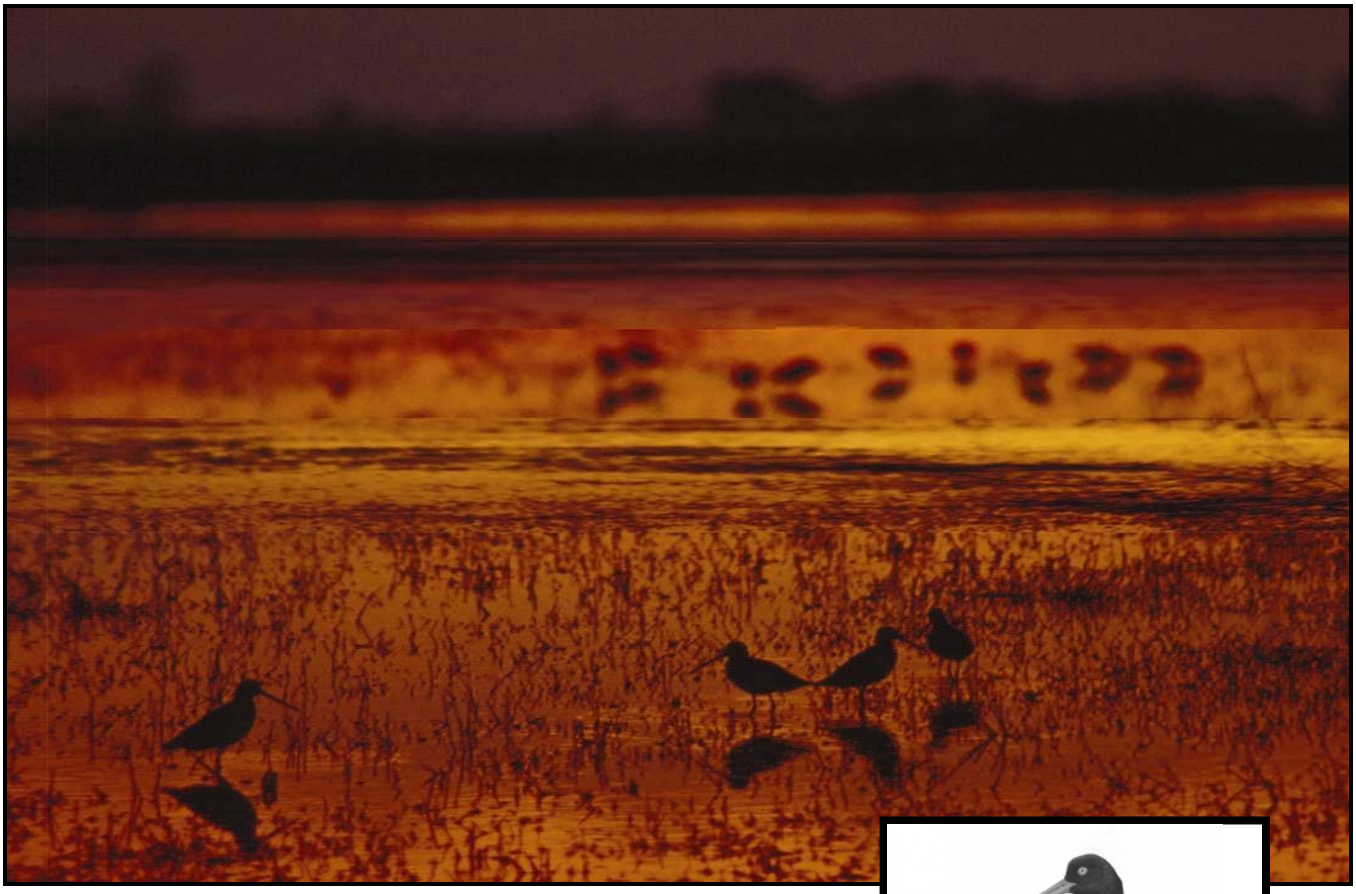
Southern Pacific Shorebird Conservation Plan

A Strategy for Supporting California's Central Valley and Coastal Shorebird Populations



A Project of PRBO Conservation Science in collaboration with the Coastal and Central Valley Shorebird Working Groups

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United States Shorebird Conservation Plan

Southern Pacific Shorebird Conservation Plan

A Strategy for Supporting California's Central Valley and Coastal Shorebird Populations

Version 1.1

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Executive Summary

The Southern Pacific Shorebird Conservation Plan is one of 11 regional plans associated with the US Shorebird Conservation Plan. Herein we provide relevant information and needs for the conservation of shorebirds on the coast and in the Central Valley of California. This plan represents the combined expertise of a broad partnership of federal and state agencies, conservation organizations, academics, and private consultants.

The approximately 1,700-km coastline and the 64-km-wide by 644 km-long Central Valley of California are the main areas where shorebirds concentrate in the Southern Pacific Region. Tidal wetlands, sand beaches, and rocky shoreline are the principal shorebird habitats on the coast. About two-thirds of the estimated approximately 154,200 ha of prime tidal wetlands at the turn of the century have been degraded or destroyed by agricultural, industrial, urban, and military development. Simultaneously, sand beaches have been heavily developed for human recreation and beachfront housing, whereas rocky shoreline has been relatively little altered. In the Central Valley, about 90% of historic wetlands have been altered or lost to agriculture and urban development.

Today the Central Valley habitats most used by shorebirds are restored, highly managed wetlands, irrigated or flooded agricultural lands, hypersaline agricultural evaporation ponds, municipal sewage ponds, and vernal pool rangelands. As shorebirds today live in an environment quite different from two centuries ago, we conclude that shorebird conservation in the Southern Pacific Region will require substantial effort to maintain current shorebird populations and to recover declining shorebird populations.

Numbers of Shorebirds

Little quantitative information is available on historic shorebird numbers in the region. Currently the Western Sandpiper is the most abundant species with several million passing through the region on migration and over 100,000 present during winter. At least 250,000 Dunlin and likely over 100,000 Long-billed Dowitchers winter in the area (PRBO unpubl. data). Over 100,000 Marbled Godwits, Least Sandpipers, and Short-billed Dowitchers likely pass through the region during migration. Tens of thousands of Black-bellied Plovers, Killdeer, Black-necked Stilts, American Avocets, Willets, Marbled Godwits, Sanderlings, Least Sandpipers, and, probably, Black Turnstones and Wilson's Snipe winter in the region. Additionally, tens of thousands of Whimbrels, Wilson's Phalaropes, and Red-necked Phalaropes pass through during migration. For breeding

shorebirds, the region is especially important to Snowy Plovers, American Avocets, and Black-necked Stilts.

Importance of Region to Shorebird Species

The Southern Pacific Region is extremely important to 20 shorebird species relative to the majority of other regions (Table 1). Of the 17 temperate breeding shorebirds in the United States, 12 are priority species that are categorized as either Species of High Concern or Highly Imperiled in the US Shorebird Conservation Plan. Of these 12 species, there are five species (Black Oystercatcher, Snowy Plover, Mountain Plover, Long-billed Curlew, and Marbled Godwit) for which the Southern Pacific Region is extremely important to the species relative to the majority of other regions. Non-temperate breeding species categorized as Species of High Concern and Highly Imperiled for which the Southern Pacific Region is extremely important relative to the majority of other regions, include the Whimbrel, Black Turnstone, Western Sandpiper, and Short-billed Dowitcher. All except two of the above species (Snowy Plover, as it is a federally threatened species, and Western Sandpiper) are also listed as USFWS Species of Conservation Concern in this region (Table 1).

Threats to Shorebirds

Shorebirds of this region have experienced high levels of habitat loss, alteration, and degradation from agricultural and urban development over the past two centuries. Ongoing urban development is highly likely to remain an agent of habitat loss, especially in agricultural lands of the Central Valley. In this region, changes in cropping patterns – such as rice to cotton or cattle grazing to viticulture – also may reduce substantially the value of agricultural land to shorebirds. Expanding urbanization may in the future reduce the supply of water available for wetlands and agriculture. Accelerated sedimentation in wetlands from watershed alteration, exacerbated by infrastructure construction within wetlands, is an ongoing problem that has reduced tidal prism and circulation at several coastal wetlands. Watershed run-off or point discharges have contaminated sediments or water at some inland and coastal locations. Mosquito abatement programs limit options for habitat management, especially the flooding of inland wetlands during summer.

The spread of exotic plants – such as European beachgrass *(Ammophila arenaria)* on coastal beaches or salt-water cord grass *(Spartina alterniflora)* in the San Francisco Bay Estuary – has reduced or, in the latter example, threatens to reduce the extent of shorebird habitat. The ongoing introduction of many non-native invertebrates into the benthos of coastal wetlands, through ship ballast discharges and other human activities,

is regularly altering the composition of potential shorebird prey in an unpredictable manner.

Nesting shorebirds in the region have experienced high rates of nest loss to introduced mammalian predators, especially the Red Fox *(Vulpes vulpes)*, and to expanding populations of native predators, especially the Common Raven *(Corvus corax)*.

Growing recreational use of beaches and wetlands appears to be causing increased disturbance of roosting and foraging shorebirds. Various oyster culture practices affect shorebird access to potential food resources in species-specific ways. The potential affects of climate change on shorebird populations, including changes in prey populations, and impacts to habitat quality, availability and extent, may be profound for those concerned with preservation of shorebird populations.

Conservation Priorities

Priorities for conservation of shorebird populations in the Southern Pacific Region are to:

- Increase breeding populations of the Snowy Plover to 2,750 breeding adults, as recommended in the draft USFWS Snowy Plover Recovery Plan.
- Increase or maintain breeding populations of the Black-necked Stilt, American Avocet, Black Oystercatcher, and Killdeer by restoring, enhancing, or creating nesting habitat.
- Increase migratory and wintering populations of all key shorebird species in the region using protection, restoration, enhancement, and management strategies as outlined in this document.

General habitat goals for broad habitat types are to:

Tidal Wetlands

- Restore tidal flats and marshes, particularly in San Francisco Bay and on the southern California coast.
- Enhance tidal action in existing wetlands as needed.
- Reduce sedimentation from alteration of wetland watersheds.
- Prevent further wetland loss to development and fragmentation by human infrastructures.
- Minimize future introductions of non-native invertebrates and plants.
- Eliminate the exotic plant *Spartina alterniflora* from tidal flats.
- Restrict further development of tidal flats for oyster culture.
- Limit human disturbance to shorebirds in all seasons.

Managed Wetlands

- Improve the value of existing managed wetlands by expanding wetland management strategies that benefit shorebirds.
- Restore additional wetlands to support migrating, wintering, and breeding populations.
- Avoid further fragmentation and encroachment of wetlands by development.
- Retain and manage a sufficient amount of salt ponds and other shallow open water habitat to support shorebird populations.

Seasonal Coastal Wetlands

- Protect coastal seasonal wetlands from development.
- Maintain hydrologic regime of seasonal coastal wetlands.

Coastal Strand

- Identify and rank beaches by importance to shorebirds, including to nesting Snowy Plover, and restrict human recreation and dogs on highest ranked beaches.
- Enforce existing restrictions on access and recreational activities on all beaches.
- Protect Snowy Plover nests with exclosures, and nests and chicks with predator management.
- Restore native coastal strand by eliminating exotic plants that reduce the extent and habitat quality of dunes and beaches, and by reestablishment of native plant communities where appropriate.
- Ensure adequate low-disturbance roost sites.

Agricultural Land

- Protect agricultural crop types and specific sites that are known to support large flocks of shorebirds.
- Employ management activities of agricultural land, conducive to crop production, that benefit shorebirds.
- Maintain acreage of flooded riceland in winter and promote conventional methods of rice harvest and shallow flooding of ricelands in winter.
- Curtail the rapid loss of vernal pool rangelands.
- Further reduce shorebird use of contaminated agricultural evaporation ponds while maintaining or creating new nearby mitigation wetlands.

Research Needs

Research priorities specific to the Southern Pacific Region reflect national priorities, while encompassing needs identified by the coastal and interior working groups and by prominent researchers in the region. Research questions outlined herein broadly are targeted to facilitate stable and self-sustaining shorebird populations and address factors potentially limiting populations such as climate change, increases in predator populations, contaminants, human disturbance, and loss and alteration of habitat. Also essential for this purpose is research that investigates size and distribution of populations, space use and dispersal, migration systems, turnover rates and stopover ecology, energetics and foraging ecology, and differentiation of subspecies or conservation units of populations. Other important research topics included are those pertaining to improved management and restoration activities for the benefit of shorebirds.

Monitoring Needs

It will be important to contribute to and participate in national/international programs being developed to estimate shorebird population sizes, detect population trends, and monitor shorebird numbers at stopover locations. Monitoring needs specific to the Southern Pacific Region include the establishment of an active network of organizations to undertake monitoring activities, establishment of monitoring methods for the region that feed into national monitoring efforts, and establishment of a data central for monitoring results for the region that also feed into a national database. Monitoring of breeding shorebird populations is a priority and includes monitoring annual numbers, reproductive success, and survival of Snowy Plover, Black Oystercatcher, and other species, particularly those dependent on habitat types that face the most imminent threats. For non-breeding shorebird populations, it will be important to establish long-term monitoring schemes for species of conservation concern and other species for which the Southern Pacific Region is particularly important relative to other regions of North America. Additionally, in light of proposed conversion of thousands of acres of salt ponds to tidally influenced wetlands in the San Francisco Bay Estuary, monitoring wintering and migrating shorebird populations use of the estuary is needed to assess impacts of the restoration activities on shorebird populations and to inform restoration and conservation activities. In addition to population monitoring, priorities include monitoring of habitat availability and condition over the long-term and quantifying the success of restoration and enhancement projects in supporting shorebird populations.

Education and Outreach

Successful shorebird conservation requires strategic implementation of education and outreach programs to engender acceptance of conservation recommendations. The goal for education and outreach in the Southern Pacific Region is to provide guidelines, messages, and resources for partners interested in creating, enhancing, or implementing education programs about shorebird conservation. Messages for education and outreach programs include information about the ecology and diversity of shorebirds, important habitats, and what groups can do to help support shorebird populations in the region. On the coast, the critical role of wetlands in the health of human populations and to breeding, migrating, and wintering shorebirds is emphasized. Coastal beaches are emphasized as especially important to threatened species that depend on beach habitat for all phases of their life cycle. For the Central Valley, messages include emphasis on the Valley as an internationally significant area for wintering and migrating shorebirds, and that shorebird habitat can be enhanced or provided on certain agriculture lands and wetlands managed for waterfowl. Key audiences for outreach efforts include stakeholders, community members, educators, and land mangers. Strategies and resources available for reaching and working with those audiences to engender support of conservation actions are presented herein.

Implementation and Coordination

Shorebird conservation working groups formed during 2001-2003 should continue to guide implementation of the goals and priorities of the shorebird conservation plan in the Southern Pacific Region. The working groups' efforts should be coordinated with the Pacific Coast Joint Venture, San Francisco Bay Joint Venture, and Central Valley Habitat Joint Venture, and provide technical expertise to the JVs for the purpose of maximizing benefits of conservation efforts for all bird species. On the portion of the California coast currently with no active Joint Venture, working group members and other interested parties should work to integrate shorebird conservation needs into existing and future initiatives that address habitat conservation.

Black-bellied Plovers

Chapter 1. Description of Region

The Southern Pacific Region of the US Shorebird Conservation Plan lies completely within the state of California and adjacent US territorial waters (Figure 1). It is bounded seaward by the 322 km limit and inland by the Cascade and Sierra Nevada mountains. The Southern Pacific Region overlaps three Bird Conservation Regions (BCR) – part of the Northwestern Pacific Rainforest (BCR 5) in California, all of Coastal California (BCR 32) within the US, and all of Sierra Nevada (BCR 15). The Coastal California BCR includes the Central Valley of California.

All or parts of three Joint Ventures of the North American Waterfowl Management Plan are included within the Southern Pacific (shorebird) Region. The Pacific Coast Joint Venture encompasses the Pacific Northwest BCR, a portion of which is within the Southern Pacific Region. The San Francisco Bay Joint Venture is completely contained within the Coastal California BCR, and the Central Valley Habitat Joint Venture, which recently expanded its boundaries to the crest of the Sierras, is contained within the Coastal California BCR and partly within the Sierra Nevada.

Within the Southern Pacific Region, the major areas of shorebird concentration are the coast, offshore waters (used by migrating phalaropes), and the Central Valley. The coast consists of rocky and sandy shoreline interspersed with wetlands. Shorebirds' main native coastal habitats are tidal flats, marshes, rocky shores, and sand beaches. Within San Francisco and San Diego bays, some commercial salt evaporation ponds are important habitat for shorebirds. Diked wetlands, sewage ponds, and agricultural lands, especially heavily grazed pastures, are other human-created habitats along the coast that support shorebirds. The natural wetlands of the coast have been greatly altered by human activities during the past 200 years. About two-thirds of the estimated approximately 154,200 ha of prime tidal wetlands at the turn of the century have been degraded or destroyed by agricultural, industrial, urban, and military development (Speth 1979). So much wetland habitat has been degraded or destroyed that all remaining habitat capable of supporting shorebirds should be preserved or enhanced.

In the Central Valley, over 90% of the historic wetlands have been altered by agricultural and urban development. At present, key shorebird habitats in the Central Valley are restored, highly managed wetlands, irrigated or flooded agricultural lands, hypersaline agricultural evaporation ponds, and municipal sewage ponds. Shorebird use of agricultural lands is concentrated primarily in Sacramento Valley rice fields and secondarily in various plowed croplands, alfalfa fields, irrigated pastures, and vernal pool rangelands.

Figure 1. The Southern Pacific Shorebird Region boundary. The region is defined by the Coastal California (US portion), Sierra Nevada, and Northwestern Pacific Rainforest (portion within California) Bird Conservation Regions.

The Southern Pacific Region is an important wintering area for shorebirds that breed in the arctic and temperate zones. For example, it is a wintering area for the Dunlin, Willet, and Marbled Godwit, which, respectively, nest in Alaska, the Great Basin, and the Prairie. The region also is important during migration, particularly for arctic-breeding species such as the Whimbrel, Western Sandpiper, and Short-billed Dowitcher. Numbers of these shorebirds in the region swell during migration periods, which, for all species combined, extend primarily from mid-March to mid-May in spring and from mid-June until at least November in autumn. Species with important breeding populations in the region include the Snowy Plover, Killdeer, Black Oystercatcher, Black-necked Stilt, and American Avocet; ones with less significant breeding populations include the Spotted Sandpiper, Wilson's Snipe, and Wilson's Phalarope.

A variety of factors impact shorebird use of the Southern Pacific Region. Historic loss and degradation of native wetlands and shorebirds' exploitation of human-created habitats undoubtedly have altered the abundance and distribution of shorebirds in the region. An increase in sedimentation rates over historical levels, from human alteration of watersheds, threatens to shorten the life spans of some coastal wetlands that are now otherwise protected. Introductions of marsh plants to some large wetlands threaten to reduce the area of unvegetated tidal flats and hence prime foraging habitats for shorebirds. Continually changing benthic invertebrate communities, as a result of ship ballast discharges and other human activities, may impact the food resources of many shorebird species.

While there is considerable effort being made to restore wildlife habitat and listed species along the coast and in the Central Valley, there can be competing needs of other species. For example, recovery of the endangered Peregrine Falcon (*Falco peregrinus*) has likely increased winter mortality of shorebirds, as shorebirds are important Peregrine prey. Restoring tidal marshes for the recovery of listed populations of marsh-dependent species, such as the California Clapper Rail *(Rallus longirostris obsoletus)* and Salt Marsh Harvest Mouse *(Reithrodontomys raviventris),* will reduce the extent of other habitats, such as salt ponds, that may be more valuable than marshes to shorebirds. In the Central Valley, the focus on wetland management for wintering waterfowl often results in wetland water levels too deep for shorebirds. However, it should be noted that shorebirds rely heavily on wetlands created, restored, and enhanced as waterfowl habitat and the shorebird community is working closely with Joint Venture partners to ensure the needs of all species are met.

Competition among agriculture, urban populations, and wildlife for a limited water supply may hamper wetland habitat restoration for all species. Even when water is

available, the manner and timing with which it can be applied to wetlands is restricted by mosquito abatement regulations designed to control and prevent human diseases.

The growing demand of an expanding human population for recreational opportunities threatens coastal habitats and especially beaches, which are an important nesting habitat for the threatened Western Snowy Plover and a foraging habitat for the plover and other shorebirds. On beaches, shorebirds are disturbed regularly by pedestrians, joggers, and, especially, unleashed dogs, which sometimes intentionally chase shorebirds. Snowy Plover nests have been stepped on by pedestrians and equestrians and have been destroyed by dogs. People also have deliberately destroyed plover nests at some locations (PRBO unpubl. data).

Long-billed Curlew

Chapter 2. Occurrence Patterns and Regional Species Priorities

Thirty-seven species of shorebirds occur regularly within the Southern Pacific Region (see Appendix A for scientific names). Based on the proportion of the estimated North American population (Morrison et al. 2001a) occurring in the Southern Pacific Region, we categorized the region's importance to species at three levels: primary importance when regional populations likely are higher (during one or more seasons) than those in the majority of other shorebird planning regions in the United States; moderate importance when regional populations likely are as high as those in only several other regions; and limited importance when regional populations likely are very small relative to those in other regions. See Table 1 for this region and see Appendix 2 in Brown et al. 2001 for all regions.

Primary Importance

The region was categorized as of primary importance to 20 species. Of those 20 species, largest numbers and principal habitats of 6 are in the Central Valley and of 10 are on the coast, whereas 4 are relatively abundant in both coastal and inland habitats.

The six species for which the Central Valley is especially important are:

Killdeer – About 11,000 to 17,000 Killdeer have been counted in the Central Valley in mid-winter, but those surveys did not include upland habitats used by many individuals (Shuford et al. 1998). Large numbers also nest in the Central Valley, particularly in and adjacent to the extensive area of Sacramento Valley rice fields (D. Shuford pers. obs.).

Mountain Plover – The majority of the Mountain Plover's entire population winters in California, primarily in the Central and Imperial valleys (Hunting and Fitton 1999). Thousands of wintering Mountain Plovers were regularly recorded in the San Joaquin Valley (southern drainage of the Central Valley) in the 1960s, but numbers have dwindled considerably in recent decades (J. Engler in litt.). The Southern Pacific Region is of primary importance to this species, as the plover concentrates in the Central Valley in winter and has imperiled status.

Greater Yellowlegs – Using a combination of aerial and ground surveys, Shuford et al. (1998) estimated an average of about 4,000 Greater Yellowlegs each winter in the Central Valley, but these undoubtedly are underestimates. From his surveys of rice fields, Chris Elphick (in litt.) extrapolated that roughly 12,300 (confidence interval 3,000-21,600) Greater Yellowlegs winter in Sacramento Valley rice fields.

Whimbrel – A minimum of about 8,000 Whimbrel migrate through the Central Valley in spring (Shuford et al. 1998).

Long-billed Dowitcher – Over 90,000 Long-billed Dowitchers occur in the Central Valley during midwinter and spring (Shuford et al. 1998).

Wilson's Snipe – Although no accurate estimates are available, there likely are tens of thousands of snipe in the Central Valley in winter. Small numbers of snipe nest in the Valley.

The 10 species for which coastal habitats in the Southern Pacific Region are especially important are:

Black-bellied Plover – At least 28,500 birds winter and 42,500 migrate along the coast (PRBO unpubl. data).

Snowy Plover – Over 90% of the listed population along the US Pacific Coast breeds here (USFWS 2001) and most of it also winters here. Snowy Plovers from the Central Valley and western Great Basin also winter along the region's coastline (Page et al. 1995a*).*

Semipalmated Plover – Coastal wetlands are important for this species during fall and spring migration, with low thousands migrating through the region (Page et al. 1999).

Black Oystercatcher – This species is limited in distribution to the west coast of North America, and, hence, the Southern Pacific Region is one of three US shorebird planning regions in which the species is found. Its primary habitat is outer coast rocky shoreline. Carter et al. (1992) recorded 888 Black Oystercatchers on the California coast during a state-wide survey of nesting seabirds from 1989 to1991. Although comparable data are lacking, similar numbers appear to occur year round.

Willet – Over 20,000 Willets winter along the California coast and over 50,000 may migrate through the coastal region (PRBO unpubl. data).

Marbled Godwit – An estimated 37,000 occur along the California coast in winter (PRBO unpubl. data), and up to 138,000 may pass through during migration, assuming the majority of birds wintering in Baja California, Mexico (Page et al. 1997) migrate through California. Wintering numbers on the California coast are unmatched elsewhere in the United States.

Black Turnstone – This species is restricted to the three shorebird planning regions on the west coast of the United States. Black Turnstones forage on rocky outer coast shoreline and estuarine tidal flats.

Short-billed Dowitcher – As many as 150,000 Short-billed Dowitchers migrate along the California coast in spring (PRBO unpubl. data).

Red-necked Phalarope – Over 80,000 migrate along the US Pacific Coast in fall (Page et al. 1999), with almost 20,000 found in San Francisco Bay alone (Stenzel et. al 2002).

Red Phalarope – Abundant offshore migrant in the California Current (Tyler et al. 1993, Warnock et al. 2001a). Accurate counts are lacking.

The four species for which the region is especially important, and that are relatively abundant both on the coast and in the Central Valley, are:

Long-billed Curlew – The region holds a large percentage of this species' wintering population. Pacific Flyway Project surveys found at least 7,000 curlews in the region in winter (PRBO unpubl. data), but this is a minimum estimate because of a lack of surveys in upland habitats of the Central Valley. Morrison et al. (2001b) estimate the North American population at 20,000 birds.

Western Sandpiper – Over one million Western Sandpipers migrate through the Central Valley and along the coast during spring (PRBO unpubl. data). The entire world population of this species is approximately 2.5 to 4.0 million birds (Bishop et al. 2000). Single day counts at San Francisco Bay in the spring have approached one million birds (Stenzel and Page 1988).

Dunlin – The minimum estimate of 250,000 individuals of the race *Calidris alpina pacifica* that winters along the coast and in the Central Valley (PRBO unpubl. data) represents about one half of that subspecies' entire population (Page and Gill 1994).

American Avocet – Avocet numbers here in winter may be greater than those in any other planning region and in fall may be surpassed only by numbers in the Intermountain West Region. Eighty-eight percent of the US Pacific coast avocets counted in winter (median count = 26,177 birds) found in San Francisco Bay (Page et al. 1999).

Moderate Importance

The region was categorized as of moderate importance to seven species: Black-necked Stilt (on coast and inland year round), Wandering Tattler (on coast during migration), Spotted Sandpiper (on coast and inland during migration and winter), Red Knot (on coast during migration and winter), Sanderling (on coast during migration and winter), Least Sandpiper (on coast and inland during migration and winter), and Wilson's Phalarope (on coast and in Central Valley wetlands during migration).

Limited Importance

The region was categorized as of limited importance to ten species: American Golden-Plover, Pacific Golden-Plover, Lesser Yellowlegs, Solitary Sandpiper, Ruddy Turnstone, Surfbird, Semipalmated Sandpiper, Baird's Sandpiper, Pectoral Sandpiper, and Rock Sandpiper.

Table 1. National prioritization scores for national conservation variables; regional scores for population trend, and threats to breeding and non-breeding populations; USFWS Species of Conservation Concern; relative importance of the region during migration, winter, and breeding; and national conservation category. See Brown et al. (2001) for explanation of variables and scores.

Shorebird Planning Region	Southern Pacific											
Species	PT	RA	TB	TN	BD	ND	PT-R	TB-R	TN-R	USFWS Species of Conservation Concern (BCR 32)	Entire Planning Region	National Conservation Category
Black-bellied Plover	5	3	2	2	2	1	U	NA	2		**M**,**W**	3
American Golden-Plover	5	3	2	4	2	3	U	NA	4		m	4
Pacific Golden-Plover	3	5	2	2	5	4	U	NA	2		m,w	4
Snowy Plover	5	5	4	4	3	4	4	5	4		**M,W,B**	5
Semipalmated Plover	3	3	2	2	1	1	U	NA	2		**M**,w	2
Killdeer	5	1	3	3	1	2	U	4	4		M,**W**,**B**	3
Mountain Plover	5	5	4	4	5	4	U	NA	5	Y	M,**W**	5
Black Oystercatcher	3	5	4	3	3	4	U	4	3	Y	**W,B**	4
Black-necked Stilt	3	3	3	2	1	2	U	3	2		M,W,B	2
American Avocet	3	2	3	4	2	3	U	3	4		**M**,W,B	3
Greater Yellowlegs	3	4	2	2	2	1	U	NA	2		M,**W**	3
Lesser Yellowlegs	5	2	2	3	2	1	U	NA	3		m,w	3
Solitary Sandpiper	3	4	4	2	3	2	U	NA	2		m	4
Willet	3	3	3	3	3	3	U	3	3		**M,W**,b	3
Wandering Tattler	3	5	2	2	3	2	U	NA	2		M,w	3
Spotted Sandpiper	3	3	2	2	1	1	U	2	2		M,W,B	2
Whimbrel	5	4	2	2	3	2	U	NA	2	Y	**M**,w	4
Long-billed Curlew	5	5	4	4	3	3	U	4	4	Y	**M,W**,b	5
Marbled Godwit	4	3	4	4	3	3	U	NA	4	Y	**M,W**	4
Ruddy Turnstone	4	3	2	4	2	2	U	NA	4		m,w	4
Black Turnstone	3	4	4	4	5	3	U	NA	4	Y	M,**W**	4
Surfbird	4	4	2	4	4	3	U	NA	4		m,w	4
Red Knot	5	2	2	4	3	3	U	NA	4	Y	M,W	4
Sanderling	5	2	2	4	2	1	U	NA	4		M,W	4
Semipalmated Sandpiper	5	1	2	3	3	3	U	NA	3		m	3
Western Sandpiper	5	1	2	4	4	2	U	NA	4		**M,W**	4
Least Sandpiper	5	2	2	2	2	2	U	NA	2		M,W	3
Baird's Sandpiper	3	2	2	2	3	3	U	NA	2		m	2
Pectoral Sandpiper	3	2	2	3	2	3	U	NA	3		m	2
Rock Sandpiper	3	3	3	4	5	4	U	NA	4		w	3
Dunlin	5	2	2	3	2	3	U	NA	3		**M**,**W**	3
Short-billed Dowitcher	5	2	2	4	3	2	U	NA	4	Y	**M**,W	4
Long-billed Dowitcher	2	2	2	3	4	3	U	NA	3		**M**,**W**	2
Common Snipe	5	1	3	2	1	2	U	3	2		**W**, b	3
Wilson's Phalarope	5	1	3	4	2	5	U	3	4		M,b	4
Red-necked Phalarope	4	1	2	3	2	1	U	NA	3		**M**	3
Red Phalarope	5	1	2	3	2	1	U	NA	3		**M**,w	3

Chapter 3. California Coast

The northern California coast extends about 676 km from the Oregon border south to the entrance of San Francisco Bay. About 40% of the coastline is sand beach, nearly half of which is backed by sand dunes; about 59% is rocky (US Army Corps of Engineers 1971). The coast south of San Francisco Bay encompasses approximately 1,046 km of coastline of which 59% is sand beach, 38% rocky shoreline, and 2% gravel or cobble beach (US Army Corps of Engineers 1971). Dozens of wetlands are interspersed along the coastline.

Wetlands of Importance to Shorebirds

Along the northern California coast 10 wetlands are known to hold over 1,000 shorebirds during peak periods of occurrence and along the California coast south of San Francisco Bay, we identified 25 wetlands that are used by hundreds to tens of thousands of shorebirds (Figures 2-8). Percent of total shorebirds and of individual species found at individual wetlands along the conterminous US Pacific Coast are presented in Table 2. For each wetland of importance along the California coast, Appendix B provides a site description, numbers of shorebirds using the site, information about ownership and current management, conservation needs and issues, and proposes site-specific conservation actions to address those issues.

Black-bellied Plover

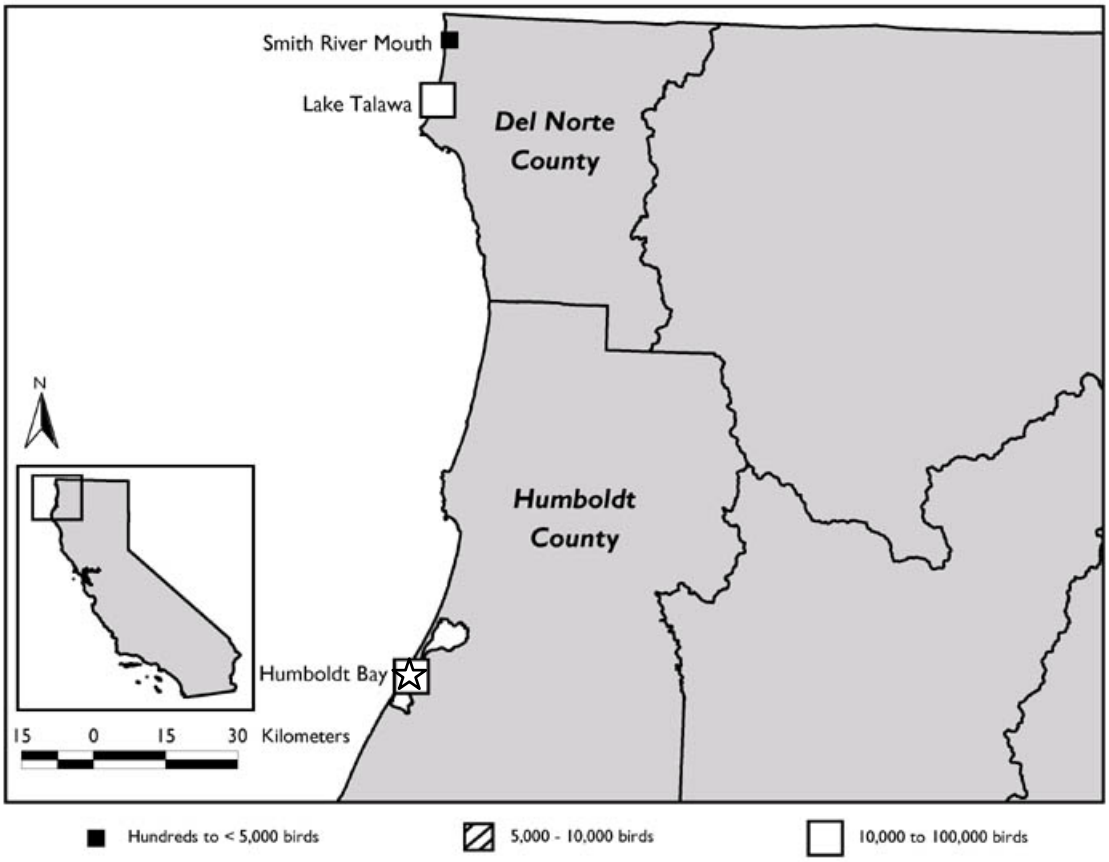

Figure 2. Important wetlands and beaches of Del Norte and Humboldt counties. Wetlands of importance are determined by level of shorebird use. Stars indicate Western Hemisphere Shorebird Reserve Network (WHSRN)-designated site. Beaches of importance currently are determined by importance to Snowy Plovers.

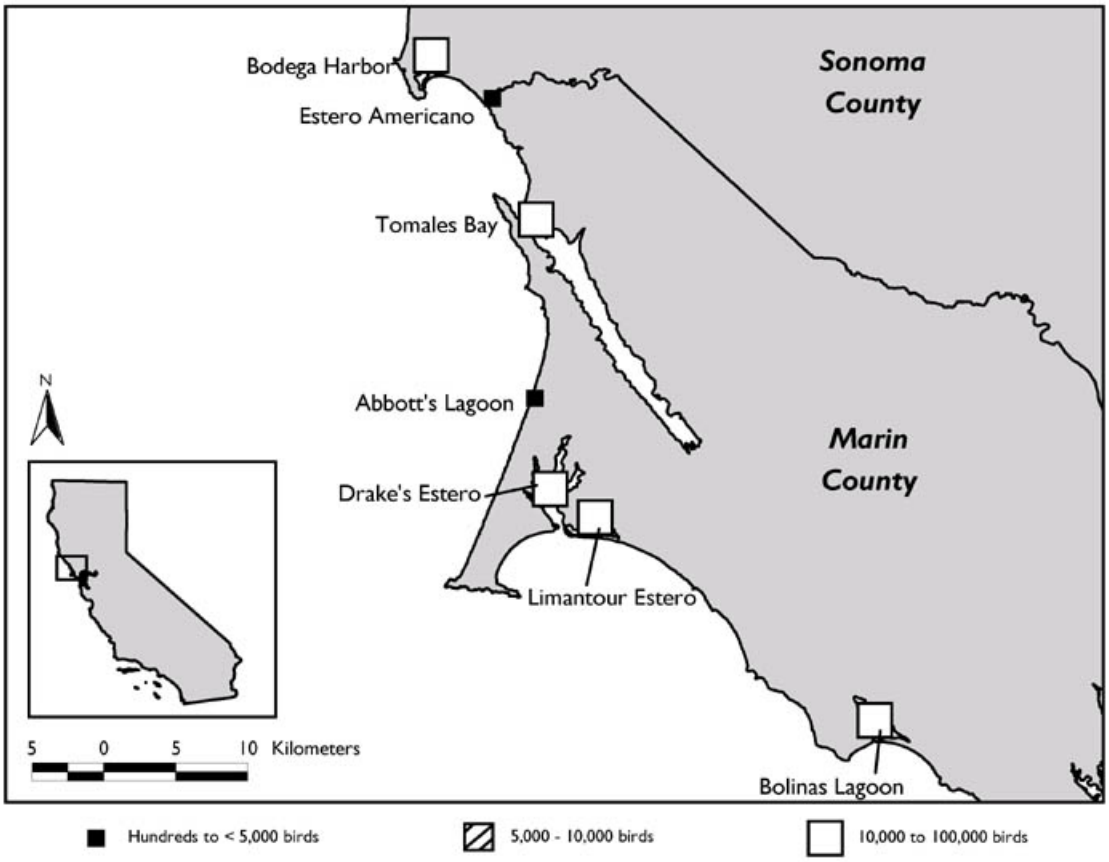

Figure 3. Important wetlands and beaches of Sonoma and Marin counties. Wetlands of importance are determined by level of shorebird use. Beaches of importance currently are determined by importance to Snowy Plovers.

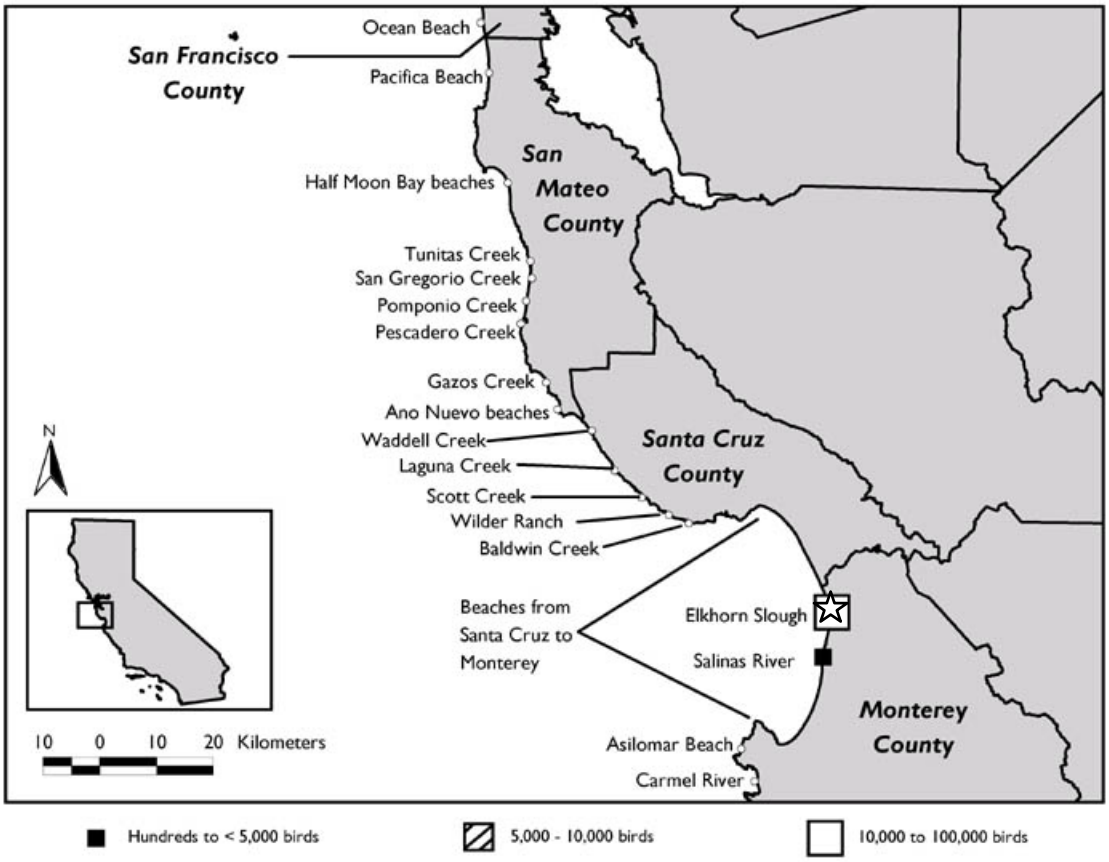

Figure 4. Important wetlands and beaches of San Francisco, San Mateo, Santa Cruz, and Monterey counties. Wetlands of importance are determined by level of shorebird use. Stars indicate WHSRN-designated site. Beaches of importance currently are determined by importance to Snowy Plovers.

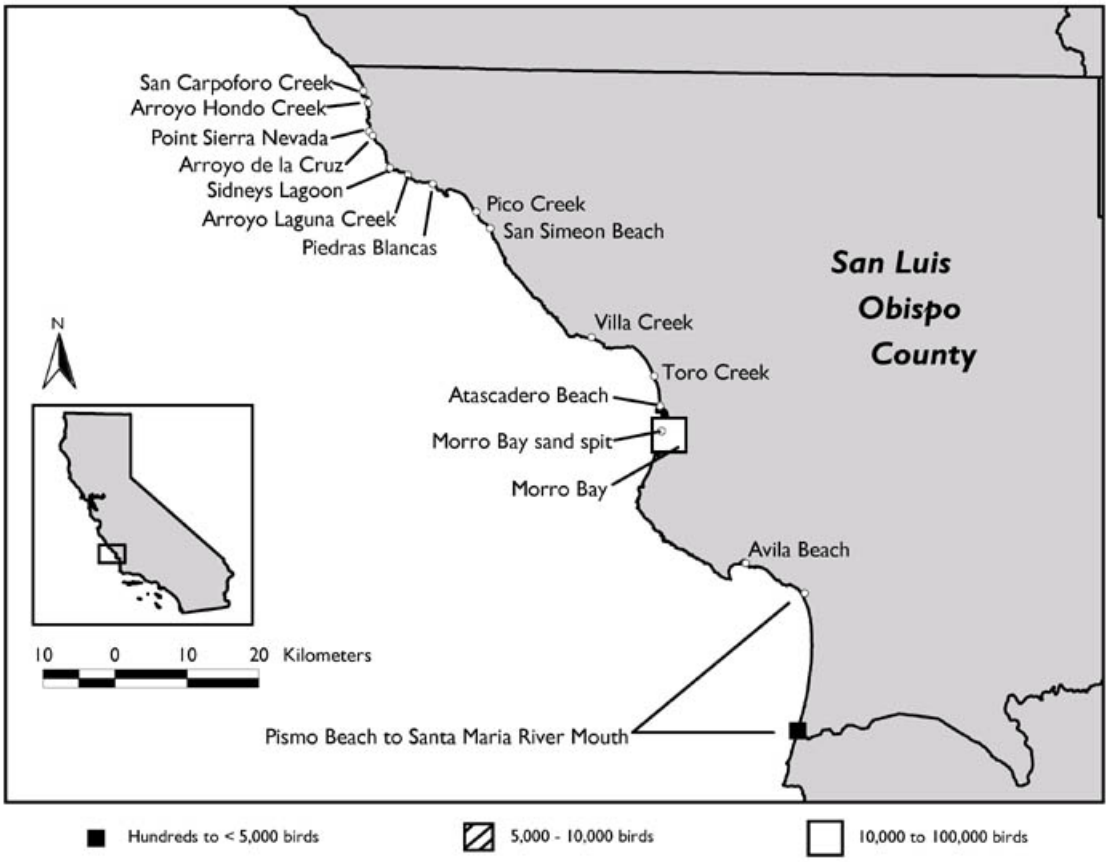

Figure 5. Important wetlands and beaches of San Luis Obispo County. Wetlands of importance are determined by level of shorebird use. Beaches of importance currently are determined by importance to Snowy Plovers.

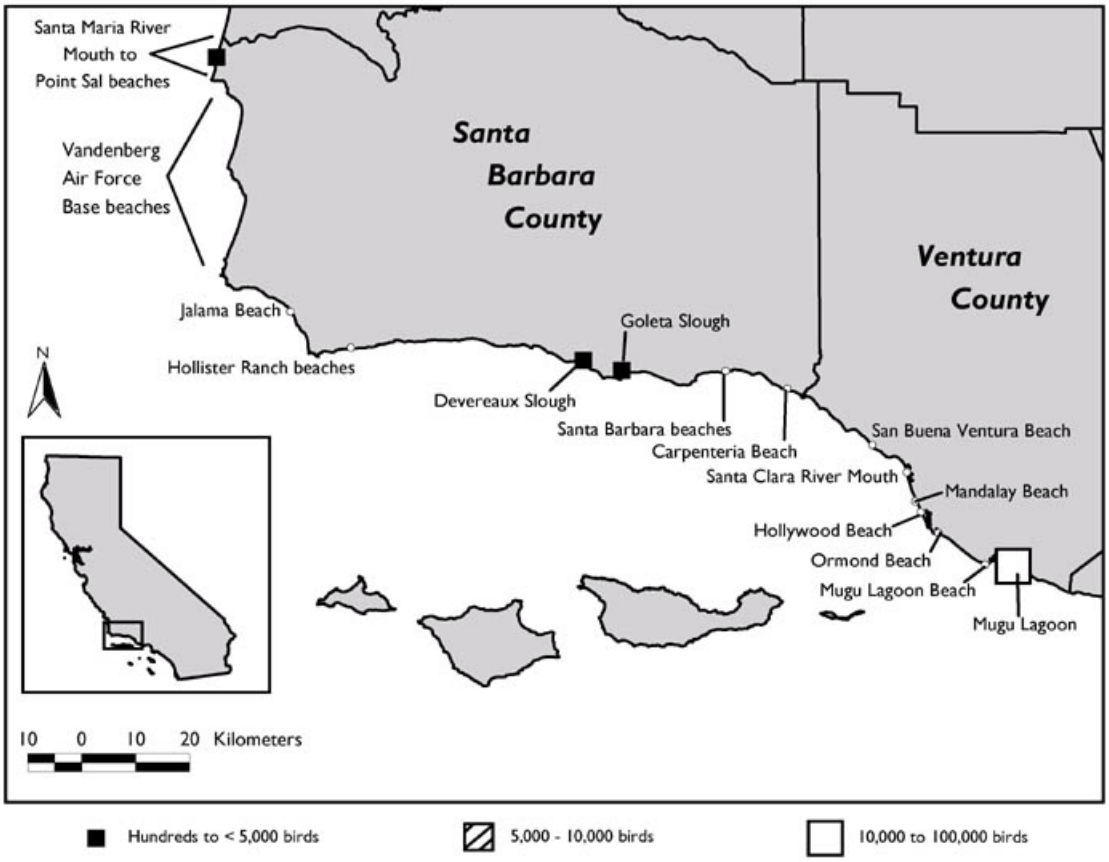

Figure 6. Important wetlands and beaches of Santa Barbara and Ventura counties. Wetlands of importance are determined by level of shorebird use. Beaches of importance currently are determined by importance to Snowy Plovers.

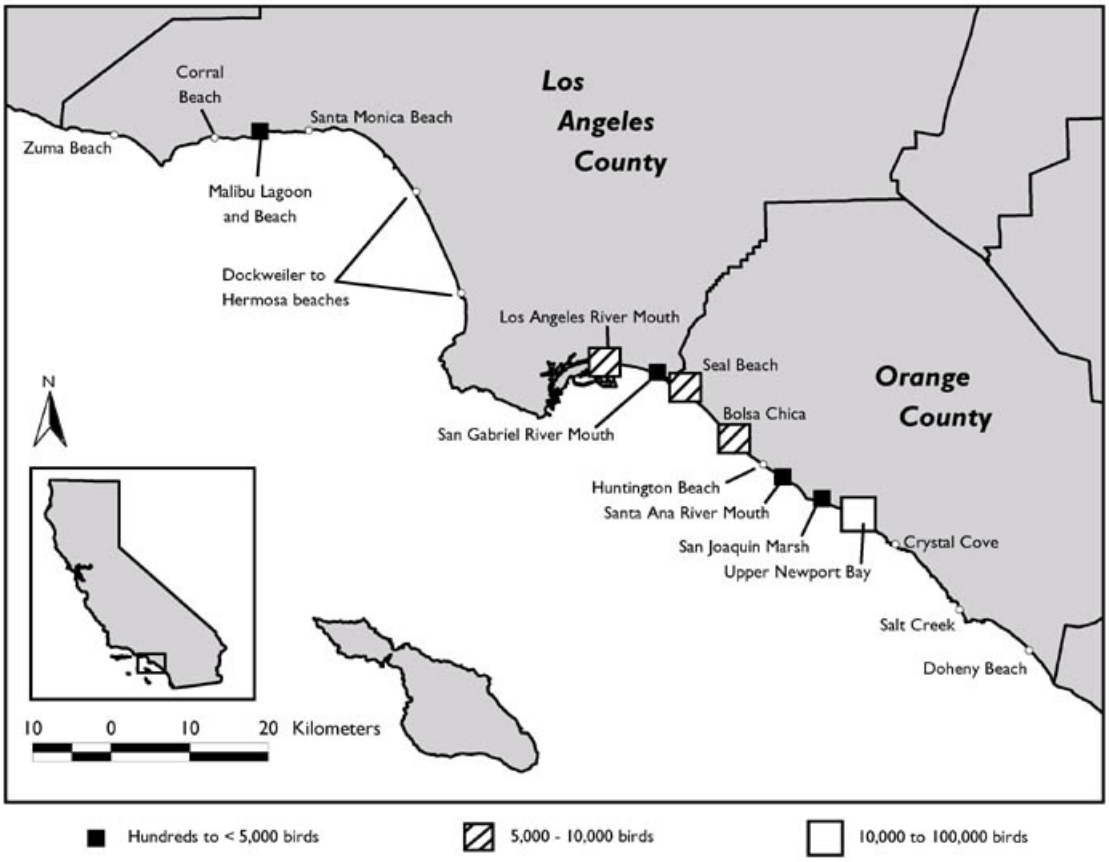

Figure 7. Important wetlands and beaches of Los Angeles and Orange counties. Wetlands of importance are determined by level of shorebird use. Beaches of importance currently are determined by importance to Snowy Plovers.

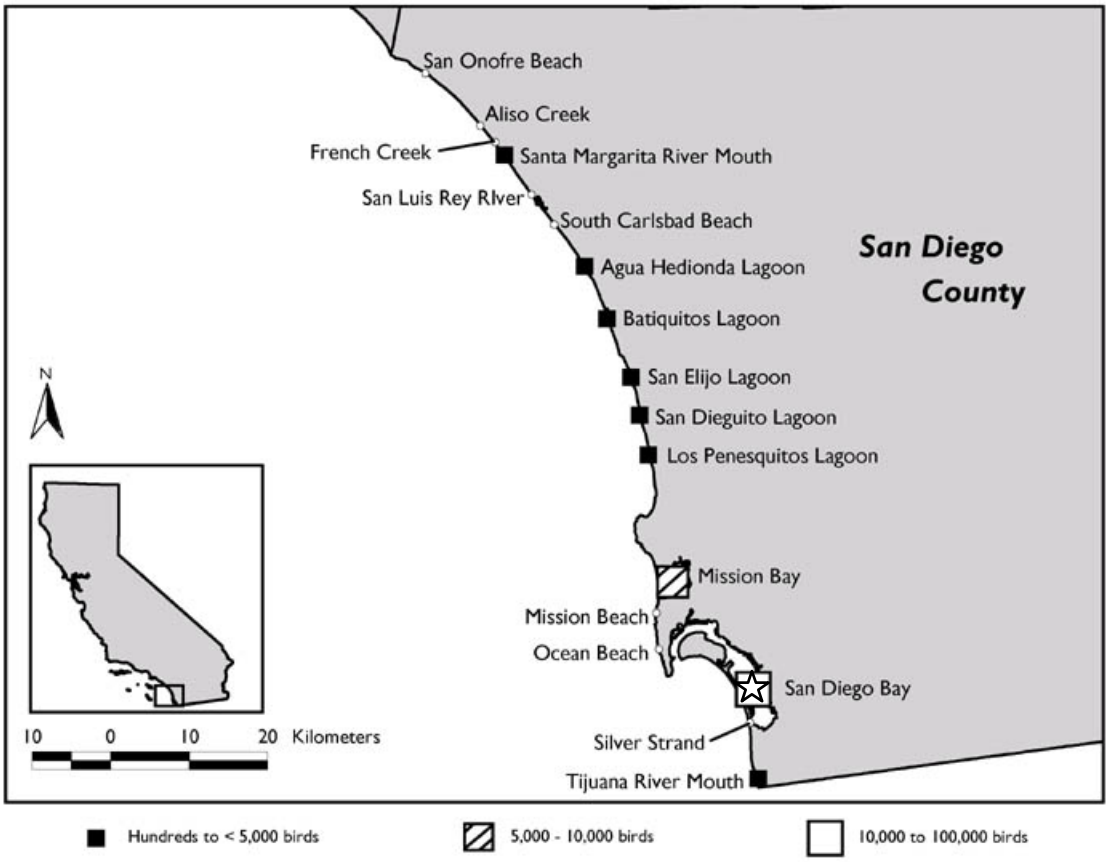

Figure 8. Important wetlands and beaches of San Diego County. Wetlands of importance are determined by level of shorebird use. Star indicates WHSRN-designated site. Beaches of importance currently are determined by importance to Snowy Plovers.

Table 2. Percent of 13 shorebird species attributed to 38 wetlands in fall (F), winter (W), and spring (S) along the US Pacific coast, based on medians conditioned on non-zero survey values for each site. Species codes are used in top row. Total number of sites holding at least 1% of a species' total in fall, winter, or spring are in parentheses. Mean percents of the 13 (12 in fall) shorebird taxa are given by season in the first columns.

Location	Mean: 13 Species (18)			BBPL (16)			SEPL (26)			BNST (12)		
	F	W	S	F	W	S	F	W	S	F	W	S
Puget Sound	2.1	2.2	3.3	3.2	3.1	6.4	2.0	0.0	0.7	0.0	0.0	0.0
Grays Harbor	1.2	1.6	8.1	6.6	1.0	2.6	2.3	0.3	4.4	0.0	0.0	0.0
Willapa Bay	1.0	2.3	5.2	2.4	3.1	8.1	2.5	0.5	3.6	0.0	0.0	0.0
Columbia RE	0.7	0.2	2.1	0.1	0.1	0.2	0.8	0.1	0.6	0.0	0.0	0.0
Tillamook Bay	0.2	0.1	0.5	0.2	0.0	0.1	0.7	1.0	0.0	0.0	0.0	0.0
Siletz Bay	0.3	0.0	0.1	0.2	0.1	0.0	0.7	0.0	0.3	0.0	0.0	0.0
Siuslaw RE	0.1	0.1	0.4	0.3	0.2	0.3	0.4	0.0	1.6	0.0	0.0	0.0
Tenmile CE	0.2		0.1	0.0		0.0	1.8		0.4	0.0		0.0
Coos Bay	0.6	0.9	0.4	0.4	0.5	0.5	1.7	1.3	0.9	0.0	0.0	0.0
Bandon/Coquille RE	0.2	0.2	0.1	0.1	0.2	0.0	0.5	0.2	0.3	0.0	0.0	0.0
New RE	0.2	0.0	0.2	0.0	0.0	0.2	0.7	0.0	0.6	0.0	0.0	0.0
Southern Pacific Region												
Smith RE	0.2	0.1	0.3	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0
Talawa Lake	0.7	0.0	0.4	0.0	0.0	0.0	1.3	0.0	0.3	0.0	0.0	0.0
Humboldt Bay	4.0	7.7	3.1	4.9	7.6	3.7	5.2	15.9	4.9	0.0	0.0	0.0
Bodega Harbor	0.5	0.8	0.6	0.3	0.5	0.3	1.2	1.1	2.4	0.0	0.0	0.0
Estero Americano	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0
Tomales Bay	1.1	1.5	1.4	0.7	0.7	1.2	0.9	2.4	2.0	0.0	0.0	0.0
Point Reyes Esteros	1.0	1.9	1.5	1.1	1.7	3.8	2.4	2.8	2.4	0.0	0.0	0.1
Bolinas Lagoon	1.1	1.5	0.9	1.8	1.9	1.9	0.6	0.2	0.3	0.0	0.0	0.0
San Francisco Bay	66.7	55.7	52.3	61.9	59.4	55.5	52.0	40.1	46.7	78.3	90.1	57.5
Pajaro RE	0.1	0.2	0.2	0.0	0.1	0.1	0.0	2.1	0.0	0.2	0.4	2.3
Elkhorn Slough	2.6	3.5	2.0	1.5	1.4	3.0	2.6	4.1	4.2	1.0	1.2	1.8
Salinas RE	0.2	0.1	0.3	0.0	0.0	0.2	0.1	0.0	0.3	0.8	0.7	2.0
Morro Bay	3.2	4.5	2.1	1.9	1.7	1.2	1.8	1.5	2.4	0.1	0.0	0.0
Santa Maria RE	0.1	0.2	1.5	0.2	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0
Devereux Slough	0.0	0.1	0.3	0.1	0.2	0.5	0.1	1.3	1.8	0.0	0.0	1.4
Mugu Lagoon	1.4	1.8	2.5	0.6	0.8	0.4	2.0	2.5	6.4	1.4	1.1	8.0
Los Angeles RE	0.9		0.2	0.1		0.0	0.6		0.0	7.5		1.8
San Gabriel RE	0.3		0.3	0.0		0.0	0.2		0.1	1.9		1.2
Seal Beach NWR	0.7	1.5	0.5	2.2	5.8	1.1	0.2	0.1	0.5	0.1	0.0	0.5
Bolsa Chica	0.7	1.5	1.5	1.9	3.9	0.9	1.2	3.8	1.7	0.7	1.9	10.8
Upper Newport Bay	0.7	1.4	0.6	1.4	1.0	0.1	1.0	4.2	1.1	0.1	0.0	0.7
Santa Margarita RE	0.2	0.1	0.1	0.1	0.1	0.0	1.0	0.2	0.4	0.1	0.4	0.5
Batiquitos Lagoon	0.4	0.2	0.5	0.0	0.0	4.4	1.1	1.3	0.3	1.8	0.2	1.2
San Elijo Lagoon	0.6	0.2	0.5	0.2	0.1	0.1	1.9	0.8	1.0	1.8	0.4	3.0
Mission Bay & FCC	0.8	1.6	0.5	1.1	1.4	0.5	1.4	3.5	1.4	0.2	0.3	0.4
San Diego Bay	3.4	4.7	3.7	2.9	2.2	1.2	2.1	4.8	3.0	3.3	2.9	5.2
Tijuana RE	0.3	0.5	0.4	0.3	0.2	0.0	0.5	1.4	0.6	0.0	0.1	0.5
Total	99.0	99.1	98.8	98.7	99.0	98.8	95.8	98.0	97.6	99.3	99.7	98.9

Table 2 continued. Percent of 13 shorebird species attributed to 38 wetlands in fall (F), winter (W), and spring (S) along the US Pacific coast, based on medians conditioned on non-zero survey values for each site. Species codes are used in top row. Total number of sites holding at least 1% of a species' total in fall, winter, or spring are in parentheses. Mean percents of the 13 (12 in fall) shorebird taxa are given by season in the first columns.

Location	AMAV (8)			GRYE (24)			WILL (14)			LBCU (12)		
	F	W	S	F	W	S	F	W	S	F	W	S
Puget Sound	0.0	0.0	0.0	9.7	4.9	8.5	0.0	0.0	0.0	0.3	0.0	0.2
Grays Harbor	0.0	0.0	0.0	0.8	6.0	7.8	0.0	0.0	0.0	0.3	1.8	0.0
Willapa Bay	0.0	0.0	0.0	3.4	10.6	12.5	0.0	0.0	0.0	0.0	2.3	0.7
Columbia RE	0.0	0.0	0.0	3.2	0.5	1.8	0.0	0.0	0.0	0.0	0.0	0.0
Tillamook Bay	0.0	0.0	0.0	0.3	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0
Siletz Bay	0.0	0.0	0.0	1.4	0.3	0.5	0.2	0.0	0.0	0.1	0.0	0.0
Siuslaw RE	0.0	0.0	0.0	0.2	0.1	2.5	0.0	0.0	0.0	0.0	0.0	0.0
Tenmile CE	0.0		0.0	0.2		0.3	0.0		0.0	0.0		0.0
Coos Bay	0.0	0.0	0.0	1.9	5.7	2.2	0.1	0.0	0.0	0.1	0.1	0.0
Bandon/Coquille RE	0.0	0.0	0.0	0.2	0.1	0.7	0.0	0.0	0.0	0.0	0.0	0.0
New RE	0.0	0.0	0.0	1.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0
Southern Pacific Region												
Smith RE	0.0	0.0	0.0	0.6	0.4	3.1	0.0	0.0	0.0	0.1	0.0	0.0
Talawa Lake	0.0	0.0	0.0	2.4	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.3
Humboldt Bay	0.7	3.3	1.6	4.3	3.3	2.1	3.7	10.7	3.9	6.9	6.9	7.1
Bodega Harbor	0.0	0.1	0.0	0.4	0.0	0.1	0.9	1.0	1.0	0.0	0.0	0.3
Estero Americano	0.0	0.0	0.0	0.0	0.1	0.0	0.4	0.3	0.6	0.0	0.1	0.0
Tomales Bay	0.0	0.0	0.0	1.5	1.6	2.6	1.7	1.4	3.4	0.0	0.0	0.3
Point Reyes Esteros	0.0	0.0	0.0	1.8	3.8	2.3	1.9	2.5	5.5	0.0	0.1	0.5
Bolinas Lagoon	0.0	0.8	0.6	1.1	2.5	1.1	2.7	2.0	2.7	1.3	2.8	1.3
San Francisco Bay	96.5	88.3	85.6	41.1	40.7	25.5	69.3	58.5	56.6	65.5	48.6	45.5
Pajaro RE	0.0	0.0	0.1	0.4	0.1	0.1	0.3	0.1	0.1	0.0	0.0	0.0
Elkhorn Slough	0.6	1.1	0.6	3.8	3.8	2.6	2.2	2.6	3.6	3.1	1.7	1.6
Salinas RE	0.2	0.0	1.0	0.4	0.5	0.2	0.0	0.0	0.4	0.1	0.3	0.2
Morro Bay	0.0	0.0	0.0	2.4	1.4	0.2	7.1	10.0	5.2	13.7	21.4	10.5
Santa Maria RE	0.0	0.0	0.1	0.2	0.0	0.0	0.1	0.0	0.0	0.9	2.1	19.8
Devereux Slough	0.0	0.0	0.0	0.4	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Mugu Lagoon	0.1	3.4	2.4	1.9	1.1	0.9	1.4	1.9	3.5	1.8	2.0	3.1
Los Angeles RE	0.1		0.1	0.4		0.0	0.0		0.0	0.0		0.0
San Gabriel RE	0.0		0.0	0.8		2.7	0.0		0.0	0.0		0.0
Seal Beach NWR	0.0	0.2	0.1	0.9	1.2	0.2	1.0	2.3	2.1	1.6	5.3	1.4
Bolsa Chica	0.0	0.3	1.1	0.6	0.6	0.1	0.5	0.5	0.6	0.2	0.3	0.5
Upper Newport Bay	0.0	1.3	2.9	0.5	0.8	0.2	1.2	0.9	1.2	0.5	0.6	0.3
Santa Margarita RE	0.0	0.0	0.6	0.5	0.6	0.2	0.0	0.0	0.0	0.2	0.1	0.2
Batiquitos Lagoon	0.6	0.1	0.4	0.6	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0
San Elijo Lagoon	0.7	0.2	1.0	1.0	0.6	0.9	0.1	0.0	0.1	0.0	0.0	0.3
Mission Bay & FCC	0.0	0.3	0.4	1.1	1.4	0.2	1.0	1.3	1.1	0.4	0.6	0.8
San Diego Bay	0.3	0.1	0.5	4.7	3.6	1.9	2.4	2.7	5.6	1.5	1.4	2.4
Tijuana RE	0.0	0.3	0.2	0.5	0.8	0.6	0.9	0.6	1.5	0.6	1.3	1.4
Total	99.8	99.8	99.3	96.6	97.6	96.3	99.2	99.3	98.7	99.2	99.8	98.7

Table 2 continued. Percent of 13 shorebird species attributed to 38 wetlands in fall (F), winter (W), and spring (S) along the US Pacific coast, based on medians conditioned on non-zero survey values for each site. Species codes are used in top row. Total number of sites holding at least 1% of a species' total in fall, winter, or spring are in parentheses. Mean percents of the 13 (12 in fall) shorebird taxa are given by season in the first columns.

Location	MAGO (12)			REKN (11)			WESA (18)			LESA (13)		
	F	W	S	F	W	S	F	W	S	F	W	S
Puget Sound	0.0	0.0	0.0	0.2	0.0	0.1	7.6	0.8	5.6	1.6	0.1	1.4
Grays Harbor	0.0	0.2	0.2	1.3	0.0	23.7	2.0	0.0	20.6	0.2	0.1	0.1
Willapa Bay	0.2	1.1	0.3	0.0	0.0	4.6	2.1	0.1	5.2	0.4	0.3	0.2
Columbia RE	0.0	0.0	0.1	0.0	0.1	0.0	2.5	0.0	6.8	0.9	0.1	3.5
Tillamook Bay	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.1	0.0	0.5	0.0	0.1
Siletz Bay	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.0
Siuslaw RE	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.4	0.3
Tenmile CE	0.0		0.0	0.0		0.0	0.0		0.0	0.1		0.2
Coos Bay	0.0	0.0	0.0	0.0	0.0	0.6	1.3	1.1	0.1	1.1	1.8	1.0
Bandon/Coquille RE	0.0	0.0	0.0	0.3	0.0	0.0	0.5	0.0	0.0	0.8	1.5	0.2
New RE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0
Southern Pacific Region												
Smith RE	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.1	0.3	0.2	0.3
Talawa Lake	0.1	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.1	0.0	0.0
Humboldt Bay	11.0	19.9	9.3	0.3	1.5	0.4	5.5	6.5	1.3	2.8	12.7	2.2
Bodega Harbor	2.8	5.4	2.4	0.0	0.4	0.4	0.1	0.4	0.1	0.1	0.4	0.2
Estero Americano	0.0	0.1	0.0	0.0	0.0	0.0	0.5	0.0	0.0	1.2	0.8	0.4
Tomales Bay	4.3	2.8	5.8	0.1	0.8	0.5	1.1	0.9	0.2	2.1	5.7	1.6
Point Reyes Esteros	1.1	1.9	2.0	0.2	3.4	0.6	1.0	1.5	0.2	1.7	3.9	1.3
Bolinas Lagoon	1.5	1.7	1.5	0.1	0.3	0.1	0.5	0.1	0.4	3.2	5.2	1.0
San Francisco Bay	61.9	46.3	67.7	76.2	43.3	39.1	58.6	67.7	53.8	66.9	39.1	73.1
Pajaro RE	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Elkhorn Slough	1.9	2.0	1.1	0.1	0.3	0.1	2.9	6.8	0.8	9.1	12.5	5.5
Salinas RE	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1
Morro Bay	6.0	7.7	2.9	0.2	1.2	0.2	0.7	1.3	0.1	3.0	11.3	5.0
Santa Maria RE	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Devereux Slough	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4
Mugu Lagoon	1.6	2.1	1.2	0.1	0.6	1.3	1.4	2.9	2.6	1.4	0.9	0.1
Los Angeles RE	0.0		0.0	0.0		0.0	0.7		0.0	0.6		0.1
San Gabriel RE	0.0		0.0	0.0		0.0	0.0		0.0	0.0		0.2
Seal Beach NWR	0.4	0.9	0.4	0.4	0.9	0.1	0.4	1.3	0.1	0.1	0.1	0.1
Bolsa Chica	0.2	0.3	0.2	0.8	4.4	3.4	1.0	1.4	0.2	0.1	0.2	0.0
Upper Newport Bay	0.6	0.7	0.4	0.3	0.9	0.1	0.9	2.9	0.5	0.2	0.8	0.1
Santa Margarita RE	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.0
Batiquitos Lagoon	0.0	0.0	0.0	0.8	0.1	0.1	0.1	0.2	0.0	0.1	0.2	0.0
San Elijo Lagoon	0.1	0.0	0.0	0.0	0.7	0.0	0.1	0.0	0.0	0.1	0.0	0.1
Mission Bay & FCC	1.5	1.6	0.6	1.3	7.1	1.0	0.5	1.1	0.2	0.0	0.0	0.1
San Diego Bay	3.6	4.1	3.1	16.1	32.9	23.0	1.1	2.1	0.7	0.1	0.4	0.1
Tijuana RE	0.4	0.4	0.2	0.1	1.2	0.1	0.0	0.3	0.0	0.0	0.0	0.1
Total	99.2	99.4	99.4	99.9	100.3	99.6	98.9	99.6	99.6	99.2	99.3	99.1

Table 2 continued. Percent of 13 shorebird species attributed to 38 wetlands in fall (F), winter (W), and spring (S) along the US Pacific coast, based on medians conditioned on non-zero survey values for each site. Species codes are used in top row. Total number of sites holding at least 1% of a species' total in fall, winter, or spring are in parentheses. Mean percents of the 13 (12 in fall) shorebird taxa are given by season in the first columns.

Location	DUNL (11)		DOWI (19)		
	W	S	F	W	S
Puget Sound	18.8	20.2	7.6	0.4	0.2
Grays Harbor	10.8	27.5	2.0	0.0	17.9
Willapa Bay	11.8	10.6	2.1	0.2	22.0
Columbia RE	1.1	13.5	2.5	0.5	0.2
Tillamook Bay	0.0	0.0	0.7	0.0	0.0
Siletz Bay	0.0	0.0	0.2	0.2	0.0
Siuslaw RE	0.1	0.0	0.1	0.2	0.1
Tenmile CE		0.0	0.0		0.0
Coos Bay	0.6	0.1	1.3	0.7	0.1
Bandon/Coquille RE	0.4	0.0	0.5	0.1	0.0
New RE	0.0	0.0	0.0	0.0	1.6
Southern Pacific Region					
Smith RE	0.0	0.0	0.8	0.1	0.0
Talawa Lake	0.0	0.0	4.0	0.0	0.1
Humboldt Bay	8.9	2.5	5.5	3.2	1.0
Bodega Harbor	1.4	0.0	0.1	0.0	0.0
Estero Americano	0.3	0.0	0.5	0.0	0.0
Tomales Bay	2.3	0.3	1.1	0.4	0.6
Point Reyes Esteros	1.9	0.6	1.0	0.7	0.2
Bolinas Lagoon	1.2	0.1	0.5	0.2	0.3
San Francisco Bay	37.8	24.0	58.6	64.8	49.1
Pajaro RE	0.0	0.0	0.0	0.1	0.0
Elkhorn Slough	1.4	0.0	2.9	7.0	1.1
Salinas RE	0.0	0.0	0.0	0.2	0.0
Morro Bay	0.1	0.0	0.7	1.5	0.2
Santa Maria RE	0.0	0.0	0.0	0.0	0.0
Devereux Slough	0.0	0.0	0.0	0.0	0.0
Mugu Lagoon	0.4	0.1	1.4	3.7	2.1
Los Angeles RE		0.0	0.7		0.0
San Gabriel RE		0.0	0.0		0.3
Seal Beach NWR	0.1	0.0	0.4	1.6	0.4
Bolsa Chica	0.0	0.0	1.0	2.5	0.5
Upper Newport Bay	0.1	0.0	0.9	4.0	0.2
Santa Margarita RE	0.0	0.0	0.0	0.2	0.0
Batiquitos Lagoon	0.0	0.0	0.1	0.0	0.0
San Elijo Lagoon	0.0	0.0	0.1	0.1	0.2
Mission Bay & FCC	0.0	0.0	0.5	2.2	0.2
San Diego Bay	0.1	0.1	1.1	4.2	0.7
Tijuana RE	0.0	0.0	0.0	0.4	0.0
Total	99.6	99.6	98.9	99.4	99.3

San Francisco Bay -- Nearly half of California's fresh water runoff finds its way to the San Francisco Bay Estuary, where Sierra snowmelt and Coast Range rainfall, captured by the Sacramento and San Joaquin rivers, meet with ocean tides entering through the Golden Gate. Once, the estuary sprawled over more than half a million acres of mud flats and salt marsh; the largest contiguous tidal marsh system on the Pacific Coast (Josselyn 1983). San Francisco Bay wetlands have a long history of human alteration, including the development of adjacent uplands and seasonal wetlands, dredging of tidal mudflats, and changes in salinity and tidal inundation. Today more than 90% of the original wetlands have been lost to urban development, converted to agricultural fields or salt ponds, or degraded by pollution, exotic species introductions, and habitat destruction. Despite the huge loss of natural habitat, the estuary's remaining wetlands provide habitat for hundreds of thousands of shorebirds, waterfowl, and other water birds throughout the year.

The San Francisco Bay Estuary is comprised of four adjoining bays: Suisun Bay, North Bay (San Pablo Bay), Central Bay, and South Bay. Each bay possesses distinct geographical, hydrological, and biological characteristics.

Suisun Bay - Prior to major human alteration, Suisun Bay shores were dominated by more than 30,000 ha of tidal marsh, bordered by narrow strips of tidal flats. Hundreds of natural ponds occurred in the western portion of the marsh. The amount of tidal marsh has been reduced by 80% over the past hundred years, along with nearly half of the associated tidal flats (Table 3.). Marsh and mudflat habitats were replaced by diked wetland and agriculture. Wetlands of Suisun Bay began to be diked about 1865, primarily for livestock grazing. In the 1870s and 1880s, the first duck clubs were established around the marsh ponds. By the early 1900s, livestock grazing was giving way to other agricultural activities, such as the production of sugar beets, asparagus, lima beans, oats, and barley. Currently, the only agricultural activity is some oat hay farming on 607 ha of former bayland. Eventually, increasing salinity and land subsidence caused agricultural activities to fail; duck clubs in the eastern part of the bay replaced these lands. Levees originally constructed for farming are now an integral part of the infrastructure of the duck clubs. Suisun Marsh is now considered San Francisco Bay's largest contiguous protected area, consisting of nearly 50,000 ha of wetland, channels, bays, and adjacent uplands. Included are 200,000 ha of privately and publicly owned marsh managed for duck hunting. Among the publicly owned areas are the state Grizzly and Joyce Island wildlife areas.

North Bay - Historically, the composition of tidal habitats in the North Bay consisted of 30,000 ha of salt marsh, mud flats, and natural salt pannes (Table 3). Today, these

productive habitats have been reduced by as much as 70%. Most affected habitats were salt marsh and tidal flat, which were converted to agricultural baylands, salt ponds, and other diked wetlands. Tidal marshes in the North Bay were diked initially to create land for livestock grazing, which remained the sole agricultural practice in the region for many decades; high water tables and soil salinities discouraged other crops. In 1952, Leslie Salt Company expanded salt production into the North Bay by converting agricultural land into salt evaporation ponds. During recent decades, some of the remaining agricultural lands have been managed for the production of cattle silage and vineyards. In 1997, all the salt ponds, except the Napa crystallizer ponds, were sold to the California Department of Fish and Game (CDFG), which now manages the ponds as a state Wildlife Area.

Central Bay - Historically, deep and shallow bay waters, which together comprised over 40,000 ha, dominated the Central Bay. Nearly the same amount exists today. In contrast, more than 70% of tidal flats and over 90% of tidal marsh have been lost (Table 3). These habitats were largely replaced with bay fill for urban development, which now abuts much of the Central Bay shoreline.

South Bay - The amount of deep bay has changed little during the past 200 years. Shallow bay has increased by 10% but tidal flat has declined by 29% and tidal marsh by 83% (Table 3). Salt ponds have replaced much of the historic tidal marsh. Other habitats that have increased or were not present historically are lagoons, other baylands, diked bayland, agricultural land, storage and treatment ponds, undeveloped bay fill, and developed bay fill. Alteration of wetlands for urban development and salt production are the two most prominent causes of habitat change in the South Bay.

Greater Yellowlegs

Table 3. Past and current habitat types of San Francisco Bay regions (information from Goals Project 1999).

Habitat Type	Suisun Bay	North Bay	Central Bay	South Bay
Natural Habitats				
Deep bay				
past	16,746	20,139	55,609	7035
current	11,584	10,362	53,614	6851
% change	- 31%	- 49%	< 1%	- 3%
Shallow bay				
past	24,095	55,120	57,272	37955
current	22,428	53,804	53,774	41812
% change	- 7%	- 2%	< 1%	+ 10%
Tidal flat				
past	2,405	13,351	13,532	21181
current	1,124	9,118	4,014	14955
% change	- 53%	- 32%	- 70%	- 29
Tidal marsh				
past	65,358	55,076	13,461	56037
current	13,562	16,347	947	9335
% change	- 79%	- 70%	- 93%	- 83%
Lagoons				
past	2	37	45	--
current	6	2,353	658	598
% change	+ 200%	+ 6259%	+ 1363%	
Salt pannes / ponds				
past	--	270	--	1316
current		7,143		27313
% change		+ 2545%		+ 1975%
Other bay lands				
past	2	24	215	13
current	570	565	380	347
% change	28380%	+ 2254%	+ 77%	2570
Replacement Habitats				
Diked wetland	49,873	7,622	1,314	5,709
Agricultural land	5,544	27,732	34	1,309
Storage/treatment ponds	720	1,266	57	1,628
Undeveloped bay fill	762	4,648	3,420	1,768
Developed bay fill	2,453	6,211	21,970	11,930

Beaches of Importance to Shorebirds

Sand beaches associated with wetlands are usually the ones most heavily used by shorebirds on the northern California coast. Not only are these beaches (except Dillon Beach) current or historic breeding and foraging areas for the Snowy Plover (Page and Stenzel 1981) and foraging areas for Sanderlings and other shorebirds, they also are important high tide roosting sites for many species of shorebirds that forage on tidal flats at low tide, or migrate along the beaches. Over half the southern California shoreline is sand beach, an important habitat for the Snowy Plover year round and for other species during migration and winter. Monterey Bay beaches support many thousands of shorebirds during migration and winter; principal species include the Black-bellied Plover, Snowy Plover, Willet, Whimbrel, Marbled Godwit, and Sanderling (PRBO unpubl. data). Beaches in the vicinity of coastal wetlands in southern California, such as Morro Bay and Mugu Lagoon, also are used by thousands of roosting shorebirds at high tide. Beaches identified as important to nesting or wintering Snowy Plovers in the draft Snowy Plover Recovery Plan (USFWS 2001) also are likely the main beaches used by other shorebirds and beaches considered of importance herein are presented in Figures 2-8.

Pastures of Importance to Shorebirds

Pastures with associated seasonal wetlands provide habitat for shorebirds at the Eel River delta, Humboldt Bay (Colwell and Dodd 1997), Bodega Bay (Ruiz et al. 1989), Tomales Bay, Drakes Estero, and Bolinas Lagoon (Page et al. 1979). Tilled lands at Drakes Estero, Bolinas Lagoon, and San Francisco Bay are also used by foraging shorebirds in winter.

Shorebird Species

Humboldt Bay lays at or near the northern boundary of the coastal wintering range of several species that breed at temperate latitudes. It is the northernmost wintering area for the American Avocet (Colwell et al. 2001), and one of the most northern wintering areas for the Long-billed Curlew, Marbled Godwit, and Willet (Page et al. 1999). Besides their importance for wintering shorebirds from temperate zone breeding areas, northern California coastal wetlands are important wintering areas for species with arctic-breeding ranges, such as the Black-bellied Plover, Western Sandpiper, Least Sandpiper, and Dunlin. During migration, these wetlands are used by even larger numbers of Western Sandpipers than in winter. Other shorebirds migrating through the wetlands, particularly during spring, are the Semipalmated Plover, Whimbrel and Short-billed Dowitcher.

The sand beaches on the northern coast are used by large numbers of migrating and wintering Sanderling and are important nesting areas for the Snowy Plover. During the mid-1970s over 100 plovers nested along California beaches north of San Francisco Bay (Page and Stenzel 1981). On comparable surveys in 2003, 56 plovers were found (PRBO unpubl. data). Other species for which sand beaches are relatively important foraging areas during migration or winter are the Willet and Whimbrel. Beaches associated with wetlands are important high tide roosting sites for many species of shorebirds that forage in the wetlands at low tide (Colwell and Sundeen 2000).

Agricultural lands, especially pastures and associated seasonal wetlands on the northern California coast, are important foraging and roosting habitat for many species during winter and spring. Such areas are most heavily used during high tides when tidal habitats are unavailable. The Black-bellied Plover, Killdeer, Greater Yellowlegs, Long-billed Curlew, Marbled Godwit, Least Sandpiper, Dunlin, and Long-billed Dowitcher are characteristic shorebirds of these habitats (Colwell and Dodd 1997).

Overall, San Francisco Bay holds higher proportions of the region's total wintering and migrating shorebirds than any other coastal wetland within the US Pacific coast wetland system (Table 2; Page et al. 1999). For eleven species, the San Francisco Bay holds over 50% of the individuals found on surveys of US Pacific Coast wetlands in at least one season (Table 4). San Francisco Bay is the northernmost regular breeding area of the American Avocet and Black-necked Stilt on the US Pacific coast. About 10% of the US Pacific coast population of the Snowy Plover breeds in South Bay salt ponds. San Francisco Bay is recognized as a Western Hemisphere Shorebird Reserve Network (WHSRN) site of Hemispheric Importance for shorebirds – the highest possible ranking.

The coast of California south of San Francisco Bay is an important wintering area for many shorebird species, such as the Black-bellied Plover, Willet, Long-billed Curlew, Marbled Godwit, Red Knot, Western Sandpiper, Least Sandpiper, Dunlin, Short-billed Dowitcher, and Long-billed Dowitcher. It also is an important migration staging area, especially for the Whimbrel, Western Sandpiper, Short-billed Dowitcher, Wilson's Phalarope, and Red-necked Phalarope. Black-necked Stilts and American Avocets nest in some of the wetlands and Black Oystercatchers on the rocky shoreline. Over two-thirds of the listed Snowy Plover population breeds at the beaches and wetlands in southern California.

The rocky shoreline of the region is occupied by resident Black Oystercatchers and thousands of wintering Black Turnstones. Other species that use the rocky coast of the region, though in relatively small numbers, are the Wandering Tattler, Spotted

Sandpiper, Whimbrel, Ruddy Turnstone, Surfbird, and Rock Sandpiper. The offshore waters of the region are used by large numbers of migrating Red-necked and Red phalaropes (Briggs et al. 1987).

Table 4. Percent of coastal shorebird totals found in San Francisco Bay on PRBO surveys of all the major wetlands of the contiguous US Pacific coast (from Page et al. 1999).

	Season		
Species	Fall	Winter	Spring
Black-bellied Plover	62	59	55
Semipalmated Plover	52	40	47
Black-necked Stilt	78	90	58
American Avocet	96	88	86
Greater Yellowlegs	41	41	26
Willet	69	58	57
Long-billed Curlew	66	49	46
Marbled Godwit	62	46	68
Red Knot	76	43	39
Western Sandpiper	59	68	54
Least Sandpiper	67	39	73
Dunlin	-	38	24
dowitcher spp.	72	65	49

Habitat Status, Threats, and Management Needs

Descriptions of historical and current habitat availability, shorebird habitat use patterns, threats to shorebirds, management issues, and needed conservation actions are provided below for the major habitat types in the region.

Tidal flat

No regional estimates are available of the total current acreage of tidal flat, the most important shorebird habitat within the coastal embayments of California. Tidal flat is the primary foraging habitat of many of the region's most abundant shorebirds, including the Black-bellied Plover, Semipalmated Plover, Willet, Long-billed Curlew, Marbled Godwit, Western Sandpiper, Least Sandpiper, Dunlin, and Short-billed Dowitcher. The main shorebird prey in the tidal flats are invertebrates, but many of these are introduced species that arrived through the release of ship ballast and other human actions. Invertebrate introductions are ongoing with unknown consequences for shorebirds. Introduced invertebrates are known to be prominent in the benthos of Humboldt Bay, Bodega Harbor, Estero Americano, and Bolinas Lagoon (Boyd et al.

2002). They probably also are an important element of the invertebrate benthos of Tomales Bay, Drakes Estero, and Limantour Estero.

Historic loss of tidal habitat from diking or filling has occurred at Humboldt Bay, Bodega Harbor, Estero Americano, Drakes Estero, Tomales Bay, Limantour Estero, and Bolinas Lagoon. Accelerated sedimentation of tidal habitat from historic or ongoing logging or grazing in the watershed has been identified for Humboldt Bay, Bodega Harbor, Estero Americano, Tomales Bay, and Bolinas Lagoon. It also may be occurring at Drakes Estero. Impaired tidal circulation has been identified for Estero Americano, and parts of Tomales Bay, Drakes Estero, and Bolinas Lagoon.

Oyster farming occurs in Humboldt Bay, Tomales Bay, and Drakes Estero. Oyster farming influences shorebird use of tidal flat by enhancing feeding opportunities for some species, such as the Willet, while decreasing them for others, such as the Dunlin (Kelly et al. 1996). Oyster culture may have increased sedimentation rates at Drakes Estero (S. Allen pers. comm.). The effect of oyster culture practices on sedimentation/erosion of tidal flats should be considered in future leases. Also, granting of leases in some areas (e.g., with *Zostera* beds) and the total area under culture at any one time should be considered in future leases.

Disturbance from human recreation is a potential problem for shorebirds at Lake Talawa, Humboldt Bay, Bodega Harbor, Tomales Bay, Drakes Estero, and Bolinas Lagoon. Specific disturbance agents include wind surfers at Humboldt Bay and Bodega Harbor; dogs chasing birds on tidal flats at Humboldt Bay and Bodega Harbor; people involved in intensive clam harvesting at Tomales Bay and Bodega Harbor; and kayakers at Tomales Bay, Drakes Estero, and Bolinas Lagoon. A study has been proposed at Bolinas Lagoon to determine the degree of disturbance caused by kayakers and the value of educational efforts to lessen this source of disturbance (G. Page pers obs.). Restrictions on kayaking in Drakes Estero from March to June, to reduce disturbance to harbor seals *(Phoca vitulina),* probably also reduces human disturbance of spring-migrating shorebirds (S. Allen pers. comm.).

Contaminants, in the form of non-point pollution sources from neighboring cities, were identified as possibly detrimental to shorebirds at Humboldt Bay (M. Colwell pers. comm.) and San Francisco Bay (N. Warnock pers. comm.). Oil spills pose a threat to the intertidal habitats of all the wetlands open to daily tidal action, and sea level rise could effect the extent of tidal flat habitat in all the wetlands.

There has been a 42% reduction of tidal flat in San Francisco Bay from the historical extent (Goals Project 1999). Today about 90% of the tidal flats occur on the bay's edges and about 10% along marsh channels. Historically, a greater proportion of the tidal flat occurred along marsh channels. Tidal flats are the principal foraging area for most shorebirds in San Francisco Bay at low tide. Species that forage on tidal flats include the Black-bellied Plover, Semipalmated Plover, Willet, Long-billed Curlew, Marbled Godwit, Red Knot, Dunlin, Western Sandpiper, Least Sandpiper, Short-billed Dowitcher, and Long-billed Dowitcher. Tidal flat invertebrates are the primary shorebird food, but the majority of invertebrates have been introduced by man.

Within the past decade, *Spartina alterniflora* has been introduced into San Francisco Bay from stock originating on the Atlantic coast of the US. This species grows at both lower and higher elevations in the intertidal zone than the native California cord grass (*Spartina foliosa)* and thereby threatens to reduce the amount of unvegetated tidal flat available to foraging shorebirds. The US Fish and Wildlife Service (USFWS), East Bay Regional Park District, CDFG, and others have ongoing management programs using physical and chemical methods to control and eliminate *Spartina alterniflora*.

Other factors impacting, or potentially impacting, tidal flats and the invertebrates living in them include sea level rise, contaminants, oil spills, and proposed new ferry systems. Sea level rise, projected from current levels of global warming, is a phenomenon that could greatly alter the acreage of tidal flat. In the San Francisco Bay Area, some communities currently are proposing to construct tidal barriers on tidal flats to prevent future flooding of urban areas from sea level rise. Contaminants, such as selenium and mercury, are widespread in San Francisco Bay sediments. There is a high potential for oil spills, which could have a major impact on shorebirds and their food supply. Proposed new ferry transport systems may involve the use of hovercraft over tidal flats, where their high noise levels and frequent presence has the potential to disturb foraging shorebirds or their benthic invertebrate prey. Dredging to accommodate ferry facilities also could reduce the amount of available intertidal habitat.

Salt marsh

Shorebirds use salt marsh to a lesser degree than tidal flats (Stralberg et al. 2003), but under some tidal conditions, roosting birds do use this habitat. Salt marsh vegetation, growing in the upper part of the intertidal zone, may be too tall or dense to provide much foraging habitat for shorebirds. The larger non-vegetated channels in salt marsh are used as foraging habitat by the same species that feed on tidal flats. Some species, such as the Willet, Whimbrel, Long-billed Curlew, and Least Sandpiper, also forage on marsh plains with sparse or low vegetation (< about 20 cm). Species such as the Willet,

Least Sandpiper, Dunlin, and Long-billed Dowitcher use salt marsh as diurnal and nocturnal roost sites, possibly to provide some protection from predators such as owls.

There currently are about 16,265 ha of tidal marsh in the San Francisco Bay, a 79% decline from historic levels. Tidal marsh has been lost primarily to the development of salt ponds, agriculture land, and urban areas. Marsh channels, ponds, and wrack are used by many species of shorebirds for foraging, whereas vegetated portions of marsh are relatively little used. Species most likely to be found foraging in marshes are the Willet and Least Sandpiper. Black-necked Stilts and occasionally American Avocets nest in marshes with shallow ponds (Rintoul et al. 2003).

Salt ponds

In the San Francisco Bay Estuary, historically, about 645 ha of natural salt pannes occurred in the tidal marsh. Salt pannes, open areas amongst the marshes, once served as supra-tidal foraging and roosting sites for many shorebird species, and as nesting areas for plovers, stilts, and avocets. Most of this habitat was located in the South Bay, primarily near Hayward at San Lorenzo Creek and Mount Eden Slough. The largest pond complex, Crystal Pond, extended over some 405 ha. As the demand for salt rose in the mid-1800s, the first artificial salt ponds were developed as extensions and improvements of the natural salt ponds. Subsequently, artificial salt ponds have entirely displaced their natural forerunners. Currently there are 13,943 ha of salt ponds in the estuary; the majority of ponds were constructed on former salt marsh.

The variety of habitats within the salt pond complex is an indirect result of the salt making process. During the initial phase of salt production, seawater is pumped into the first of a series of ponds. After a year or more, the salt becomes concentrated through evaporation and the water is shunted from pond to pond, closer to the final crystallization area. The entire process can take five or more years to complete. At any one time the salt pond complex hosts a mosaic of pond types. The ponds vary in size, depth, salinity, and most importantly, invertebrate characteristics. Thus each type of pond varies in the vertebrate populations that are supported by the particular invertebrate assemblage found in that pond. Very shallow ponds often contain drier areas that serve as excellent salt panne 'mimics.'

More than half of the shorebird use of the San Francisco Bay estuary occurs within the more than 16,150 ha of diked salt ponds that rim the South Bay. Though the habitat value of the once extensive vegetated marsh was lost when the ponds were formed, the ponds and levees within the salt complex became significant roosting and nesting sites for a wide variety of non marsh-dependent species, and the ponds themselves became

important foraging areas for millions of shorebirds and other species of waterfowl and sea birds and other waterbirds (Stenzel and Page 1988, Accurso 1992, Stenzel et al. 2002, Warnock et al. 2002a).

Salt ponds are the principal foraging habitat (south of Suisun Bay) of the Black-necked Stilt, Wilson's Phalarope, and Red-necked Phalarope. The large increase in acreage of salt ponds during the past 200 years likely has augmented numbers of these species in the bay over historical levels. On PRBO shorebird surveys of the North, Central, and South bays, the median proportions of Black-necked Stilts found in the salt ponds, versus other habitats, were 86% and 60% for fall and spring, respectively. For the Red-necked Phalarope, comparable proportions were 99% and 93% (PRBO unpubl. data). The American Avocet and Snowy Plover are species that use both salt ponds and tidal flats for foraging and now likely are more abundant in the bay than formerly. Other species that feed principally on tidal flats at low tide, such as the Dunlin, Western Sandpiper, Least Sandpiper, and Willet, also forage in the salt ponds at high tide. Most shorebirds use the salt ponds, especially the levees and islands, as high tide roosting areas.

The federally threatened Western Snowy Plover relies heavily on salt pond habitat (Page et al. 2000). Dry margins and levees of salt ponds are their chief nesting habitat in San Francisco Bay and also are important nesting areas for the Black-necked Stilt and American Avocet (Rintoul et al. 2003). The Snowy Plover was known to nest in the bay at salt ponds by 1918, whereas the American Avocet and Black-necked Stilts were first known to breed there in 1926 and 1927, respectively (Harvey et al. 1992). Numbers of Black-necked Stilts and American Avocets likely have increased in the estuary due to the existence of salt ponds (Gill 1977, Shuford and Ryan 2000, Rintoul et al. 2003).

In the last two decades, shorebirds nesting in the salt ponds have been impacted by introduced mammalian predators and expanding populations of native predators. Feral Red Foxes have been identified as important predators of plover, avocet, and stilt clutches; feral and free-roaming cats also may be a problem. Common Ravens – important predators of the eggs of nesting shorebirds – are expanding their breeding range into the bay, where they nest on power line towers and other artificial structures.

The recent acquisition of salt ponds by state and federal wildlife agencies provides an unprecedented opportunity to restore large areas of contiguous tidal wetlands in South San Francisco Bay. Acquisition and restoration of wetlands in the South Bay began in 1994 when Cargill Salt Company sold over 4,000 ha of the North San Francisco Bay to the State of California (Siegel and Bachand 2002), and in 2003 sold over 6,000 additional

ha in the South Bay to the State of California and the federal government (Sample 2003). Restoration of these complexes is now either underway (North Bay) or being planned (South Bay). In addition to the salt ponds, over 100 other wetland restoration projects have been completed or planned in the South Bay (see http://www.wetlandtracker.org), with a wide range of management plans, performance criteria, and monitoring activities.

In order to aid in the management and creation of salt pond and tidal marsh habitat in the South Bay, PRBO Conservation Science has been developing a predictive modeling approach called the Habitat Conversion Model (HCM) to determine what the impact might be on bird populations when salt ponds are restored to a mix of other habitats (see Stralberg et al. 2003). The model hopes to inform restoration decisions about how resulting habitat maximally benefits and supports a diverse bird community.

Managed diked wetlands

Diked wetlands are a human-created habitat currently totaling about 26,110 ha in the San Francisco Bay. Of these, 77% are in Suisun Bay, 11% in North Bay, 2% in Central Bay, and 9% in South Bay. Diked wetlands make up about 67% of all bayland habitat in Suisun Bay. The Suisun Bay diked wetlands, which are privately and publicly owned, are managed primarily for waterfowl hunting. These wetlands provide important foraging habitat for the Black-necked Stilt, American Avocet, Greater Yellowlegs, Dunlin, and Long-billed Dowitcher and nesting habitat for the Killdeer, Black-necked Stilt, and American Avocet. Diked wetlands, whether duck ponds or abandoned salt evaporation ponds, vary considerably in water level, salinity, and amount and type of vegetation. Consequently, shorebird use can be highly variable among ponds.

Agricultural lands and seasonal wetlands

Currently there are about 14,010 ha of agricultural baylands in the San Francisco Bay Estuary of which about 80% are located in the North Bay. Seasonal wetlands that form on these agricultural lands after winter rains are foraging habitat for many shorebirds, such as the Greater Yellowlegs, Western Sandpiper, Least Sandpiper, Dunlin, and Long-billed Dowitcher.

Heavily grazed pastures – especially around Humboldt Bay, Bodega Bay, Tomales Bay, Drakes Estero, and Bolinas Lagoon – are important foraging and roosting sites for shorebirds when winter high tides inundate tidal flat foraging areas. Additionally, rains make prey more available in pastures and less available in tidal habitats (M. Colwell pers. comm.). Tilled land also is used in the Point Reyes area by some shorebirds, such as the Black-bellied Plover, Semipalmated Plover, and Killdeer. At Humboldt Bay, the California Department of Fish and Game and US Fish and Wildlife Service rely on

livestock grazing to manage pasture vegetation height to promote use by shorebirds and waterfowl (M. Colwell pers. comm.). Livestock grazing of flat land near coastal estuaries should be viewed as beneficial to shorebirds as long as the grazing does not contribute to increased sedimentation of intertidal habitats or impact sensitive species. In the Arcata Bottoms at Humboldt Bay, pastureland created by diking of salt marsh, inter-digitating with alder and spruce forest, may now provide more habitat for wintering shorebirds than former salt marsh (M. Colwell pers. comm.).

Coastal strand

The region has about 267 km of outer coast sand beach, of which about 124 km is backed by dunes (US Army Corps of Engineers 1971). Although sand beaches may be used by a large number of species, they are most important to the Snowy Plover, Willet, Whimbrel, and Sanderling. The Snowy Plover nests on the upper beach and forages on invertebrates on the upper and lower beach. Barren to sparsely vegetated sand dunes, which back some beaches, are also important Snowy Plover nesting and foraging areas (Page et al. 1995b). Migrating and wintering Black-bellied Plovers, Western Sandpipers, Semipalmated Plovers, Willets, Whimbrels, Sanderlings, and other shorebirds forage on beaches and roost on the higher portions of the beach (Colwell and Sundeen 2000) or in barren to sparsely-vegetated dunes backing beaches, particularly at high tides. In northern California, beaches nearer to Humboldt Bay had higher shorebird use than those more distant (Colwell and Sundeen 2000).

Shorebirds foraging and roosting on coastal beaches experience considerable disturbance from humans and other threats to habitat quality. Birds are flushed by off-road vehicle drivers, especially in Del Norte and Humboldt counties, and by pedestrians and joggers, particularly those with dogs, in all counties. Leash laws are seldom enforced and dogs are often permitted to chase roosting and foraging shorebirds. With the growing human population in California this type of disturbance undoubtedly will increase. Oil spills are another problem shorebirds experience on sand beaches. Shorebirds were oiled on Humboldt Bay in November 1997 and in 1999, and on Point Reyes beaches in November 1997 and January 1998 (PRBO unpubl. data). Nesting Snowy Plovers face numerous threats on sand beaches. These include loss of dune habitat to the introduced European beachgrass, decreased nesting success from human disturbance, and high levels of egg predation by Common Ravens.

Rocky shoreline

Resident Black Oystercatchers use this habitat for nesting, foraging, and roosting. During winter, the rocky shoreline of the region is the primary habitat of the Black Turnstone, which also forages on tidal flats. Other rocky coast species, occurring in

small numbers in migration and winter, are the Wandering Tattler, Spotted Sandpiper, Ruddy Turnstone, Surfbird, and Rock Sandpiper. Oil spills are the main threat to the species using this habitat.

Offshore waters

Offshore waters are important for migrating Red-necked and, particularly, Red phalaropes (Briggs et al. 1987, Tyler et al. 1993). Available food supplies in these waters are undoubtedly affected by ocean temperatures and large scale oceanic events such as El Niño conditions (Warnock et al. 2001). The Red Phalarope may be affected by winter storms, which sometimes cause large numbers to come ashore in a weakened condition that leaves them susceptible to predators. Oil spills are the main human-induced problem for phalaropes in offshore waters.

Coastal Population and Habitat Goals

Population Goals:

1. Attain and maintain a breeding population of 2,040 Snowy Plovers on the southern California coast following the management recommendations of the Western Snowy Plover Pacific Coast Population Draft Recovery Plan (USFWS 2001).
2. Attain and maintain a breeding population of 210 Snowy Plovers on the northern California coast, consistent with the objectives of the Snowy Plover Draft Recovery Plan (USFWS 2001).
3. Attain a breeding population of 500 Snowy Plovers in San Francisco Bay, consistent with the population objectives of the Snowy Plover Draft Recovery Plan (USFWS 2001).
4. Maintain or increase current breeding populations of Killdeer, Black Oystercatcher, Black-necked Stilt, and American Avocet.
5. Increase numbers of wintering and migrating shorebirds on the California coast.

Habitat Goals and Conservation Actions:

Site-specific conservation actions to achieve the following habitat goals and objectives are presented in Appendix B. Some of the following goals and objectives overlap with those presented as necessary for the recovery of the Western Snowy Plover. For a more in-depth treatment of those goals and a Recovery Task Outline, please refer to the Draft Recovery Plan (USFWS 2001, specifically Table 6). The recovery plan is endorsed by this shorebird conservation plan.

Tidal flat

Goal: Increase the extent and habitat quality of tidal flat.

Priority conservation actions for tidal flats are to:

- Improve and revise watershed management actions for all coastal wetlands to reduce sediment accumulation on intertidal habitat.
- Remove levees, maintain levee breaks, or breach barrier bars after closures to maintain tidal exchange and thus retain tidal flats currently used by shorebirds at some river mouths, diked pastures, and leveed marshes along the coast.
- Protect existing tidal flat from introduced plants and invertebrates.
- Develop regulations to reduce invasions of non-native benthic invertebrates, including legislation to restrict ballast discharge.
- Eliminate non-native vegetation (e.g., *Spartina alterniflora*) that threatens to reduce the extent of tidal flats.
- Restrict human activities that cause substantial disturbance to large flocks of shorebirds foraging on tidal flats, including use of jet skis, kayaks, and other recreational activities, as well as various fishing activities, including claming, oyster culture, and bait digging, especially during periods of peak shorebird occurrence.
- Prohibit further alteration of tidal flats for oyster culture.
- Increase the extent of tidal flat by adding 1,620 ha throughout the San Francisco Bay.

Salt marsh

Goal: Increase amount and quality of shorebird habitat within salt marshes.

Priority conservation actions for salt marshes are to:

- Eliminate the introduced *Spartina alterniflora*.
- Incorporate shorebird habitat components in tidal marsh restorations and creations, including broad channels with exposed mudflat during low tides, shallow ponds for foraging and breeding, and undisturbed roost sites.
- Increase tidal circulation and water quality in marshes to enhance invertebrate productivity and shorebird foraging areas.

Salt ponds

Goal: Maintain sufficient amount of high quality salt pond habitat to support breeding shorebirds, including the Western Snowy Plover, as well as migrating and wintering shorebirds.

Priority conservation actions for salt ponds are to:

- Manage some amount of salt ponds, especially at San Francisco Bay, Monterey Bay, and San Diego Bay, specifically for nesting, feeding, and roosting shorebirds, including some to be managed specifically for nesting Snowy Plovers, as recommended in the Snowy Plover Draft Recovery Plan.

- Maintain public closures of Snowy Plover nesting areas during the breeding season.
- Continue to manage non-native and native mammalian and avian predators to limit predation of the eggs and chicks of the Snowy Plover and other nesting shorebirds in all important nesting habitat. Use fencing and exclosures to protect Snowy Plover nests from egg predators when necessary.
- Prevent the spread of vegetation in dry salt ponds.

Managed diked wetlands

Goal: Maintain and improve habitat quality for shorebirds in existing managed diked wetlands.

Priority conservation actions for managed diked wetlands are to:

- Time water drawdowns in managed marshes to correspond with the peak of spring shorebird migration from mid-April to mid-May.
- Manage vegetation in some ponds to provide broad expanses of open habitat.
- Create 1-6 inch water depths in some managed ponds for wintering shorebirds.
- Increase nesting habitat for the Black-necked Stilt and American Avocet in managed marshes through the strategic placement of islands.

Agricultural land and seasonal wetlands

Goal: Maintain current amount of seasonal wetlands and improve habitat quality in those seasonal wetlands as well as in adjacent agricultural lands.

Priority conservation actions for agricultural lands and seasonal wetlands are to:

- Protect from development, including use of conservation easements, seasonal wetlands and pastures with known high shorebird use.
- Limit recreational use of seasonal wetlands with known high shorebird use.
- Restore seasonal wetlands.
- Protect or enhance agricultural lands adjacent to seasonal wetlands with know high shorebird use.
- Reduce reliance on toxic pesticides and herbicides.

Coastal strand

Goal: Increase the habitat quality of coastal strand habitat.

Priority conservation actions for sand beaches and dunes are to:

- Identify and rank beaches of importance to migrant and wintering shorebirds, as well as to the Western Snowy Plover, for the purpose of prioritizing conservation actions for this habitat type.
- Remove non-native vegetation in coastal dunes, especially Eurpean beachgrass, *Ammophila arenaria* and iceplant, *Mesembryanthemum* sp.
- Where appropriate, restore native plant communities of coastal dune systems.
- Implement recommendations of the draft Western Snowy Plover Recovery Plan (USFWS 2001). These include but are not limited to: In known Snowy Plover nesting and brood-rearing areas, restrict human recreation, use nest exclosures to protect plover nests, implement predator management to protect plover clutches and to increase fledge rate of plover chicks, and implement public education programs.
- Restrict dogs from beaches of highest importance to the Western Snowy Plover and those with highest relative importance to migrant and wintering shorebirds.
- Increase enforcement of dog leash laws on other beaches used by nesting Snowy Plovers and large flocks of migrant and wintering shorebirds.
- Restrict off-road vehicle driving on Snowy Plover nesting beaches, especially during the breeding season (March-September).
- Restrict nighttime driving on beaches used by large flocks of foraging and roosting shorebirds.
- Limit human use of beaches with consistent roosts of large numbers of shorebirds, and beaches with feeding and roosting Snowy Plovers to produce conditions conducive to nesting (where they do not currently nest).
- Increase enforcement of county ordinances that already exist to prohibit much of the above activity.
- Restrict building on coastal strand.

Rocky shoreline

Goal: Protect and improve habitat quality of rocky shoreline.

Priority conservation actions for rocky shorelines are to:

- Develop an inventory of rocky shoreline habitat, as well as jetties that function similarly for shorebirds.
- Identify and rank rocky shoreline of highest importance to breeding Black Oystercatchers and large flocks of migrant and wintering shorebirds.
- Limit human access to Black Oystercatcher breeding sites.

- Control predators of Black Oystercatcher eggs and chicks where they are found to substantially reduce reproductive success.
- Promote regulations reducing the probability of oil spills.

Offshore waters

Goal: Protect offshore waters.

A priority conservation action for offshore waters is to:

- Promote regulations reducing the probability of oil spills.
- Promote creation of a California Current Joint Venture.

All habitats

Goal: Increase the current amount and distribution of shorebird nesting, migration, and wintering habitat.

Priority conservation actions for all habitats are to:

- Protect existing habitat from loss to development or from further fragmentation by human-created infrastructures. For example, additional power lines can artificially increase predation pressure on shorebirds.
- Develop site-specific management plans for habitat under public ownership, where they are currently lacking.
- Implement management practices favorable to breeding, wintering, and migrating shorebirds.
- Improve management capacity for existing protected habitats.
- Enhance existing shorebird nesting habitat.
- Reduce level of disturbance and other degrading impacts of human recreational activities on nesting, foraging, and roosting areas of the Snowy Plover and other shorebirds.
- Reduce erosion of sediment from watersheds into lagoon and estuarine habitats.
- Encourage cleanup of areas containing hazardous levels of environmental contaminants in invertebrates or substrates and reduce shorebird use of areas until hazardous materials are removed.

Chapter 4. Central Valley

The Central Valley – stretching northwest to southeast through the heart of the state – is California's largest valley. Surrounded by mountains, except for its western drainage into San Francisco Bay, the Central Valley averages about 644-km long and 64-km wide. The Valley is divided into the Sacramento Valley, draining southward, the San Joaquin Valley draining northward, and the Sacramento-San Joaquin River Delta (hereafter Delta) where these rivers converge. The Sacramento Valley is further divided into the Colusa, Butte, Sutter, American, and Yolo drainage basins, and the San Joaquin Valley into the San Joaquin Basin and the, usually closed, Tulare Basin. Further discussion will focus primarily on the four major subdivisions of the Central Valley – the Sacramento Valley, Delta, San Joaquin Basin, and Tulare Basin.

The Central Valley has lost about 90% of its historic wetlands (Frayer et al. 1989), and the region is now dominated by agricultural lands. Readers should consult Heitmeyer et al. (1989) for an overview of the physiography and extent of historical and recent wetlands and croplands by subregion of the Central Valley. Primary shorebird habitats in the Central Valley currently are restored and highly managed wetlands, flooded agricultural lands, hypersaline agricultural evaporation ponds, and municipal sewage ponds (Table 5). The Central Valley's vernal pool rangelands probably also provide important shorebird habitat (Silveira 1998) but use of these pools by shorebirds has been poorly studied. During comprehensive surveys of shorebirds in the Central Valley in the early 1990s, managed wetlands, agricultural fields (especially rice), and agricultural evaporation ponds held the most shorebirds (Shuford et al. 1998). These authors provide additional detail on habitat use by various species of shorebird throughout the Central Valley.

Long-billed Dowitcher

Table 5. Extent (acres) of key shorebird habitats in the Central Valley, 1992 to 1995 (from Shuford et al. 1998).

	Habitats[a]				
Basin	MGWE[b]	AGLA[b]	AGRI[c]	EVAP[d]	SEPO[e]
Colusa	24,359	200,885	33,790	0	136
Butte	23,235	156,240	61,078	0	116
Sutter	5093	92,958	13,452	0	79
American	7336	116,875	30,043	0	274
Yolo	10,305	51,532	3927	0	620
Delta	17,389	36,791	291	0	1032
San Joaquin	?[f]	?	?	0	2507
Tulare	15,260	132,449	0	5409	3648
Total	___	___	142,581	5409	8412

[a] MGWE = managed wetlands: palustrine habitat of permanent and seasonal marshes; AGLA = all agricultural lands (including ricelands) in winter with standing water or moist soil; AGRI = ricelands intentionally flooded in winter; EVAP = hypersaline agricultural evaporation ponds; SEPO = municipal sewage ponds.

[b] Data from GIS mapping of satellite images from 3 Jan 1993, except that images from 20 Dec 1992 used for the Tulare Basin (D. Kempka in litt.); ? = no data available for San Joaquin Basin in winter 1992-93.

[c] Data for 6 Jan 1994 from Spell et al. 1995); ? = no data available for San Joaquin Basin.

[d] The 6264 acres of ponds active in 1992 (Moore et al. 1990) had been reduced to 5409 acres in 1995 (A. Toto pers. comm.), and structural changes were made at some remaining ponds to limit bird use. Creation of mitigation wetlands may have compensated for some of these habitat losses.

[e] Data from Chilcott and Johnson (1991) and R. Diekstra (pers. comm.). Figures are minimums; throughout the Central Valley some small sewage ponds not reported and none north of Chico in the Butte Basin reported.

[f] GIS data from 13 Nov 1990 (in dry winter) estimated 59,408 acres of wetlands (R. Spell in litt.); recent Central Valley Habitat Joint Venture figures estimated 135,620 acres (D. Paullin in litt.).

Shorebird Species

Surveys have shown the Central Valley to be one of the most important regions in western North America for migrating and wintering shorebirds. Manolis and Tangren (1975) provided coarse descriptions of seasonal abundance patterns and habitat selection in the northern drainage of the Valley. Shuford et al. (1998) conducted nearly comprehensive surveys of the Central Valley and found that shorebird populations in the early 1990s averaged 134,000 individuals in August, 211,000 in November, 303,000 in January, and 335,000 in April. Of 33 species recorded on these surveys, the 10 or 11 that averaged over 1000 individuals each season accounted for 99% of total numbers. In winter and spring, the Central Valley supports more shorebirds than any other inland site in western North America, and in winter is the only inland area in western North America, other than California's Salton Sea and Oregon's Willamette Valley, that supports tens of thousands of shorebirds. In fall, it is the second most important inland site to shorebirds after Great Salt Lake, Utah. Shorebird totals in the Valley seasonally range from about 20% to 40% of those on the California coast, but seven species have Valley populations that can exceed those on the coast in at least one season.

Species with regionally important populations in the Central Valley are the Black-bellied Plover (winter, spring), Snowy Plover (winter), Killdeer (winter, summer), Mountain Plover (winter), Black-necked Stilt (fall-spring), American Avocet (fall-spring), Greater Yellowlegs (fall, winter), Whimbrel (spring), Long-billed Curlew (fall, winter), Western Sandpiper (spring), Least Sandpiper (winter), Dunlin (winter), and Long-billed Dowitcher (fall-spring). A number of these species are differentially distributed within subregions of the Central Valley (Shuford et al. 1998), indicating a need to adapt management efforts locally.

The Central Valley is one of only a few key wintering areas in the World for the Mountain Plover, a species that had been proposed for federal threatened status but is now being proposed as a Bird Species of Special Concern in California (CDFG and PRBO 2001, Edson and Hunting 1999, USFWS 1999). The Central Valley also hosts two other species listed as Bird Species of Special Concern in California, the Snowy Plover and the Long-billed Curlew (CDFG 1992), but note that the Long-billed Curlew is not included in the new draft list (CDFG and PRBO 2001). The San Joaquin Valley is one of two key inland wintering areas in western North America for the Snowy Plover (Shuford et al. 1995). See Barnum et al. (1992) and Roster et al. (1992) regarding Snowy Plovers breeding on agricultural evaportation ponds in the San Joaquin Valley.

Within the Central Valley, two sites have been designated Western Hemisphere Shorebird Reserve Network Sites of International Importance: 1) the Grasslands

Ecological Area in the San Joaquin Basin near Los Banos, and 2) the ricelands and wetlands of the Sacramento Valley.

Seven species of shorebirds breed within the Central Valley. Of these, only three species – the Killdeer, Black-necked Stilt, and American Avocet – are widespread, numerous, and nest at a variety of wetland, agricultural, and municipal or industrial water storage or treatment habitats. Data from a valley-wide survey of breeding shorebirds in 2003 have not yet been compiled, but many thousands of each species breed in the Central Valley and hence these populations are important on both a state-wide and regional scale. The other four breeding species in the Valley are Snowy Plover, Spotted Sandpiper, Wilson's Snipe, and Wilson's Phalarope.

Snowy Plovers formerly bred at terminal or playa lakes in the Tulare Basin in the southern San Joaquin Valley but now most nest locally at saline agricultural evaporation ponds in the Tulare Basin and a few on the salt-encrusted margins of managed wetlands in the Tulare and San Joaquin basins (Page and Stenzel 1981, Page et al. 1991, L. Ruport pers. comm.). Numbers of plovers breeding in the San Joaquin Valley in 1988 represented roughly 10% of the total for all of California in 1988-1989 (Page et al. 1991).

Spotted Sandpipers breed in the Central Valley mainly on the edges of rivers and streams in the Sacramento Valley (Gaines 1974). No estimates are available for the size of the population breeding in this area but numbers are undoubtedly small relative to the total California nesting population, which is scattered mainly along streams and lakes in mountainous portions of the northern two-thirds of the state (Grinnell and Miller 1944).

Wilson's Snipe breed very locally in low marsh or wet meadow habitat on the extreme eastern edge of the Sacramento Valley in Browns Valley in central Yuba County and at several isolated locations east of Sheridan in northwestern Placer County (McKibben and Hofmann 1985). The size of this population is unknown but it is clearly a tiny fraction of the total California breeding population, which is concentrated in the northeastern portion of the state.

Wilson's Phalaropes breed very locally in rice fields and other wetlands in the Sacramento and San Joaquin valleys (Grinnell and Miller 1944, Lee 1984). Again, the size of this population is unknown but likely represents only a small fraction of the entire California nesting population, which is concentrated in the northeastern portion of the state (Grinnell and Miller 1944).

Habitat Status, Threats, and Management Needs

Descriptions of current habitat availability, shorebird habitat use patterns, threats to shorebirds, management issues, and needed conservation actions are provided below for the major habitat types in the Central Valley overall and for the valley's major habitat types separately.

Valley-wide habitat status and concerns

Given that 90% of the Central Valley's historic wetlands have been lost, the main concerns for shorebirds are water availability, poor and sometimes toxic water quality, habitat loss and degradation from urbanization, and changing agricultural practices (see Shuford et al. 1998). Other concerns of lesser or unknown magnitude are disturbance from human recreation activities, effects of mosquito control, competing needs of other species (e.g., salmon), and improper management (e.g., lack of grazing where needed).

Availability of high quality water is a perennial problem throughout the Central Valley because of competition for limited supplies among agricultural, urban, and wildlife uses. Shorebirds should, however, benefit from the sizeable acreage of habitat recently created for waterfowl and dependable supplies secured for wetlands via the Central Valley Project Improvement Act. Still, wetlands upon which shorebirds depend receive only about 1% of the states' water supply, and future legislation potentially could reverse past gains, particularly as the state's population and water costs increase. The need for increased water supplies to meet the requirements of other species, such as salmon, potentially could limit the amount available for shorebird habitat. Mosquito control efforts also may limit options for managing for shallow-water for shorebirds in summer and early fall, when such habitat is particularly in short supply.

Pesticides used on agricultural fields have caused limited direct mortality of shorebirds and other species, but they may reduce shorebirds' invertebrate prey in winter or perhaps have other sublethal effects. Similarly, concern has been expressed about the impact on fish and wildlife of chemicals used for mosquito control in wetlands (Washino and Dritz 1995). A study at the Sacramento National Wildlife Refuge complex in the Sacramento Valley, however, suggested that ultra low volume applications of insecticides to control adult mosquitoes did not substantially affect the abundance of aquatic macro-invertebrates or fish in treated waters (Lawler et al. 1995). Still, more needs to be known about the potential effects of pesticides on shorebirds or their invertebrate prey.

Expanding urban development directly threatens wetlands, most notably at the Grasslands near Los Banos in the San Joaquin Basin and near Yuba City in the Sacramento Valley. Urbanization continues to reduce agricultural lands in the Central

Valley at a rate among the highest of any region in North America (American Farmland Trust 1995, Sorensen et al. 1997), although the effect on shorebirds is undocumented. Similarly, conversion of thousands of acres of land valley-wide to vineyards, orchards, and row crops likely has reduced foraging habitat for shorebirds, particularly species using vernal pools and those using uplands, such as the Black-bellied Plover, Killdeer, Mountain Plover, Whimbrel, and Long-billed Curlew.

Although many of the problems listed above are faced by shorebirds valley-wide, some have been or are restricted primarily to certain subregions of the Valley. For example, as recently as the 1980s, agricultural drain water used to flood wetlands in the Grasslands Ecological Area of the San Joaquin Basin resulted in biological accumulation of selenium sufficient to harm reproduction of shorebirds and other wildlife (Ohlendorf et al. 1987). Conditions in the Grasslands have steadily improved after replacement with uncontaminated water in 1985 (references in Shuford et al. 1998). Similarly, concentrations of salts and trace elements, such as selenium, at agricultural evaporation ponds in the Tulare Basin have caused reproductive impairment in the Black-necked Stilt and American Avocet (Skorupa and Ohlendorf 1991, Ohlendorf et al. 1993). Efforts are being made to reduce use of these ponds by hazing, altering their physical structure, and creating nearby uncontaminated wetlands. How this has changed the size and species composition of shorebird populations in the Tulare Basin is currently being examined.

Because agriculture is by far the dominant land use in the Central Valley, any broadscale changes in farming practices could tremendously influence shorebird habitat. For example, some Sacramento Valley riceland could be lost to the current expansion of cotton, a less friendly crop to shorebirds, although 80% of the region's riceland is incapable of supporting other economically viable crops. Conversely, an increase in flooded acreage of rice fields in winter to aid in stubble decomposition should benefit shorebirds. In the Tulare Basin, changing irrigation practices in recent decades have reduced the amount of shallow-water agricultural habitat available to ducks and shorebirds (Barnum and Euliss 1991). Concentrations of salts in agricultural fields may lead to abandonment of these lands and reversion to habitats less suitable to shorebirds.

Anecdotal evidence suggests invasive exotic plants are degrading wetland habitats, but more needs to be known of the extent of this problem in the Central Valley. Bermuda grass *(Cynodon dactylon)* and knot grass *(Paspalum distichum)* pose problems in the Butte Sink and major bypasses of the Sacramento Valley where the water table is high.

Limited anecdotal evidence suggests that human recreational activities may potentially cause harm to shorebirds in the Central Valley, but this may be a greater issue in coastal areas.

Overall management needs

With the limited amount of wetlands now available in the Central Valley, it is imperative that remaining habitat be managed to maximize the diversity and abundance of wetland-dependent species. Studies in ricelands in the Sacramento Valley (Elphick and Oring 1998) and managed wetlands of the Grasslands in the San Joaquin Valley (Williams 1996, Isola et al. 2000, Colwell et al. 2002) both have shown that the greatest diversity of waterbirds in winter is found when water depths *average* about 15 cm. Hence, a reduction in water depths in these habitats over those of previous management practices would benefit shorebirds without harming dabbling ducks. As outlined below, a number of other specific management recommendations have been made to increase wetland use of shorebirds during winter, migratory, and breeding periods.

Managed wetlands

Managed wetlands on refuges and private duck clubs cover about 65,560 to 96,720 ha in the Central Valley (Table 5). These wetlands provide important shorebird habitat in the Central Valley in winter and, especially, spring, when receding water levels expose extensive mudflats. Species that forage extensively in shallow water or mudflats in managed wetlands are the Killdeer, Black-necked Stilt, American Avocet, Greater Yellowlegs, Western and Least sandpipers, Dunlin, and Long-billed Dowitcher. The amount of acreage of managed wetlands has increased in the Central Valley in recent years, in large part from the efforts of the Central Valley Habitat Joint Venture (USFWS 1990).

Personal communications with refuge and duck club managers indicate that most wetlands in the Central Valley currently are managed to benefit shorebirds to some degree but that management is habitat- rather than species-based. The main management techniques used to benefit shorebirds are water level management, slow or staggered drawdowns, timing of drawdowns to match periods of peak use, mechanical vegetation control (burning, disking, mowing), and creation of a variety of habitats and varied topography within and among management units. Education is viewed as the best tool to convince private landowners to incorporate shorebird management into existing wetland management for waterfowl. While most respondents indicated their management efforts were successful, few had specifically defined goals; monitoring effort varied from regular unit-by-unit monitoring to anecdotal observations. Many respondents indicated there was inadequate knowledge of shorebird habitat

requirements. Most land managers indicated that management for shorebirds posed little conflict with other management goals, though one person felt conflicts could arise if there was a major shift in water management to target shorebird use exclusively.

Williams (1996) and Colwell et al. (2002) studied the responses of shorebirds and other waterbirds to late winter and early spring drawdowns of moist-soil managed wetlands in the Grasslands of the San Joaquin Valley. During winter, shorebird diversity and density increased significantly, peaking during the mid-point of drawdowns when habitat diversity was greatest. Densities of large shorebirds (Black-necked Stilt, American Avocet, yellowlegs spp., dowitcher spp.) and sandpipers (Western Sandpiper, Least Sandpiper, Dunlin) in winter correlated with availability of habitat 5 to 15 cm and < 5 cm deep, respectively. By contrast, densities of shorebirds during spring drawdowns were not correlated with the amount of shallow habitat. These patterns of shorebird occurrence may at least in part reflect patterns of habitat availability on a landscape level across the entire Grasslands. Large responses to the provision of shallow-water habitat in winter may reflect the usually limited supply of this type of habitat in this region at this season. Conversely, shorebirds may not respond as well to similar experimental drawdowns in spring because shallow water typically is widely available during this period when extensive areas of wetland are dewatered for moist-soil plant management. A lack of significant response in spring also may reflect the transitory and variable use of wetlands by migratory shorebirds. Williams (1996) recommended that managers could provide for the greatest diversity of waterbirds, including shorebirds, by flooding most Grasslands wetlands less deep in autumn or partially dewatering them in winter to average depths of 15 to 20 cm.

Water depth is the most important variable influencing habitat use by foraging waterbirds in the late winter and early spring in the Grasslands of the San Joaquin Valley (Williams 1996, Safran et al. 1997, Isola 1998). Isola (1998) identified four waterbird foraging groups based on similarities in water depth use. Of these, small shorebirds (Western Sandpiper, Least Sandpiper, and Dunlin) foraged in waters 1.8 to 3.6 cm deep and large shorebirds (Black-necked Stilt, American Avocet, and dowitcher spp.) in waters 5.8 to 10.9 cm deep. Small shorebirds, particularly Least and Western sandpipers, foraged at shallower depths than found at random sites. Large shorebirds did not appear, at the level of the individual wetland, to select foraging depths that were shallower than random. On a landscape level, though, they may have selected wetlands that tended to be shallower than other available habitats. Isola (1998) concluded that differences in observed foraging depth variation indicated that habitat use of small shorebirds and, to a lesser degree, large shorebirds is more constrained by water depth than that of waterfowl.

A two-year study at Sacramento NWR in the Sacramento Valley showed differential shorebird use between a wet and a dry spring and among various wetland types (Feldheim et al. 1999). Substantially higher peak shorebird numbers in a dry versus a wet year likely reflected concentration of shorebirds on the refuge when valley-wide habitat was limited in the dry year. These results suggest the need to tailor management actions to varying climatic conditions. Most shorebird species preferred seasonally-flooded marshes or vernal pools, but the Long-billed Curlew and Whimbrel preferred watergrass production units.

Agricultural fields

With the exception of rice, few data are available on the acreage of irrigated or flooded agricultural lands in the Central Valley at any specific time, although this habitat is very extensive seasonally. In January 1994, about 57,465 ha of rice were flooded in the Central Valley, primarily in the Sacramento Valley (Table 5). Flooded agricultural fields support large numbers of shorebirds, particularly in winter, and the amount of flooded habitat can vary greatly both seasonally and among years of varying precipitation. Rice fields alone can hold 20% to 30% of valley-wide shorebird totals (Shuford et al. 1998). Species that forage extensively in flooded fields are the Killdeer, Greater Yellowlegs, small sandpipers (especially Dunlin in winter), and Long-billed Dowitcher. The Black-bellied Plover, Killdeer, Whimbrel (mainly in spring), and Long-billed Curlew use both flooded and drier upland fields for foraging. By contrast, the Mountain Plover almost exclusively uses dry, very open upland habitats, such as heavily grazed pastures, plowed fields, and alkali flats (Knopf and Rupert 1995).

To meet a legislative mandate to reduce air pollution in the Sacramento Valley, farmers recently have begun winter flooding of fields as an alternative to burning to dispose of rice stubble. Although the increase in winter-flooded habitat so far has been modest (Spell et al. 1995), it is expected to expand from the current level of 56,655 ha to 76,890 to 80,940 ha (F. Reid pers. comm.). This change in land use has prompted new research on the effects of various harvest, flooding, and rice straw manipulation techniques. Elphick and Oring (1998) studied the effect of various water depth and straw treatments on waterbird use of Sacramento Valley rice fields in winter. Median water depths of flooded rice fields used by shorebirds in winter were about 2.5 to 12.7 cm, whereas in early winter median depths of most fields were greater than 20.3 cm. The Killdeer, Least Sandpiper, Dunlin, and Long-billed Dowitcher occurred in highest densities in fields in which straw had been incorporated in the soil prior to flooding, though this may have been due to shallower water in incorporated fields. By contrast, the American Avocet was most abundant in fields that had no treatment except flooding. These authors recommended that reducing water depths in rice fields in the

early part of the winter would lead to use by a wider variety of species while also lowering water costs. Results of across habitat measures of food abundance, perceived predation threat, foraging performance, and time allocation suggest that flooded rice fields may provide equivalent foraging habitat to semi-natural wetlands and, because of reduced predation threat, may be safer habitat for waterbirds (Elphick 1998).

Elphick (1998) also found shorebirds responding differentially to features in the landscape at various scales. Shorebird densities in rice fields were positively related to the proportion of the surrounding landscape at the 2 km (1.2 mi) scale that was a wildlife refuge, semi-natural wetland, or both. Conversely, shorebird densities were negatively correlated with an abundance of flooded agricultural land at the 10 km (6.2 mi) scale.

Day and Colwell (1998) also studied the effects of harvest method, post-harvest treatment of straw, and extent of flooding on waterbird use of Sacramento Valley rice fields in winter. Shorebirds occurred primarily in conventionally-harvested (vs. "stripped") fields that were puddled or flooded; species richness of waterbirds did not differ among straw treatments.

Agricultural evaporation ponds

The approximately 2,190 ha of very saline agricultural evaporation ponds in the Tulare Basin of the southern San Joaquin Valley (Table 5) can support high densities of shorebirds seasonally. In fall, highest numbers of shorebirds in the Central Valley can occur in these evaporation ponds (Shuford et al. 1998). In that season, key species foraging in these ponds include the Black-necked Stilt, American Avocet, small sandpipers (Western and Least sandpipers), and Wilson's and Red-necked phalaropes. Shorebird numbers in these ponds appear to be declining because of management efforts to limit their use and thereby reduce the risk of exposure to concentrated contaminants, such as selenium. Pond owners have sought to reduce the risk to wildlife of these ponds by hazing, physically altering ponds to make them less attractive, and creating nearby uncontaminated wetlands as alternative habitat.

Sewage ponds

A minimum of 3,405 ha of sewage ponds are present in the Central Valley, with the greatest extent of this habitat occurring in the San Joaquin and Tulare basins (Table 5). Although sewage ponds hold a relatively small percentage of the valley-wide shorebird total at any season, particular pond systems periodically may host large numbers of shorebirds. Sewage ponds also may serve as important roosting sites for species, such as the Black-bellied Plover, that forage in nearby fields.

Although various management actions potentially could increase the use of sewage ponds by shorebirds, pre-implementation studies are needed first to determine if transmission of diseases or concentrations of toxic substances pose substantial threats to shorebirds or other species of wildlife using these ponds.

Vernal pool rangelands

Holland (1998) mapped the distribution of grassland-vernal pool complexes in California and found them scattered widely around the perimeter of the Central Valley and in a swath in the basin lands along the valley trough. A total of 404,410 ha of this habitat occurred in counties with valley floor terrain; roughly 31% was in the Sacramento Valley, 14% in the Delta, 47% in the San Joaquin Basin, and 8% in the Tulare Basin. Although these figures include both vernal pools and surrounding grasslands, nevertheless the total acreage of wetlands represented by vernal pools valley-wide is impressive. Although there has been considerable historical loss of vernal pool habitat, the extent of this loss is unknown.

Silveira (1998) described the importance of vernal pools to birds, but use of these pools by shorebirds has been poorly studied. Shuford et al.'s (1998) study of shorebird use of Central Valley habitats did not find especially large numbers of shorebirds in vernal pools, though their surveys did not include large areas of vernal pool rangelands on the periphery of the valley (D. Shuford, G. Page pers. obs.). Although used by a variety of shorebirds, vernal pools probably are particularly important to species, such as the Greater Yellowlegs, that occur singly or in small loose flocks. Feldheim et al. (1999) conducted a two-year study of shorebird habitat use at Sacramento NWR in the Sacramento Valley. Although vernal pools comprised less than 2% of the refuge's total available wetland habitat, they held the highest shorebird densities, and more species preferred vernal pools than other wetland types.

Central Valley Population and Habitat Goals

Breeding shorebirds

The Central Valley Shorebird Working Group set interim goals of increasing summer wetland habitat by two times the current amount in both the Sacramento Valley and in the Delta, by three times in the San Joaquin Basin, and by ten times in the Tulare Basin.

A lack of long-term quantitative data on shorebird populations in the Central Valley makes it difficult to set population and habitat goals to guide wetland restoration and enhancement for their benefit. Although trend data are lacking, in the early 1990s baseline data were collected on the size of populations of wintering and migratory

shorebirds in the Central Valley (Shuford et al. 1998). Even less is known about the status of breeding shorebirds in the Central Valley. Once data are compiled from a valley-wide survey of breeding shorebirds in 2003 this information will form the basis for refining breeding shorebird population and habitat objectives for the various major subregions of the Central Valley. In 2002, the Central Valley Shorebird Working Group set tentative goals for increasing the amount of summer wetland habitat in each of the Central Valley's major subregions. These goals were set despite a lack of data on long-term trends or the current size of nesting populations of shorebirds in the Valley and without an exhaustive assessment of the degree of loss of historic wetlands by basin and of the former mix of various wetland habitat types within these basins. It was judged that these goals could be refined as new information became available but that in the meantime it was important to move forward with on-the-ground efforts to increase shorebird nesting habitat.

Although needing refinement, the interim habitat goals set by the Central Valley Shorebird Working Group are justifiable by qualitative information and by some quantitative data. Despite the paucity of historical data on shorebird abundance in the Central Valley, the replacement of over 90% of its wetlands (Frayer et al. 1989), largely with agricultural habitats, surely had a profound effect on shorebird numbers and distribution there. Losses were particularly great in the Tulare Basin, where Tulare Lake, formerly the largest freshwater lake and marsh system west of the Mississippi River (Johnson et al. 1993, Thelander and Crabtree 1994), and several smaller but important terminal lakes (Buena Vista, Goose, Kern) are no longer extant. Preliminary PRBO analysis of data from the Central Valley Historic Mapping Project (http://www.gic.csuchico.edu/historic/), apportioned by major subregions of the Central Valley (Sacramento Valley, Delta, Suisun Marsh, San Joaquin Basin, Tulare Basin), indicates that combined loss of "wetland" and "aquatic" land cover types was 96% in the Tulare Basin from the pre-1900 to current (1995) periods. Exclusive of Suisun Marsh, where the Central Valley transitions to tidal habitats of the San Francisco Bay estuary, loss of these habitat types ranged from 55% to 87% in the other subregions of the Central Valley. Further analyses are needed to better interpret these data as "aquatic" habitat has increased in some subregions; presumably these increases have been in the form of reservoirs, which generally provide very little shallow water suitable for breeding shorebirds. Also, these figures appear to represent wetland extent at the season of greatest availability, which in the Central Valley typically is in winter rather than summer.

Characteristics of the Tulare Basin suggest that it likely had a very high proportion of summer to winter wetland habitat relative to other subregions of the Central Valley.

The Tulare Basin, except in the most extreme of wet years, was a terminal basin, which increased the likelihood of water remaining in wetlands into summer as water was lost from evaporation only, whereas other "basins" of the Central Valley drain to the ocean through San Francisco Bay. The phenology of flood runoff was another factor that likely affected the extent of suitable wetland habitat remaining into the shorebird breeding season. Rainfall induced floods (Dec-Mar) predominated in the Sacramento Valley, whereas prolonged snowmelt floods (Apr-June) were the norm in the San Joaquin Valley, particularly in the Tulare Basin (The Bay Institute 1998). Various accounts indicate that Tulare Basin wetland habitats supported large numbers of breeding waterbirds, including pelicans, cormorants, waterfowl, shorebirds, and terns.

Non-breeding shorebirds

The Central Valley Shorebird Working Group set population objectives for winter and spring as 50% increase over current estimates, and double current estimate for fall, resulting in population targets of 200,000 shorebirds in fall, 400,000 in winter, and 600,000 in spring.

The process of developing habitat objectives for these target populations is currently under development and is being coordinated with efforts of the Central Valley Habitat Joint Venture (CVHJV). The CVHJV uses an energetic approach to setting habitat objectives for wintering waterfowl. Their modeling efforts, and habitat information contained therein, will be used as a basis for setting migrating and wintering shorebird habitat objectives. Where information on some of the important variables are lacking, variable estimates will be approximated from other shorebird habitat modeling efforts in the US (Loesch et. al 1995, Collazo et al. 2002). Results of the first approximations of various habitats needed to support target shorebird populations in the Central Valley will be included in the CVHJV's Implementation Strategy Update (2004) and in future versions of this conservation plan.

Priority conservation goals for the Central Valley are to:

- Increase the wintering population of the Mountain Plover in the Central Valley.
  Strategy: Create suitable open foraging habitat by managing for giant kangaroo rats (*Dipodomys ingens*) and using fire and grazing, as appropriate.
- Increase populations of breeding and wintering Snowy Plovers and wintering Long-billed Curlews in the Central Valley.
- Increase breeding and wintering populations of other shorebirds in the Central Valley.
  Strategies include:

- Restore, enhance, and manage wetlands with integrated wetland management goals, which accommodate the needs of a greater diversity of birds, including shorebirds (Isola 1998).
- Ensure the availability of high quality water for wetlands.
- Resist fragmentation or loss of existing wetland complexes by urban encroachment.
- Promote management practices in agricultural lands and vernal pool rangelands that will provide for a greater diversity of birds, including shorebirds.
- Promote easements and other options for maintaining wildlife-friendly agricultural lands and vernal pool rangelands.
- Reduce use of contaminated agricultural evaporation ponds by shorebirds and other waterbirds while creating alternative uncontaminated habitats that will mimic historic saline playa wetlands thereby maintaining the current mix of waterbird communities.
- Address issues of disease transmission and contaminants in sewage ponds or wetlands using treated sewage effluent.

Managed wetlands

Priority conservation actions for managed wetlands of the Central Valley are to:

- Promote wetland restoration projects that show high potential to benefit shorebirds. Regional experts indicated a few sites or regions of the Central Valley that had a high potential for large-scale restoration of habitats important to shorebirds. The most notable of these were in the Tulare Basin of the southern San Joaquin Valley, where a unique opportunity now exists to obtain retired agricultural lands with water rights from willing sellers (H. T. Harvey and Associates 1998). Still, a dependable and substantial water supply will be needed to maximize benefits to shorebirds and other wetland-dependent species. Additionally, private lands in the South Wilbur Flood Area and the Hacienda Ranch hold high potential for wetland restoration if cooperation can be obtained from private landowners.
- Restore, and secure with conservation easements, habitats that have been greatly reduced historically, such as playa lake wetlands.
- Expand current management strategies that benefit shorebirds:
  (a) Keep water levels that benefit both waterfowl and shorebirds during periods when water is maintained at relatively constant levels. *Average* depths of 15 to 20 cm are recommended for managed wetlands in the Grasslands (Williams 1996, Safran et al. 1997, Isola 1998).
  (b) Conduct slow (~2 weeks) and staggered drawdowns of water throughout wetland complexes. Slow drawdowns should be discouraged in wetlands of high

salinity in the Grasslands, as this practice can increase salt levels in the soil and impede plant growth (Isola 1998).

(c) Time drawdowns to coincide with periods of peak shorebird abundance and need, such as during migration, or when suitable habitat might otherwise be limited. For instance, increase drawdowns in the Grasslands during late winter (Jan to mid-Mar) when dynamic shallow water habitat is in short supply (Williams 1996, Isola 1998). Increase the practice of temporary drawdowns in late winter to help flush salts from degraded wetlands in the Grasslands.

(d) Mimic historic hydrologic conditions by fluctuating water levels in wetlands throughout the winter and spring (Isola 1998).

(e) Design new wetlands based on integrated wetland management goals (Williams 1996, Isola 1998). Create a variety of habitats and varied topography within and among management units to maximize diversity of waterbirds, including shorebirds. When enhancing and rehabilitating existing wetlands, take care to maintain habitat and topographic diversity. For wetlands with diverse topography with varied depths and (generally gentle) elevational gradients, *average* depths should be about 15 to 20 cm when fully flooded. Less topographically diverse wetlands will have to be flooded more shallowly (2.5-15 cm) to provide shorebird habitat. Gentle grading of side slopes of levees, islands, underwater berms, and drainage swales should provide structural integrity and greater diversity of water depths.

(f) Set vegetation succession back by various means of mechanical control, fire, or grazing.

(g) Provide predator-free, sparsely vegetated nesting islands for breeding shorebirds, which also may serve as roost sites for other shorebirds during the non-breeding season. Islands most suitable for shorebirds are low and shallowly sloped, thereby providing shoreline foraging areas for both adults and chicks (Engilis and Reid 1996). Be careful not to flood nests during spring irrigations or leave them high and dry during drawdowns.

- Coordinate, if possible, management practices over large wetland complexes of state, federal, and private lands, such as the Grasslands Ecological Area.
- Devise wet-year, dry-year management strategies to best use water when it is available and/or most needed.

Agricultural fields

Priority conservation actions for agricultural lands of the Central Valley are to:

- Promote conservation easements.
- Promote harvesting of rice fields by conventional methods (or add secondary efforts to cut stubble) and promote winter flooding to water depths suitable for a high diversity of waterbirds, including shorebirds.

- Increase the acreage of flooded rice in winter and reduce water depths in rice fields early in the winter relative to current practices.
- Curtail loss and restore habitats, such as vernal pool rangelands, that currently are diminishing at a rapid rate.

Agricultural evaporation ponds

Priority conservation actions for agricultural evaporation ponds in the Central Valley are to:

- Continue to devise strategies to reduce shorebird use on contaminated evaporation ponds while increasing shorebird use of nearby mitigation wetlands.
- Ensure that alternative habitats created provide suitable conditions for species, such as the Snowy Plover, that favor shallow saline water and alkali flats.

Vernal pools rangelands

Priority conservation actions for vernal pool landscapes in the Central Valley are to (Silveira 1998):

- Identify large intact vernal pool complexes and develop conservation plans for these complexes and surrounding vernal pool landscapes.
- Develop a vernal pool conservation team.
- Create patterns of land use in and around vernal pool landscapes consistent with agriculture and open space conservation.
- Develop public private partnerships and obtain (and monitor) conservation easements on large private cattle ranches.

Chapter 5. Monitoring Needs

National/International Monitoring Program

The national shorebird conservations plans of the United States and Canada (http://www.cws-scf.ec.gc.ca/birds/pdf/CSCP.pdf) both established the need to begin collecting standardized monitoring data on North American shorebird populations at regional and national/international scales. In order to ensure that the monitoring goals of the plan were implemented, the Canadian Shorebird Working Group and the US Shorebird Council initiated the Program for Regional and International Shorebird Monitoring (PRISM). PRISM's goals (Skagen et al. 2003) are based on the shorebird conservation plans completed in Canada and the US and provide a single blueprint for implementing both of these plans. The goals of PRISM are to:

1) Estimate the size of breeding populations of 74 shorebird taxa in North America;
2) Describe shorebirds' distribution, abundance, and habitat relationships;
3) Monitor trends in shorebird population sizes;
4) Monitor shorebird numbers at stopover locations, and;
5) Assist local managers in meeting their shorebird conservation goals.

PRISM has two main monitoring components: 1) breeding surveys (arctic, boreal, temperate, neotropical), and 2) non-breeding surveys. Currently, PRISM is in a 5-year phase to design statistically valid, logistically feasible schemes to achieve monitoring goals for breeding and non-breeding shorebird populations. Until PRISM completes its five-year assessment period and comes out with national monitoring protocol, it is still not possible to identify a single, accepted monitoring program for the shorebirds of the Southern Pacific Region. Presently, for the Southern Pacific Region, there are two options for inputting local shorebird monitoring data into more regional/national monitoring schemes: the International Shorebird Survey (ISS) and the Western Shorebird Survey (WSS).

The International Shorebird Survey was started in 1974 by the Manomet Center for Conservation Sciences. Volunteers visit sites every 10 days during spring and fall, and shorebirds are counted at these sites. The ISS data files contain results from more than 35,000 surveys of approximately 1,700 sites widely distributed across the Western Hemisphere. ISS data helped spark the formation of the Western Hemisphere Shorebird Reserve Network and have been used to identify sites in North and South America that qualify for WHSRN site designation. ISS data also have been used to chart

migration timing at key sites, and to develop a shorebird atlas (Skagen et al. 1999).

The Western Shorebird Survey was initiated in 2000 by the US Fish and Wildlife Service and the US Geological Survey to improve shorebird monitoring during the non-breeding period, especially in the western United States where ISS data were largely lacking. The focus of the WSS is to monitor numbers of shorebirds at major stop-over sites, with specific survey areas being chosen to include the most heavily used areas at each site and any areas that are of special interest to local managers. The program includes about 200 sites and the program features a web-based data entry system (see http://wss.wr.usgs.gov/ for details).

Regional Monitoring Needs

In light of the importance of the Southern Pacific Region to North American shorebirds, a number of monitoring priorities exist for the region. They include:

Monitoring program(s):

- Establish a network of organizations to undertake monitoring activities, as well as a baseline of funding to support these activities.
- Establish monitoring methods for the region that feed into national monitoring efforts.
- Establish a database and data central for monitoring results for the region that also feed into a national database.

Breeding shorebird populations:

- Monitor annual numbers, reproductive success, and survival of adult and young Snowy Plover on the coast, including distribution within San Francisco Bay wetlands.
- Monitor annual numbers, reproductive success, and survival of adult and young Snowy Plover in the Central Valley, especially the San Joaquin Valley.
- Monitor annual numbers, reproductive success, and survival of the Black Oystercatcher on the coast.
- Monitor breeding shorebird populations in San Francisco Bay in light of proposed conversion of thousands of acres of salt ponds to tidally influenced wetlands.

Non-breeding shorebird populations:

- Establish long-term monitoring schemes for species of conservation concern.
- Establish long-term monitoring programs for migrating and wintering shorebird species for which the Southern Pacific region is particularly important relative to other regions of North America.

- Conduct winter surveys of Mountain Plover, Long-billed Curlew, Marbled Godwit, Whimbrel, and Black Turnstone to detect population trend and dependence on the region.
- Monitor wintering and migrating shorebird populations in San Francisco Bay in light of proposed conversion of thousands of acres of salt ponds to tidally influenced wetlands.

Predator populations:

- Determine trends in abundance of shorebird predators, especially the Merlin (*Falco columbarius*), Peregrine Falcon, Short-eared Owl (*Asio flammeus*) – presence and abundance at key wintering sites - and corvids, especially Common Ravens and American Crow (*Corvus brachyrhynchos*).

Habitat:

- Monitor shorebird foraging and roosting habitat availability and condition, including levels of human disturbance.
- Quantify success of restoration projects in meeting shorebird objectives. Especially in the Central Valley, such efforts should recognize that landscape level effects, such as the extremes of drought and flooding on nearby and/or widely distributed agricultural lands, may override beneficial wetland practices in certain years.
- Monitor long-term trends in habitat availability.
- Monitor effects of *Spartina alterniflora* on coastal shorebird habitat.

Education:

- Establish an education program that includes a web-based component to convey the results of different monitoring programs to state and federal agencies, land managers, private citizens, and other interested parties.

Chapter 6. Research Needs

As part of the US Shorebird Conservation Plan, an associated technical report was developed that outlines priority areas of research in shorebird ecology and habitat management (Oring et al. 2000). Oring et al. (2000) encourage independent and coordinated research that provides information that will assist in maintaining stable and self-sustaining shorebird populations. An emerging effort, the Hemisphere Shorebird Project, coordinated by the Shorebird Research Group of the Americas (SRGA), proposes to focus research on factors limiting shorebird populations in the Western Hemisphere. In this section, we present research recommendations for the Southern Pacific Region in the context of research priorities identified by the US Shorebird Conservation Plan, the SRGA, and working groups of the Southern Pacific region.

A. Essential research designed to facilitate stable and self-sustaining shorebird populations

1. Identification of population limiting factors

Research into factors that limit shorebird populations is a top priority at the national level. It is particularly important to determine factors that cause recently detected declines in shorebird populations (Page and Gill 1994, Butler and Lemon 2001, Morrison et al. 2001a). As noted by the SRGA, several possible factors deserve critical study: climate change, increases in the populations of predators of shorebirds, long-term environmental contamination, increased levels of human disturbance, and habitat loss, degradation, and alteration.

a. Effects of climate change

The effects of climate change on shorebirds and their habitat include sea level rise (Galbraith et. al 2002), zooplankton decline (Roemmich and McGowan 1995), habitat alteration (Lindstrom and Agrell 1999), and storm pattern change (Michener et al. 1997). All shorebird species will be affected by at least one of these changes during some phase of their life cycle. For a more extensive summary of direct and indirect factors that could affect shorebird populations see Rehfisch and Crick (2003). The approach proposed by the SRGA to determine the impact of climate change on shorebird populations includes an analysis of data on climatic variables and reproductive success from the breeding grounds of arctic nesting species. Currently, it does not propose to assess changes in migration or wintering habitat for those species nor does it address impacts on temperate breeding species. Presently, no regional research recommendations have been formulated specific to this region.

b. Effects of the increase in predator populations

Predators can have a major influence on the structure of bird populations. The presence of predators may strongly affect adult shorebird mortality (Page and Whitaker 1975), egg and chick mortality (USFWS 2001), behavior (Lima and Dill 1990), migratory strategy (Lank and Ydenberg 2003), and choice of wintering or breeding area (Lima 1993). Increases in the populations of some avian predators (including raptors) have followed bans on hunting and DDT use (US EPA 2002, Hoffman and Smith 2003). These increases may cause migrating and wintering shorebirds to avoid some sites and decrease their stopover time at others (Butler et al. 2003, Lank et al. 2003). Thus their ability to obtain necessary food resources for migration or survival over winter may be restricted. An expanding raptor population also requires more prey and consumes more shorebirds, resulting in lower shorebird survival rates and overall shorebird population decline. The SRGA indicates the need to decipher if increasing predator populations are responsible for observed shorebird population declines or are changing shorebird migration patterns, including routes and length of stay, thus giving the appearance of a population decline at individual sites.

In addition to the recovery of many species of birds of prey, the expansion of other native and non-native predators may be impacting shorebird populations, particularly temperate breeding species. Close monitoring of Western Snowy Plovers reveals that expanding populations of corvids substantially reduce hatching success (Lynne Stenzel pers. comm.). Corvids may similarly affect other species breeding in the Southern Pacific Region, including the Black Oystercatcher, Black-necked Stilt, and American Avocet. Non-native red fox, released into the wild early in the last century after the collapse of the fur trade, have had a detrimental effect on Snowy Plover hatching success in the Monterey Bay area (PRBO unpubl. data). Domestic cats, abandoned by owners near breeding areas also could be major predators of shorebird adults and young.

Regional research recommendations:

- Acquire more information on the effect of avian predator populations on shorebird demographics.
- Collaborate with the SRGA to test hypotheses concerning the effect of increasing populations of birds of prey on migratory behavior of shorebirds.
- Assess predator impact, including Common Ravens, on the reproductive success of Western Snowy Plovers and Black Oystercatchers throughout the coastal region, of Snowy Plover in the interior of the region, and of Black-necked Stilt and American Avocet nesting success at coastal and interior sites.

c. Effect of contaminants on energy uptake and expenditure by migratory and breeding shorebirds

Some environmental contaminants and pesticides, such as selenium and organochlorines, have produced well-documented detrimental effects on breeding water birds in the region (Ohlendorf 1986, Takekawa et al. 2002a, Hotham and Welch 1994) and some migrants (Warnock and Schwarzbach 1995). The extent to which other shorebirds and waterbirds in the Southern Pacific Region are affected by contaminants is largely unknown. On the wintering grounds, the immediate consequences of toxin ingestion may not be apparent in behavior or mortality of shorebirds at the site. The SRGA postulates that industrial and urban contaminants accumulate in the tissues of birds and are released in sudden high doses as birds migrate, disrupting normal physiological processes so severely to result in the death of birds. They propose to test this "trophic contamination hypothesis" by assessing contaminant levels in birds during migration and at the breeding grounds. A specific regional issue is the possible negative consequences of renewed mobilization of mercury on breeding Black-necked Stilts, American Avocets, and Snowy Plovers in San Francisco Bay that might result from the conversion of salt ponds to salt marsh.

Regional research recommendations:

- Where appropriate, collaborate with the SRGA to test the trophic contamination hypothesis.
- Identify potential contaminants, sources of contaminants, and which species most likely would be affected in the Southern Pacific Region.
- Investigate the potential for mercury mobilization in San Francisco Bay to detrimentally affect nesting stilts, avocets, and plovers.

d. Increasing levels of human disturbance

As human populations in coastal environments continue to grow, interactions between humans and shorebirds increase. Multiple studies have attempted to assess the impact of human disturbance on shorebirds during migration and winter (Burger 1986, Pfister et al. 1992, Gill et al. 1996). Many human commercial and recreational activities have the potential to disrupt the normal foraging and resting activities of shorebirds, leading to decreased fitness and mortality. Direct mortality of shorebirds has occurred due to collision with vehicles driving on beaches and predation of shorebird chicks and adults by unleashed dogs. Indirect mortality could occur from high levels of human disturbance in feeding or roosting areas, resulting in diminished energy reserves and increased susceptibility to predation. For the threatened Western Snowy Plover, Lafferty (2001) documented human disturbance caused a decline in feeding rates. Additionally, it has been suggested that human disturbance is a factor in reduced

reproductive success of Western Snowy Plovers breeding in the Southern Pacific Region (Ruhlen et al. 2003).

Regional research recommendations:

- When appropriate, collaborate with SRGA to assess differences in numbers of shorebirds, including declines over time, at sites with varying levels of human disturbance.
- Assess impact of off-road vehicles on mortality of shorebirds on beaches, particularly at night.
- Assess degree of disturbance of roosting or feeding shorebirds by various sources including, personal watercraft operated in wetlands, parasailing, pedestrians on trails surrounding wetlands, and pedestrians and pets on beaches.
- Determine effect of bait digging, clamming, and different oyster culture techniques on availability of shorebird invertebrate prey at coastal sites, degree of substrate alteration, and level of disturbance to shorebirds.
- Investigate impact of beach replenishment and grooming activities on invertebrates.
- Further investigate effect of human disturbance on reproductive success of coastal nesting shorebird species, especially the Western Snowy Plover.
- Identify areas of rocky shoreline where recreational or maintenance activities could disturb breeding Black Oystercatchers or migrant and wintering shorebirds.

e. Loss and alteration of important habitat

Habitat loss and alteration is probably the single most important cause of shorebird decline over the past century (Brown et al. 2000). Habitat degradation and alteration can affect shorebird populations nearly to the extent of outright loss. Substantial degradation is caused by non-native species -- plants and animals that colonized Pacific Coast wetlands through bilge dumping, oyster culture, and restoration activities. Introduced invertebrates now make up the major prey of most shorebirds in San Francisco Bay, where new invasions are identified frequently (Carlton 1979). *Spartina alterniflora*, can overtake broad expanses of mudflat, reducing shorebird foraging area available as well as feeding time (Goss-Custard and Moser 1988). Due to the high relative importance of the San Francisco Bay estuary to shorebird populations in the Pacific Flyway (Page et al. 1999), and as the estuary holds 70% of the mudflat in California (Ayres et al. 1999), two important investigations have been initiated. One is to determine the potential effect of the spread of *Spartina alterniflora* on availability of shorebird foraging habitat in the estuary. The second is a modeling exercise to evaluate potential restoration scenarios in the estuary on bird populations (Stralberg et al. 2003). Initial work suggests that there is a great potential for negative effects on shorebirds from restoration of salt ponds to salt marsh habitats (Stralberg et al. 2003).

Regional research recommendations:

- Investigate the effect of introduced invertebrates on fitness of wintering and migrating shorebirds in coastal wetlands.
- Pursue research questions identified through the investigation of the effect of the spread of *Spartina alterniflora* on availability of shorebird foraging habitat in San Francisco Bay.
- Pursue research identified through the investigation of the effects of habitat change on shorebird populations in San Francisco Bay.
- Support research on the effects of habitat changes at sites outside the Southern Pacific Region such as the Salton Sea and Klamath Basin, as change in those locations might be reflected within the region.

2. Size and distribution of shorebird populations

Substantial published information documents the abundance and distribution of migrating and wintering shorebirds in many wetlands of the region (e.g., Colwell 1994, Shuford et al. 1998, Page et al. 1999, Stenzel et al. 2002). Considerable information also exists on the distribution some breeding species on the coast (Page et al. 1981, 1991, Carter et al. 1992, Rintoul et al. 2003). And recently, the first comprehensive survey of breeding American Avocets and Black-necked Stilts in the Central Valley was conducted (PRBO unpubl. data). However, for the region, there are few data on the abundance and distribution of wintering and migrating shorebirds on coastal sand beaches (except see Colwell and Sundeen 2000), on rocky shoreline, or in Central Valley agricultural lands and vernal pool habitats.

Regional research recommendations:

- Identify and rank coastal sandy beach and rocky shoreline areas important to migrating and wintering shorebirds.
- Identify the relative importance of different types of agricultural land to shorebirds migrating and wintering in the Central Valley, specifically species not adequately covered by other survey efforts (e.g., Long-billed Curlew, Whimbrel, Black-bellied Plover, Mountain Plover, and breeding Killdeer).
- Assess shorebird use of vernal pools during migration and winter throughout the region.

3. Space use within and among years

Understanding shorebird movements and use of habitat seasonally and inter-annually is critical to designing effective conservation strategies. Shorebird movements within and between wetlands in the Southern Pacific Region vary by species and season. In coastal wetlands, Western Sandpipers exhibit considerable site fidelity throughout the winter

(Warnock and Takekawa 1995), while Dunlin and Long-billed Dowitchers may move as much as 160 km from the coast in mid-winter (Warnock et al. 1995, Takekawa et al. 2002b). Little data exist on winter movements of other shorebird species. Some breeding space use analyses have been conducted in San Francisco Bay (Kelly and Cogswell 1979, Hickey 2002) and, for the Western Snowy Plover, along the coast (Stenzel et al. 1994). To better understand shorebird use of wetlands of the region at the landscape level, studies of shorebird site fidelity and seasonal movements are encouraged, particularly for species of high conservation concern.

Regional research recommendations:

- Investigate the degree of shorebird movement within coastal wetland complexes (e.g., Upper Newport Bay, San Joaquin Marsh, Santa Ana River and Bolsa Chica in Orange County, and in San Francisco Bay).
- Examine the degree of winter movement of shorebirds among Central Valley wetlands and agricultural lands.
- Determine site fidelity and survivorship of wintering shorebirds in coastal and interior wetlands.

4. Migration systems

The study of migration systems includes understanding breeding origins, migration routes, and winter destinations of specific populations. Migration systems and strategies vary widely among shorebird species (see Oring et al. 2000 for categorization of species). Often, obtaining detailed knowledge of a species' migration system requires large-scale research design, intensive tracking of individuals, and international cooperation (e.g., Warnock and Bishop 1998, Warnock et al. 2001b, 2002b). Along the Pacific Flyway, multiple years of cooperative research have been conducted to track annual migrations of several species, including the Western Sandpiper, Dunlin, Long-billed Dowitcher, and Short-billed Dowitcher (Bishop and Warnock 1998,Warnock and Bishop 1998, Warnock et al. 2001b, 2002b).

Regional research recommendations:

- Further investigate connectivity and relative importance of wetlands along the Pacific Flyway by tracking individuals of several key species, including species of high conservation concern and "flagship species" recommended by Morrison (in Oring et al. 2000).
- Improve understanding of quality of stopover sites for migratory shorebirds in the region.

5. Turnover rates and stopover ecology

Understanding the timing of landscape level habitat use and factors affecting turnover rates, including body condition and prey depletion, is important not only to understanding the complete life cycle of species but to effective conservation of migratory stopover sites (Warnock and Bishop in Oring et al. 2000).

Regional research recommendations:

- Document length of stay of migratory shorebirds within the region's wetlands.
- Further investigate factors influencing turnover rates at key stopover sites.

6. Energetics and foraging ecology

There is limited information on the energetic requirements of shorebirds in the Southern Pacific Region (but see Kelly et al. 2002). Information on the Basal Metabolic Rate of birds provides an indication of physiological needs as they change through the season (Piersma et al. 1995). The amount of habitat needed to sustain shorebird populations during migration and throughout winter in an area can be estimated from analyses of the metabolic requirements of shorebirds combined with prey biomass and availability in different habitat types (Loesch et al. 1995, Collazo et al. 2002). Information is also needed on the caloric value of various prey species, rates of prey consumption, population dynamics of prey populations, and availability of different habitat types in the region. An energetic approach is being employed by the Central Valley Habitat Joint Venture to estimate the acreage of various habitats in different regions of the Valley necessary to support target shorebird populations (see Central Valley section of this report). But see Goss-Custard (2003) for limitations of this approach and discussion of how energetic studies can help predict which management practices will best support shorebird populations.

Regional research recommendations:

- Determine the energetic requirements of wintering shorebirds in the Central Valley and relate these to prey availability in managed wetlands and agricultural lands.
- Test assumptions of the Central Valley energetic model and acquire better estimates of key model variables.
- Investigate further key questions that arise from model development.
- Improve understanding of diets of shorebirds year round in the region.

7. Differentiation of sub-species or species

Recognizing and conserving geographically distinct populations is a stated goal of the US Shorebird Conservation Plan (Brown et al. 2001). Identifying specific breeding areas and migratory pathways of such populations is necessary in order to achieve this

conservation goal. Distinct populations of several species breed, migrate, or winter in the Southern Pacific Region, including the western race of Dunlin (*C. a. pacifica*) and the Western Snowy Plover. Another species for which focused research is necessary is the Marbled Godwit. The vast majority of Marbled Godwits nest in the grassland prairies of northern US and southern Canada. An isolated population of Marbled Godwits nests in Alaska at the base of the Aleutian chain (Gibson and Kessel 1989). This godwit population's wintering areas lie somewhere along the US Pacific coast. More information is needed on the population size and the winter distribution of these godwits to ensure their long-term protection.

Research recommendations:

- Identify the California coastal wintering areas of Marbled Godwits from the isolated breeding population in Alaska.

B. Management and Restoration Research

To increase the value of habitat restoration and enhancement projects in coastal and interior habitats, it is desirable to identify the characteristics of wetlands and the management techniques that result in the largest concentrations of migrating, wintering, and breeding shorebirds. Controlling vegetation, establishing suitable water depths, and timing water drawdowns to coincide with shorebirds' energetic needs during migration are recommended management techniques for attracting shorebirds to inland wetlands (Helmers 1992, Safran et al. 1997). Recent studies by Colwell et al. (2002) indicate that managing water levels for shorebirds in Central Valley wetlands in winter may be even more important than during spring. They underscore the need to learn more about the effects of fluctuating water levels on invertebrate recruitment and depletion by wintering shorebirds. Other researchers also point out the value of flooded agricultural land, particularly rice, for shorebirds in the Central Valley and report on how farming techniques affect use of rice fields by shorebirds and other waterbirds (Day and Colwell 1998, Elphick and Oring 1998). Little is known about the value of other central agricultural land for supporting shorebirds in winter. On the coast, managed habitats, especially salt ponds, provide very important foraging and roosting habitat (Warnock et al. 2002a). Many San Francisco Bay salt ponds will be converted to tidal marsh in the future and research is needed on how to manage this conversion to minimize the impact on existing shorebird populations (Stralberg et al. 2003). Tidal flats are threatened by rising sea levels related to global warming (Galbraith et al. 2002). Atkinson (2003) stresses the need for increased knowledge of how to restore lost tidal flats and other wetland habitats to prevent future declines of shorebird populations. Rogers (2003) emphasizes the need to learn more about shorebird roosting requirements to improve our ability to restore and enhance this essential component of shorebird habitat.

Finally, there is a need to understand and manage the impact of predators, people and introduced vegetation on coastal beaches on breeding populations of Snowy Plovers (USFWS 2001).

Regional research recommendations:

- Determine the best water drawdown techniques in coastal and interior managed wetlands to maximize invertebrate prey production, availability, and utilization by shorebirds.
- Determine how to manage water in retired coastal salt ponds for the maximum abundance and diversity of migrating and wintering shorebirds.
- Determine salinities, water depths, and physical features of retired salt ponds most valuable to migrating, wintering, and breeding shorebirds.
- Identify the key characteristics of high quality breeding habitat for Black-necked Stilts and American Avocets in inland and coastal wetlands.
- Determine the most appropriate water depth and substrate type to maximize shorebird use of soft-bottomed portions of channelized rivers (e.g., Los Angeles River).
- Determine the number, size, characteristics, and distribution of shorebird roosts to minimize disturbance of migrating and wintering shorebirds in coastal wetlands.
- Examine the temporal and spatial dynamics of roost use, including anthropogenic factors such as disturbance and habitat loss.
- Identify coastal uplands, especially pastures, important to foraging and roosting shorebirds and investigate determinants of observed use patterns.
- Evaluate the relative importance of different habitats, i.e. tidal flat, sand flats, muted tidal wetlands, seasonal wetlands, salt marsh, and salt ponds to migrating and wintering shorebirds in coastal wetlands.
- Develop management techniques to restore breeding populations of Snowy Plovers on the coastal strand of the region.

Chapter 7. Education and Outreach

Successful shorebird conservation requires strategic implementation of education and outreach programs to engender acceptance of conservation recommendations. The needs and priorities at the national level are summarized in the US Shorebird Conservation Plan (USSCP; Brown et al. 2001), and outlined in more detail in the technical report of the Education and Outreach Working Group of the USSCP, the National Shorebird Education and Outreach Plan (Johnson-Schultz et al. 2000). The goal for Education and Outreach in the Southern Pacific Region is to provide guidelines, messages, and resources for partners interested in creating or enhancing education programs about shorebird conservation. Key messages, audiences, and strategies for reaching those audiences are presented below. A compilation of resources available concerning shorebird ecology and conservation for each of the audiences identified is available for download from the PRBO Conservation Science web site (www.prbo.org).

Key Messages for Shorebird Education and Outreach Programs

General messages for North America

1) Shorebirds require specific habitats to complete critical phases of their life cycle. Some of these habitats are threatened.

- There are three critical phases in the shorebird life cycle where specific habitat needs must be met: breeding, staging (migratory), and non-breeding (over-wintering).
- A species may require different habitats for each phase.
- Critical habitats upon which shorebirds depend include upland pastures and agricultural areas, coastal shores and wetlands, and interior wetland areas.
- Many of these habitats currently face threats from habitat loss and degradation from agricultural and urban development, and human disturbance.

2) Shorebirds are a fascinating, diverse, and highly migratory group of birds.

- The four main families of shorebirds in North America include oystercatchers, stilts and avocets, plovers, and sandpipers.
- Shorebirds have fascinating life histories that include unique physical and behavioral adaptations for breeding, migrating, and winter survival.

3) Landowners and land managers can manage for shorebirds without compromising other objectives.

Education and outreach messages for the California Coast

- Coastal wetlands play a critical role in the health of human populations:
    - Wetlands improve water quality by filtering contaminants and excess nutrients.
    - Wetlands provide necessary nutrients to the food chain that includes commercial fish populations.
    - Wetlands provide flood control.
- Coastal wetlands, rocky shore, and sandy beaches provide essential habitat for thousands of breeding, migrating, and wintering shorebirds and other waterbirds.
- Coastal beaches, especially south coast beaches, are especially important to threatened Western Snowy Plovers and endangered Least Terns that depend on beach habitat for all phases of their life cycle.

Education and outreach messages for the San Francisco Bay Estuary

- San Francisco Bay Estuary is one of the largest and most important shorebird migration stopover sites south of Alaska.
- San Francisco Bay Estuary holds more wintering and migrating shorebirds than any other coastal wetland on the US Pacific coast; it has been designated as a WHSRN site of Hemispheric Importance (highest possible ranking for a wetland ecosystem).
- Migrating birds rely on the estuary for predictable food and resting areas.
- San Francisco Bay Estuary is one of the northernmost breeding area for American Avocets and Black-necked Stilts along the Pacific Coast.
- Salt marsh channels are important habitat for foraging Willet and Least Sandpiper.
- South San Francisco Bay salt ponds provide critical habitat for:
    - > 70 species of shorebirds and waterfowl;
    - a half-million (single day count) migrating shorebirds seeking supra-tidal (high tide) foraging and roosting habitat;
    - 10% of breeding threatened Western Snowy Plover, and
    - thousands of breeding Black-necked Stilts and the American Avocets.
- Salt pond restoration efforts will be directed towards replacing much of the pond habitat with vegetated marsh; retaining a mix of habitats will be critical to maintain current wildlife values.
- The San Francisco Bay ecosystem is negatively affected by:
    - invasive plants that replace beneficial habitat;
    - introduced non-native predators and human-aided expansion of native predators that prey on breeding and migrating shorebirds, their nests, and chicks; and
    - oil spills, dumping, development, and dredging that can reduce and degrade habitat.

- Almost half (42%) of tidal flat habitat in the San Francisco Bay estuary has been filled for urban or agricultural development.
- To reduce human disturbance of breeding, migrating, and roosting shorebirds in the San Francisco Bay estuary, it will is necessary to:
  - focus outreach and signage on reducing human disturbance of shorebird nesting and roosting sites around the Bay;
  - target outreach efforts to engender support for seasonal restrictions and habitat protection measures for breeding Western Snowy Plovers;
  - promote volunteerism at local parks, wetland, and refuge visitor centers;
  - educate the public against keeping open compost or trash bins, which support predators of shorebirds and young, including jays, crows, ravens, cats, coyotes, and foxes; and
  - educate the public to take unwanted cats, dogs, or other pets to the local SPCA and to never abandon them on roadsides, in local parks, or in wild lands.

Education and outreach messages for the Central Valley

- Shorebirds are not found only at the shore!
- More than 160 km inland, the Central Valley is one of the most important places in the west for migrating, wintering, and nesting shorebirds.
- The Central Valley is the second most important inland site for shorebirds on fall migration (after Great Salt Lake, UT).
- The Central Valley supports more shorebirds in winter and spring than any other inland site in Western North America (approx. 300,000 birds).
- Seven species of shorebirds breed in the Central Valley: Black-necked Stilt, American Avocet, Killdeer, Snowy Plover, Spotted Sandpiper, Wilson's Snipe, and Wilson's Phalarope.
- Though over 90% of the Valley's natural wetlands are gone, managed wetlands, agricultural fields, and evaporation ponds currently provide feeding and nesting habitat for over 20 species of shorebirds.
- Agriculture and shorebird habitat can be compatible.
- The most important shorebird habitats in the Valley today are all highly managed: restored wetlands, flooded agricultural lands, saline evaporation ponds, refuges, and sewage ponds.
- High concentrations of toxins, pesticides used on agricultural fields and buildup of naturally occurring elements, have caused mortality of shorebirds.
- The expansion of urban and suburban areas is a major threat to shorebird habitats in the Central Valley.

Key Audiences and Associated Strategies for Outreach

The four key user groups to be targeted through shorebird education and outreach programs are:

A. Stakeholders (farmers, fisherman, hunters, off highway vehicle users,)
B. Community members (families, outdoor recreation enthusiasts)
C. Educators (school teachers, students, and educators)
D. Land managers

Stakeholders - Major stakeholders are private landowners, outdoor enthusiasts like hunters and fishermen. All have a stake in the future of California's land management. These interest groups also have a high potential to influence the direction of change to management practices. To effectively communicate with stakeholders, conservation advocates and educators need to find common ground to build a relationship of trust. Conservation programs on private lands work best when there is a direct relationship between owners and biologists. Effective programs and activities that target stakeholders include:

- Restoration programs that provide incentives to landowners for restoration and conservation;
- Government funded agricultural/wildlife conservation programs for farmers (http://www.nrcs.usda.gov/programs/farmbill/2002/products.html);
- Reaching private landowners through flyers, brochures, posters, and talks to local growers clubs, county fairs, farmers associations, and NRCS Resource Conservation Districts;
- Tours that bring stakeholders into the field to observe the wildlife that depend on and co-exist with properly-managed habitats; and
- Articles about shorebirds in stakeholder newsletters that communicate the need for proper habitat management.

Community members - Community members include birders, outdoor recreation groups, beach-goers, and other members of the general public. Access to recreation areas is of key interest. This group has the potential to bring economic benefit to California as a result of their recreational activities. In addition, these community members participate in conservation by creating favorable public sentiment for legislation to protect and enhance shorebird habitat. Effective outreach measures to address the community in general include informational flyers, birding trips, presentations within the community, outreach at local environmental fairs, articles in newspapers and newsletters, and educational materials distribution through websites. Strategies for public education on the California Coast include:

- Encourage beach and dune restoration projects to recover critical habitat for shorebirds. Hands-on conservation is an excellent way to involve the public.
- Educate about the effects of human actions on breeding, migrating and roosting shorebirds in coastal California by posting signs and developing literature that encourage:
  - respect for restrictions to off-road vehicle use in important bird habitat;
  - walking on wet sand to avoid disturbing Snowy Plovers, and walking around, rather than through, shorebird flocks;
  - obeying leash laws;
  - leaving driftwood flat on the beach to avoid creating perches for birds that prey on shorebirds;
  - packing trash out and do not feed scavenging birds like gulls and ravens; and
  - taking unwanted cats, dogs, or other pets to local SPCA, never abandoning them on roadsides, or in local parks and wild lands, and keep cats indoors because cats kill birds.
- Promote the national shorebird education program Shorebird Sister Schools Program (USFWS), an excellent way to involve educators and youth in shorebird conservation in the classroom and in the field.

Educators - Delivering the conservation messages to teachers, naturalists, bird tour leaders, and docents, can accomplish broad-scale outreach quickly and economically. Outreach to educators can be accomplished by:

- Partnering with existing programs offering science programs for teachers (e.g., Environmental Education Exploratorium, STRAW);
- Partnering with existing networks that offer professional development opportunities for classroom teachers;
- Providing classroom materials such as posters, bird identification guides, and conservation curricula that align with state standards in science, math, and language arts where possible; and
- Offering training for environmental educators, staff and volunteers at visitor centers, and providing outreach materials for distribution (informational flyers, posters, signs).

Land managers - Land managers are user groups that require more technical information to make informed decisions about changing land management practices to benefit shorebirds. In addition, land managers are often charged with managing their preserve or refuge for a variety of resources and are often understaffed for the amount of work they are expected to accomplish. As a result, connecting land managers with shorebirds becomes extremely important. This can be accomplished by:

- Tours which bring land managers into the field with biologists to share knowledge and ideas, and combine technological expertise; and
- Clear and concise messages that advise managers on conservation practices, presented through presentations, booklets, brochures, and workshops.

Black-necked Stilt

Chapter 8. Implementation and Coordination

Conservation of shorebirds in the Southern Pacific Region will of necessity involve a host of public and private agencies, conservation organizations, and individuals to ensure its success. It will be particularly important to continue to coordinate with already established collaborative efforts such as Joint Ventures of the North American Waterfowl Conservation Plan,

The wetlands of the coastline north of Marin County are included in the Pacific Coast Joint Venture of the North American Waterfowl Plan. Given the collaboration of many agencies in the Pacific Coast Joint Venture, it is the best entity to coordinate the shorebird management issues there. The many agencies involved in the Joint Venture or that otherwise manage coastal habitats are listed in Appendix C.

From 1995 to 1999 scientists and resources managers familiar with the San Francisco Bay ecosystem worked together on the San Francisco Bay Area Wetland Ecosystem Goals Project to produce a blueprint for the kinds, amounts, and distribution of wetland habitats needed in the estuary to sustain diverse and healthy wildlife communities. The results of this planning effort are outlined in the Bay Ecosystem Habitat Goals Report (Goals Project 1999) and the project's habitat recommendations were synthesized, modified as necessary, and incorporated into the San Francisco Bay Joint Venture's Implementation Strategy (Steere and Shaefer 2001). The purpose of the Implementation Strategy is to guide the efforts of the partnership involved in habitat acquisition, restoration, and enhancement in the estuary. San Francisco Bay Joint Venture partners and additional agencies and groups responsible for habitat in the estuary are listed in Appendix D (for full list see www.sfbayjv.org). It would be appropriate for the San Francisco Bay Joint Venture to take the lead role in implementing the shorebird conservation plan in San Francisco Bay.

Currently, there is no Joint Venture along the coast of California south of San Francisco Bay. It will be essential to be involved in any emerging Joint Venture for that area. In southern California, there is a successful wetland partnership called the Southern California Wetlands Recovery Project. Efforts should be made to integrate shorebird conservation needs outlined in this plan into planning and decision-making of this partnership. A partial list of the many organizations and agencies with regulatory or management responsibilities in the California coastal zone that might participate in the shorebird conservation plan are listed in Appendix E.

It will be essential to continue to work closely with the Central Valley Habitat Joint Venture, and natural resource programs like USFWS Partners for Fish and Wildlife & Habitat Conservation and the USDA NRCS Wetlands Reserve Program. Various wetland restoration, easement, incentive, and technical assistance programs offered by federal, state, and private agencies, including the two mentioned above, are the best means to coordinate water drawdowns and implement integrated management practices on private lands (Isola 1998). In addition, coordination already exists at the local level at some wetlands complexes such at the Grasslands Ecological Area in the San Joaquin Valley. There, shorebird concerns can be brought to their Habitat Coordination Committee, which has representatives from US Fish and Wildlife Service, California Department of Fish and Game, Grasslands Water District, Grasslands Resource Conservation District, and private landowners.

A Central Valley Shorebird Working Group formed in August 2002 and is recognized as a subcommittee of the Central Valley Habitat Joint Venture's Technical Committee. The primary roles of the group include: 1) setting habitat and population objectives for shorebirds in the Central Valley, 2) assimilating the best available information on management needs and practices, and 3) implementing goals as stated in the Southern Pacific Shorebird Conservation Plan for the Central Valley. This group should continue to provide technical guidance on shorebird conservation issues in the Valley and remain active in planning, implementation, and evaluation of the goals stated herein.

In California, as in all other states of the US, a Comprehensive Wildlife Conservation Plan is being developed. The Comprehensive Plan will serve to guide California's investments in habitat conservation and thus shorebird conservation needs identified in this regional plan should be integrated into the state's planning and implementation efforts.

For the entire region and for North America, in addition to coordinating with JVs of the North American Waterfowl Management Plan, it will be essential to integrate shorebird conservation efforts with those of other bird conservation initiatives, such as Partners in Flight, Waterbirds of the Americas, and ultimately the North American Bird Conservation Initiative. The combined goals and objectives of these initiatives should lay a blueprint for the conservation of all birds in North America.

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American Avocet

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Appendix A. List of common and scientific names of shorebird species cited in the text

Black-bellied Plover	*(Pluvialis squatarola)*
American Golden-Plover	*(Pluvialis dominica)*
Pacific Golden-Plover	*(Pluvialis fulva)*
Snowy Plover	*(Charadrius alexandrinus)*
Semipalmated Plover	*(Charadrius semipalmatus)*
Killdeer	*(Charadrius vociferus)*
Mountain Plover	*(Charadrius montanus)*
Black Oystercatcher	*(Haematopus bachmani)*
Black-necked Stilt	*(Himantopus mexicanus)*
American Avocet	*(Recurvirostra americana)*
Greater Yellowlegs	*(Tringa melanoleuca)*
Lesser Yellowlegs	*(Tringa flavipes)*
Solitary Sandpiper	*(Tringa solitaria)*
Willet	*(Catoptrophorus semipalmatus)*
Wandering Tattler	*(Heteroscelus incanus)*
Spotted Sandpiper	*(Actitis macularia)*
Whimbrel	*(Numenius phaeopus)*
Long-billed Curlew	*(Numenius americanus)*
Marbled Godwit	*(Limosa fedoa)*
Ruddy Turnstone	*(Arenaria interpres)*
Black Turnstone	*(Arenaria melanocephala)*
Surfbird	*(Aphriza virgata)*
Red Knot	*(Calidris canutus)*
Sanderling	*(Calidris alba)*
Semipalmated Sandpiper	*(Calidris pusilla)*
Western Sandpiper	*(Calidris mauri)*
Least Sandpiper	*(Calidris minutilla)*
Baird's Sandpiper	*(Calidris bairdii)*
Pectoral Sandpiper	*(Calidris melanotos)*
Rock Sandpiper	*(Calidris ptilocnemis)*
Dunlin	*(Calidris alpina)*
Short-billed Dowitcher	*(Limnodromus griseus)*
Long-billed Dowitcher	*(Limnodromus scolopaceus)*
Wilson's Snipe	*(Gallinago delicata)*
Wilson's Phalarope	*(Phalaropus tricolor)*
Red-necked Phalarope	*(Phalaropus lobatus)*

Red Phalarope *(Phalaropus fulicarius)*

Appendix B. Wetlands of importance on the California coast. Wetland sites, organized by county from north to south, known to hold at least hundreds of shorebirds included here. San Francisco County and other counties surrounding the San Francisco Bay Estuary are treated extensively in the main text and are not treated here. Data on shorebird use from PRBO Conservation Science's Pacific Flyway Project unless otherwise indicated. This appendix is in development and will be updated regularly.

Western Sandpipers

1) DEL NORTE COUNTY

A) SMITH RIVER MOUTH

Wetland habitat description:

Smith River, one of the last free-flowing rivers in California, empties into an estuary that forms part of a larger complex that includes Lake Talawa and Lake Earl. A narrow spit separates the estuary from the outer beaches. Agriculture, pastureland, coniferous forest and low-density housing surround the estuary.

Max population, all shorebirds combined:

4,000 shorebirds in fall.

General use by species and season:

Shorebirds use wet pastureland, especially Long-billed Curlew (Cooper 2001).

Current ownership:

Private ownership; California State Parks.

Current management:

California State Parks.

Conservation needs and issues:

- Livestock, gravel mining, and agricultural chemicals affect water quality.
- Dikes, ditches, and levees reduce the historical extent of wetlands.
- Habitat management is needed to restore snowy plover breeding populations .
- Lack of local enforcement results in heavy disturbance levels from humans and off-leash dogs.

Priority conservation actions for this wetland:

- In 2000, the Estuary Enhancement Program was initiated to address restoration issues in the Smith River Estuary.

B) LAKE TALAWA

Wetland habitat description:

Lake Talawa, an extension of the Smith River floodplain, is a brackish lagoon separated from the ocean by a barrier bar (Funderburk and Springer 1989). It adjoins Lake Earl, and the two together form an estuary of about 4,047 ha, bound by freshwater marsh and mixed conifer forests. State lands (Lake Earl State Park and Lake Earl Wildlife Area. Headlands are in private ownership, feature pastureland. Exchanges of water occur

between the estuary and the Smith River during periods of high rainfall. The barrier bar is occasionally breached by heavy surf or rainfall, or by mechanical methods in order to benefit fish spawning.

Max population, all shorebirds combined:
13,000 shorebirds.

General use by species and season:
The sandy beach separating Lake Talawa from the ocean supports wintering Snowy Plovers, but birds no longer use the beach for nesting.

Current ownership:
Lake Earl Wildlife Area – Department of Fish and Game, State Parks (Talawa Dunes) Redwood National and State Park.

Current management:
CA Department of Fish and Game, Talawa Dunes State Park.

Conservation needs and issues:
- An increase in off-highway vehicle riders disturb shorebirds, especially snowy plovers.
- Feral cats are supported by feeding stations (Cooper 2001)
- Understaffed camping areas.
- California Department of Fish and Game proposes breaching the sandbar when the lake rises eight feet, but proponents of a proposed community near the lake argue in favor of breaching when the lake rises four feet.

Priority conservation actions for this wetland:

2) HUMBOLDT COUNTY

A) HUMBOLDT BAY

Wetland Description:
Northern Humboldt Bay consists of marshes and mudflats with extensive eelgrass beds, wet pastures and the estuary of the Mad River, which is separated from the ocean by extensive sandy dunes. Arcata Marsh contains restored freshwater marsh habitat. Seven shellfish reserves are set aside for public clamming and oyster gathering. East Bay marshlands were diked for railroad and highway construction. Humboldt Bay National

Wildlife Refuge manages the southern Bay. A large marsh borders the southern bay; a vast system of tidal channels winds through wet pastures.

Max population, all shorebirds combined:
Depending on season 20,000 to 80,000 shorebirds reside in Humboldt Bay (Colwell 1994). The Western Hemisphere Shorebird Reserve Network (WHSRN) recognizes this large estuary as a site of International Importance for shorebirds.

General use by species and season:
Tidal wetlands, especially the broad mudflats, support Dunlin, Long-billed Dowitchers, Whimbrel (Cooper 2001).

Current ownership:

Current management:

Conservation needs and issues:
- The Bay's tributaries carry high sediment loads from industrial timberlands and grazing in the watershed.
- Introduced invertebrates may be replacing native species in the benthos.
- Loss of tidal habitat from diking or filling.
- Oyster and shellfish farming.
- Disturbance from human recreation: wind surfers, dogs chasing birds on tidal flats.
- Many toxic pollutants from industrial facilities, storm drains, and ships, and other contaminants in the form of non-point pollution sources from neighboring cities (M. Colwell pers. comm.).

Priority conservation actions for this wetland:
- Prohibit further alteration of tidal flats for oyster culture.
- Eliminate the introduced salt-water cord grass (*Spartina alterniflora*) from the tidal flats at Humboldt Bay.
- Protect seasonal wetlands and pastures important to shorebirds from development.

3) SONOMA COUNTY

A) BODEGA HARBOR

Wetland habitat description:

A long sandy spit separates the 344-ha estuary of Bodega Harbor from Bodega Bay. On the north side of the harbor, two marinas house a commercial fishing fleet. Access to the Spud Point Marina is by a deepwater channel that undergoes periodic dredging; dredge spoils have been stored in diked ponds on the east harbor. Salt marshes border the northwest and southeast harbor, and expansive mudflats extend to the channel on low tides. Substantial clam and bait harvesting occurs on the flats. A marine reserve protects mudflats on the northwest end of the harbor from exploitation and is a source for larval recruits to the rest of the harbor.

Max population, all shorebirds combined:

Mid-winter numbers vary from 2,000 to 12,000 shorebirds in winter.

General use by species and season:

Large shorebirds are especially attracted to Bodega Harbor, and consistently high numbers of godwits, Willits, and dowitchers feed and roost within the harbor. Smaller shorebirds such as Dunlin and Sanderling feed in the harbor at low tide, and fly to beaches or northern Tomales Bay at high tide to take advantage of additional feeding opportunities.

Current ownership:

Sonoma County.

Conservation needs and issues:

- Introduced invertebrates replace native species.
- Historic loss of tidal and salt marsh habitat has occurred, due to diking for water treatment facilities, dredge-spoil ponds, private and commercial buildings, and the marinas.
- Dredge spoil ponds are full; placement for newly dredged sediments needs to be determined.
- Disturbance level of human recreation is high: wind surfers disturb roosting flocks, intensive clam harvesting is on the increase bringing hundreds of people and their dogs, to the mudflats at low tide.
- Invasion by non-native cordgrass is potentially problematic and searches for the plant are conducted regularly.

Priority conservation actions for this wetland:

- Periodic dredging of the channel as likely prevented obvious buildup of sediments that has occurred in other estuaries and should be continued.
- The Marine Sanctuary Reserve should be maintained to provide recruits to the exploited habitat.
- Restrictions on clam and bait fishing should be considered.

4) MARIN COUNTY

A) ESTERO AMERICANO

Wetland habitat description:

Estero Americano consists of approximately 162 ha of wetlands. A sand bar forms at the mouth of the estero, removing the wetlands from tidal action. Heavy grazing by sheep on the surrounding hills has lead to erosion of sediments into the estuary. A restoration and management plan has been implemented for a 35-ha Preserve established at the mouth of the Estero.

Max population, all shorebirds combined:

When open to daily tidal influence, has 1,000 to 3,000 shorebirds in fall and winter.

General use by species and season:

A small area of mudflats attracts migrating shorebirds.

Current ownership:

Current management:

Sonoma County Agricultural Preservation and Open Space District, the California Coastal Conservancy.

Conservation needs and issues:

- Introduced invertebrates.
- Historic loss of tidal habitat from diking or filling, impaired tidal circulation, and accelerated sedimentation of tidal habitat from historic or ongoing logging or grazing in the watershed.

Priority conservation actions for this wetland:

- Maintain continuous tidal exchange by breaching the barrier bar after closures.

B) TOMALES BAY

Wetland habitat description:
3,504-ha coastal embayment.

Max population, all shorebirds combined:
The Bay holds 5,000 to 10,000 shorebirds in spring and fall and up to 20,000 in winter, thereby qualifying it as a potential WHSRN site of Regional Importance.

General use by species and season:

Current ownership:
The primary owner and manager of tidal flats in the bay are the State Lands Commission (owner) and State Fish and Game (manager). Other inter-tidal areas are owned and managed by Audubon Canyon Ranch, Point Reyes national Seashore, GGNRA, Calif State Parks, and numerous private landowners.

Current management:
See above.

Conservation needs and issues:
- Introduced invertebrates.
- Historic loss of tidal habitat from diking or filling, accelerated sedimentation of tidal habitat from historic or ongoing logging or grazing in the watershed, and impaired tidal circulation.
- Oyster farming.
- Disturbance from human recreation: intensive clam harvesting, kayakers.

Priority conservation actions for this wetland:
- Annual surveys for all species of non-native cord grass. Currently, only native cord grass is known to be present, but some *Spartina densiflora* individuals have been found and removed, and continued surveys will require follow-up removal and monitoring. Audubon Canyon Ranch, the *Spartina* Project, Point Reyes National Seashore, and others currently conduct surveys and monitor.
- Close proximity of Tomales Bay to SF Bay and its large percentage of non-native species, a priority action will be to inventory benthic invertebrates to assess the potential presence of invasive species.
- Prohibit further alteration of tidal flats for oyster culture.

- Breach levees to restore mud flat and tidal marsh in diked pastures at Giacomini Ranch, Tomales Bay. An estimated 36.4 ha of tidal flat could be restored through this action (Philip Williams and Associates et al. 1993).
- Increase tidal circulation in the leveed marsh at Tomasini Point, Tomales Bay; examine the potential benefit of a similar action for leveed marsh at Bivalve Point.
- Develop a management plan for the large sandbars north of Tom's Point, to limit the effect of claming and other recreational activities on foraging shorebirds.
- Protect grazed lowlands adjacent to Tomales Bay from development.
- Limit recreational use and restore seasonal wetlands with known high shorebird use, e.g., pastures at Lawson's Landing.

c) Abbotts Lagoon

Wetland habitat description:

85.8-ha wetland consists of three fresh-to-brackish ponds separated from the ocean by a barrier bar. Surrounding habitat includes coastal dunes, coastal scrub, and an active dairy ranch. Ongoing dune restoration involves removal of *Ammophila* (introduced beach grass) to restore native plant species and increase Snowy Plover breeding habitat.

Max population, all shorebirds combined:

During low tide shorebird numbers are usually in the hundreds but at high tide they may exceed 1,000 from movement of birds from nearby Drakes Estero. Western Snowy Plovers nest at this site.

General use by species and season:

Current ownership:

National Park Service.

Current management:

Point Reyes National Seashore.

Conservation needs and issues:

- Water quality may be affected by runoff from dairy.
- A high population of ravens and crows due to access to grains fed to dairy cows are negatively affecting egg and chick survival of Western Snowy Plovers.

Priority conservation actions for this wetland:

- Continue dune and beach restoration to improve Western Snowy Plover nesting sites.

D) DRAKES AND LIMANTOUR ESTEROS

Wetland habitat description:

These two esteros are best considered as a single wetland system because of their common entrance to the ocean and the regular interchange of shorebirds between them. The 735-ha Drakes Estero is managed partly for mariculture and the 194.6-ha Limantour Estero is an Ecological Reserve. Coastal scrub habitat surrounds the estuary; grazing by dairy cows occurs within the watershed. The Drakes and Limantour Estero system is designated a WHSRN site of Regional Importance.

Max population, all shorebirds combined:

Each regularly holds thousands of shorebirds with combined totals sometimes reaching nearly 20,000 individuals in winter.

General use by species and season:

Current ownership:

National Park Service.

Current management:

Point Reyes National Seashore.

Conservation needs and issues:

- Introduced invertebrates are possible due to proximity to San Francisco Bay.
- Historic loss of tidal habitat from diking or filling.
- Water quality issues generating from the septic system of oyster farms.
- Impaired tidal circulation, and possibly accelerated sedimentation in Drake's Estero from oyster farming.
- Disturbance to shorebird flocks by kayakers.

Priority conservation actions for this wetland:

- Prohibit further alteration of tidal flats for oyster culture.
- Increase tidal flat and tidal circulation by removing levees at the Glenbrook and Muddy Hollow ponds at Limantour Estero.
- Restrict kayaking during periods of peak shorebird occurrence at Drakes and Limantour Esteros.
- Restrict low-flying Ultra-lights over shorebird flocks on Drakes Estero.
- Disturbance studies needed on kayaking groups.

E) BOLINAS LAGOON

Wetland habitat description:

445-ha, very shallow estuary.

Max population, all shorebirds combined:

Regularly holds 5,000 to 10,000 shorebirds; during spring migration, numbers have been known to swell to 35,000 (Shuford et al. 1989). Bolinas Lagoon is recognized as a Ramsar site of International Importance to waterbirds and also would qualify as a WHSRN site of Regional Importance.

General use by species and season:

Current ownership:

Current management:

Conservation needs and issues:

- Proximity to San Francisco Bay increases risk of settlement by introduced invertebrates like the voracious Green Crab, which flourishes in the inner lagoon.
- Accumulation of sediment from erosion of beach cliffs near the mouth of the lagoon, from historic and ongoing logging, grazing, or agriculture practices in the watershed, or both.
- Impaired tidal circulation results from, and exacerbates, sediment accumulation.
- Disturbance from human recreation, mainly kayakers.
- Canada Geese are increasing in numbers and are displacing native species from foraging and roosting areas.

Priority conservation actions for this wetland:

- Support U.S. Army Corps of Engineers studies to improve the tidal circulation and increase the tidal prism at Bolinas Lagoon.
- Study effects of kayakers on foraging and roosting shorebird flocks.
- Study effects of Canada Geese on shorebird feeding and roosting behaviors.

5) SANTA CRUZ COUNTY

A) PAJARO RIVER MOUTH

Wetland habitat description:

The 142-km long Pajaro River empties into Monterey Bay at the town of Watsonville. Agricultural fields border much of the river's length, as well as the inland side of the small estuary that forms at the river's mouth. The river mouth migrates seasonally between a seawall retaining a residential complex to the north, and the sandy beaches of Zmudowski State Beach to the south. Watsonville Slough extends from the Pajaro River Mouth north along the residential complex. The river mouth is continually open to tidal action, either by natural tidal influence or by mechanical means, to prevent nearby agricultural fields from flooding.

Max population, all shorebirds combined:

1,800 shorebirds.

General use by species and season:

Snowy Plovers nest from within 0.1 km of the seawall to Zmudowski beach. Small numbers of the American Avocet and Black-necked Stilt nest along Watsonville Slough. The beach and mud flats around the river mouth provide roosting and foraging for large numbers of pelicans, terns, and many species of migrating and wintering shorebirds, including Willet, Marbled Godwit, Black-bellied Plover, Sanderling, and Western and Least Sandpipers.

Current ownership:

The beach between the seawall and the river mouth is currently in transition to state ownership.

Current management:

The California Department of Parks and Recreation (CDPR)

Conservation needs and issues:

- Dog and human disturbance of nesting Snowy Plovers and other shorebirds feeding or roosting on the beach.
- Colonization of the beach by introduced beach grass *(*CDPR has also commenced an *Ammophila* eradication program to increase Snowy Plover nesting habitat (G. Page pers. obs.).
- Predation of Snowy Plover eggs and chicks by feral red fox, Loggerhead Shrikes, and corvids.

- Poor water quality from agricultural run-off (Organic farming in fields that border the river is becoming established, which should have a positive impact on water quality.).

Priority conservation actions for this wetland:

- The California Department of Parks and Recreation (CDPR) manages the beach for nesting Snowy Plovers by closing areas and erecting exclosures to protect nests from egg predators, dogs, and humans.

6) MONTEREY COUNTY

A) ELKHORN SLOUGH

Wetland habitat description:

Approximately 1,619-ha Elkhorn Slough and associated wetlands.

Max population, all shorebirds combined:

General use by species and season:

See Ramer et al. (1991) for full information on seasonal abundance, habitat use, and diet of shorebirds in Elkhorn Slough. Tidal mudflat is the primary feeding area for most shorebirds. Marbled Godwit, Willet, Long-billed Curlew and Least Sandpiper use the extensive *Salicornia* marsh for foraging and roosting, particularly at high tide. Tidally restricted mudflat occurs in North Marsh and Moro Cojo Slough. Culverts restrict tidal flow into Moro Cojo Slough, creating an area where water fluctuations are governed by rainfall and evaporation. The slough is used as a high tide foraging and roosting area by many shorebirds. Black-necked Stilt, American Avocet, and Killdeer forage on all tides in the slough; these species also breed on the slough's edge. At the upper end of Elkhorn Slough, Black-necked Stilts also nest in the diked Porter Marsh, which is cut off from tidal influence; tide gates prevent water from entering but not exiting into the main channel of Elkhorn Slough. North and Strawberry marshes are managed for flood and mosquito control but provide important foraging habitat for the American Avocet, Black-necked Stilt, and dowitchers. Strawberry Marsh also provides foraging habitat for the Red-necked Phalarope in fall. Salt ponds support nesting Snowy Plovers, Black-necked Stilts, and American Avocets during summer and many other shorebirds at other seasons. Sand beach at the Elkhorn Slough mouth serves as foraging and roosting habitat for several shorebird species and nesting habitat for the Snowy Plover.

Current ownership:
CDFG, The Nature Conservancy, and private parties own Elkhorn Slough. It is a NOAA National Estuary Research Reserve (S. Connors pers. comm.).

Current management:
Former salt ponds are now managed by CDFG as the Moss Landing Wildlife Area.

Conservation needs and issues:
- Excessive erosion of the salt marsh along the main channel from the construction of Moss Landing Harbor in 1947, which changed the slough from a depositional to an erosional environment.
- Non-native invertebrates in the benthos.
- Predation of Snowy Plover eggs by feral red fox and expanding raven populations.
- Other avian predation of Snowy Plover chicks.
- Agricultural run-off contaminating water and sediments with pesticides.
- Degraded salt marsh at Moro Cojo Slough from cattle grazing.
- Water level manipulation for mosquito control.

Priority conservation actions for this wetland:
- Acquire, and enhance for migrating and wintering shorebirds, privately owned wetland parcels at Moro Cojo Slough and Porter Marsh, Elkhorn Slough.
- Provide incentives for landowners to reduce run-off (sediment and agricultural chemicals) from farmland into Elkhorn Slough.
- Improve tidal circulation to increase mudflat exposure in Kirby Marsh, Elkhorn Slough.
- Enforce boat speed limits to reduce bank erosion along the main channel of Elkhorn Slough.
- Increase predator control to improve nesting success of the Snowy Plover, Black-necked Stilt, and American Avocet at Moss Landing Wildlife Area and Porter Marsh, Elkhorn Slough.
- Repair water control structures to better manage water levels for nesting and wintering shorebirds at Moss Landing Wildlife Area, Elkhorn Slough.
- Remove cattle to eliminate degradation of salt marsh at Moro Cojo Slough, Elkhorn Slough.

B) SALINAS RIVER MOUTH

Wetland habitat description:
The Salinas River meanders through agricultural fields and emerges from among the dunes at Monterey Bay. During dry months, the river is separated from the ocean by a

low sand bar. A long sandy beach extends to the north and south of the river. Salinas River National Wildlife Refuge and Salinas State Beach border the Salinas River Mouth.

Max population, all shorebirds combined:
1,000 shorebirds in fall and spring.

General use by species and season:
When the river mouth closes during the summer, Snowy Plover, Black-necked Stilt, and American Avocet nest on islands within 0.4 km of the river mouth. Avocets and stilts also nest in pond and marsh areas adjacent to the river on the wildlife refuge; Snowy Plover and Killdeer nest on the beach.

Current ownership:

Current management:

Conservation needs and issues:
- Water quality of the river should be monitored because of agricultural run-off from extensive farmlands upstream.
- Human disturbance and shorebird egg and chick loss to predators are management issues at Salinas River mouth (G. Page pers. obs.).
- Much beach in the area is closed to the public. Nest exclosures also are used to protect Snowy Plover eggs from being trampled by people or taken by feral red fox, skunks, and gulls.

Priority conservation actions for this wetland:

7) SAN LUIS OBISPO COUNTY

A) MORRO BAY

Wetland habitat description:
The 930-ha estuary of Morro Bay is designated a National and State Estuary and is a Globally Important Bird Area. Six kilometers long, the estuary is separated from the Pacific Ocean by a long sandy spit with a narrow opening. The estuary is managed for oyster harvesting, fishing, and hunting, and contains a marina. Mudflats, salt marsh, and patches of fresh water marsh exist in the eastern and southern reaches of the estuary. The town of Morro Bay borders the north end of the estuary.

Max population, all shorebirds combined:
20,000 shorebirds in winter (qualifies as a potential WHSRN site of Regional Importance).

General use by species and season:
Morro Bay supports tens of thousands of migrating and wintering shorebirds, including the Black-bellied Plover, Willet, Long-billed Curlew, Marbled Godwit, Sanderling, Western Sandpiper, and Least Sandpiper (PRBO unpubl. data). The Morro Bay sand spit is an important Snowy Plover nesting area.

Current ownership:
Multiple owners (see management).

Current management:
Agencies responsible for Morro Bay oversight include the National Guard, CDPR, CDFG, California Department of Corrections, State Department of Health Services, California Coastal Commission, State Water Resources Control Board, Central Coast Regional Water Quality Control Board, Coastal San Luis Obispo Resource Conservation District, State Coastal Conservancy, California Conservation Corps, California Polytechnic State University, San Luis Obispo, University of California Extension, County of San Luis Obispo, City of Morro Bay, Los Osos Community Services District, U. S. Army Corps of Engineers, USFWS, and US National Marine Fisheries Service.

The 1989 Morro Bay Watershed Enhancement Plan focuses on preventing and controlling soil erosion. Many agencies are now cooperatively producing a Comprehensive Conservation and Management Plan (CCMP) for Morro Bay and its watershed. Management for shorebirds is expected to be compatible with other management goals (K. Kropp pers. comm.).

Conservation needs and issues:
- Accelerated rates of sedimentation from human alteration of the watershed occur at Morro Bay. The Coastal San Luis Obispo Resource Conservation District is addressing this problem through its management plan.
- The District acquires watershed parcels to reestablish natural flood plains and create sediment deposition areas above Morro Bay.
- Invasion of non-native plants and invertebrates; the spit is covered with the non-native European beachgrass, which degrades it as a nesting area for the Snowy Plover.

Priority conservation actions for this wetland:

- Support the Coastal San Luis Obispo Resource Conservation District's efforts to reduce watershed erosion at Morro Bay.
- Support Morro Bay's Comprehensive Conservation and Management Plan (CCMP) to address problems impacting the Morro Bay National Estuary.

B) SANTA MARIA RIVER MOUTH

Wetland habitat description:

A narrow spit separates the estuary at the Santa Maria River mouth from the ocean. The estuary is closed to tidal action during most of the year. Bordering the estuary are oil production fields to the north and a ranching operation to the south. Inland, agricultural fields border the river. The oil production portion of the estuary is currently undergoing restoration.

Max population, all shorebirds combined:

Hundreds of shorebirds.

General use by species and season:

Black-bellied Plover, Snowy Plover, Willet, and Sanderling move between feeding and roosting areas on the sand beach and the estuary. In spring and summer, the dry river flats and adjacent beach are important Snowy Plover nesting areas. Avocets nest on the riverbank.

Current ownership:

The County of Santa Barbara owns the preserve area; Unical operates oil production fields to the north and south, and a private ranching operates to the east.

Current management:

The non-profit Center for Lands Management manages the preserve. An Estuary Enhancement and Management Plan is being developed to restore preserve lands and improve water quality.

Conservation needs and issues:

- A sediment deficit due to an upstream dam negatively affects the estuary system.
- Historically, the estuary experienced oil discharges from oil production fields to the north and south of the estuary (G. Page pers. obs.).
- Poor water quality results from a sewage treatment plant, ground water extraction affecting the natural flow of river, accumulation of toxins from agricultural runoff, cattle grazing in and along the river within the preserve.

Priority conservation actions for this wetland:

- The sewage treatment plant is in the process of developing a plan to upgrade facilities.
- Fencing is being installed to keep cattle out of the lower river and away from avocet nesting habitat.
- Clean-up operations are underway to remove oil field deposits that could potentially contaminate the area.

8) SANTA BARBARA COUNTY

A) DEVEREAUX SLOUGH

Wetland habitat description:

The 28.3-ha Coal Oil Point Natural Reserve supports both coastal and estuarine habitats. Within the reserve, Devereaux Slough feeds a seasonally flooded tidal lagoon. In the dry months, salt flats and hypersaline ponds support breeding Snowy Plovers. West and south of the reserve is open to dunes and sandy beach. A private school, the UCSB Campus, oil tanks, residential development, and a golf course border the reserve to the east and north.

Max shorebird population:

Hundreds of shorebirds.

General use by species and season:

The area is used by hundreds of migrating and wintering shorebirds, and an adjacent beach is an important wintering and potential nesting area for the Snowy Plover.

Current ownership:

The University of California owns the Coal Oil Point Preserve area of Devereaux Slough.

Current management:

The University of California 's Long Range Development Plan management guidelines for the Slough are established in the 'Natural Areas Plan' (1995). A management plan for the Coal Oil Point Natural Reserve was developed in 1997.

Conservation needs and issues:

- Exotic plants reduce available Snowy Plover habitat.

- Introduced and native predators (feral red fox and raccoon) affect chick recruitment of Snowy Plovers.
- Mosquito abatement practices.
- Human access to trails needs to be limited.
- Pet restrictions need to be enforced.
- Nighttime recreation activities should be reduced.
- Parking restrictions should be enforced (K. Lafferty pers. comm.).
- Sedimentation restricts channel flow.

Priority conservation actions for this wetland:

- A management plan is being prepared to reduce disturbance to wintering Snowy Plovers.
- In the fall of 1996, restoration and enhancement of the South Finger. The project includes removing of fill and re-contouring the site, increasing tidal action, controlling erosion, removing exotic plants, and planting with native species.

B) GOLETA SLOUGH

Wetland habitat description:

The 174-ha Goleta Slough wetlands include a 146-ha Ecological Reserve. Goleta Slough is designated as Open Space and Environmentally Sensitive Habitat. Industrial, utility, residential, and agriculture areas, border the reserve, as do open space and park/recreation areas. Within and surrounding the wetlands are public transportation corridors, airport runways, a sanitary treatment plant, and a power generation station. Tidal flooding is limited to the south-central portion of the slough; dikes and berms prevent flooding in the upper reaches. The beach berm is mechanically breached to maintain water quality in the slough.

Max population, all shorebirds combined:

Holds over a hundred shorebirds.

Current ownership:

City of Santa Barbara (Municipal Airport site), California Department of Fish and Game, UC Santa Barbara, Goleta Sanitary District, Southern California Gas Co., private owners.

Current management:

City of Santa Barbara (Municipal Airport site), California Department of Fish and Game, UC Santa Barbara. The mitigation plan (1996) for the 'safety area grading project' at the airport proposes to create transitional middle and high marsh habitats along the

northern margin of the slough, remove selected berms, and establish native plants. In 1996 a draft plan for management of the Goleta Slough Ecosystem established overall priorities for the various enhancement proposals, and the Santa Barbara County Flood Control District has established a 'Best Practices' management plan for the watershed to maintain the sediment basins on the major tributaries of the marsh.

Conservation needs and issues:

- The 303(d) List identifies the water as impaired, citing contamination of priority organisms, metal concentrations, siltation, and pathogens. Sedimentation has been reduced in recent years (1980/90's) through the construction of sedimentation basins upstream of the estuary.
- Increased development of sloughs for airport runway expansion.
- Continued sediment deposition is reducing the tidal prism.
- Human and dog disturbance.

Priority conservation actions for this wetland:

9) VENTURA COUNTY

A) MUGU LAGOON

Wetland habitat description:

Mugu Lagoon is a 599-ha estuary within Mugu Naval Air Station weapons testing facility. The lagoon consists of tidal flats, salt pannes, tidal marsh, channels, creeks, and open water, fed by Calleguas Creek. Surrounding the weapons facility are agricultural fields, open space, duck clubs, and Point Mugu State Park.

Max population, all shorebirds combined:

Holds up to 66,000 shorebirds during spring and over 10,000 in fall and winter. Mugu Lagoon is a potential WHSRN site of Regional and possibly International Importance.

General use by species and season:

The lagoon is used by tens of thousands of migrating and wintering shorebirds and modest numbers of nesting Snowy Plovers, Black-necked Stilts, and American Avocets.

Current ownership:

US Navy.

Current management:
US Navy. A fish and wildlife plan has existed since 1963 and was amended in 1976 (Onuf 1987, Harrington and Perry 1995). An Integrated Natural Resource Management Plan has been put together in 2002, which addresses wetland conservation, restoration, and management methods. The Mugu Lagoon Task Force was formed in 1990 to coordinate activities affecting the lagoon and to work towards its protection and enhancement. The task force participated in preparation of a 1995 erosion and sediment control plan for the watershed. In 1996 the Calleguas Creek Watershed Management Plan Committee identified water quality issues, formed technical subcommittees, and developed guidelines for preparing a comprehensive watershed plan.

Conservation needs and issues:
- Mugu Lagoon is impacted by run-off from the large adjacent agricultural area, which enters the lagoon through Calleguas Creek.
- The most serious threat is increased sedimentation from development of the watershed.
- Pollutants – including lead, mercury, silver, and methoxychlor – have been detected at or above hazardous levels in drains to the lagoon.
- The lagoon mouth also closes periodically affecting sedimentation rates.
- Sedimentation, contaminated sediments, modified hydrology caused by land uses in the watershed, and flood control efforts affect habitat quality in the lagoon.
- The lagoon is included in the 1996 list of impaired water bodies - High concentrations of banned pesticides in sediment and biota sediment and tissue toxicity.
- Invasive plants are becoming a significant problem (i.e. *Carpobrotus, Arrundo, Myoporum*).

Priority conservation actions for this wetland:
- The Navy has undertaken 3 wetland restoration projects since 1995, resulting in a total of 9.5 ha of tidal mudflat, sandflat, channels, ponds, salt marsh and sand islands; mitigation plans were developed in 1997 for restoration of a 15-ha site to predominantly salt marsh.
- An invasive exotic plant plan has been written to address this problem. Any loss of wetlands would be compensated by mitigation and the restoration of wetlands on base.
- Several studies focus on reducing flooding and sedimentation have led to installation of sediment control structures, and altered range management practices.

10) LOS ANGELES COUNTY

A) MALIBU LAGOON

Wetland habitat description:

Malibu Lagoon is a 37.2-ha wetland estuary fed by Malibu Creek. During winter storms, the lagoon opens to the Pacific at Malibu Surfrider Beach, a popular recreation area attracting over 1.5 million visitors each year. Residential, commercial, and recreational developments surround the inland areas of the lagoon. California Department of Parks and Recreation excavated three channels to reintroduce tidal flow and create salt marsh and upland habitat. Together, the salt marsh, exposed mudflats and beaches support a wide variety of migrating and wintering shorebirds (L. Hays pers. comm.). Historically, the lagoon and surrounding wetlands were much larger, and undoubtedly held more shorebirds than at present (K. Garrett, pers. comm.).

Max population, all shorebirds combined:

Holds hundreds of shorebirds.

General use by species and season:

In winter when the sand berm is breached, the lagoon is open to tidal action. Several hundred shorebirds roost in the lagoon at high tide and feed during low tide on the tidal flats and channels. Additional high tide foraging occurs on the adjacent sandy beach and rocky intertidal. During late summer and fall migration, the lagoon is separated from the ocean by the spit, and shorebirds forage along the outer lagoon edges. Black-bellied Plovers and other shorebirds forage on the lawns of Pepperdine University, as do Whimbrels in spring (K. Garrett, pers. comm.).

Current ownership:

California Department of Parks and Recreation.

Current management:

California Department of Parks and Recreation, in association with Heal the Bay, California State Coastal Conservancy, the Lagoon Technical Advisory Committee, the Lagoon Restoration Working Group and other city, county and state agencies. A non-profit organization (Heal the Bay) and California Department of Parks and Recreation are developing the *Malibu Lagoon Enhancement Project* under a grant from the California State Coastal Conservancy.

Conservation needs and issues:

- Freshwater input from a variety of human sources fills the lagoon during the summer months. Stagnation occurs due to the lack of tidal action, and water quality decreases (K. Garrett pers. comm.). A water treatment facility that had been a major source of freshwater input is now prohibited from discharging during the dry months; however, there are still sources contributing to water quality problems.
- Direct disturbance of roosting and feeding flocks occurs from off-leash dogs and by humans trespassing into protected areas. This is especially a problem during the warm months, which encompass the fall migration season (K. Garrett, pers. comm.).

Priority conservation actions for this wetland:

- California State Coastal Conservancy funded UCLA study to identify water quality issues in the lagoon. The study recommends the restoration of existing wetland habitat and the creation of treatment wetlands to enhance the water quality of storm water runoff.

B) LOS ANGELES RIVER

Wetland habitat description:

Once part of one of the largest flood plain in the United States, the Los Angeles River is now entirely channelized and operated as a flood control facility by the Los Angeles Department of Water and Power and the US Army Corps of Engineers. Within the intertidal portion of the river, extending inland from the mouth about 4.2 km to the Willow Street crossing in Long Beach, the river is soft-bottomed (no concrete) and supports approximately 95 ha of wetlands, which provide waterfowl and passerine habitat throughout the year. Above this area, extending north approximately 11 km to the 105 Fwy. in the city of Paramount, the concrete river bottom supports a thin sheet of water during the dry season (summer, fall). This area annually holds thousands of shorebirds during migration (L. Hays pers. comm.). Bottom scraped with bulldozers irregularly throughout the year, typically in fall (during shorebird movement).

Max population, all shorebirds combined:

Holds 14,000+ shorebirds per day during the peak of shorebird migration (mid-August to mid-Sept.). Maximum 17,000 in fall (D. Cooper unpubl. data).

General use by species and season:

Black-necked Stilt, Western Sandpiper and Least Sandpiper occur in the thousands of individuals per day through the fall, and American Avocet and Long-billed Dowitcher in the hundreds. Other species using the habitat (22 spp. recorded in weekly surveys 2000-01), in descending order of abundance, include: Killdeer, Semipalmated Plover,

Greater Yellowlegs, Black-bellied Plover, Lesser Yellowlegs and Spotted Sandpiper. Species diversity peaks in late Aug/early Sept., and is lowest in May and June. Large numbers of shorebirds may occur in mid-winter, given low enough flows (e.g., 8224 individuals on 06-07 January 2001). Four species nest (stilt, avocet, Killdeer and Spotted Sandpiper), with 137 nests of Black-necked Stilt on 19 May 2002 (*fide* K. Larson).

Current ownership:
Various owners along its course, but managed by Los Angeles Co. Dept. of Public Works in area of shorebird habitat.

Current management:
Los Angeles Department of Water and Power and the US Army Corps of Engineers.

Conservation needs and issues:
- Develop, with local conservationists, a coherent management plan for the Willow – 105 Fwy. Area of the lower Los Angeles River to lessen the impact of channel scraping and human disturbance on shorebirds, particularly in August and September.

Priority conservation actions for this wetland:
- Allow sediment accretion in the concrete channel of Los Angeles River to increase microhabitat heterogeneity, particularly at the river mouth.

c) San Gabriel River Mouth

Wetland habitat description:
The San Gabriel River Mouth/Los Cerritos /Hellman Ranch wetland complex, located primarily in the City of Long Beach, contains a minimum of 62.7 ha of wetland habitat exclusive of the San Gabriel River channel. The river channel is mostly subtidal and not extensively used by shorebirds. Adjacent to the channel, within the Los Cerritos wetlands, are 7.7 ha of salt marsh, about 7.3 ha of diked wetlands, 3.2 ha of tidal mudflat, and 38.4 ha of subtidal habitat. Although the salt marsh north of Westminster Avenue is open to tidal action, levees isolate the remaining marsh from the tides. The Hellman Ranch wetland, adjacent to the San Gabriel River and about 1.6 kilomteres upstream from the mouth, consists of 1.2 ha of tidal channel, 6 ha of degraded salt marsh, 0.8 ha of seasonal ponds, and 2.8 ha of alkaline flats.

Max population, all shorebirds combined:
Holds hundreds of shorebirds.

General use by species and season:

Current ownership:
The Cerrito and Hellman Ranch wetlands are mostly privately owned (L. Hays pers. comm.).

Current management:
See ownership.

Conservation needs and issues:

Priority conservation actions for this wetland:
- Restore tidal action to at least 24.3 ha of diked and other degraded habitats in the Los Cerritos and Hellman Ranch areas at San Gabriel River.

11) ORANGE COUNTY

A) SEAL BEACH NWR

Wetland habitat description:
The approximately 405-ha Seal Beach National Wildlife Refuge lies within the 508-ha Anaheim Bay wetland complex, which includes 229 ha of salt marsh, 24.3 ha of tidal flat, 46.1 ha of tidal channels and ponds, and 192.2 ha of human-created waterways and open water. Over 809 ha of surrounding agricultural land, mostly in row crops, buffer the wetlands on two sides from dense urban development and provide additional foraging habitat for wintering shorebirds. Anaheim Bay's wetlands have been reduced to about half their former extent during the past 150 years by diking and filling for agriculture and construction of a railway and interstate highway through the marsh, an ammunition depot with connecting harbor, a marine-oriented residential community, and an oil pumping facility.

Max population, all shorebirds combined:
Holds up to 5,500 shorebirds in winter; recognized as a wetland of International Importance by the Ramsar Convention Treaty.

General use by species and season:
Thousands of shorebirds occur here during migration and winter, feeding primarily on tidal flats; some rocky coast species forage on rock jetties. About a dozen Black-necked Stilts breed in the wetlands.

Current ownership:
US Navy's Seal Beach Naval Weapons Station.

Current management:
Seal Beach National Wildlife Refuge.

Conservation needs and issues:
- There is potential for further habitat loss and degradation from development.
- Habitat also has been altered by the introduction of non-native invertebrates into the benthic invertebrate community and probably by chemical contamination of water and sediments from the oil facility and motorboats.
- Feral red fox, feral cats, and stripped skunks *(Mephitis mephitis)* impact the reproductive success of nesting birds.
- Human disturbance and habitat needs of endangered species, such as the Light-footed Clapper Rail and Belding Savannah Sparrow, are wildlife management issues.

Priority conservation actions for this wetland:
- Reduce human disturbance.
- Reduce predation pressure on nesting birds - feral red fox populations have been controlled on the refuge but not in surrounding areas.
- Protection and restoration of adjacent historic coastal wetlands and protection of high tide roosting areas are actions that would benefit shorebirds at the refuge (J. Bradley pers. comm.).
- Expand Seal Beach NWR at Anaheim Bay by 81 ha through acquisition of adjacent wetland habitat; enhance acquired habitat for nesting, migrating, and wintering shorebirds.

B) BOLSA CHICA

Wetland habitat description:
Although recently threatened with development, all 526 ha of the Bolsa Chica wetlands are now in state ownership. A project is underway to remove oil field infrastructure and restore tidal influence to about 283.3 ha, which will create large tidal flats; the largest seasonal ponds and flats will be retained for shorebirds and other species. The existing 133.5-ha Bolsa Chica Ecological Reserve is managed by CDFG. It consists of open water, tidal marsh, sandy islands, and 32.4 ha of tidal flats. The remaining 405 ha contain an operating oil field with extensive areas of seasonal ponds and non-tidal flats.

Max population, all shorebirds combined:
Holds up to 5,400 shorebirds in fall, 7,000 in winter, and 7,700 in spring.

General use by species and season:
Bolsa Chica supports nesting Snowy Plovers, Black-necked Stilts, American Avocets, and thousands of migrating and wintering shorebirds.

Current ownership:
State of California.

Current management:
CDFG.

Conservation needs and issues:
- Remaining habitat is degraded by invasive non-native plants, non-native benthic invertebrates, and restricted tidal circulation.
- Introduced mammalian predators impact nesting birds.
- Human disturbance and habitat needs of endangered species also are wildlife management issues.

Priority conservation actions for this wetland:
- Bolsa Chica currently is protected to provide nesting, feeding, and roosting habitat for aquatic birds, especially listed species, including the Snowy Plover.
- Shorebirds will benefit from a new tidal entrance for the Ecological Reserve and the wetland habitat restoration being undertaken on the oil field (Hays 1985, E. Burres and L. Hays pers. comm.).

c) Santa Ana River Mouth

Wetland habitat description:
Located about half way between Bolsa Chica and Upper Newport Bay. Although fully channelized at the mouth and considerably smaller than the 1,194 ha footprint of historic wetlands, the Santa Ana River, adjacent US Army Corps of Engineers (USACE) mitigation wetlands, and Huntington Beach wetlands contain developing salt marsh, over 24.3 ha of tidal mudflat, and diked wetlands under consideration for restoration to full tidal influence. The USACE mitigation has established a tidal channel, salt marsh, and island nesting habitats. Although much of the Santa Ana River mouth is undeveloped and used for recreation and flood control purposes, oil field operations continue to the northeast.

Max population, all shorebirds combined:
Holds hundreds of shorebirds (L. Hays pers. comm.).

General use by species and season:
The Santa Ana River mouth accommodates a large array of shorebirds much of the year, including the Black-bellied Plover, Semipalmated Plover, Willet, Long-billed Curlew, Marbled Godwit, Western Sandpiper, Least Sandpiper, and Long-billed Dowitcher.

Current ownership:
Ownership includes the CDPR (Huntington State Beach); Orange County; the Cities of Huntington Beach, Costa Mesa, and Newport Beach; and private parties (L. Hays pers. comm.).

Current management:

Conservation needs and issues:

Priority conservation actions for this wetland:
- Acquire and restore tidal flow to at least 40.5 ha of degraded diked wetlands east of the river channel at Santa Ana River mouth.
- Prevent unnecessary grading and removal of channel sediments at Santa Ana River mouth to increase the extent and heterogeneity of mudflats.

D) SAN JOAQUIN MARSH

Wetland habitat description:
Located west of Upper Newport Bay Ecological Reserve and connected to it by a 0.6-mi stretch of San Diego Creek, the 199-ha San Joaquin Marsh includes about 123.4 ha of seasonal ponds, freshwater marsh, and seasonally wet meadows. The San Joaquin Marsh is the largest coastal freshwater marsh in California; Campus Drive effectively splits it into east and west parcels. The University of California owns the 81.7-ha San Joaquin Freshwater Marsh Preserve and Irvine Ranch Water District owns the remainder of the area. Although not managed specifically for shorebirds, drying seasonal ponds provide varying amounts of non-tidal flats, which support hundreds (occasionally thousands) of small and large sandpipers, stilts, and avocets. Seasonal pond and marsh habitats are currently being restored. The flats serve as an important feeding area for shorebirds that commute from Upper Newport Bay, particularly during high tides. Construction of islands within some of the larger pond cells has increased numbers of nesting Black-necked Stilts and American Avocets (L. Hays pers. comm.).

Max population, all shorebirds combined:
Holds hundreds of shorebirds (L. Hays pers. comm.).
General use by species and season:

Current ownership:
Irvine Ranch Water District, University of California, Irvine.

Current management:
University of California, Irvine.

Conservation needs and issues:

Priority conservation actions for this wetland:
- Create additional marsh and pond habitat for shorebirds by restoring flow to currently degraded wetlands at San Joaquin Marsh.
- Manage island vegetation to improve shorebird nesting, foraging, and roosting habitat at San Joaquin Marsh.
- Manage pond water levels to protect shorebird nesting sites and provide shorebird foraging habitat at San Joaquin Marsh.

E) UPPER NEWPORT BAY

Wetland habitat description:
Upper Newport Bay, fed by San Diego Creek and Delhi Channel, consists of nearly 567 ha of open water, salt marsh, freshwater marsh, and tidal mudflat. Upper Newport Bay was heavily used for salt extraction until the salt works were destroyed by San Diego Creek floodwaters. Marinas have been constructed, and now the bay is used intensively for motor boating, camping, and kayaking. Managed as a mix of marsh, mudflat, and open water for migrating and wintering shorebirds and other aquatic species.

Max population, all shorebirds combined:
Holds up to 14,800 shorebirds in winter; a potential WHSRN site of Regional Importance.

General use by species and season:
Thousands of shorebirds forage on the mudflats much of the year. Willets, Long-billed Curlews, and Marbled Godwits also feed in the salt marsh. Many species forage in the freshwater marsh. Black-necked Stilt and American Avocet nest there.

Current ownership:
The State Lands Commission owns the 295-ha Upper Newport Bay Ecological Reserve.

Current management:

Managed cooperatively by CDFG and Orange County.

Conservation needs and issues:

- Accelerated sedimentation and reduced tidal circulation from watershed development.
- Degraded water quality.
- Invasion of salt marsh by pampas grass, and introduction of non-native invertebrates into the benthos.
- Risk of further habitat alteration from development..
- Disturbance from human recreation (E. Burres and L. Hays pers. comm.).

Priority conservation actions for this wetland:

- Remove fill from Shellmaker Island and other locations in Upper Newport Bay to increase intertidal habitat.
- Restrict boat and kayak traffic from areas used heavily by foraging and roosting shorebirds at Upper Newport Bay.
- Maintain closures and increase predator control in shorebird nesting areas in the northeastern part of the Ecological Reserve at Upper Newport Bay.
- Reduce the need for frequent dredging projects at Upper Newport Bay.
- Install silt traps in the creek above Michelson Drive to avoid shorebird habitat loss at San Diego Creek mouth, Upper Newport Bay.

12) SAN DIEGO COUNTY

A) SANTA MARGARITA RIVER MOUTH

Wetland habitat description:

The estuary is located at the mouth of the Santa Margarita River, the longest free flowing river in coastal southern California. The estuary covers about 108.5 ha west of Interstate 5, 1.6 km north of the City of Oceanside. It includes 38.4 ha of salt marsh, 14.2 ha of open water, 2.8 ha of mudflat, 2.4 ha of brackish marsh, and 50.6 ha of salt flat. To the north is the Camp Pendleton Marine Corps Base military training facility. Additional areas to the north of the estuary are leased for agriculture. The river mouth is open to the sea for extended periods, depending on rainfall and tides. Tidal influence is constrained by the rock jetties of the I-5 and railroad crossings. In 1965 the river channel was dredged deeper for waterfowl, and in 1971 the brackish marsh on the north side of the estuary was dredged to make a salt marsh (Marcus and Kondolf 1989).

Max population, all shorebirds combined:

Holds up to 1,600 shorebirds in fall and hundreds in winter and spring.

General use by species and season:
The beach and salt flats are an important nesting area for the Snowy Plover (A. Powell pers. comm.) and a foraging and roosting area for many other species of shorebirds (PRBO unpubl. data). The USMC protects nesting California Least Terns by erecting large enclosures, within which some Snowy Plovers also nest. The US Marine Corps at Camp Pendleton dredged in 1971 to convert the brackish marsh along the north side of the estuary to salt marsh, and created a 0.4-ha least tern nesting island in 1983.

Current ownership:
U. S. Marine Corps (USMC).

Current management:
U. S. Marine Corps (USMC). The California State Coastal Conservancy, in cooperation with Riverside and San Diego Counties, is developing an integrated watershed management plan for the Santa Margarita River watershed. EPA will coordinate Superfund activities (including an ecological assessment and remediation of Superfund sites along the Santa Margarita River). Riverside and San Diego Counties have recently initiated a planning effort for the Santa Margarita River, with the assistance of the National Park Service's Rivers, Trails, and Conservation Assistance program.

Conservation needs and issues:
- Invasive exotic vegetation in the upper watershed modifies river hydrology and increases sedimentation (US Fish and Wildlife Service 1988).
- Water quality issues include: nutrient runoff from orchards, waste and storm water discharges, and hazardous waste sites along the river.
- Loss of wetland and associated riparian habitat, flooding, and development pressures reduce habitat quality and availability.

Priority conservation actions for this wetland:
- Nest enclosures California Least Terns and Snowy Plovers.

B) AGUA HEDIONDA LAGOON

Wetland habitat description:
The 161.9-ha Agua Hedionda Lagoon has been fully tidal since it was dredged and its mouth stabilized with jetties in 1954 (Marcus and Kondolf 1989). While tidally well flushed, there is relatively little tidal mudflat (L. Hays pers. comm.). Historically it held a great deal more salt marsh than it does today (Marcus and Kondolf 1989). Roads

separate Agua Hedionda Lagoon into three regions. San Diego Gas and Electric owns most of the lagoon, part of which serves as a deepwater reservoir for cooling water for a power plant. The eastern basin, operated by the City of Carlsbad for recreational boating, contains a marina. Eighty-one hectares of the eastern end are managed by CDFG as an Ecological Reserve.

Max population, all shorebirds combined:
Holds hundreds of shorebirds.

General use by species and season:

Current ownership:
San Diego Gas and Electric.

Current management:
City of Carlsbad manages the marina for recreational boating; CDFG manages 81–ha Ecological Reserve.

Conservation needs and issues:

- Large sediment inflows from agricultural land around the lagoon are a management problem (Marcus and Kondolf 1989).

Priority conservation actions for this wetland:

c) Batiquitos Lagoon

Wetland habitat description:
Roads and a railway bisect Batiquitos Lagoon's 242.8 ha. Historically fully tidal, excessive sedimentation reduced the tidal prism to a fraction of its former size and the lagoon rarely opened to tidal influence after the 1940s (Marcus and Kondolf 1989). It was dredged and reopened to tidal influence in 1996 and now has extensive tidal mudflat and high tide roosting areas available to shorebirds (L. Hays pers. comm.).

Max population, all shorebirds combined:
Holds up to 1,000 to 2,000 shorebirds at all seasons.

General use by species and season:

Current ownership:

The State Lands Commission and CDFG.

Current management:
The State Lands Commission and CDFG manage the eastern and middle basins as an Ecological Reserve.

Conservation needs and issues:
- The lagoon has been impacted from historic habitat loss and is at risk to further degradation from future development.
- It also is subject to accelerated rates of filling, reduced tidal circulation, poor water quality, detrimental agricultural practices in the watershed, non-native invertebrates in the benthos, and invasive plant species (T. Dillingham pers. comm.).
- Excessive rates of nest predation by introduced and native predators and human disturbance are management issues.

Priority conservation actions for this wetland:
- Thirteen hectares are actively managed as nesting habitat for the California Least Tern and Snowy Plover.
- There is an erosion control plan for the watershed.
- Shorebirds will benefit by maintaining the lagoon opening to the ocean and limiting sediment input from the watershed (T. Dillingham pers. comm.).

D) SAN ELIJO LAGOON
Wetland habitat description:
Historically, the 214.5-ha San Elijo Lagoon was fully tidal, but from 1880 to1940 roads, a railway, duck ponds, and sewage ponds were constructed, causing it to become a brackish shallow-water estuary and rarely experience tidal flows (Marcus and Kondolf 1989). Currently an endowment enables maintenance of the lagoon mouth and restoration of tidal influence (L. Hays pers. comm.). Extensive areas of tidal mudflat have been revived. The lagoon has a 19,943 ha watershed with two main tributaries, Escondido Creek and Orilla Creek. San Elijo Reserve covers approximately 364 ha. In recent years county, state, US Fish and Wildlife Service, and the San Elijo Lagoon Conservancy have periodically dredged open the inlet, allowing tidal exchange.

Max population, all shorebirds combined:
Holds up to 3,500 shorebirds in fall and 1,500 in spring.
General use by species and season:

Current ownership:

CDFG, San Diego County, San Elijo Foundation, and private owners.

Current management:
CDFG manages the eastern and middle basins as an Ecological Reserve (King et al. 1987, Marcus and Kondolf 1989). Four hectares of the Ecological Reserve are actively managed for waterfowl, shorebirds, and endangered species. The San Elijo Lagoon Conservancy, through a Memorandum of Understanding with the County of San Diego, manages water levels in the lagoon.

Conservation needs and issues:
- The lagoon has been impacted by historic habitat loss and is at risk to further degradation from future development.
- It also is subject to accelerated rates of filling, reduced tidal circulation, poor water quality, detrimental agricultural practices in the watershed, and invasive plant species.
- Important management issues are excessive rates of nest predation by introduced and native predators, human disturbance, and mosquito abatement practices.

Priority conservation actions for this wetland:
- Shorebirds would benefit from improved tidal circulation achieved through restoration projects (T. Dillingham pers. comm.).

E) SAN DIEGUITO LAGOON
Wetland habitat description:
Historically, San Dieguito Lagoon was fully tidal and the largest of San Diego County's six lagoons but has been reduced from probably 405 to 120 ha. Between 1905 and 1970 the marsh was filled for roads, a racetrack, a fair grounds, a shopping center, and a military airfield; much of the San Dieguito River, which flowed into the lagoon, was impounded. Treated wastewater was dumped in the lagoon for 20 years. By the 1940s the lagoon mouth closed most years, but in 1983 tidal action was restored to 28 ha. Although San Dieguito Lagoon is mostly privately owned, CDFG owns and manages 43 ha of restored wetland as an Ecological Reserve and the City of San Diego owns a 8-ha abandoned sewage treatment pond and 12 ha of wetlands (Marcus and Kondolf 1989).

Max population, all shorebirds combined:
Holds hundreds of shorebirds.
General use by species and season:

Current ownership:

Private landowners, CDFG, City of San Diego

Current management:
CDFG - Four hectares of the Ecological Reserve are managed for nesting California Least Terns and Snowy Plovers.

Conservation needs and issues:
- The Ecological Reserve is impacted by accelerated rates of sedimentation, reduced tidal circulation, and excessive nest predation by introduced and native predators.
- Human disturbance.

Priority conservation actions for this wetland:
- The managed site is inadequate and should be relocated (T. Dillingham pers. comm.).
- Shorebirds could benefit from multi-agency actions to increase the amount of wetland habitat around the reserve.
- A project to restore an additional 55 ha to regular tidal influence and create tidal mud flats is imminent (T. Dillingham and L. Hays pers. comm.).

F) LOS PENASQUITOS LAGOON

Wetland habitat description:
The 255-ha Los Penasquitos Lagoon is fed by Los Penasquitos Creek, which flows nearly year-round due to development in the watershed. The lagoon is bisected by levees supporting a major railway and highway, which severely limit tidal flow and allow creek waters to accumulate in the lagoon. Currently, the lagoon mouth is mechanically opened twice a year to keep it open to tidal flushing. Little tidal mudflat or unvegetated habitat remains.

Max population, all shorebirds combined:
Holds hundreds of shorebirds.

Current Ownership:
State of California and the San Diego Gas and Electric Company.

Current Management:
The portion owned by the State of California has been designated as a natural preserve within the Torrey Pines State Reserve, under the administration of the State Department of Parks and Recreation. In 1985, the Los Peñasquitos Lagoon Foundation and the State Coastal Conservancy published the Los Peñasquitos Lagoon Enhancement

Plan to alleviate environmental degradation of the lagoon and plan for restoring and enhancing the environmental qualities of the lagoon.

Conservation needs and issues:

- Water quality is affected by urban runoff, groundwater contamination, and sedimentation.
- Groundwater contamination from commercial and industrial wastes such as petroleum products, pesticides, and heavy metals.
- High sediment loads, due to agricultural and urban development in the watershed and erosion caused by replacement of native plants by exotics, are converting salt marsh vegetation to upland habitat.
- Year–round flows from sewage treatment facilities discharge nitrate and phosphate nutrients, promoting eutrophication of the lagoon (LPLF & SCC, 1985).
- Human activities, including recreational use, refuse dumping, illegal off-road vehicular and pedestrian access.

Priority conservation actions for this wetland:

- Continue public pressure to periodically breach the lagoon entrance.

G) MISSION BAY/SAN DIEGO FLOOD CONTROL CHANNEL

Wetland habitat description:

This 1,862-ha area was once a deep-water embayment. After the USACE diverted the San Diego River from San Diego Bay to Mission Bay, sediment began to rapidly fill False Bay (part of Mission Bay) making it very shallow by the turn of the century. Mission Bay was then dredged to create a park complex of islands and is now used primarily as a recreation area. Extensive tidal beaches now surround Mission Bay, and large expanses of mudflat occur at the edge of the Northern Wildlife Preserve, which includes the 6.5-ha Kendall Frost Marsh Reserve. This preserve and the 15-ha Famosa Slough contain the only remnants of native marsh.

Max population, all shorebirds combined:

Holds up to 5,000 to 6,000 shorebirds.

General use by species and season:

Current ownership:

Most of area is owned by the City of San Diego, but the University of California Natural Land and Water Reserve System owns Kendall Frost Marsh Reserve (Marcus and Kondolf 1989) and the City of San Diego owns the remainder of Mission Bay Park, the Flood Control Channel, and Famosa Slough.

Current management:
The a Mission Bay Park Natural Resource Management Plan (1990) addresses measures to protect natural resources in Mission Bay Park, including the Flood Control Channel. Famosa Slough has an Enhancement Plan that was approved in 1993 which provides a framework to enhance the degraded habitat found along Famosa Channel and Slough.

Conservation needs and issues:
- Tributary streams carry in urban pollutants, and sewage lines occasionally back up into the bay (Marcus and Kondolf 1989).
- Mission Bay has been subject to historic habitat loss, the spread of non-native plants, nest predation by introduced mammals, and the introduction of non-native invertebrates into the benthic invertebrate community.
- Key management issues are disturbance from human recreation, needs of endangered species, and, at Famosa Slough, poor water quality and reduced tidal circulation.

Priority conservation actions for this wetland:
- At Famosa Slough, tidal restoration projects are proceeding.
- Shorebirds would benefit from a trail system with educational signs to reduce disturbance (L. Hays and R. Stribley pers. comm.).

H) SAN DIEGO BAY

Wetland habitat description:
San Diego Bay consists of 4,504 ha of subtidal and intertidal habitat and 567 ha of salt ponds (M. Mailander pers. comm.). Less than half of the mud flats that surrounded the bay in 1850 remain (310 ha). After the San Diego River was diverted, the large marsh at the river delta was filled and developed by the City of San Diego. The bay has been dredged to fill tidelands, to widen beaches along Silver Strand, and to create military and domestic ports. The dredged area is much deeper and narrower than 150 years ago. Only the south bay contains significant areas of marsh, mudflat, and salt ponds (Marcus and Kondolf 1989). Also, see County of San Diego Environmental Task Force (1970) for more information on tidal wetlands of San Diego.

Max population, all shorebirds combined:

Holds up to 18,000 shorebirds in fall, 11,000 in winter, and 13,000 in spring; recognized as a WHSRN site of Regional Importance. See also Terp (1998).

General use by species and season:
Tidal mudflats are the main shorebird feeding area; the salt ponds provide additional feeding and roosting habitat (Terp 1998). Sweetwater Marsh consists of salt and brackish marsh, salt pannes, mudflats, fill, and upland and supports breeding Snowy Plovers and many species of migrating and wintering shorebirds (B. Collins pers. comm.).

Current ownership:
US Navy, San Diego Unified Port District (SDUPD), multiple private owners, administers 37% of the bay (includes both submerged and historic tidelands), the State Lands Commission retains ownership of 42%, and the military controls almost 20% (Marcus and Kondolf 1989). Over half the salt ponds are privately owned; the State Lands Commission owns the remainder. The USFWS owns and manages the entire 127-ha Sweetwater/Paradise Marsh complex and manages the salt works as part of the national wildlife refuge system (B. Collins pers. comm.).

Current management:
The SDUPD manages the Emory Cove Reserve (3.4 ha), Chula Vista Wildlife Reserve (29 ha), and D Street Fill (5.3-8 ha). The latter are is managed jointly with the USFWS, principally for nesting California Least Terns and Snowy Plovers.

Conservation needs and issues:

Priority conservation actions for this wetland:
- Maintain salt pond habitat for migrating phalaropes and nesting Snowy Plovers at San Diego Bay.
- At Chula Vista Wildlife Reserve, the primary management goal is to preserve the 5.7 ha of subtidal habitat, 14 ha of mudflat, 4.5 ha of salt flat, and 4.9 ha of sand and dune substrate for the long-term benefit of migrating and wintering shorebirds and for nesting Snowy Plovers.
- SDUPD and the US Navy currently are developing a bay-wide management plan (M. Mailander pers. comm.).

I) TIJUANA RIVER ESTUARY

Wetland habitat description:

Since 1852 the Tijuana River Estuary has lost 80% of its tidal prism and 101 ha of the southern arm to sedimentation and agricultural reclamation. Apartments have been erected on most of the northern dunes. In 1983 the mouth closed and had to be dredged; now it is susceptible to periodic closure (Marcus and Kondolf 1989). Today the approximately 534-ha Tijuana River Estuary is included within the 1,024-ha NOAA Tijuana River National Estuarine Research Reserve consisting of tidally flushed wetland, riparian habitat, and upland.

Max population, all shorebirds combined:

Holds up to 1,000 to 2,000 shorebirds at all seasons.

General use by species and season:

Besides supporting thousands of migrating and wintering shorebirds, the Tijuana River Estuary is a nesting area for the Snowy Plover, Black-necked Stilt, and American Avocet.

Current ownership:

Current management:

The area is owned and managed cooperatively by the CDPR (Border Field State Park), USFWS (Tijuana Slough National Wildlife Refuge), City and County of San Diego, and US Navy (B. Collins pers. comm.).

Conservation needs and issues:

- Management issues are accelerated sedimentation, reduced tidal circulation, exotic plants, introduced benthic invertebrates, clutch predation of nesting shorebirds by native and non-native predators, and human disturbance.

Priority conservation actions for this wetland:

- USFWS manages for nesting Snowy Plovers and California Least Terns through closed areas and predator control.
- Projects to improve tidal circulation have been recently completed or are planned for the near future.
- The USFWS annually works on dune stabilization north of the river mouth to protect Oneonta Slough from sand deposition.
- USFWS projects in the planning stage include dune restoration south of the river mouth (including exotic vegetation removal) and a sediment control project in the Goat Canyon watershed (B. Collins pers. comm.).

Appendix C. Agencies, partnerships, and organizations responsible for habitat planning on the Northern California Coast

California Coastal Conservancy – a state regulatory agency that also administers programs to improve the natural resources along the entire coastline.

California Department of Fish and Game – the primary agency managing wildlife on state lands; particularly active on the north coast at Lake Talawa, Humboldt Bay, and Tomales Bay.

California Department of Parks and Recreation – manages many of the sand beaches along the northern California coastline.

Golden Gate Biosphere Reserve – a collaborative effort of various agencies, including those with management interests at Point Reyes wetlands.

Golden Gate National Recreation Area – has management responsibilities at Bolinas Lagoon.

Humboldt Bay Harbor District – a group that proposes to balance conservation and development of bay habitats.

Humboldt Bay Management Group – focuses on management issues within Humboldt Bay.

Humboldt County Public Works – County lands on beaches and gravel bars.

Marin County Open Space District – manages resource protection and recreational activities at Bolinas Lagoon.

National Oceanic and Atmospheric Administration – through the Gulf of the Farallones Marine Sanctuary this agency has regulatory responsibilities at Estero Americano, Tomales Bay, Bolinas Lagoon, and adjacent offshore waters.

Sonoma County – manages bay-front parks at Bodega Harbor.

US Fish and Wildlife Service – manages Humboldt Bay National Wildlife Refuge.

US National Park Service – through the Point Reyes National Seashore (PRNS) manages Tomales Bay (in part), Abbotts Lagoon, Drakes Estero, and Limantour Estero. PRNS is facilitating development of a Tomales Bay User Plan with area stakeholders. It would be desirable if this plan would incorporate the recommendations for Tomales Bay included in the shorebird conservation plan.

Various county park departments – manage some coastal beaches.

Appendix D. Agencies, partnerships, and organizations responsible for habitat planning in the San Francisco Bay Area. For a complete list and description of partners, see the San Francisco Bay Joint Venture web site (www.sfbayjv.org).

CALFED – a collaborative effort of state and federal agencies and urban, agricultural, and environmental interest groups to address the environmental and water management problems of the San Francisco Bay-Delta system. CALFED is developing a long-term comprehensive plan for restoring the ecological health of the bay and delta and for improving water management. Within CALFED, the Ecosystem Restoration Program's stated objectives include increasing and improving aquatic and terrestrial habitats, improving the ecological functioning of the bay-delta system, and increasing the ability of the system to support sustainable populations of diverse plant and animal species. CALFED is a source of funding for restoration and enhancement projects, especially in Suisun Bay and North Bay.

California Coastal Conservancy – a state agency that administers programs to improve natural resources along the California coastline. In 1997 the Conservancy initiated its San Francisco Bay Area Conservancy Program in an effort to identify and adopt long-term goals for resource protection and recreation in the nine counties surrounding the bay. The California Coastal Conservancy undertakes acquisition projects and awards grants for restoration projects.

California Department of Fish and Game

California Department of Water Resources – this state agency has developed the Plan of Protection for the Suisun Marsh in recognition of the wildlife values of the managed and tidal marshes.

San Francisco Bay Conservation and Development Commission (BCDC) – BCDC has developed the San Francisco Bay Plan for the conservation of San Francisco Bay waters and the regulation of shoreline development. In 1999, the Commission will commence a five-year process to update the plan. It is expected to use information from the Goals Project for revising its sections on bay habitats and wildlife. BCDC also developed the Suisun Marsh Protection Plan and Act, which the Legislature ratified in 1997. This plan, which has wide support among private landowners and public agencies, decrees that when feasible historic marshes should be returned to either managed or tidal wetland status and that if managed wetlands are not needed for waterfowl hunting they should be restored to tidal marshes.

San Francisco Bay Joint Venture – this public and private partnership was formed in 1996 to promote the acquisition, restoration, and enhancement of bay area wetlands and associated habitats. Operating under the North American Waterfowl Management Plan, this Joint Venture is currently preparing an implementation strategy for habitat acquisition, restoration, and enhancement using the Goals

Project. The Joint Venture has identified about 40 pending or proposed restoration projects that could benefit shorebirds in the bay.

Suisun Resource Conservation District – this agency has been working since the 1960s to encourage private landowners to manage lands more effectively.

US Fish and Wildlife Service – USFWS is aiding conservation of bay habitats through its Recovery Plan for Tidal Marsh Ecosystems of Central and Northern California and the Recovery Plan for the Western Snowy Plover Pacific Coast Population (USFWS 2001). They are also an integral planning partner in the San Francisco Bay Joint Venture.

Black-necked Stilt

Appendix E. Agencies, partnerships, and organizations responsible for habitat planning in the Southern California Coast.

California Coastal Commission – regulatory responsibilities at all sites.
California Department of Fish and Game – Elkhorn Slough, Morro Bay, Bolsa Chica, Upper Newport Bay, Agua Hedionda Lagoon, Batiquitos Lagoon, San Elijo Lagoon, and San Dieguito Lagoon.
California Department of Parks and Recreation – Pacifica Beach, Half Moon Bay beaches, San Gregorio Creek, Pomponia Beach, Pescadero Beach, Gazos Creek, Año Neuvo beaches, Waddell Creek, Baldwin Creek, Seabright Beach, Monterey Bay beaches, Pajaro River mouth, Salinas River mouth, Asilomar Beach, Point Sur Beach, San Simeon Beach, Atascadero Beach, Morro Bay, Pismo Beach, Carpinteria Beach, San Buenaventura Beach, Mandalay Bay to Santa Clara River mouth beach, Malibu Lagoon, Huntington Beach, Santa Ana River mouth, Doheny Beach, Agua Hedionda Lagoon, South Carlsbad Beach, San Elijo Lagoon, Los Penasquitos Lagoon, and Tijuana River Estuary.
City of Carlsbad – Agua Hedionda Lagoon.
Cities of Costa Mesa, Huntington Beach, Newport Beach – Santa Ana River mouth.
City of Del Mar – San Dieguito Lagoon Beach.
City of Hermosa – Hermosa Beach.
City of Morro Bay – Atascadero Beach and Morro Bay.
City of Long Beach – San Gabriel River mouth.
City of Oceanside – San Luis Rey River mouth.
City of Oxnard – Ormond Beach.
City of Pacifica – Pacifica Beach.
City of San Diego – San Dieguito Lagoon, Mission Bay, San Diego Flood Control Channel, Ocean Beach, and Tijuana River Estuary.
City of Santa Monica – Santa Monica Beach.
City of Ventura – San Buenaventura Beach.
Irvine Water District – San Joaquin Marsh.
Los Angeles County – Zuma Beach and Corral Beach.
Los Angeles Department of Water and Power – Los Angeles River mouth.
The Nature Conservancy – Elkhorn Slough, Nipomo Dunes, and Santa Cruz Island beaches.
Orange County – Santa Ana River Mouth, Upper Newport Bay, Crystal Cove Beach, and Salt Creek Beach.
San Diego County – San Elijo Lagoon and Tijuana River Estuary.
San Diego Gas and Electric – Agua Hedionda Lagoon.
San Diego Unified Port District – San Diego Bay.

The San Elijo Foundation – San Elijo Lagoon.
The San Elijo Lagoon Conservancy – San Elijo Lagoon.
Santa Barbara County – Jalama Beach.
Santa Cruz County – Scott Creek Beach.
State Water Control Board – Morro Bay.
State Lands Commission – Upper Newport Bay and San Diego Bay.
US Air Force – Vandenberg Air Force Base beaches, including Santa Ynez River mouth and Jalama Beach.
US Army Corps of Engineers – Los Angeles River Mouth and Santa Ana River mouth.
US Fish and Wildlife Service – Salinas River Mouth, Morro Bay, Anaheim Bay, San Diego Bay, and Tijuana River Estuary.
US Marine Corps – San Onofre Beach, Aliso Creek, French Creek, and Santa Margarita River mouth.
US National Oceanic and Atmospheric Administration – Elkhorn Slough, Morro Bay, and Tijuana River Estuary.
US National Park Service – Ocean Beach and beaches of San Miguel and Santa Rosa islands.
US Navy – Mugu Lagoon, San Nicolas Island, Anaheim Bay, San Diego Bay, and San Clemente Island.
University of California – Devereaux Slough, San Joaquin Marsh, and Mission Bay.
Various private property owners – Tunitas Creek, Gazos Creek, Elkhorn Slough, Monterey Bay beaches, Point Sur Beach, San Carpoforio Creek, Arroyo Hondo Creek, Point Sierra Nevada Beach, Arroyo de la Cruz, Sidneys Lagoon, Piedras Blancas Beach, Arroyo Laguna Creek, Pico Creek, Villa Creek, Toro Creek, Avila Creek, Nipomo Dunes, Hollister Ranch, Hollywood Beach, Ormond Beach, Santa Ana River mouth, Corral Beach, Agua Hedionda Lagoon, San Elijo Lagoon, San Dieguito Lagoon, and Tijuana River Estuary.
Ventura County – beach between Mandalay Bay and Santa Clara River mouth, Hollywood Beach, and Dockweiller Beach.