunes by early May. Of 19 marked departing birds most left between 20 March and 26 April (Figure 1b). Two remained until 2 and 8 May respectively and exhibited some nesting behavior before leaving. Four of the 19 birds returned for brief periods during summer before departing again. Marked birds did not begin to return in numbers until early July (Figure 1b). It appears that the most appropriate time to conduct the statewide surveys was May and June since this is the period that migrants are least likely to be encountered.

Some breeding birds move between areas in May and June. For example, after 14 June 1978 nine plovers from failed Pajaro nests were found 6 km to the south at Moss Landing salt works. At least two of the nine renested there. Two other birds dispersed even farther, one turning up 27 km to the northwest at Wilder State Beach and one 75 km northeast at South San Francisco Bay. Midsummer movements of breeding birds to and from a site may vary annually. In 1977 the breeding population increased at Pajaro Dunes from early May to early June and then leveled off. In contrast in 1978 numbers were relatively constant in May but declined in June. The above examples illustrated that repeated censuses of particular breeding sites often produce variable numbers, hence any single census may not reflect the maximum capacity of the area to support plovers that year.

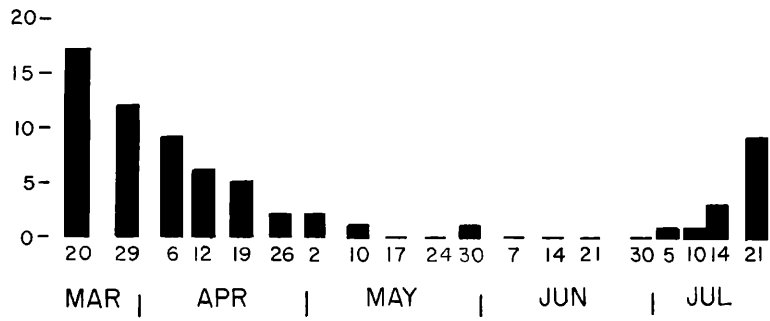

Figure 1b. Number of marked, locally non-breeding Snowy Plovers on censuses at Pajaro Dunes in 1978.

DISCUSSION AND SUMMARY

GARY W. PAGE and LYNNE E. STENZEL

Breeding Snowy Plovers were distributed widely over the state (Figure 2) but, unexpectedly, most were in the interior rather than on the coast (Table 7). Apparently few observers had explored the interior so that the large number of birds there had escaped notice until this survey. On the coast, larger concentrations of birds were in the south than in the north, suggesting the center of the species' coastal distribution lies closer to the southern than the northern boundary of the state; therefore, Baja California may also support substantial numbers of breeding birds.

Throughout the state openness of habitat seemed to be a key requirement for nesting. Of 116 nests observed on the coast and in the interior, 46% were vegetation-free within a 10 m radius and an additional 23% lacked vegetation within a 1 m radius. At only 12 nests did vegetation cover exceed 10% within 10 m and at only 5 did it exceed 10% cover within 1 m. Plovers were absent from beaches heavily littered with driftwood.

Access to water is probably a breeding requirement although birds sometimes nested hundreds of meters away when no obstacle prevented movements of chicks between the nest and water. Thus plovers nest around shallow alkaline lakes where the waterline may retreat several hundred meters from the nest during the month between the laying and hatching of eggs.

We did not find plovers nesting on bluff-backed beaches on the mainland as we did on San Miguel and San Nicolas islands. Island bluff-backed beaches with plovers had generous areas of strand which were lightly vegetated or were 50% or more covered by driftwood, kelp, shells or small rocks. In contrast the upper strand on mainland bluff-backed beaches was generally narrow, barren and often washed by the highest tides.

The amount of available habitat at any site may vary seasonally or from year to year. On the coast winter storms regularly erode beaches and fill lagoons with water, thus reducing potential breeding habitat. This reduction is followed by a slow increase in habitat during spring and summer when beach width increases and shrinking water levels in the lagoons expose suitable nesting flats. This process is related to the severity of winter storms, which varies considerably from year to year. Similarly, intensity of winter rains, in the absence of human induced water diversions, determines whether interior breeding areas, such as shallow alkaline sinks, are dry, partly filled or flooded to surrounding vegetation. Thus the number of breeding Snowy Plovers may change annually or even mid-breeding season, in response to natural alterations in habitat availability.

Humans have altered breeding habitat, at least on the mainland coast. Some coastal areas have been developed to the extent that they no longer support plovers; at others disturbance probably reduces breeding numbers and lowers breeding success. At Zmudowski State Beach in Monterey County the Warriners (unpubl. data) found hatching success to be much lower than on undisturbed salt pan just 1 km away. At Zmudowski some eggs were obviously picked up by people and others were probably stepped on. Others apparently were lost to high winds when disturbed birds were unable to in-

cubate and prevent their eggs from being scattered and buried by blowing sand. In some instances humans have enhanced habitat for the species through the construction of salt evaporators in coastal bays or flooding of dry interior areas. However, such enhancement probably does not compensate for the degradation of other areas.

Our conclusions concerning the plover's change in status over the past century are limited by the paucity of historical data, particularly for the interior. Numbers have definitely declined on the coast; the species was not found breeding in 33 of the 53 locations with breeding records prior to 1970.

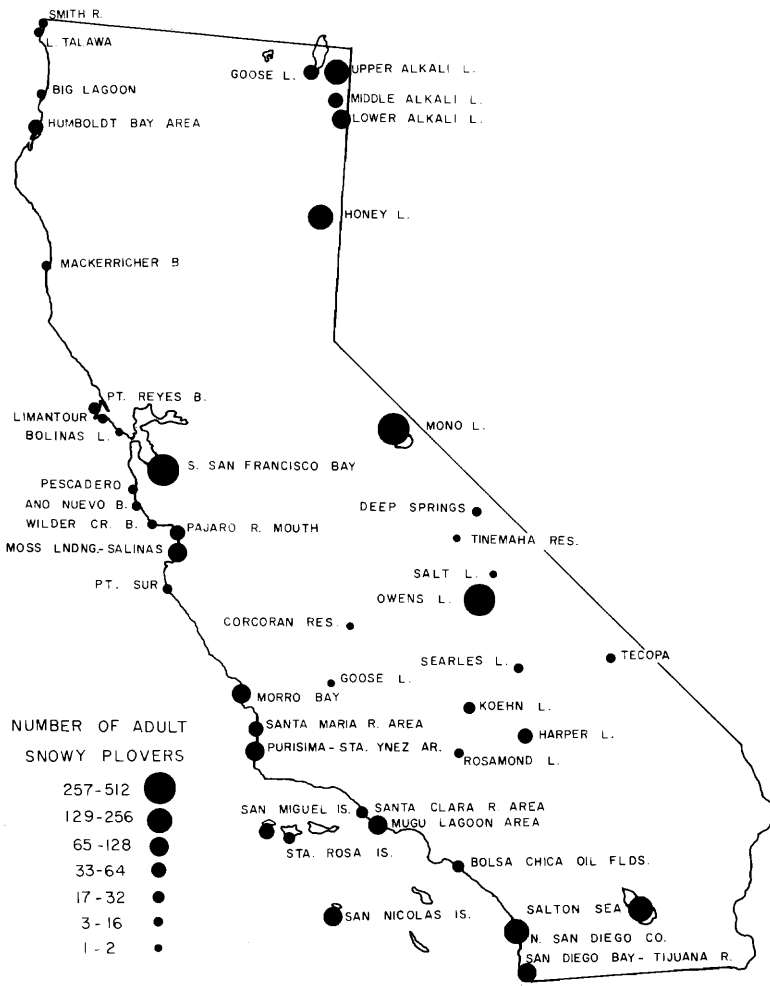

Figure 2. Distribution of breeding Snowy Plovers in California from 1977-80 surveys.

Table 7. Number of adult Snowy Plovers found during 1977-80 surveys in California.

	Estimated Pairs	Total Adults
Channel Islands	130	261
Mainland coast	498	954
San Francisco Bay		351
Interior		1843
TOTAL		3409

Of the 33 areas 28 are not likely to have regular breeding populations again because the habitat has been destroyed or human use of the area is too great. The greatest losses have occurred in southern California where breeding plovers have vanished from parts of San Diego, Ventura and Santa Barbara counties, most of Orange County and all of Los Angeles County. In all these areas the plover's absence can be correlated with industrial or residential development and/or heavy recreational use of former beach nesting areas. To the north, such human factors come into play less frequently, although they may still have caused declines in places around Monterey Bay, at San Francisco, at Bodega Bay and the north spit of Humboldt Bay.

Current emphasis on coastal development for recreation by the State of California probably means a further loss of habitat for the plover. If no exchange occurs between interior and coastal breeding populations, a subject currently under investigation, then the status of coastal and interior populations must be considered separately. There may be a greater survival problem on the coast if there is no recruitment from the less disturbed interior breeding areas.

This survey located the important California breeding sites and developed an index of the Snowy Plover's abundance against which future surveys can be compared. We encourage interested persons to keep track of breeding numbers in areas near them, especially when habitat alterations are occurring, and to promote the protection of important breeding sites.

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This is Contribution 205 of Point Reyes Bird Observatory.

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APPENDIX 1. Survey results and historical records of Snowy Plovers breeding in mainland California. Locations are listed from south to north, first along the coast, then at San Francisco Bay, and then inland. Under Survey Status the estimated numbers of adults (A) or pairs (P) is given unless habitat was not present when visited due to erosion, flooding or draining (E), the habitat had been destroyed or made unsuitable by human activity or development (D), apparently suitable habitat was present but plovers were not seen (H), or the area mentioned was not surveyed (W). Under Records, the most convincing evidence of breeding is given, with the number of: adults reported during May or June (A), pairs reported in May or June (P), females reported nesting (F), broods (B), chicks (C), or nests (N). An N without a number is given when a source makes a general reference to Snowy Plovers breeding. Under Source, initials refer to individuals or institutions listed in Appendix 3, numbers to references in the literature cited, and initials with numbers to information from museum egg set or specimen records. Max. under Egg Sets in Museum Egg Collections is the maximum number of egg sets collected during one 5 day period.

	Survey Status	Records			Egg Sets in Museum Collections		
MAINLAND COAST		Numbers	Year	Source	Total	Max.	Years
San Diego County							
Tijuana R Mouth	P 19	N1	1973	KB			
		N1	1977	PJ			
Silver Strand Beach	P 3	N1, B1	1930s	44	18	3	1918-1940
Silver Strand Bay Shore	P 3	N1	1977-78	PJ,DP			
San Diego Bay	P 16	A	1973	KB			
Salt Works		N2	1975	BM			
		N20*	1977	PJ			
Sweetwater R Mouth	P 9	A	1973	KB	3	1	1931-1938
		A	1977	PJ			
		A20,B5	1978	DP			
North Is NAS	H	N2	1979	EC,DP			
Lindbergh Field	W	N1	1979	EC,DP			
Ocean Beach	E,D				5	3	1904-1917
San Diego: site unk.					4	1	1894-1938
Mission Bay Beach	D				23	4	1915-1930
Mission Bay Fill	H	N1	1972	SL,LOCU			
		N1	1977	PJ			
Pacific Beach	D				4	2	1904-1916
Penasquitos Lagoon	H	N2	1977	PJ			
		A4	1978	DP			
Del Mar Beach	E,D				19	8	1922-1954
San Elijo Lagoon	P 12	N1	1976	PJ			
Batiquitos Lagoon	P 3	A18,N1	1970	He	3	1	1932-1936
		A75,N5	1971	He			
		A39,N,B5	1978	DP			
Agua Hedionda	P 27	A9	1973	KB			
Lagoon		A60	1975	BM			
		N2	1977	PJ			
Buena Vista Lagoon	D	B1**	1951	36			
		None	1977	PJ			

APPENDIX 1 (Cont.)

	Survey Status	Records			Egg Sets in Museum Collections		
		Numbers	Year	Source	Total	Max.	Years
Oceanside to Santa	P 37	N8	1971	DS,LOCU	12	2	1917-1928
Margarita R Mouth		N7	1972	DS,LOCU			
		N1	1973	DS,LOCU			
		N10	1974	AF,LOCU			
		A20,C17	1975	BM			
		N,C	1977	PJ			
French Creek Mouth	P 2	C1	1979	DP			
Orange County							
Balboa Beach	D				3	1	1907-1917
Newport Beach	D				39	7	1893-1928
Huntington State Beach	D	N1	1955	37	21	4	1917-1940
Bolsa Chica Beach	D	None	1947	10	12	3	1905-1907
Bolsa Chica Salt Flats	P 10				2	1	1960-1961
Sunset Beach	D				1	1	1916
Sunset Beach Bay Fill	H	N1	1970	BM			
		N2	1971	BM			
		C1	1973	KB			
Anaheim Landing	D				1	1	1907
Los Angeles County							
Redondo Beach	W				24	4	1894-1904
Manhattan Beach	W	N1	1947	10			
Playa del Ray	D	N4	1914	3	1	1	1914
P. del R. Salt Flats	H				1	1	1923
Ballona Beach	D	P50	1903	NMNH 31481	46	5	1894-1904
Santa Monica/Malibu	D,W	N6	1938	WFVZ 3497	8	1	1895-1947
		N1	1949	40			
Nigger Slough	W				2	2	1895
Los Angeles: site unk.	W				14	5	1883-1905
Ventura County							
Mugu Lagoon Spits	P41	N,C	1973	KB			
		N1	1976	SW			
		P15,N1	1977	BM			
Ormond Beach	P14	C1	1975	SW	22	3	1896-1937
McGrath Lake Beach	P3						
Santa Clara R Mouth	P13	A30,N6	1975	SW			
		A25	1976	SW			
Ventura Beach	D,H				6	2	1915-1948
Santa Barbara County							
Carpinteria-Sandyland	E,D	N1	1960	FM	25	6	1909-1946
Santa Barbara Beach	E,D				15	2	1891-1933

APPENDIX 1 (Cont.)

	Survey Status	Records			Egg Sets in Museum Collections		
		Numbers	Year	Source	Total	Max.	Years
Goleta Beach	E,D	P24	1927	WFVZ 31500	16	3	1927-1948
		A	1970s	SW			
Goleta Slough Flats	H				2	1	1934-1936
Santa Ynez R Mouth	P5	A	1970s	SW			
Purisima Point Beach	P55						
South Nipomo Dunes	P4						
Santa Maria R Mouth	P18						
San Luis Obispo County							
No. Nipomo Dunes	P2						
Pismo Beach	D	N2	1965	LOCU			
Morro Bay Area	P40	N1	1974	EJ	18	4	1926-1934
Spit and Beach to N		C	1977	EJ			
Monterey County							
Point Sur Beach	P2						
Pacific Grove	E,D				2	1	1916
Monterey-Seaside	E,D				8	3	1875-1899
Marina Beach	P12						
Salinas R Spit	P16	B2	1967	5	24	4	1894-1938
		A	1968	6			
		A5-16,C0	1972	DPI,15			
		A50+	1976	SW			
Moss Landing Beach:	P6	N5	1930	34	38	8	1895-1948
(Salinas R-Pajaro R)		C1-4,N1	1948-53	VA,35			
		A20,C1	1963	13			
		A5,N0,C0	1965	9			
		A10,N0,C0	1966	8			
		N	1971	14			
Moss Landing	P24	B1	1967	5			
Salt Works		N1,B2	1954	VA			
Santa Cruz County							
Pajaro R Mouth &	P17	N7,C14	1972	15	15	4	1893-1940
Palm Beach		N7	1973	JW:LOCU			
		N10	1975	41			
Santa Cruz Beach	D				5	2	1877-1878
Wood's Lagoon	D				1	1	1876
Moore Cr Mouth	D				1	1	1887
Wilder Cr Mouth	P8	F2	1922	CAS70154, 70155			
		N	1976	49			
Four-Mile Beach	D				1	1	1929

APPENDIX 1 (Cont.)

	Survey Status	Records			Egg Sets in Museum Collections		
		Numbers	Year	Source	Total	Max.	Years
Laguna Cr Mouth	H	B1	1979	EV			
Scott Cr Mouth	D				4	2	1878-1946
Waddell Cr Mouth	H	B2	1979	PM			
Meader's Beach	W				1	1	1878
San Mateo County							
Año Nuevo Beach	P5	P	1968	6			
		C1	1969	7			
Franklin Point	E				1	1	1905
Pescadero	P2	N	pre-1927	21			
		N	1975	PM			
Marin County							
Bolinas Lagoon Spit	P1	N1-2	1970s	GP,LS			
Limantour Spit	P4	N1	1967	PL:LOCU			
		N	1970s	GP,LS			
Drakes Beach Spit	P1						
Point Reyes Beach	P15	N1	1926	4			
Sonoma County							
Bodega Harbor Spit	H	C	1960s	GB			
Salmon Creek Beach	H	N	1978	DFS			
Mendocino County							
MacKerricher Beach	P9						
Humboldt County							
So. Humboldt Bay Spit	P4						
Elk R Spit	P1				1	1	1920
No. Humboldt Bay Spit	P6	A	1910s	12	22	2	1899-1948
Lanphere Dunes	P2						
Mad R Spit	P10	C2	1976	PK	2	1	1931-1935
Clam Beach	P1						
Carson's Landing Penin.	H				1	1	1935
Big Lagoon Bar	P8						
Del Norte County							
Lake Talawa Beach	P3	P1	1974	50			
Smith R Spit	P4						
SAN FRANCISCO BAY							
Santa Clara County							
So. San Francisco Bay	A14	N15	1971	18			
Alviso		C	1950	38			
		N3	1959	11			

APPENDIX 1 (Cont.)

	Survey Status	Records			Egg Sets in Museum Collections		
		Numbers	Year	Source	Total	Max.	Years
San Mateo County							
So. San Francisco Bay	A19						
Belmont		A2	1972	24			
		N	1975-76	41,49			
Bair Island		A2	1977	TM			
Redwood City					1	1	1919
Alameda County							
So. San Francisco Bay	A318	P many	1910s	20			
Dumbarton Bridge		N	1971	14			
		N1	1975	JA:LOCU			
Hayward		N	1965	9			
West of Coyote Hills		N1	1972	HP			
Bay Farm Island		A1,C1	1974	ER			
		A8	1977	TM			
		A5	1979	LF			
Alameda So. Shore		A2-8	1971-77	ER			
		A1	1978	ER			
Napa County							
Little Is. Evaporator	H	N3	1975	RG			
INTERIOR OF STATE							
Imperial County							
Salton Sea	A226	N	1933	47	2	1	1929-1950
		N	1968	27			
		A0-10	1971-74	24			
Riverside County							
Salton Sea	A10						
Lake Elsinore	E	N1	1939	22	2	1	1948
		C1	1940	22			
		C3	1974	28			
San Bernardino County							
Harper Lake	A61	A68,N1,B3	1977	PH			
Searles Lake	A16						
Kern County							
Rosamond Lake	A6						
Koehn Lake	A26						
Goose Lake	A2						
Buena Vista Lake	D	N1	1907	26			
		P	1912	25			
Kings County							
Corcoran Reservoir	A1						
Tulare Lake	D	A	1912	12			

APPENDIX 1 (Cont.)

	Survey Status	Records			Egg Sets in Museum Collections		
		Numbers	Year	Source	Total	Max.	Years
Madera County							
East of Firebaugh	W	P1	1915	42			
Merced County							
Los Banos	H	A	1912	12	4	1	1937-1939
		A	1914	12			
		N5-6	1937	43			
Yolo County							
Davis Sewage Ponds	W	C	1963	13			
Woodland Sewage Ponds	W	B1	1970	1			
Inyo County							
Tecopa Marsh	A7	A1-12	1974-77	JT			
Owens Lake	A499	A"many"	1893	16			
		A130,C	1975	29			
Salt Lake	A1	A2	1977	PH			
Tinemaha Reservoir	A2						
Deep Springs Lake	A13	N2	1964	30			
		A30	1971	RL			
Mono County							
Mono Lake	A384	N3,B6	1976	48			
		A90,N8	1977	GP,SP			
Butte County							
Near Reigo	W				1	1	1913
Lassen County							
Honey Lake	A208	P2	1977	DG			
Eagle Lake	H	A3	1948	fide DA			
Modoc County							
Lower Alkali Lake	A92						
Middle Alkali Lake	A36						
Upper Alkali Lake	A230						
Goose Lake	A33	A	1912	12			
Siskiyou County							
Lower Klamath Refuge	H	N	1957	17			
		A	1971-73	24			

*Observer found total of 20 nests during nesting season; some may have been renests.

**This record is questionable as observer found a four-chick brood, which is a very unusual brood-size for Snowy Plovers.

APPENDIX 2. Sites not listed in Appendix 1 where apparently suitable habitat was surveyed for breeding Snowy Plovers are listed below by county.

ALAMEDA: Alameda Naval Air Station. DEL NORTE: Klamath River mouth, Crescent Beach, Pebble Beach, Pelican Beach. HUMBOLDT: Mattole River mouth, McNutt Beach, Eel River spits, Little River spit, Agate Beach, Dry Lagoon bar, Stone Lagoon bar, Freshwater Lagoon bar, Gold Bluffs Beach, Carruthers Beach. KERN: Rogers Lake, Pazuza Land and Water Company, Kern National Wildlife Refuge. KINGS: Hanford Sewage Ponds. LASSEN: Eagle Lake, Horse Lake. MADERA: Madera Lake. MARIN: Cronkhite Beach, Dillon Beach. MENDOCINO: Manchester Beach, Navarro River mouth. MERCED: Volta Wildlife Area, Santa Fe Grade (road from Gustine to Los Banos), Merced National Wildlife Refuge. MODOC: Clear Lake. MONTEREY: Little Sur River mouth, Carmel River mouth, Carmel Beach, Moss Beach, Spanish Beach, Elkhorn Slough south shore. NAPA: North San Francisco Bay marshes and salt evaporators. ORANGE: San Juan Creek mouth (Doheny State Beach), Aliso Beach, Corona del Mar State Beach. RIVERSIDE: San Jacinto Reservoir, Ford Lake, Palen Lake. SAN BERNARDINO: Dale Lake, Danby Lake, Cadiz Lake, Bristol Lake, West Cronese Lake, East Cronese Lake, Soda Lake, Silver Lake. SAN DIEGO: Naval Training Center, San Diego Flood Control Channel, San Dieguito Creek mouth, Cockleburr Canyon mouth, San Onofre Creek mouth, San Mateo Creek mouth. SAN LUIS OBISPO: Cayucos Creek mouth, Villa Creek mouth, Santa Rosa Creek mouth, San Simeon Creek mouth, Pico Creek mouth, San Simeon Beach, Soda Lake. SAN MATEO: Half Moon Bay, Linda Mar Beach (San Pedro Creek mouth). SANTA BARBARA: Devereaux Beach, Devereaux Slough, Bell to Tecolote Creek mouths, El Capitan Beach, Refugio beach, Gaviota Beach, Canada de Santa Anita mouth, Arroyo El Bulito mouth, Jalama Beach. SANTA CRUZ: Seacliff State Beach, Moran Lake, Cocoran Lagoon, Schwans Lagoon, County Dump Gulch, Major's Creek mouth, San Vicente Creek mouth, Davenport Landing Beach. SOLANO: North San Francisco Bay marshes and salt evaporators. SONOMA: Russian River mouth, Gualala River mouth. TULARE: Pixley National Wildlife Refuge. VENTURA: Calleguas Creek (creek bars from Highway 101 to Lewis and Las Posas Roads), Silver Strand, Hollywood Beach, Santa Clara River bars (Harbor Blvd. north 8.4 km).

APPENDIX 3. Unpublished sources of Snowy Plover nest or egg records and breeding population estimates for various locations, with abbreviations used in Appendix 1 or the text.

Daniel Airola DA, J. Anderson JA, Vivian Anderson VA, Kristen Bender KB, Gordon Bolander GB, Elizabeth Copper EC, Leora Feeney LF, Alice Fries AF, David Gaines DG, Robert Gill RG, John and Dorothy Helmer He, Philip Henderson PH, Eric Johnson EJ, Paul Jorgensen PJ, Paul Kelly PK, Philip Lenna PL, Ronald LeValley RL, S. Liston SL, Flora Maclise FM, Timothy Manolis TM, Barbara Massey BM, Peter Metropulos PM, Gary Page, GP, Dennis Parker DP, Susan Peaslee SP, Henry Pelzl HP, Donald Pine DPi, Elsie Roemer ER, David F. Shuford DFS, Lynne Stenzel LS, Dean Swickard DS, Jan Tarble JT, John G. Tyler (unpub. field notes) JGT, Edna Vollmer EV, Jane (Ricky) Warriner JW, Sanford Wilbur SW.

American Museum of Natural History AMNH, California Academy of Sciences CAS, Carnegie Museum of Natural History CMNH, Clemson University CU, Delaware

Museum of Natural History DMNH, Field Museum of Natural History FMNH, Humboldt State University HSU, Laboratory of Ornithology, Cornell University LOCU, Museum of Zoology, Louisiana State University LSU, Museum of Vertebrate Zoology, University of California MVZ, National Museum of Natural History NMNH, Peabody Museum, Yale University PMY, Museum of Natural History, University of Puget Sound UPS, Royal Ontario Museum ROM, San Bernardino County Museum SBCM, Santa Barbara Museum of Natural History SBMNH, and Western Foundation of Vertebrate Zoology WFVZ.

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Snowy Plover, Mono Lake, California, June 1980. *Photo by Ian C. Tait*

Snowy Plover, Mono Lake, California, June 1980

Photo by Ian C Tait