

State of California
The Resources Agency
Department of Fish and Game
Wildlife Management Division

**WESTERN SNOWY PLOVER
USE OF STATE-MANAGED LANDS
IN SOUTHERN CALIFORNIA, 1995**

by

Abby N. Powell

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ABSTRACT

Western snowy plovers (*Charadrius alexandrinus nivosus*) were monitored during the breeding and wintering seasons of 1995. Surveys were conducted on lands managed or owned by the State of California, in Orange and San Diego Counties. Of the ten sites monitored for breeding activity, three supported nesting snowy plovers in 1995. Bolsa Chica Lagoon was the only breeding site in Orange County, whereas Silver Strand State Beach and Tijuana Estuary were two of eight known breeding sites in San Diego County. Many of the state lands did not support nesting plovers due to insufficient habitat and heavy recreational use. Both of the San Diego County sites have potential for supporting more snowy plovers given appropriate management actions. In contrast, nine sites on or adjacent to State-managed lands were used by plovers during the wintering months. Wintering plovers may not be affected by recreational beach use, but habitat needs to be protected from future development or habitat alteration.

¹Powell, A. N. 1996. Western snowy plover use of State-managed lands in southern California, 1995. Calif. Dep. Fish and Game, Wildl. Manage. Div., Bird and Mammal Conservation Program Rep 96-03, Sacramento, CA. 14 pp.

INTRODUCTION

The western snowy plover (*Charadrius alexandrinus nivosus*) was listed in 1993 as a threatened species by the federal government (U. S. Fish and Wildlife Service 1993). Snowy plovers are known to nest in several locations in southern California and are associated with the coastal wetlands in this region. The decline of western snowy plover populations along the Pacific coast has been attributed to habitat loss and disturbance caused by urbanization (Page and Stenzel 1981, Page et al. 1991).

The greatest loss of plover habitat has occurred along southern California's coast (U. S. Fish and Wildlife Service 1993). Although there have been no recent records of breeding snowy plovers along the mainland coast of Los Angeles County, several of the channel islands (Santa Rosa, San Miguel and San Nicolas) have traditionally supported large numbers of plovers (Page et al. 1991). Orange County has historically supported relatively small numbers of breeding snowy plovers, and the population along the San Diego County coast has declined significantly since the 1970's (Page and Stenzel 1981, Page et al. 1991). Many of the historical breeding sites in San Diego and Orange Counties have been lost or altered (Page and Stenzel 1981).

The purpose of this study was to survey snowy plovers along the coast of Orange and San Diego Counties, specifically on property owned or managed by the State of California. Many of the potential breeding sites in these counties have not been systematically searched for snowy plovers in recent years because attention has focused on federally owned lands (Powell et al. 1995). In addition, no formal surveys for wintering snowy plovers have been conducted on many of the State-managed sites. Information on use by snowy plovers on these properties is essential for California land and wildlife managers.

STUDY SITES

Twelve sites were visited to determine whether there was evidence of use by nesting and/or wintering snowy plovers. Sites were chosen for historical snowy plover activity, and for being on or adjacent to lands owned or managed by the State of California. Descriptions of the study sites, from north to south, are as follows:

Orange County

Bolsa Chica State Beach and Ecological Reserve — Sites surveyed at Bolsa Chica included only those areas owned by the State. Surveys were not conducted on adjacent private lands due to difficulties in obtaining permission for access. The areas surveyed for breeding and wintering activities included mudflats and algal flats around the perimeter of Bolsa Bay east of Pacific Coast Highway. This area consisted of salt marsh vegetation mixed with salt panne habitat, and two islands (North Island and South Island) that were created as tern habitat. These islands supported California least, Forster's, royal and Caspian terns, and black skimmers. The wetland was divided into large diked cells which were made up primarily of dried mudflat with little water flow. Large areas within these cells were covered with dried algal mats. The beach west of the highway (Bolsa Chica State Beach) was also checked for plover activity. This was a heavily used recreational beach with no remaining natural dune habitat. The sand was raked by State Parks regularly and had no vegetative cover.

Huntington Beach State Park — This beach was surveyed from Magnolia Avenue south to the Santa Ana River mouth. This sandy beach was heavily used for recreation and was also raked regularly. There was no natural dune habitat. A California least tern nesting area was fenced off just north of the Santa Ana River mouth. Due east of Pacific Coast Highway and north of the Santa Ana River was a restored salt marsh with some mudflat habitat.

Newport Bay California least tern colony — This site was located south of the Santa Ana River and east of Pacific Coast Highway. This area consisted of artificial fill habitat, two ponds, and some mudflats.

Dana Point — This beach was located south of Salt Creek Beach Park and was heavily used for recreation. There was no native dune habitat and the beach was raked.

Doheny State Beach — This was another heavily used recreational beach. The areas surveyed included the sandy beach located south of San Juan Creek.

San Diego County

San Onofre State Beach — This sandy beach was used primarily for surfing and received heavy use during the spring and summer months. Although there was some native dune habitat remaining, it was often disturbed by people and dogs. Two creek mouths, San Mateo and San Onofre, provided small wetland habitats.

Buena Vista Lagoon — This site was divided by both Interstate 5 and Pacific Coast Highway. The habitat along the edges of the lagoon consisted of cattails (*Typha* sp.) and bulrush (*Scirpus* sp.). The northeastern shore had some bare dirt areas, but these were rutted with tire tracks since people parked there for fishing. The southeastern shore had a parking lot and informational kiosk. The beach at the mouth of the lagoon was blocked by sand and cobble. Only the highest tides entered the lagoon and there was a small amount of outflow. The beach was narrow and heavily used by walkers and joggers.

South Carlsbad State Beach/Batiquitos Lagoon — Construction for habitat restoration at Batiquitos Lagoon was taking place during 1995. The mouth of the lagoon was closed throughout the breeding season, and the water levels within the lagoon inundated the salt panne/mudflats area on the north and eastern perimeters. A newly constructed California least tern nesting area was located just east of Interstate 5 on the southern perimeter of the lagoon. This area consisted of dredged fill and had minimal vegetative cover. The substrate was a mixture of sand and shell fragments.

Cardiff State Beach/San Elijo Lagoon — The area east of the flood control dike had been a snowy plover nesting site in past years. In 1995 the dike flood gate was broken and stuck closed, which kept the eastern area inundated until it was repaired on 18 May. The water level had been dropping very slowly until that time, and on 19 May water was down but the mudflats were saturated and unsuitable for nesting. By 11 June the area was dry with the surface a maze of cracks. Between the flood control dike and Interstate 5 was an area of sandflats and a tidal channel.

channel. Disturbance in this area was limited to infrequent joggers crossing the dike, and cats (*Felis catus*) and one coyote (*Canis latrans*) were observed there. The area west of the freeway was tidally influenced and a former plover nesting site in this area (towards the north shore) was inundated intermittently. On 4 December this main area of the lagoon was flooded and the mouth at the ocean was blocked. Cardiff State Beach, west of Pacific Coast Highway, was very narrow and heavily used for walking, jogging and surfing.

Torrey Pines State Beach/Los Penasquitos Lagoon — The sandy beach west of Pacific Coast Highway was narrow and heavily used by joggers, walkers, and surfers. Los Penasquitos Lagoon consisted primarily of salt marsh habitat, with a small area of mudflats and sandflats located east of highway. There was no suitable nesting habitat within the lagoon area.

Silver Strand State Beach — This sandy beach along the western side of Highway 75 was used heavily by beachgoers during the summer months. The southern half of the beach still sustained natural dune habitat, including a dune habitat restoration site on the south end. Iceplant (*Carpobrotus edulis*) was dense along the strip of beach adjacent to the highway, but native dune plants were found in sparse stands as well. Debris was cleared from the beach below the high tide line, and there were moderate amounts of organic debris, such as washed up aquatic vegetation.

Tijuana Estuary/Border Field State Park — The beach extending north from the Mexican border to the Tijuana River mouth included native dune habitat and heavy amounts of debris (both organic and inorganic). The area closest to the river mouth consisted of a sand spit backed by a channel with regular tidal flow. Mudflat habitats east of the river mouth and along tidal channels were exposed at low tides. This was the only State Beach that received little human use. Traffic from U.S. Border Patrol vehicles was restricted to below the high tide line. Horseback riding was a regular event, but in general riders remained on trails and below the high tide line. The beach north of the Tijuana River mouth — part of Tijuana Slough National Wildlife Refuge — received light to moderate recreational use by walkers, joggers, and people fishing. This area also had native dune vegetation and a sand spit backed by a tidal channel.

METHODS

Potential nesting areas were surveyed for snowy plover breeding activities throughout the nesting season (1 March - 31 August 1995). Nests were located after observing nesting behavior, and they were marked inconspicuously. Hatching success was calculated as the number of hatched eggs per number of eggs laid, fledgling success by the number of color-banded chicks that survived until fledging per number of hatched chicks that were color-banded, and reproductive success by the number of fledglings produced per nesting attempt.

Adult snowy plovers were trapped on the nest with open-bottomed Potter's traps. Individuals were given unique color-band combinations with standard USFWS aluminum bands and three plastic color-bands. Some of the service bands were covered with black tape to provide an extra color combination. Color-banding was coordinated with other snowy plover researchers through

Point Reyes Bird Observatory. Capture and banding was conducted under appropriate permits (FWS Banding Permit No. 22207-C FWS Endangered Species Permit No. NBSSDS, FWS PRT-70263 1, CA Dept. Fish & Game MOU, and Scientific Collector's Permit No. 9261). Care was taken to trap adults during the part of the reproductive cycle when nest abandonment was unlikely (Hill and Talent 1990, MacIvor et al. 1990, Powell and Cuthbert 1993). Chicks were uniquely color-banded on the nest at the time of hatching. Lists of other avian species observed incidentally were kept during the nesting season at selected sites (Table 1).

Wintering snowy plovers were surveyed either weekly or biweekly at 11 sites from 1 September - 31 December 1995. Surveys were conducted both at high and low tides. Winter survey sites do not necessarily correspond directly to the areas surveyed for breeding plovers but were based on historical observations. Band combinations, flock sizes, and locations were recorded.

RESULTS

Reproductive Success

No snowy plover nests were found at Bolsa Chica Lagoon. However, on 16 June a brood of young chicks was seen foraging with an adult male within the Ecological Reserve (Table 2). It was estimated that the chicks were 2-3 days old on 16 June. All three chicks from this single brood survived to fledging, and none were banded. It is likely that there were more nesting attempts outside of the State-managed area since 4-5 pairs of snowy plovers were seen there regularly throughout the breeding season. No other juveniles were seen within the Ecological Reserve. However, an independent birdwatcher reported seeing evidence of several snowy plover broods within the privately owned area at the Bolsa Chica oil fields (Doreen Stadtlander, USFWS, personal communication). No other site in Orange County was known to support breeding snowy plovers in 1995.

There was no evidence of snowy plover breeding activity at San Onofre State Beach or Buena Vista, San Elijo or Los Penasquitos Lagoons. There was no suitable nesting habitat available along the perimeters of these lagoons in 1995. The snowy plovers occasionally sighted around these areas during the breeding season were most likely transients.

Although no snowy plovers nested along the perimeter of Batiquitos Lagoon, the newly created least tern site described on page 2 supported 15 nests. Two banded females had three consecutive clutches each at this site. Only three of the 15 clutches did not hatch; two were lost to ravens early in the season (April) and a one-egg nest was lost to unknown causes. Three (9%) of the remaining 3.5 eggs failed to hatch. Fledging success at Batiquitos Lagoon was the highest in San Diego County, producing an average of 1.13 fledglings per nesting attempt (Table 3) (Powell et al. 1995).

Silver Strand State Beach supported four nesting pairs of snowy plovers early in the season (Table 2). These nests were all located in the natural dune habitat south of the southernmost life guard tower. All four nests hatched, and an average of 0.75 fledglings were produced per nesting attempt (Table 3). Reproductive success was high at Silver Strand State beach in comparison to San Diego County as a whole, which produced an average of 0.38 fledglings per nest (Powell et al. 1995). However, nesting at this site ended after Memorial Day, when recreational beach use increased significantly.

Tijuana Estuary supported nesting snowy plovers throughout the 1995 breeding season. Most of the nests (73%) were located south of the Tijuana River mouth within or adjacent to a California least tern nesting area (Table 2). All nests were located on sandy beaches with moderate amounts of plant cover and organic debris. Only one nest was lost to predation in late March. Ravens took all three eggs from this nest. Only one (3%) of the 31 eggs laid at Tijuana Estuary failed to hatch. Two small chicks were found dead of unknown causes. Reproductive success increased from no fledglings produced in 1994 to 0.64 fledglings per nest in 1995 (Table 3) (Powell et al. 1995).

Disturbance During the Breeding Season: The snowy plovers breeding at Bolsa Chica Lagoon were seen within the area fenced off from human use by California Department of Fish and Game and were therefore exposed to little human disturbance. Although predators were seen in the area, including peregrine falcons and white-tailed kites, the single snowy plover brood survived until fledging. Human use of the area was primarily by trained researchers monitoring terns and skimmers.

Although two nests were lost to raven predation at Batiquitos Lagoon, U.S.D.A., Animal Damage Control (ADC) personnel monitored this site closely because it was also a least tern nesting site. A great horned owl was suspected of taking adult phalaropes in April, but the ADC removed the owls from the area. Six common barn owls were also removed (Adam Whelchel, Wetland Research Associates, Inc., personal communication). There was no evidence of owl predation on snowy plovers. This area received very little human disturbance except from least tern and snowy plover monitors.

Potential predators observed at Silver Strand State Beach included red-tailed hawks, northern harriers, ravens, and feral cats. However, there was no evidence of predation on snowy plovers. Both egg and brood survival were high in this area. The beach received light to moderate use by recreational beach users before Memorial Day and heavy use thereafter. Use before Memorial Day was primarily by people walking below the high tide line. Life guards drove their vehicles only below high tide line and were informed of the locations of snowy plover nests.

We observed less human disturbance at Tijuana Estuary in 1995 than in 1994. This was probably due to Operation Gatekeeper and the cooperation of the U.S. Border Patrol in driving their vehicles only below high-tide line. Potential predators included ravens, American kestrels, white-tailed kites, loggerhead shrikes, coyotes, and feral cats. However, this area received predator management from ADC personnel, and there was little evidence of predation on snowy plovers. The causes of chick mortality at this site were unknown.

Table 1. Avian species seen incidentally during the 1995 breeding season. List is only for specific areas surveyed for snowy plovers.

Common Name	Species	Bolsa Chica Lagoon	Huntington Beach	Buena Vista Lagoon	Batiquitos Lagoon	San Elijo Lagoon	Silver Strand State Beach	Tijuana Estuary
Western grebe	<i>Aechmophorus occidentalis</i>	X			X		X	X
Eared grebe	<i>Podiceps nigricollis</i>	X		X				
Pied-billed grebe	<i>Podilymbus podiceps</i>	X		X	X			
California brown pelican	<i>Pelecanus occidentalis</i>	X					X	X
Double-crested cormorant	<i>Phalacrocorax auritus</i>	X		X			X	X
Black-crowned night heron	<i>Nycticorax nycticorax</i>	X						
Snowy egret	<i>Egretta thula</i>	X		X		X	X	X
Great egret	<i>Casmerodius albus</i>			X		X	X	
Great blue heron	<i>Ardea herodias</i>	X		X	X	X	X	X
White-faced ibis	<i>Plegadis chihi</i>			X		X		
Ross' goose	<i>Chen rossii</i>			X				
Canada goose	<i>Branta canadensis</i>					X		
Brant	<i>Branta bernicula</i>	X						X
Mallard	<i>Anas platyrhynchos</i>			X	X			X
American widgeon	<i>Anas americana</i>			X	X	X		
Northern pintail	<i>Anas acuta</i>			X	X	X		X
Northern shoveler	<i>Anas clypeata</i>				X	X		
Ruddy duck	<i>Oxyura jamaicensis</i>			X				
Redhead	<i>Aythya americana</i>			X				
Lesser scaup	<i>Aythya affinis</i>			X				
Bufflehead	<i>Bucephala albeola</i>			X				
Red-breasted merganser	<i>Mergus serrator</i>	X			X			
American coot	<i>Fulica americana</i>			X	X			
American avocet	<i>Recurvirostra americana</i>	X		X	X	X		X
Black-necked stilt	<i>Himantopus mexicanus</i>	X		X	X	X		
Western snowy plover	<i>Charadrius alexandrinus nivosus</i>	X	X		X	X	X	X
Semipalmated plover	<i>Charadrius semipalmatus</i>	X				X	X	X
Killdeer	<i>Charadrius vociferus</i>		X	X	X	X	X	X
Black-bellied plover	<i>Pluvialis squatarola</i>	X				X	X	X
Marbled godwit	<i>Limosa fedoa</i>	X					X	X
Whimbrel	<i>Numenius phaeopus</i>			X			X	X
Long-billed curlew	<i>Numenius americanus</i>		X				X	X
Willet	<i>Catoptrophorus semipalmatus</i>	X		X			X	X
Greater yellowlegs	<i>Tringa melanoleuca</i>	X				X	X	X
Spotted sandpiper	<i>Actitis macularia</i>			X	X	X		
Red-necked phalarope	<i>Phalaropus lobatus</i>	X			X			

Table 1. Avian species seen incidentally during the 1995 breeding season. List is only for specific areas surveyed for snowy plovers.

Common Name	Species	Bolsa Chica	Huntington	Buena Vista	Batiquitos	San Elijo	Silver Strand	Tijuana
		Lagoon	Beach	Lagoon	Lagoon	Lagoon	State Beach	Estuary
Dowitcher sp.	<i>Limnodromus spp.</i>	X		X		X	X	X
Ruddy turnstone	<i>Arenaria interpres</i>						X	X
Red knot	<i>Calidris canutus</i>	X					X	X
Dunlin	<i>Calidris alpina</i>					X	X	X
Sanderling	<i>Calidris alba</i>	X	X				X	X
Western sandpiper	<i>Calidris mauri</i>	X				X	X	X
Least sandpiper	<i>Calidris minutilla</i>	X		X		X	X	X
Heermann's gull	<i>Larus heermanni</i>	X					X	X
Ring-billed gull	<i>Larus delawarensis</i>	X		X	X	X	X	X
Western gull	<i>Larus occidentalis</i>	X		X	X		X	X
Common tern	<i>Sterna hirundo</i>	X						
Gull-billed tern	<i>Sterna nilotica</i>							X
Forster's tern	<i>Sterna forsteri</i>	X					X	
California least tern	<i>Sterna antillarum browni</i>	X	X	X	X	X		X
Elegant tern	<i>Sterna elegans</i>	X			X			X
Royal tern	<i>Sterna maxima</i>							
Caspian tern	<i>Sterna caspia</i>	X		X	X			X
Black skimmer	<i>Rynchops niger</i>	X			X		X	X
White-tailed kite	<i>Elanus caeruleus</i>	X						X
Northern harrier	<i>Circus cyaneus</i>						X	X
Red-tailed hawk	<i>Buteo jamaicensis</i>	X					X	X
Osprey	<i>Pandion haliaetus</i>	X	X					X
American kestrel	<i>Falco sparverius</i>							X
Peregrine falcon	<i>Falco peregrinus</i>	X	X					
Rock dove	<i>Columba livia</i>			X			X	
Common barn owl	<i>Tyto alba</i>				X			
Great-horned owl	<i>Bubo virginianus</i>				X			
Horned lark	<i>Eremophila alpestris</i>						X	X
Violet-green swallow	<i>Tachycineta thalassina</i>							
Cliff swallow	<i>Hirundo pyrrhonota</i>							
American crow	<i>Corvus brachyrhynchos</i>		X					
Common raven	<i>Corvus corax</i>				X			X
Loggerhead shrike	<i>Lanius ludovicianus</i>							X
American pipit	<i>Anthus spinoletta</i>						X	X
Belding's Savannah sparrow	<i>Passerculus sandwichensis beldingi</i>	X			X	X		X

Table 2. Western snowy plover nests on State lands in 1995. Band combinations are read from left top to bottom right, B=blue, G=dark green, K=black, R=red, S=Service (FWS), W=white, Y=yellow.

Site	Nest Number	Date Found	Habitat	Adult Female	Adult Male	Number of Eggs	Nest Outcome	Number of Chicks	Number of Fledglings
Bolsa Chica Lagoon	1	6/10	unknown	unknown	unbanded	unknown	hatched	3	3
Silver Strand State Beach	1	4/20	sandy beach	unknown	unbanded	3	hatched	3	unknown
	2	4/20	sandy beach	YK/WW	RK/KB	3	hatched	3	2
	3	4/23	sandy beach	RK/BB	RK/KY	3	hatched	2	1
	4	5/6	sandy beach	RK/YY	unbanded	3	hatched	3	unknown
Tijuana Estuary (north) (Tijuana Slough NWR)	1	3/28	sandy beach	WK/WR	unknown	3	raven predation	0	0
	3	5/1	sandy beach	WK/BY	unknown	3	hatched	2	0
	10	8/1	sandy beach	unbanded	unbanded	3	hatched	3	2
Tijuana Estuary (south) (Border Field State Park)	2	4/25	sandy beach	WK/KR	unknown	3	hatched	3	1
	4	5/23	sandy beach	KY/YK	WK/RB	3	hatched	2	0
	5	5/23	sandy beach	WK/WK	unbanded	3	hatched	2	0
	6	6/8	sandy beach	YR/BK	YK/YB	3	hatched	3	0
	7	6/15	sandy beach	RK/YB	unbanded	3	hatched	3	2
	8	8/1	sandy beach	unbanded	unbanded	?	hatched	2	1
	9	7/30	sandy beach	WK/WR	SB/KG	2	hatched	2	0
	11	8/9	unknown	unknown	unbanded	?	hatched	3	1

Table 3. Reproductive success of snowy plovers nesting on State-managed lands in 1995.

Nest Site	Number Clutches	Number Eggs	Clutch Size	Number Chicks Hatched	Fledglings per Nest
<u>Orange County</u>					
Bolsa Chica Lagoon	1	?	3?	3.0 ± 0.0	3.0
<u>San Diego County</u>					
Batiquitos Lagoon	15	40	2.7 ± 0.7	2.1 ± 1.2	1.13
Silver Strand State Beach	4	12	3.0 ± 0.0	2.8 ± 0.5	0.75
Tijuana Estuary	11	31	2.8 ± 0.4	2.4 ± 0.9	0.64

Winter Surveys

Nine sites were surveyed consistently for winter use by snowy plovers. Doheny and San Onofre State Beaches and Newport Bay were not surveyed due to minimal use by plovers and time constraints. Use of State-managed lands by wintering snowy plovers differed from breeding season use both in importance of sites and in habitats within each site. Use varied over time and with different tides (Table 4).

Orange County

At Bolsa Chica, snowy plovers were observed in the same location as breeding birds within the Ecological Reserve area and in mudflat and algal mat habitats. Use of this site was highest in September during migration, and was used for both loafing and foraging during the winter (Table 4). Although Huntington Beach was rarely used by plovers during the breeding season, it received higher use during the winter months (Table 4). Plovers were observed at Huntington Beach just north of the Santa Ana River mouth and west of the least tern colony during high tides. This area appeared to be used primarily as a loafing and roosting site, although foraging was observed when piles of organic debris (primarily kelp) were present on the beach. Dana Point also received variable use by wintering snowy plovers (Table 4). Snowy plovers were observed regularly on the sandy beach south of the mouth of San Juan Creek and west of the railroad tracks. Plovers were observed loafing in the dry sand of the upper beach and foraging in the wet sand along the shoreline.

San Diego County

No snowy plovers were seen at Buena Vista or San Dieguito Lagoons or the beaches adjacent to them during migration or winter months, and no plovers were seen at Batiquitos Lagoon after the water level was raised for construction of new least tern nesting islands (Table 4). San Elijo and Los Penasquitos supported small flocks of plovers which were most often seen loafing and foraging along the beaches and mudflats at the mouths of the lagoons. Plovers at Los Penasquitos were found regularly just northwest of the lagoon on Torrey Pines State Beach. Numbers of plovers seen at Los Penasquitos increased during the winter, while they decreased at San Elijo (Table 4). This may have been due to the increased inundation of San Elijo in November and December which made mudflats unavailable to plovers for foraging. Silver Strand State Beach supported high numbers of migrating and wintering snowy plovers. Flock sizes were highly variable with numbers increasing during high tides. Ongoing work on snowy plovers in south San Diego Bay has shown that birds move between the beach on the oceanside at high tide and mudflats on the bayside at low tide. There was also movement of plovers along the beaches of the Silver Strand between Silver Strand State Beach and the Naval Amphibious Base (NAB), Coronado, to the north (Powell et al. 1995). Snowy plovers were seen during migration and early winter months south of the Tijuana River, but use dropped off in this area later in the winter (Table 4). This same trend was seen in the previous year and may be due to changes in the beach slope during winter (Powell et al. 1995). Use of the area north of the Tijuana River also dropped off later in the winter (Table 4).

Table 4. Mean (\pm s.d.) number of snowy plovers seen on or adjacent to State-managed lands during winter 1995. Tidal ranges are for dates and time of surveys.

Site	September			October			November			December		
	Mean No. Plovers	No. Surveys	Tidal Range	Mean No. Plovers	No. Surveys	Tidal Range	Mean No. Plovers	No. Surveys	Tidal Range	Mean No. Plovers	No. Surveys	Tidal Range
Bolsa Chica	10.25 \pm 4.79	4	2.8-5.4	4.25 \pm 1.26	4	-0.5-1.3	4.50 \pm 1.00	4	2.5-2.8	3.67 \pm 3.21	3	0.8-3.4
Huntington Beach	4.00 \pm 3.16	4	2.2-4.1	11.00 \pm 10.03	4	1.3-5.9	20.00 \pm 1.41	4	0.2-5.0	20.00 \pm 4.00	3	2.0-5.0
Dana Point	0	1	3.3	16.75 \pm 11.35	4	3.5-5.4	22.33 \pm 4.16	3	5.3-6.5	18.00 \pm 4.36	3	2.6-5.0
Buena Vista	0	1	n/a	0	1	n/a	0	1	n/a	0	1	n/a
Batiquitos	7.00 \pm 4.24	2	2.5-4.2	-	-	n/a	-	-	n/a	-	-	n/a
San Elijo	9.00 \pm 3.61	3	0-6.1	11.00 \pm 11.31	2	0.4-6.3	0	3	-0.5-7.4	1.00 \pm 1.73	3	-0.6-6.6
Los Penasquitos	6.00 \pm 0.00	2	0.6	1.50 \pm 2.12	2	0.2-6.5	6.00 \pm 8.49	2	0.2-7.4	22.50 \pm 3.54	2	-0.5-6.0
Silver Strand	28.50 \pm 23.33	2	0.6-5.6	35.50 \pm 2.12	2	0.3	49.50 \pm 7.78	2	1.4-6.2	4.50 \pm 6.36	2	0.7-6.2
Tijuana Estuary (N)	34.50 \pm 48.79	2	0.8-5.8	61.00 \pm 25.46	2	0-6.2	11.00 \pm 7.07	2	-0.3-6.0	2.50 \pm 3.54	2	-1.0-4.8
Tijuana Estuary (S)	34.50 \pm 19.09	2	1.5-4.8	0	2	-0.6-4.0	0	2	0.3-5.8	0	1	4.7

DISCUSSION

Several sites owned or managed by the State were important as western snowy plover breeding and wintering habitat. Bolsa Chica Ecological Reserve and the privately owned lands surrounding it continued to be the only known viable breeding site in Orange County. In San Diego County, both Silver Strand State Beach and Border Field State Park provided breeding habitat and led to the production of fledglings in 1995. Baticuitos Lagoon also had high plover productivity, but the actual breeding areas were not managed by the State. Beach sites that received heavy recreational use or that were raked free of organic debris and vegetation were not used by snowy plovers during the breeding season. These sites included Huntington, Doheny, San Onofre, South Carlsbad, Cardiff, and Torrey Pines State Beaches.

Silver Strand State Beach had natural dune habitat available south of the southernmost lifeguard tower, and this area did not receive heavy use until June in 1995. This site had not been formally monitored for nesting snowy plovers in the recent past. Plovers nesting at Silver Strand State Beach were successful at producing 0.75 fledglings per nest, with a 60% fledging rate in 1995. However, when recreational beach use became more intense after Memorial Day, we documented a shift in plover use to the beaches owned by the U.S. Navy on the Silver Strand. No nesting occurred at Silver Strand State Beach after 4 June, but two females renested in late June at NAB, Coronado.

The beaches at Border Field State Park received little recreational beach use other than horseback riding and occasional beach walkers. Snowy plovers have traditionally nested both north and south of the Tijuana River mouth. Although no fledglings were produced at this site in 1994, 0.64 fledglings were produced per nest in 1995. Prior to 1995, there was heavy foot traffic along the beach from people illegally crossing the border and vehicular traffic from Border Patrol agents. Considerably less human disturbance was observed at this site in 1995, probably due to Operation Gatekeeper and the cooperation of the U.S. Border Patrol in driving their vehicles only below high-tide line.

The loss of snowy plover eggs to predation was extremely low in San Diego County compared with other sites along the west coast (Powell et al. 1995). The low rate of predation is likely due to the predator control program implemented by ADC for the management of California least terns. All of the major tern colonies within the study area had predator management programs in place throughout the breeding season.

Areas that had large mudflats exposed during low tide were as important to snowy plovers as beach areas during migration and winter months. We found that use of individual sites fluctuated widely between September and December. The Tijuana River Mouth and Silver Strand State Beach were used more frequently by plovers during fall-migration, and use dropped off during winter months. Huntington State Beach, Dana Point, and Torrey Pines State Beach were important as wintering sites. Snowy plovers appeared to be tolerant of heavy human use during the winter months as seen at the three aforementioned sites.

MANAGEMENT RECOMMENDATIONS

1) Protection of nesting habitat.

Wetland and dune habitat loss in southern California has been extensive, especially in Los Angeles and Orange Counties. The remaining breeding habitats need continued protection in southern California. Sandy beaches on State-managed property are used primarily for recreation and may therefore not be amenable for nesting by plovers. These heavily used recreational beaches, such as Huntington and Doheny State Beaches, have no remaining native vegetation or dune systems. In addition, organic debris, which provides forage for plovers (e.g., brine flies), and inorganic debris, which provides shelter, are removed by crews for public use purposes. Beach raking leads to unsuitable breeding habitat. Encroachment by exotic plant species, such as iceplant, may also limit nesting habitat (Wilson-Jacobs and Meslow 1984). Beach areas that still provide dune habitat, sparse vegetation, and some organic debris — such as south Silver Strand State Beach and Border Field State Park — should be protected during the breeding season (March through August).

2) Disturbance during the breeding season.

Disturbance by humans and vehicles have been shown to increase both egg and chick mortality in snowy and piping plovers (*Charadrius melodus*) (Warriner et al. 1986, Flemming et al. 1987, Melvin et al. 1994, Staine and Burger 1994). Plover chicks and adults were observed using tire tracks and human footprints for loafing at all of the beach sites surveyed. The use of tire tracks for loafing is potentially dangerous for both adults and chicks during the breeding, migratory, and wintering seasons. Researchers on the east coast have documented mortality of piping plover chicks and adults from vehicles running over them while loafing (Melvin et al. 1994). When foot and vehicular traffic decreased at Border Field State Park in 1995, fledging success increased significantly. Adult plovers nesting at Silver Strand State Beach shifted to NAB, Coronado, after recreational beach use increased after Memorial Day. Management for snowy plovers should include restricted access by vehicles and foot traffic to nesting sites and areas adjacent to breeding grounds that may provide brood-rearing habitat.

3) Protection of winter habitat.

A large percentage of wintering plovers observed in southern California were unbanded, suggesting that many were individuals from other populations on the west coast (Page et al. 1991). Individuals banded in Oregon and northern California have been sighted along the coast of southern California (Page et al. 1995, Powell et al. 1995). In addition, some of the plovers that nested in southern California remained there over the winter months. Sites used by migrating and wintering plovers changed according to tides and time of year. Some of these sites received heavy human use during the nonbreeding months with seemingly little effect on snowy plovers. However, all of these areas should be protected from development and further habitat alteration.

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LITERATURE CITED

- Flemming, S. P., R. D. Chasson, P. C. Smith, P. J. Austin-Smith, and R. P. Bancroft. 1987. Piping plover status in Nova Scotia related to its reproductive and behavioral responses to human disturbance. *J. Field Ornithol.* 59:321-330.
- Hill, L. A., and L. G. Talent. 1990. Effects of capture, handling, banding and radio-marking on breeding least terns and snowy plovers. *J. Field Ornithol.* 61: 3 10-3 19.
- MacIvor, L. H., S. M. Melvin, and C. R. Griffin. 1990. Effects of research activity on piping plover nest predation. *J. Wildl. Manag.* 53: 443-447.
- Melvin, S. M., A. Hecht, and C. R. Griffin. 1994. Piping plover mortalities caused by off-road vehicles on Atlantic Coast beaches. *Wildl. Sot. Bull.* 22:409-414.
- Page, G. W., and L. E. Stenzel. 198 1. The breeding status of the snowy plover in California. *Western Birds* 12: 1-40.
- Page, G. W., L. E. Stenzel, W. D. Shuford, and C. R Bruce. 1991. Distribution and abundance of the snowy plover on its western North American breeding grounds. *J. Field Ornithol.* 62: 245-255.
- Page, G. W., M. A. Stern, and P. W. C. Paton. 1995. Differences in wintering areas of snowy plovers from inland breeding sites in western North American. *Condor* 97:258-262.
- Powell, A. N., and F. J. Cuthbert. 1993. Augmenting small populations of plovers: an assessment of cross-fostering and captive-rearing. *Conserv. Biology* 7: 160- 168.
- Powell, A. N., C. L. Collier, and B. Peterson. 1995. The Status of western snowy plovers (*Charadrius alexandrinus nivosus*) in San Diego County, 1995. Report to U.S. Fish and Wildlife Service, Portland OR, and CA DFG, Sacramento, CA.
- Staine, K. J., and J. Burger. 1994. Nocturnal foraging behavior of breeding piping plovers (*Charadrius melodus*) in New Jersey. *Auk* 111:579-587.
- U. S. Fish and Wildlife Service. 1993. Determination of threatened status for the Pacific Coast population of the western snowy plover. Federal Register 58: 12864-12874.
- Warriner, J. S., J. C. Warriner, G. W. Page, and L. E. Stenzel. 1986. Mating system and reproductive success of a small population of polygamous snowy plovers. *Wilson Bull.* 98: 15-37.
- Wilson-Jacobs, R., and E. C. Meslow. 1984. Distribution, abundance, and nesting characteristics of snowy plovers on the Oregon coast. *Northwest Science* 58:40-48.